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Vesicular Neurotransmitters Exocytosis Monitored by Amperometry: Theoretical Quantitative Links Between Experimental Current Spikes Shapes and Intravesicular Structures

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Single-cell amperometry has proven to be a powerful and well-established method for characterizing single vesicular exocytotic events elicited from excitable cells under various experimental conditions. Nevertheless, most of the reported features are descriptive, mostly concerned with the morphological characteristics of the recorded current spikes (maximum current intensities, released charge, rise and fall times, etc.), which are certainly important but do not provide sufficient direct kinetic information on exocytotic mechanisms, especially considering the lack of quantitative models.

Here, continuing our previous efforts to provide rigorous models that rationalize the kinetic structures of commonly encountered spike types (spikes with exponential decay tails and kiss-and-run events), we describe a new theoretical approach that provides a rigorous kinetic modeling of all types of exocytotic events that give rise to current spikes with exponential decay tails. This model is rooted on the physicochemical principle that storing charged molecules at high concentrations inside biological membranes requires that vesicles contain long polyelectrolytic strands whose elementary blocks carry dipoles and an electrical charge opposed to that of the neurotransmitter. A high density storage of neurotransmitters may then occur when mono-ions neurotransmitters serve as counter-ions of the polyelectrolyte and engage favorable dipole-dipole interactions which cooperate to condense the polyelectrolyte strands.

However, unless the vesicles have dimensions of a few nanometers, this cannot lead to a single phase due to entropic reasons. Rather, it is predicted that the matrix must exhibit at least two main phases.

One phase correspond to a highly compacted state (analogous to the compact layer in electrochemistry) in which the neurotransmitter is chelated and not able to diffuse easily. The size of these phases is limited by the increasing entropy accumulated by such tight arrangements so they cannot serve to store all the available transmitters under usual circumstances. They are thus necessarily associated to second phases which are less compact and serve to release the excess of entropy accumulated within the compact phases and may store the rest of the available transmitters. Neurotransmitters are weakly

bound to the polyelectrolyte strands in this domains so they can diffuse easily therein (as occurs in the diffuse layer in electrochemistry) provided that their charge is compensated by incoming ions of equivalent charge or changes in pH. Hence, most of the released neurotransmitter originate from these domains.

The corresponding decrease of neurotransmitter concentration in these less compact ranges may then be compensated by slow neurotransmitter exchanges from the compact domains. When the exchange rate is sufficient this leads to a second exponential release tail, hence to spikes with double-exponential tails.

This matrix structure organized in two-phases and the ensuing kinetic model have been validated theoretically (direct and inverse problems) and its experimental agreement and interest has been established by analyzing amperometric spikes recorded from chromaffin and PC12 cells previously published by some of us.

Acknowledgements

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References

1. R. Dannaoui, R. Hu, L. Hu, Z.Q. Tian, I. Svir, W.H. Huang, C. Amatore, A. Oleinick. *Chem. Sci.,* **15**, 13909 (2024).

Oxidase-Like Rhodium Single-Atom Nanozymes: Performance and Application

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Single-atom nanozymes have received increasing attention due to their unique properties [1]. In recent years, we have designed and have synthesized some rhodium single-atom nanozymes and investigated their applications [2-4]. For example, we have synthesized a single-atom rhodium catalyst to mimic the properties of flavoenzymes. It can dehydrogenate some substrates and catalyzes the reduction of oxygen to hydrogen peroxide with excellent selectivity under mild conditions. We have also synthesized rhodium single-atom nanozymes by mimicking the function of natural glucose oxidase (GOD) for both biometabolism and electrometabolism of glucose oxidation. We have used it to make enzymatic biofuel cell by coupling with a bilirubin oxidase biocathode. The biofuel cell using the rhodium single-atom nanozymes exhibited higher power density than that using GOD.

Acknowledgements

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References

1. Jinxing Chen, Qian Ma, Minghua Li, Daiyong Chao, Liang Huang, Weiwei Wu, Youxing Fang, Shaojun Dong. Glucose-oxidase like catalytic mechanism of noble metal nanozymes. Nat. Commun., 2021, 12, 3375.
2. Jinxing Chen, Qian Ma, Xiliang Zheng, Youxing Fang, Jin Wang, Shaojun Dong. Kinetically restrained oxygen reduction to hydrogen peroxide with nearly 100% selectivity. Nat. Commun., 2022, 13, 2808.
3. Panpan Zhao, Xiaoxuan Sun, Shuai Hao, Yuehan Zhang, Jinxing Chen, He Zhang, Shaojun Dong. Glucose oxidase-like rhodium single-atom nanozymes: a mimic platform for biometabolism and electrometabolism of glucose oxidation at neutral pH. ACS Energy lettters, 2023, 8, 1697.
4. Rui Li, Jinxing Chen, Panpan Zhao, Jianguo Zhao, Chenguang Li, Xiaoxuan Sun, Shaojun Dong, Bioinspired design of rhodium single-atom nanozymes enable a non-poisoning pathway for direct formic acid oxidation in enzymatic biofuel cells. Nano Energy, 2024, 130, 110178.

Bioelectrochemical Devices Based on Different Configurations of Carbon Nanotubes

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Some new approaches for developing nanostructured biomaterials based on functionalized carbon nanotubes, will be briefly described as the compressions of carbon nanotubes, the self-assembly of carbon nanotubes in the form of buckypapers or the creation of hollow electrodes [1,2].

The self-assembly of carbon nanotubes in the form of conductive sheets (buckypapers) was used to generate bioelectrodes. We, thus, reported the modification of carbon nanotubes with both alkyne-modified diazonium salts and alkyne-modified pyrene followed by photo-irradiated thiol-yne click reaction with thiol-modified redox mediators. The resulting carbon nanotubes achieve the mediated bioelectrocatalytic glucose oxidation by adsorbed FAD-glucose dehydrogenase [3]. Recently, the concept of hollow bioelectrodes based on the bonding of two buckypapers was developed to generate a microcavity defined by the thickness of the glue linking the two sheets. These buckypapers are permeable only to water and enzyme substrates but not allow the permeation of enzymes. The electrocatalytic performance of the bilirubin oxidase hollow electrode was described as a function of pH, temperature and the amount of entrapped enzyme [4].

Owing to the complexity of optimizing a multienzyme system, this concept also constitutes an attractive strategy to design and optimize enzyme cascade reactions. Besides the easy modulation of enzyme ratios, we have also demonstrated the possibility of trapping with enzymes a redox mediator, HRP and GOx in a buckypaper microcavity [5].

The effect of the geometry of carbon nanotubes on the structure and hence, properties of buckypaper used as electrode materials was studied in terms of wettability, porosity, and permeation efficiency. It appears that the optimal design of buckypaper electrodes requires careful consideration of pore structure and arrangement to balance redox mediator and enzyme leakage, oxygen diffusion, and enzyme wiring.

Acknowledgements

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References

1. M. Holzinger, P. Buzzetti, S. Cosnier. Sensors and Actuators B, **348,** 130700 (2021).
2. M. Saad, K. Krukiewicz, M. Berthuel, J. Hammond, S. Cosnier. J. Power Sources **642,** 236990 (2025).
3. M. Brachi, F. Giroud, S. Cosnier, A. Le Goff. J. Mater. Chem. A, **11,** 26681-26686 (2023)
4. H. M. Buzzetti A. Berezovska, Y. Nedellec, S. Cosnier, Nanomaterials **12,** 2399-2405 (2022).
5. Jeerapan, Y. Nedellec, S. Cosnier. Nanomaterials **14,** 545 (2024).

Light conversion by combining electrochemiluminescence and photoelectrochemistry at semiconductor surfaces

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Electrochemiluminescence (ECL) is the electrochemical generation of light. It involves an interfacial charge transfer that produces the excited state of a luminophore at an electrode surface. ECL is a powerful technique that is widely employed for immunoassays and clinical diagnosis. On the other hand, photoelectrochemistry at illuminated semiconductors is a field of research that deals with the charge transfer of photogenerated charge carriers at an electrode surface.

The combination of ECL with photoelectrochemistry at illuminated semiconductors is referred to as photoinduced ECL (PECL) and is a growing field of research.[1] PECL results in the conversion of incident photons ($_{exc}$), that are absorbed by the semiconductor photoelectrode to emitted photons ($_{ECL}$), produced by the ECL reaction. Although demonstrated in the seventies, PECL remained unexplored until the last five years, as a result of the considerable progress achieved in semiconductor photoelectrodes and ECL systems.[1] Nowadays, a large variety of PECL systems can be designed by combining photoelectrode materials with ECL luminophores, making it a versatile tool for light conversion.[2] In this talk, we will present the recent developments in PECL and we will show that, by engineering the photoelectrode material and carefully considering the reactivity involved for ECL and its counter-reaction, PECL enables the ultimate concept of all-optical ECL (AO-ECL), i.e., ECL generation at an illuminated monolithic device immersed into the electrolyte solution.[3] Due to the robustness of recently manufactured PECL systems, several applications can already be envisioned for microscopy, elucidation of mechanisms solar conversion mechanisms, bioanalysis, and near-infrared imaging.[4]

References

1. Zhao, Y.; Bouffier, L.; Xu, G.; Loget, G.; Sojic, N., *Chem Sci* 2022, 13, 2528–2550.
2. a) Zhao, Y.; Yu, J.; Xu, G.; Sojic, N.; Loget, G., *J Am Chem Soc* 2019, 141, 13013–13016. b) Yu, J.; Saada, H.; Abdallah, R.; Loget, G.; Sojic, N., *Angew Chem Int Ed* 2020, 59, 15157–15160. c) Zhao, Y.; Descamps, J.; Ababou-Girard, S.; Bergamini, J.-F.; Santinacci, L.; Léger, Y.; Sojic, N.; Loget, G., *Angew Chem Int Ed* 2022, 61, e2022018.
3. a) Zhao, Y.; Descamps, J.; al Hoda Al Bast, N.; Duque, M.; Esteve, J.; Sepulveda, B.; Loget, G.; Sojic, N., *J Am Chem Soc* 2023, 145, 17420–17426. b) Zhao, Y.; Léger, Y.; Descamps, J.; Sojic, N.; Loget, G., *Small* 2024, 2308023.
4. a) Descamps, J.; Zhao, Y.; Le-Pouliquen, J.; Goudeau, B.; Garrigue, P.; Tavernier, K.; Léger, Y.; Loget, G.; Sojic, N. *Chem Commun* 2023, 59, 12262–12265. b) Y. Zhao, J. Descamps, Y. Léger, N. Sojic, G. Loget. *Acc. Chem. Res.*, 2024, 57, 2144.

Nanoelectrochemical measurements of nano vesicular subcompartments and stress granules

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Cellular communication is mediated by nanometer-sized organelles (vesicles, stress granules, exosomes) that are potentially responsible for carrying and releasing signalling molecules. We are developing and applying nanoelectrochemical methods to chemically dissect vesicles, exosomes, and stress granules both dynamically and in fixed samples with spatial discrimination across living cells - the next frontier in cell analysis. The following topics have seen recent progress: 1) methods have been developed to chemically dissect and dynamically determine chemical species at and in nanometer organelles and suborganelles, 2) we have spatially measured and evaluated the chemistry of organelles across cells, 3) nanoelectrochemical approaches have been used to measure exchange of transmitters and metabolites between organelles. Tied together with the discovery that most regular exocytosis is partial, adding a third release mode to kiss n run or full vesicle distention, this opens a window of discovery concerning the structural and dynamical mechanisms of organelles that regulate neural communication.

Real time label free study of biomolecule interactions in neuroscience

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(Bio)catalytic and chemosensitive materials for electrochemical biosensors

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We pioneered direct bioelectrocatalysis (presuming direct electron exchange between the enzyme active site and the electrode) by hydrogenases, the enzymes responsible in nature for oxidation/evolution of molecular hydrogen [1]. Since proteins are dielectrics, to improve efficiency of bioelectrocatalysis the oriented immobilization anchoring the enzymes by their substrate residues has been proposed. Such residues appeared on modified electrodes through electropolymerization of the corresponding precursors. Accordingly, the limiting efficiencies of the enzyme bioelectrocatalysis are achieved [2]. The corresponding hydrogen enzyme electrode under chromatographically pure H_2 achieve *negative* potential *vs* E_r (standard hydrogen electrode based on Pt).

The new group of electroactive polymers – polyazines – has been discovered [3]. The electropolymerized azines (methylene blue, toluidine blue etc.) are characterized by both monomer- and polymer-type redox activities. The highest polymer growth rate is observed in neutral and weak acidic aqueous solutions, while known conducting polymers require extreme pH values. Novel materials serve as unique catalysts. The electropolymerized neutral red allows to observe the NAD^+/NADH equilibrium potential [4], whereas on Pt overvoltage of NADH oxidation exceeds one Volt, and the backward reaction does not occur.

Boronate-functionalized polyaniline increases its conductivity in course of interaction with polyols (saccharides and hydroxy acids), providing in contrast to other affinity-based sensors the oppositely directed response to target analyte distinguishing it from non-specific interactions [5]. The corresponding impedimetric sensor allows lactate detection in human sweat without use of any biological recognition element (enzyme) [6].

For oxidase-based biosensors we discovered ferric hexacyanoferrate [7], as the most advantageous electrocatalyst for hydrogen peroxide reduction. In neutral media favorable for biosensors, the advantages of Prussian Blue modified electrodes over the conventionally used platinum are [8]: (i) 3 orders of magnitude higher activity in H_2O_2 reduction and oxidation, obviously providing the similarly improved sensitivity, and (ii) 3 orders of magnitude higher selectivity in hydrogen peroxide reduction relative to oxygen reduction allowing low-potential H_2O_2 detection, which practically avoids the problem of false-positive results due to reductants. Importantly, that Prussian Blue based electrocatalyst in contrast to platinum is not poisoned by sulfur-containing compounds making it suitable for analysis of undiluted human sweat.

Enzyme immobilization on the top surface of Prussian Blue modified electrodes through novel protocol from water-organic mixtures with the high content of the organic solvent, preserving the highest activity and stability of biomolecules, results in advanced

biosensors, opening a possibility for *noninvasive diagnostics*. Flow-through wearable devices based on continuous analysis of just secreted sweat are suitable for monitoring of hypoxia [9] and diabetes [10]; the latter has shown also for diabetic subjects [11].

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References

1. A.I. Yaropolov, A.A. Karyakin, S.D. Varfolomeyev and I.V. Berezin, *Bioelectrochem. Bioenerg.*, **12**, 267-277 (1984)
2. A.A. Karyakin, S.V. Morozov, O.G. Voronin, N.A. Zorin, E.E. Karyakina, V.N. Fateyev and S. Cosnier, *Angew. Chem. Int. Ed.* **46**, 7244-7246 (2007)
3. A.A. Karyakin, E.E. Karyakina and H.-L. Schmidt, *Electroanalysis* **11**, 149-155 (1999)
4. A.A. Karyakin, Y.N. Ivanova and E.E. Karyakina, *Electrochem. Commun.* **5**, 677-680 (2003).
5. E.A. Andreyev, M.A. Komkova, V.N. Nikitina, N.V. Zaryanov, O.G. Voronin, E.E. Karyakina, A.K. Yatsimirsky and A.A. Karyakin, *Anal. Chem.* **86**, 11690-11695 (2014)
6. N.V. Zaryanov, V.N. Nikitina, E.V. Karpova, E.E. Karyakina and A.A. Karyakin, *Anal. Chem.* **89**, 11198-11202 (2017)
7. A.A. Karyakin, O.V. Gitelmacher and E.E. Karyakina, *Anal. Lett.* **27**, 2861-2869 (1994)
8. A. A. Karyakin, *Curr. Opin. Electrochem.* **5**, 92-98 (2017)
9. M.M. Pribil, G.U. Laptev, E.E. Karyakina and A.A. Karyakin, *Anal. Chem.* **86**, 5215-5219 (2014)
10. E.V. Karpova, E.V. Shcherbacheva, A.A. Galushin, D.V. Vokhmyanina, E.E. Karyakina and A.A. Karyakin, *Anal. Chem.* **91**, 3778−3783 (2019)
11. E.V. Daboss, M.A. Komkova, V.N. Nikitina, E.A. Andreev, D.V. Vokhmyanina and A.A. Karyakin, *Biosensors* **14** 486 (2024)

Intelligent Soft Bioelectronics

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In the era of telehealth and the Internet of Things (IoT), there is an unprecedented demand for remote diagnostic tools capable of monitoring chemical and biological markers anytime, anywhere—ideally through smartphones. To achieve this, sensing devices must be soft and ultra-thin to form "bio-friendly" interfaces with the body's soft biological systems. However, traditional biosensors are typically built with bulky, rigid, and planar electrodes, limiting both their flexibility and electroactive surface area.

We have successfully developed nano-enabled electronic skin materials and sensors that address these limitations.

In this talk, I will present our skin-like sensing devices that form intimate, "soft contacts" with skin, tissues, and organoids, enabling real-time, in-situ health monitoring—even remotely via a smartphone.

References

1. Materials-driven soft wearable bioelectronics for connected healthcare. Shu Gong, Yan Lu, Jialiang Yin, Arie Levin, Wenlong Cheng*. Chemical Review, 2024, 124, 455.
2. Hierarchically resistive skins as specific and multimetric on-throat wearable biosensors. Shu Gong, Xin Zhang, Xuan Anh Nguyen, Qianqian Shi, Fenge Lin, Sunita Chauhan, Zongyuan Ge, Wenlong Cheng*. Nature Nanotechnology, 2023, 18, 889.
3. Gold Nanowire Sponge Electrochemistry for Permeable Wearable Sweat Analysis Comfortably and Wirelessly. ACS Sensors, 2024, 9, 5414.
4. Disruptive, soft, wearable sensors. Yunzhi Ling, Tiance An, Lim Wei Yap, Bowen Zhu, Shu Gong, Wenlong Cheng*. Advanced Materials 2020, 32 (18), 1904664.
5. A soft and ultrasensitive force sensing diaphragm for probing cardiac organoids instantaneously and wirelessly. Quanxia Lyu, Shu Gong, Jarmon G Lees, Jialiang Yin, Lim Wei Yap, Anne M Kong, Qianqian Shi, Runfang Fu, Qiang Zhu, Ash Dyer, Jennifer M Dyson, Shiang Y Lim, Wenlong Cheng*. Nature Communications 2022, 13, 7259.

Stimuli-Responsive Dynamic Electrochemical Systems

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Stimuli-responsive materials find growing interest for diverse applications including sensing, controlled drug release, robotic,s nanotechnology and more. The base-sequence encoded in nucleic acids and the stimuli-triggered reconfiguration of nucleic acids provide an important biopolymer for electrochemical sensing and electrochemically controlled drug release. These will be introduced with several examples:

Cytochrome c (Cyt. c) is a key initiator of capases that activates cell apoptosis. The spatiotemporal detection of Cyt. c in sub-cellular compartments upon apoptosis is important for probing cell viabilities, disease progression and diagnosis. An electrochemical method for detecting Cyt. c at single-cell levels will be introduced. The method is based on a redox-labeled (Methylene Blue) anti-Cyt. c aptamer-functionalized micro-electrode being displaced by Cyt. C[1]. The voltammetric responses of the electrode enable quantitative evaluation of Cyt. c concentrations in various cell compartments, levels of cell apoptosis, and differentiation between breast cancer cells (MCF-7; MDA-MB-231) and epithelial breast cells (MCF-10A).

Bioelectronic devices consisting of pH-responsive DNA-based, glucose oxidase (GOx) and insulin-loaded hydrogels assembled on electrodes for the glucose-regulated electrochemical release of insulin will be introduced. The electrical contacting of hydrogel frameworks towards the GOx-bioelectrocatalyzed oxidation of glucose changes the pH within the hydrogel, resulting in the reconfiguration of the hydrogel matrix (through formation of i-motif units), and accompanying stiffness changes. The glucose-controlled stiffness changes dictate the insulin release capacities of the hydrogel framework and its functions as an “Artificial Pancreas”[2].

A redox-active Fe^{3+}-crosslinked carboxymethyl cellulose hydrogel matrix will be introduced. The hydrogel reveals dissipative stiffness properties driven by chemical reducing agents (ascorbic acid), light or electrochemical input[3]. The dissipative transient-stiffness properties are controlled by transient Fe^{3+}/Fe^{2+} transitions. The transient stiffness properties of the redox-active hydrogel are implemented for controlled load release and soft-robotic applications.

Reference

1 Duan, Z.; Ouyang, Y.; Fu, Y.; Huang, F.; Xia, F.; Willner, I., *Angew. Chem. Int. Ed.,* **62**, e202301476 (2023).
2 Fadeev, M.; Davidson-Rozenfeld, G.; Li, Z.; Willner, I., *ACS Appl. Mater. Interfaces,* **15,** 37011-37025 (2023)**.**
3 Baretta, R.; Davidson-Rozenfeld, G.; Gutkin, V.; Frasconi, M.; Willner, I., *J. Am. Chem. Soc.,* 146, 9957-9966 (2024**).**

Aptomics

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A full understanding of the molecular basis of diseases depends on the development of molecular probes able to recognize disease targets of interest. Until very recently, such tools have been absent from the clinical practice of medicine. The newest molecular probe, and one that holds most promise, is a new class of designer nucleic acids, termed aptamers, which are single-stranded DNA/RNA able to recognize specific targets, such as single proteins and even small molecules. Recently, we applied a simple, fast and reproducible cell-based aptamer selection strategy called Cell-SELEX which uses whole, intact cells as the target for aptamer selection. This selection process then generates multiple aptamers for the specific recognition of biological cells, but without the need for prior knowledge about the signature of target cell-surface molecules. The selected aptamers have dissociation constants in the nanomolar to picomolar range. Thus far, we have selected aptamer probes for many different diseases, and used them to carry out studies at the vanguard of biomedical science, including ultrasensitive detection of tumors, molecular imaging, targeted drug delivery, and, most critically, cancer biomarker discovery. Taken together, these molecular level tools form a solid scientific platform from which to pursue advanced studies in molecular medicine. We will report our most recent progress in this exciting research area, especially in molecular engineering, nanomedicine and molecular elucidation of cancer biomarkers and theranostics.

Spatial Engineering of Single-Atom Fe Adjacent to Cu-Assisted Nanozymes for Biomimetic O_2 Activation

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The precise design of single-atom nanozymes (SAzymes) and understanding of their biocatalytic mechanisms hold great promise in the development of ideal substitutes for natural enzymes. While considerable efforts have been directed towards mimicking partial bio-inspired structures, the integration of heterogeneous SAzymes configurations and homogeneous enzyme-like mechanism remains a major concern and grand challenge. Herein, we employ a comprehensive spatial engineering strategy to fabricate dual-sites SAzymes with atomic Fe active center and adjacent Cu sites (Fe–N4 and Cu–N4). Compared to the planar Fe–Cu dual-atomic sites with two-dimensional (2D) configuration, the vertically stacked Fe–N4 and Cu–N4 geometry (FePc@2D-Cu–N–C) possesses highly optimized scaffolds, favorable substrate affinity, and fast electron transfer process. These unique characteristics of FePc@2D-Cu–N–C SAzyme induces biomimetic O2 activation through a homogenous enzymatic pathway, resembling functional and mechanistic similarity to natural CcO. Furthermore, it presents an appealing alternative of cytochrome P450 3A4 (CYP3A4) for drug metabolism and feasible paradigm for systematic investigation of drug–drug interaction. These findings are expected to deepen the fundamental understanding of atomic-level design in next-generation bio-inspired nanozymes.

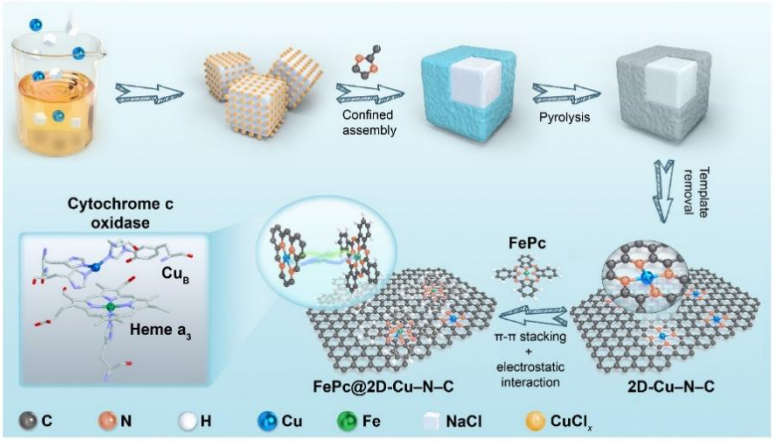


Fig.1 A schematic illustration showing the preparation of 2D-Cu–N–C and FePc@2D-Cu–N–C hybrid.

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References

1. Y. Wang, V. K. Paidi, W. Wang, Y. Wang, G. Jia, T. Yan, X. Cui, S. Cai, J. Zhao, K. S. Lee, L.Y. S. Lee, K.Y. Wong, *Nature Communications*, **15**, 2239 (2024)

Electroanalytical aspects of the lithium-ion battery

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The lithium ion battery has now become the cornerstone of the energy transition with many applications both for moblity and for electricity distribution.

Here, I shall discuss the electrochemical aspects, in particular the redox reactions taking place in a lithium battery.

First, we shall recall the fundamental basis of redox rections in solution theory and recall that the Nersnt equation results from a two-state Fermi Dirac statistics. We shall discuss the HOMO-LUMO misconception[1] regarding the redox stability of the electrolyte solution.

Then, we shall discuss a lithium-ion battery with the eyes of an electro-analytical chemist, and discuss the so-called cathode materials (metal oxide, metal phosphate.) dsitinguising between solid solution material and biphasic materilas[2].

We shall finally discuss graphite as an anode, and question if it is really an anode according to IUPAC. In particular, we shall discuss the potential response fo a graphite electrode as a function of charging.

References

1. P. Peljo and H.H. Girault, *Energy Env. Sci.*, **11** 2306-2309 (2018)
2. P. Peljo, C. Villevieille and H.H. Girault *Energ. Environ. Sci.*, **18,** 1658-1672 (2025)

The Role of Electrocatalysis in Energy Storage and Conversion

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Compared to modern fossil fuel-based industrial refineries, the emerging electrocatalytic refinery (e-refinery) is a more sustainable and environmentally benign strategy to convert renewable feedstocks and energy sources to transportable fuels and value-added chemicals. E-refinery promisingly leads to defossilization and decarbonization of chemical industry. Meanwhile new battery technologies with high energy and power densities provide cost-effective solution for electricity storage. This presentation will focus on our recent progress in mechanism understanding and catalyst innovation for seawater splitting for green hydrogen production by combining atomic-level material engineering, electrochemical evaluation, theoretical computations, and advanced *in situ* characterizations. Moreover, I will also introduce recent research progress on electrocatalysis in metal-sulphur batteries.

References

1. J.X. Gao, et al., *Nat. Energy,* **8**, 264-272 (2023).
2. X.G. Sun, S.Z. Qiao, et al., *Nat. Commun,* **15**, 10351 (2024).
3. H. Li, S.Z. Qiao, et al, *Nat. Nanotech.,* **19**, 792-799 (2024).

Green Electrochemical Transformation of Carbon Dioxide: Challenges and Solutions

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The use of renewable electricity-powered electrocatalytic carbon dioxide reduction reactions to produce chemicals/fuels not only curbs greenhouse gas emissions but also reduces our reliance on the rapidly diminished petroleum resources. Despite remarkable scientific progress, economically viable production of chemicals/fuels via carbon dioxide reduction reactions faces a number of formidable challenges, for instance, directly converting carbon dioxide into high value-added products with least energy input, achieving high operational current density under the limited carbon dioxide solubility in aqueous electrolytes, and the scalable fabrication of highly stable cathodes.

This presentation intends to illustrate pressing practical issues in electrocatalytic carbon dioxide reduction reactions. Several of our recent research findings will be used to exemplify potentially applicable approaches to address practical challenges.

A New Potentiometric Estimate of the pK_a of Acetic Acid in Water Based on the Electrochemical Cell Equipped with Ionic Liquid Salt Bridge

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In the present study, we have found that the pK_a value of acetic acid (HAc) in water at 25 °C is 4.810 ±0.006(95 % C.I.) based on the measurements of the electromotive force of the cell (E_{cell}),

I	II	III	IV	V	VI	
Ag	AgCl	a mol L^{-1} NaCl (W_{ref})	[TBMOEP$^+$][$C_2C_2^-$] (ILSB)	c^0_{HAc} mol L^{-1} HAc, H_2(g) (W_S)	Pt	(I)

,

where [TBMOEP$^+$][$C_2C_2N^-$] stands for an ionic liquid, tributyl(2-methoxyethyl)phosphonium bis(penta-fluoroethanesulphonyl)amide, with varying the concentration of HAc (c^0_{HAc}) from 0.01 to 0.7 mol L^{-1}. Assuming that the phase-boundary potentials on both sides of the ionic liquid salt bridge (ILSB) are cancelled out with each other, E_{cell} is

$$E_{cell} = \frac{RT}{F}\ln \gamma^{V}_{H^+} c^{V}_{H^+} - E_{ref}, \quad \text{where } E_{ref} = E^{\circ}_{AgCl|Ag} - \frac{RT}{F}\ln \gamma^{III}_{Cl^-} c^{III}_{Cl^-}$$

Because the solubility of [TBMOEP+][C2C2N-] in water is as low as 2 x 10-4 mol L-1[1] and the degree of the acidity of HAc is weak, the ionic strength(I) of V remains to be less than 4 x 10-3 mol L-1even at the highest value of c0HAc = 0.7 mol L-1.studied. It is then possible to apply the Debye-Hückel's limiting law to calculate the activity coefficient of H+ in V(γVH+), that is, -log10(γVH+) = 0.5108(I)1/2. Once an aqueous HAc solution is prepared to the concentration of HAc being c0HAc, a certain amount of H+ is released in V by the dissociation of HAc, the degree of which is restricted by the dissociation equilibrium $K_a = (\gamma_{H^+}\gamma_{Ac^-})/\gamma_{HAc} \cdot (c_{H^+}c_{Ac^-})/c_{HAc} = (\gamma_{H^+}\gamma_{Ac^-})/\gamma_{HAc} \cdot K'_a$ If K'a is known, it is straightforward to calculate cH+ for a given value of c0HAc. However, for a given Ka, the value of K'a is an implicit function of I. We solved it iteratively. The dashed lines in Fig.1 are theoretical curves of (RT/F)lnγVH+ vs.(c0HAc)1/2 for seven pKa values, 4.5(topmost), 4.6, 4.7, 4.756, 4.8, 4.9, and 5.0(bottom). Red circles are experimentally obtained mean values from 3 to 5 measurements and the error bars attached indicate the 95 % confidence intervals. It is seen that almost all the red circles are located closer to, and tend to be slightly lower with respect to, the single theoretical curve at pKa = 4.8, having the average value of 4.810 with the 95% confidence interval of ±0.006 as stated above. As pKa is a thermodynamic quantity, it should not depend on the magnitude of c0HAc. The fact that is has been confirmed for the 700-fold change in c0HAc suggests that the assumptions employed are not improper. The

systematic deviation of the experimental data from the line at pKa = 4.756 may be taken as an experimental evidence that the long-lived pKa value of HAc proposed by Harned and Ehlers in 1932[2] be scrutinized.

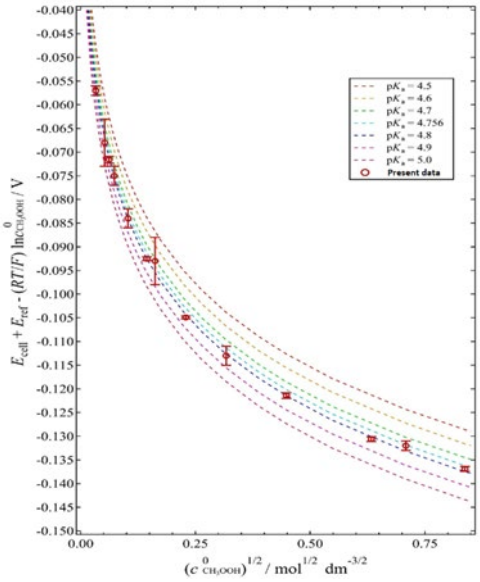


Fig.1 Change of $(RT/F)\ln\gamma_{H^+}^{V}$ with $(c^0_{HAc})^{1/2/}$

References

1. H. Sakaida;.Y. Kitazumi, T. Kakiuchi,. Talanta, 83, 663–666.(2010).
2. H. S. Harned and R. W, Ehlers, J. Am. Chem. Soc., 54, 1350-1357 (1932)

Nanofluidics in High-Density Pore Monolayer Membranes

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The Navier-Stokes (NS) equations, as the cornerstone of classical fluid mechanics, are widely applicable at macroscopic scales. However, when the characteristic dimensions of a fluid approach or fall below the mean free path of molecules, non-classical phenomena such as wall slip, non-equilibrium transport, and rarefied gas effects become prominent, challenging the continuum assumption upon which the NS equations are based. Therefore, investigating fluid transport in confined spaces is of great significance for developing a multiscale fluidic theory. Such research holds the potential to bridge continuum mechanics and non-equilibrium dynamics, ultimately leading to a more universal theory of fluid transport. This study focuses on the precise construction of well-defined nanofluidic model systems and the exploration of confined transport behavior: (1) Using a bottom-up interfacial assembly polymerization strategy, we fabricated ordered monolayer porous membranes and, for the first time, revealed pore–pore coupling effects at ultralow inter-pore distances, along with electric field–flow field coupling in high pore-density systems; (2) Through precise ion complexation within nanoscale channels, we constructed dynamic angstrom-scale hydrapores, uncovering selective transport of monovalent ions governed by hydration layer differences at specific distances, thereby enabling rapid and efficient ion sieving; (3) We constructed solid-state nanopores with diameters of ~0.8 nm, and identified nonlinear ion transport behavior resulting from Coulomb blockade effects, characterized by an "off" state at low voltages and an "on" state at high voltages. These findings provide a theoretical foundation for understanding ion transport mechanisms in biological membranes and contribute to the broader development of nanofluidics and confined transport theory.

References

1. J. Yang†, B. Tu†, G. Zhang, P. Liu, K. Hu, J. Wang, Z. Yan, Z. Huang, M. Fang, J. Hou, Q. Fang, X. Qiu, L. Li*, Z. Tang*, Nat. Nanotechnol., 2022, 17, 622.
2. X. Zhang†, B. Tu†, Z. Cao†, M. Fang, G. Zhang, J. Yang, Y. Ying, Z. Sun, J. Hou, Q. Fang, Z. Tang, L. Li*, J. Am. Chem. Soc., 2023, 145, 17786
3. M. Fang†, Z. Yan†, Y. Ying, C. Hu, X. Xi, G. Zhang, X. Zhang*, X.-C. Chen*, Z. Tang, L. Li*, Nano Letters 2024, 24, 4618

Redox Mediation and the Role of Electrode Material for the Enhancement of Electrogenerated Chemiluminescence

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Recently, Ir(III)-complex-based redox mediators have received significant attention within the ECL community, after the seminal work by Kerr et al.,[1] demonstrating that the addition of tris(2-(2-pyridinyl-kN)-4-sulfonatophenyl-kC)-iridium(III) to a TPrA solution could significantly amplify the ECL signal of $[Ru(bpy)_3]^{2+}$. The underlying electrochemical pathways leading to signal enhancement, either in homogeneous systems or in the case of microbeads-based systems, where then thoroughly investigated, in the latter case especially by exploiting the advantages offered by the ECL-microscope.[2-5] Our studies highlighted that, in view of its rapid oxidation kinetics, the Ir(III) complexes may catalyze the TPrA coreactant oxidation, leading to enhanced emission, especially under conditions where the TPrA anodic kinetics results very slow.

Such is the case, e.g., of boron-doped diamond (BDD), a very attractive alternative to platinum and other materials for its superior mechanical and electrochemical properties which however suffers, in the case of coreactant ECL, of very sluggish TPrA oxidation kinetics.[6] As a matter of fact, the incorporation of an Ir(III) complex as an additive in the coreactant solution, brought about significant enhancements, up to 46-fold, of the ECL intensity, under conditions that are suitable for most biological components.[7] This opens the possibility to promote BDD, already recognized for its superior properties compared to other electrodes (exceptionally wide electrochemical stability window, low capacitive current, remarkable chemical and physical durability, and ease of in situ cleaning[8]), as a reliable platform for commercial ECL-based bioanalysis.

References

1. E. Kerr et al., Chem. Sci., 2022, 13, 469–477.
2. E. Kerr et al., ACS Sens., 2023, 8, 933–939.
3. A. Fracassa et al., Chem. Sci., 2024, 15, 1150–1158.
4. S. Knezevic´ et al., Electrochim. Acta, 2024, 499, 144677.
5. N. S. Adamson et al., Angew. Chem., Int. Ed., 2024, 136, e202412097.
6. K. Sakanoue et al., ACS Sens., 2022, 7, 1145−1155
7. A. Fracassa et al., Chem. Commun., 2025, 61, 3900–3903
8. A. Fiorani et al, Chem. Commun., 2023, 59, 7900–7910.

Electrochemical Biosensors Integrated Organ/Organ-on-a-Chip for Multidimensional Precision Measurement and Evaluation

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Organoids and organ-on-a-chip systems are rapidly evolving technologies designed to construct miniature models of human tissues. These platforms can simulate complex physiological functions and pathological conditions, offering a more realistic environment for disease modeling, drug screening, precision medicine, and regenerative therapies. On April 10, 2025, the FDA released its *Roadmap for Reducing Animal Testing in Preclinical Safety Studies*, systematically outlining a strategic framework to replace traditional animal experiments with "New Approach Methodologies" (NAMs), including organoids and organ-on-a-chip systems. However, global standards for these technologies have yet to be unified, and challenges remain in areas such as microenvironment control, quantitative assessment, and measurement of organoids.

At the measurement technology level, electrochemical sensor integrated organ-on-a-chip systems enable real-time, comprehensive, and high-precision monitoring. This allows for continuous tracking of the cell culture environment, fluid flow dynamics, and biochemical reactions within the chip, achieving multidimensional precision measurements—from microscopic cellular activity to macroscopic chip performance.

We introduce a microelectrode array-based sensor integrated into a microfluidic system. By leveraging cell polarity, the electrochemical activity of cellular secretions, and precise cell manipulation and capture, this system monitors cell and tissue growth, microenvironment regulation, and quantitative analysis of metabolic byproducts. It provides real-time, dynamic measurements of the organ-on-a-chip's operational status. For example, it can track parameters such as culture medium flow rate, temperature, and pH, as well as morphological changes and functional indicators of cells during cultivation. If abnormalities are detected, the system can issue immediate alerts and initiate automated adjustments based on predefined protocols. Emphasizing timeliness and continuity in detection, this system ensures the stability of organ-on-a-chip experiments, promptly identifies and resolves potential issues, and offers reliable technical support for long-term, complex research.

Anticipated Excellence in Chemical Measurement Science

Yong WANG
National Natural Science Foundation of China, China

Fine-Tuning the Optoelectronic and Redox Properties of an Electropolymerized Thiophene Derivative for Highly Selective OECT-Based Zinc Detection

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Organic mixed ionic-electronic conductors (OMIEC) have emerged as pivotal materials in organic bioelectronics, particularly when integrated into organic electrochemical transistors (OECTs). Conducting polymer-based devices have indeed demonstrated their capability to transduce biological signals into amplified output signals, harnessing the high transconductance of OECTs. The OECT operating principle and sensing capability strongly depends on ion-conjugated backbone coupling: the dual nature of OMIECs, i.e. ion-conductor and electron/hole-conductor, presents an intrinsic interface in the bulk of the thin film across which transduction of ionic signals into electronic signals and vice versa occurs. Recent works have shown how selective sodium and potassium detection can be achieved by direct chemical modification of the polymer [1]. Well-adapted substituents with specific features can be easily integrated into the polymer matrix [2]. Such modifications introduce ligands on the polymer chain with affinity for the cations of interest. The present work explores the integration of specifically modified conducting polymers into OECT channels, offering selectivity for zinc cations [3]. Zinc fluxes are crucial in various biological processes, and thus their reliable detection, especially at low concentrations, is an important challenge. By electropolymerizing a thiophene-based trimer, modified with a dipicolylamine (DPA) substituent, we obtain a conducting polymer-based OECT that can selectively detect Zn^{2+} in the 10^{-6} to 10^{-3} mol L^{-1} concentration range in physiological buffers with high selectivity with respect to other competing cations such as Ca^{2+} or Mg^{2+} (Figure 1).

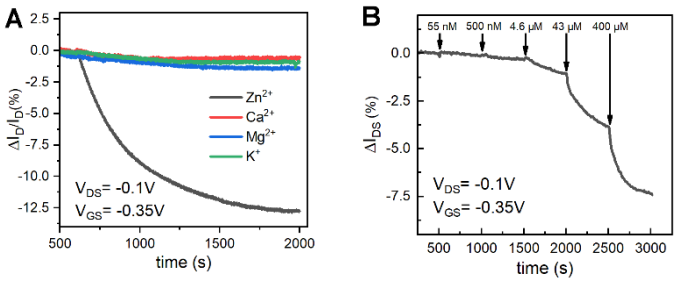


Fig.1 A) Selectivity measurement comparing the normalized current response, ΔI_{DS}, for Zn^{2+}, Mg^{2+}, Ca^{2+}, and K^{+} for 550 µmol L^{-1} (final concentrations) additions. B) Real-time sensitivity measurement for Zn^{2+} concentrations ranging over 5 orders of magnitude.

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References

1. G. Salinas, A. Villarroel Marquez, M. Iidir, S. Shinde, B. A. Frontana-Uribe, M. Raoux, J. Lang, E. Cloutet, A. Kuhn, *ChemElectroChem,* **7,** 2826 (2020)
2. T. Nicolini, B. A. Frontana-Uribe, A. Kuhn, G. Salinas, *ChemElectroChem,* **10**, e202300346 (2024)

T. Nicolini, S. Shinde, R. El-Attar, G. Salinas, D. Thuau, M. Abbas, M. Raoux, J. Lang, E. Cloutet, A. Kuhn, Adv. Mater. Interfaces, ı ı, 2400127 (2024)

Tip-enhanced Raman scattering using a Chemically-modified Tip

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Tip-enhanced Raman scattering (TERS) has recently been a matter of great interest because it provides site-specific information on a nano- to subnano-scale, with spatial resolution beyond the diffraction limit of light (1). TERS can be performed in various environments, such as ambient air, ultrahigh vacuum (UHV), solutions, and electrochemical environments.

We proposed chemically modified tips with various probe molecules to improve the sensitivity, selectivity, and stability of TERS tips during liquid phase measurements (2,3). These tips were employed for nanoscale pH measurement in solutions and chirality discrimination using TERS. Using p-mercaptobenzoic acid (pMBA) and p-aminothiophenol (pATP) molecules attached to the tip, we measured the pH profile near an amino-group-modified surface, revealing a local increase in pH due to water dissociation and an exponential decay with distance (2). This technique may allow to probe pH in biological samples and investigate other solution-based properties using various tip-modifying molecules.

Sukmanee et al. introduced a TERS method for enantiomeric discrimination using a para-mercaptopyridine (pMPY)-coated silver tip (3). The asymmetric electric field at the tip apex, arising from the arrangement of silver atoms, interacts differently with enantiomers, leading to distinct changes in pMPY's Raman spectra. For this reason, even if pMPY is an achiral molecule, different spectra from different enantiomers can be obtained, and then enantiomeric discrimination can be achieved.

References

1. T. Itoh, M. Procházka, Z.-C. Dong, W. Ji, Y. S. Yamamoto, Y. Zhang, and Y. Ozaki; Chem. Rev. 123, 1552-1634 (2023) .
2. P. Pienpinijtham, S. Vantasin, Y. Kitahama, S. Ekgasit, and Y. Ozaki, J. Phys. Chem. C, 120, 14663-14668 (2016) .
3. T. Sukmanee, K. Wongravee, Y. Kitahama, S. Ekgasit, T. Itoh, P. Pienpinijtham, Y. Ozaki; Angew. Chem. Int. Ed. 59, 14564-14569 (2020).

Fluorescent RNA Tools for Molecular Imaging

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RNA functions as the critical intermediary in genetic information flow, bridging genomic DNA to functional proteins while orchestrating extensive regulatory control across diverse physiological processes and pathological pathways. Consequently, the capacity to visualize RNA spatial distribution and temporal dynamics holds profound implications for fundamental life science investigations and translational health research. However, traditional RNA detection methods struggle to achieve real-time dynamic detection of multiple RNA target molecules in live cells. Responding to these challenges, our recent research has engineered a new generation of functional nucleic acid mimics derived through strategic modifications of fluorescent protein chromophores, enabling in situ imaging of RNA in live cells and even in living organisms. On one hand, we developed fluorescent probes with high brightness and near-infrared emission properties targeting the unique secondary structure of G-quadruplexes, successfully achieving imaging of RNA in the genome of live hepatitis C virus in live cells and living organisms. On the other hand, by analyzing and mutating the fluorescent RNA sequences and structures, as well as modifying the fluorescent molecules, we successfully realized orthogonal detection and spatiotemporal-specific detection of multiple genetically encoded RNAs through orthogonal light activation. These findings provide powerful tools for real-time dynamic measurement of RNA in living organisms.

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References

1. Z. Nie*, et al. *Angew. Chem. Int. Ed.*, 2025. 64. e202424060.
2. Z. Nie*, et al. *J. Am. Chem. Soc.*, 2021, 143, 19317-19329.
3. Z. Nie*, et al.. *J. Am. Chem. Soc.*, 2019, 141, 5182-5191.
4. Z. Nie*, et al.. *Chem. Sci.*, 2023, 14, 4538-4548.
5. Z. Nie*, et al.. *Chem. Sci.,* 2023, 14, 14131-14139.

Biomedical Application of Boron-doped Diamond Electrodes

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Boron-doped diamond (BDD) electrodes are very attractive material, because of their wide potential window, low background current, chemical inertness, and mechanical durability.[1] In these years, we have reported several electrochemical applications such as electrochemical organic synthesis,[2] CO_2 reduction,[3] and electrochemical sensor. Here, several examples for biomedical application are reported.[4]

Microsensing system for *in vivo* real time detection of local drug kinetics[4a]

We have developed a microsensing system for *in vivo* real time detection of local drug kinetics and its physiological relevance. The system consists of two different sensors of both BDD microelectrodes with tip diameter ~40 μm and a glass microelectrode. By using the system, we have first tested bumetanide, a diuretic that is ototoxic but applicable to epilepsy treatment.

Real-time Measurement of Antiglaucoma Drugs [4e, 4f]

The primary treatment for glaucoma, the most common cause of intermediate vision impairment, involves administering ocular hypotensive drugs in the form of topical eye drops. Observing real-time changes in the drugs that pass through the cornea and reach the anterior chamber of the eye is crucial for improving and developing safe, reliable, and effective medical treatments. We have developed a measurement method that employs BDD microelectrodes to monitor real-time drug concentrations in the anterior chamber of the eye. We optimized the method for continuous measurement of drugs, and generated calibration curves for each BDD microelectrode using aqueous humor. We successfully demonstrated the continuous monitoring of drug concentrations in the anterior chambers. Furthermore, recently, the pharmacological effect of brimonidine tartrate (BRM), i.e., a reduced intraocular pressure, was observed 30 min after administration, lagging behind drug migration. These findings may provide valuable insights into the ocular pharmacokinetics of novel drugs and facilitate the development of more effective therapeutic approaches.

Molecularly Imprinted Polymer-Modified BDD Electrodes[4g]

We developed an electrochemical sensor using a BDD electrode modified with a molecularly imprinted polymer (MIP) to provide specificity in drug sensing. By the strategy, selective DOX measurement using the MIP–BDD was also possible in human plasma. The MIP–BDD was durable for use in several repeated measurements, and it may be applicable as an electrochemical sensor for application in therapeutic drug monitoring.

References

1. [1] (a) *Bull. Chem. Soc. Jpn.* 91, 1752 (2018). (b) *Acc. Chem. Res*. 55, 24, 3605 (2022). (c) *Chem. Soc. Rev.* 48, 157 (2018). [2] *Angew. Chem. Int. Ed.* 51, 5443 (2012). [3] (a) *Angew. Chem. Int. Ed.* 57, 2639 (2018). (c) *J. Am. Chem. Soc.* 141, 7414 (2019). [4] (a) *Nature Biomed. Eng.* 1, 654 (2017). (b) *Anal. Chem.* 92, 13742 (2020). (c) *Anal. Chem.* 94, 3948 (2022). (d) *ACS Sensors* 8, 4245 (2023). (e) *ACS Sensors* 9, 781 (2024). (f) *ACS Sensors*, in press (2025). (g) *ACS Sensors* 9, 1611 (2024).

The Development and Sensing Application of Antifouling Electrochemical Biosensors Based on Designed Peptides

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Biofouling caused by nonspecific protein adsorption presents a critical challenge for biosensors, significantly compromising their reliability and stability when analyzing real biological samples (e.g., human blood and serum). This limitation severely restricts the practical application of biosensors in complex biological media. Consequently, the development of antifouling biosensors capable of effectively minimizing nonspecific adsorption has become imperative.

Here, an antifouling zwitterionic peptide CPPPP(D-Dap)(D-Dap)(D-Dap)(D-Dap) (CP(DDap)) was designed by adjusting the distance between the adjacent amino and carboxyl groups of the peptide, and it was further employed to fabricate antifouling electrochemical biosensors. Compared with traditional zwitterionic peptides, CP(DDap) exhibited not only superhydrophilicity, but also higher structural rigidity and a smaller dipole moment, enabling it to achieve superior antifouling performance in complex biological media, while its unnatural characteristics endowed it with robust stability against hydrolysis by natural proteinase in biofluids. The CP(DDap)-based biosensor demonstrated high sensitivity for cortisol detection in serum with a remarkably low detection limit of 3.5 pg·mL^{-1}, and it displayed superior antifouling performance in real serum over three weeks. Notably, the assay results obtained by this biosensor in a series of clinical samples are consistent with those obtained using a commercial cortisol assay kit. The strategy of adjusting amino-carboxyl spacing in zwitterionic peptides explored in this study provides a new approach for designing highly efficient antifouling materials, thereby advancing the development of robust biosensors and bioelectronics tailored for practical applications in complex biofluids.

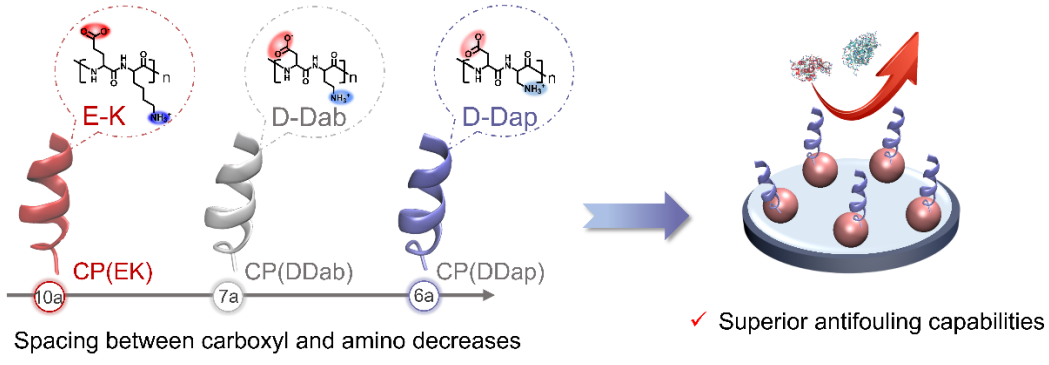


Fig. 1 Diagram of the designed of peptides by adjusting spacing between carboxyl and amino, and the fabrication of the CP(DDap)-based electrochemical biosensor.

Acknowledgements

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References

1. W. Wang, Y. Zhang, B. Zhu, M. Shi, R. Han* and X. Luo*, *Anal. Chem.*, **97**, 7221-7230 (2025)
2. Y. Li, Y. Liu, Y. Zhan, Y. Wang, C. Wang, G. Fan* and X. Luo*, *Anal. Chem.*, **97**, 7343-7351 (2025)
3. R. Han, Y. Li, W. Wang, C. Ding, J. J. Davis* and X. Luo*, *Anal. Chem.*, **96**, 15511-15517 (2024)
4. Y. Li, R. Han, J. Feng, J. Li and X. Luo*, *Anal. Chem.*, **96**, 531-537 (2024)
5. X. Qiao, Z. Qian, W. Sun, C. Zhu, Y. Li and X. Luo*, *Anal. Chem.*, **95**, 11091-11098 (2023)
6. R. Han, Y. Li, M. Shi, C. Ding and X. Luo*, *Anal. Chem.*, **95**, 18540-18548 (2023)
7. R. Han, Y. Li, W. Hou, C. Ding* and X. Luo*, *Anal. Chem.*, **95**, 9025-9033 (2023)

Instrumentation for ECL Analysis

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Light measurements are a significant part of chemical analyses. Instrumentation plays a crucial role in many techniques. Electrogenerated chemiluminescence (ECL) is a light emission phenomenon during solution electrolysis. This is an attractive technique for chemical analysis in many areas, including pharmacy, biology, and medicine. Advantages of this technique include relative simplicity, selectivity, and sensitivity. Different ECL techniques are based on various analytical mechanisms, such as direct and indirect techniques; in any case, light emission relates to the amount of analyte. The sensitivity and limit of detection of analytical reaction are determined by the efficiency and noise level of instrumentation. In this work, we discussed different factors that influence light signal acquisition in measurement instrumentation. Different devices that assisted the realization of ECL techniques are considered, including our design experience.



Fig.1 ORIGEN 1.5 Analizer by Eisai



Fig.2 ORIGEN M-SERIES M8 Analizer



Fig.3 PicoLumi



Fig.4 Sector Imager 6000 Analizer electrophoresis by Meso Scale Discover developed in at the Changchun Institute of Applied Chemistry, Chinese Academy of Sciences



Fig.5 Cobas e 411Analizer by Roche Diagnostics



Fig.6 MPI-A capillary ECL Analizer

The basic concept of ECL analytical instrumentation is a combination of an electrochemical instrument, an optical detector, and a reaction cell. To obtain a satisfactory measurement performance, the light signal acquisition should be synchronized with electrochemical excitation that drives the analytical reaction in a measurement reaction cell. Most of the ECL instrumentation reported in the literature is

still carried out homemade, but commercial instrumentation is also available (Fig.1-6).

Light signal acquisition involves two processes: light collection and sensing. Both processes are connected enough in a design strategy. A light collection can use different systems of reflectors and collimators. Reflectors can be mirrors and diffusion as reflection surfaces work on electrodes frequently. Also, reflection can be more efficient from cell walls. The diffusion type of reflection dominates under mirror reflection for the most part. Transparent construction materials are sufficient for producing windows in reaction chambers. Fabrication of a thin-film electrochemical cell from transparent material is only less efficient, as it reduces the amount of collected light by the optical detector.

ECL has excellent potential as a detection technique and is applicable in FIA, LC, and CE, including microchip CE. Various thin-layer ECL cells have been constructed using various materials, such as Teflon, PMMA, PEEK, glass, and silicon. Nobel metal as well as glassy carbon working electrodes are widely used in constructions, and stainless steel, a common material for counter electrodes, can be interesting as a working electrode or driving electrodes in bipolar electrochemical techniques [1,2]. ECL microchip with CE separation is raising interest due to a number of advantages, which include high performance, portability, short analysis time, disposability, and small consumption of samples and reagents.

Photomultiplier tubes (PMT) are still wider usable photodetectors in ECL analyzers. PMT has the best limit of detection, controllable sensitivity, and big active photodetector area; last one significantly simplifies the light collection process in many solutions. PMTs are used in analog mode to register relatively high light levels. Usually, it considerably reduces electronics to design a trans-impedance amplifier that works as a current-to-voltage convertor. In pulse mode or photon counting mode, it is possible to reach a significantly low level of light emission down to a single photon detection level. The pulses counting mode asks more complex electronics (fig. 7) [3]. The advantages of PMT photon counting mode over analog mode are reimburses spending and the next.

1) The signal-to-noise ratio (SNR) is higher.

2) The operation stability of PMT in the photon counting mode is much better than in the analog mode.

3) The dynamic range of signal registration is wider.

4) The same resolution is in the whole dynamic range with the finest precision.

5) The long-term stability is better.

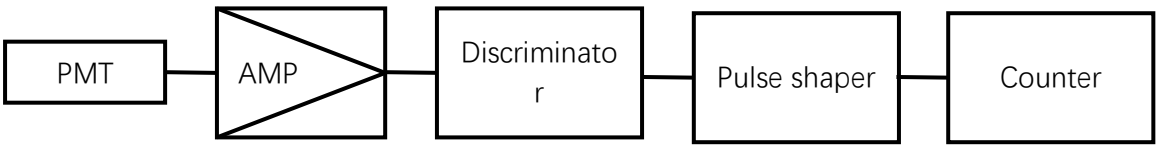


Fig.7 Circuit diagram for photon counting

Many modern potentiostats have external signal acquisition functions that can be adapted to synchronize the recording of ECL signals with electrochemical information [4]. The analog mode of PMT operation can be easily integrated into a measurement system. Signal integrity is an important factor in the integration of an optical detector into a measurement system. The spectral response of a signal should be in the bandwidth of the acquisition system. In another case, additional low-pass filter application is significant [3-4].

ECL intensity measurements are normally used for quantitative analysis. ECL spectral recording is complicated by a weak emission of ECL analytical reaction and is usually used for qualitative analysis of the reaction mechanism [5].

The development of future devices will be gradual. It will focus on using new optical detectors, especially those that allow imaging, which will significantly simplify the work with multiparameter sensors, allowing several tests to be performed simultaneously. At the same time, further work will be carried out to integrate sensitive miniature detectors with new ECL sensors.

Acknowledgements

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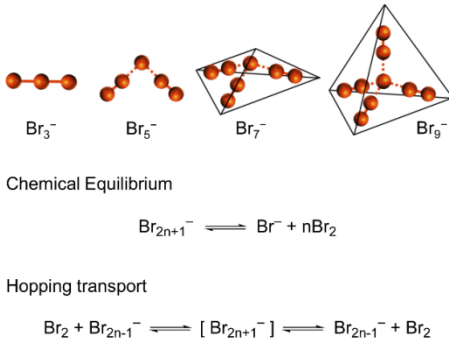
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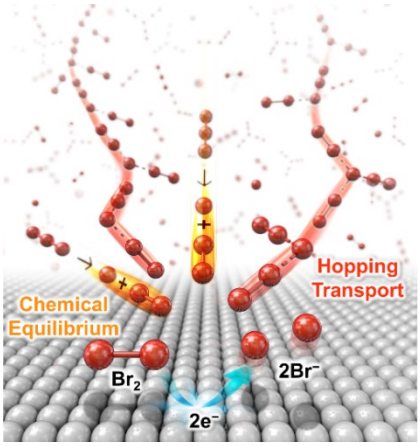
1. F. Yuan, L. Qi, T.H. Fereja, D. Snizhko, Z. Liu, W. Zhang, G. Xu, *Electrochimica Acta,* **262**, 182 – 186 (2018).
2. S.A. Kitte, W. Gao, Y. Zholudov, L. Qi, A. Nsabimana, Z. Liu, G. Xu, *Anal. Chem.*, **89,** 9864 – 9869 (2017).
3. D. Snizhko, A. Bykh, B. Lou, G. Xu, *Przegląd Elektrotechniczny*, **97**, 29-34 (2021).
4. D. Snizhko, G. Bani-Khaled, K. Muzyka, G. Xu, *Przegląd Elektrotechniczny*, **94**, 38-42 (2018).
5. T.H. Fereja, S.A. Kitte, D. Snizhko, L. Qi, A. Nsabimana, Z. Liu, G. Xu, *Anal. and Bioanal. Chem.,* **410**, 6779–6785 (2018).

In Situ monitoring of a Single Polybromide Droplet by Snapshots of Electrochemical Impedance Spectroscopy

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Polybromide-based ionic liquids (ILs) have recently gained attention as energy storage devices because of their dual roles as a solvent and a redox pair. A single droplet of 1-ethyl-1-methylpyrrolidinium polybromide ($MEPBr_{2n+1}$) can be formed electrochemically on the top of ultramicroelectrode and examined in terms of mass transport along the droplet as well as heterogeneous electron transfer. The diffusion coefficient of charge transport in $MEPBr_{2n+1}$ medium is surprisingly high, an order greater than that of proton conduction. In this study, the electrochemical impedance of the bromide redox reaction in the presence of 1-ethyl-1-methylpyrrolidinium bromide (MEPBr), an IL-forming bromine complexing agents (BCAs), was analyzed. Fourier Transform Electrochemical Impedance Spectroscopy (FTEIS) revealed pronounced asymmetry in mass transport impedance between polybromide ionic liquid (PBIL) formation and dissolution, corresponding to charging and discharging phases of zinc bromine battery (ZBB), respectively. Bromide was found to diffuse approximately 10 times faster than bromine or polybromide due to its Grotthuss transport mechanism, whereas polybromide exhibited slower, conventional diffusion—supported by bromide's diffusion coefficient exceeding that of protons in water. During charging, zinc plating on the anode was the limiting factor, as PBIL facilitated bromide transport via Grotthuss shuttling toward the cathode. In contrast, during discharging, PBIL dissolution at the anode became the limiting factor due to the sluggish internal mass transport of polybromide. Dual-plating utilizing IL-forming exhibit enhanced performance by minimizing halogen crossover and enabling high conductivity.





References

1. 1. Kim M.; Park, S.; Chung T. D., Heterogeneous electron transfer reorganization energy at the inner Helmholtz plane in a polybromide redox-active ionic liquid, *Chem. Sci.*, **2022**, *13*(*30*), 8821.
2. 2. Kim M.; Tetteh, E. B.; Savan, A.; Xiao, B.; Ludwig, A.; Schuhmann, W.; Chung T. D.,

Reorganization energy in a polybromide ionic liquid measured by scanning electrochemical cell microscopy, *J. Chem. Phys.*, **2023**, *158*(*13*), 134707.

3. 3. Kim, S. I.; Chung, T. D., In Situ Real-Time Dendritic Growth Determination of Electrodeposits on Ultramicroelectrodes, *Anal. Chem.*, **2024**, *96*(*7*), 3096.

Electrochemical Properties of Highly Concentrated Electrolyte Phases

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Water-in-salt systems, formed from highly concentrated electrolytes, have attracted interest because of their applications in energy storage [1,2]. Many of the more fundamental electrochemical and electroanalytical properties of these unusual phases have not been explored in detail. One interesting property is their tendency to phase segregation, thereby forming aqueous biphasic electrolytes [3,4]. Another very interesting aspect of concentrated electrolytes is their ability to dissolve normally hydrophobic molecules, thus presenting a way to study the electrochemical properties of lipophilic molecules in a pseudo-aqueous environment [5,6]. We present here an overview of our recent work in this area, and point to future applications in analysis.

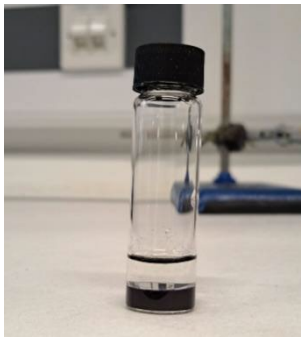


Fig.1 A biphasic electrolyte system, formed from concentrated LiCl(aq) and LiTFSI(aq). The latter phase also contains 1-amino-anthraquinone. TFSI is the bis(trifluoromethanesulfonyl)imide anion.

Acknowledgements

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References:

1. L. Suo, O. Borodin, T. Gao, M. Olguin, J. Ho, X. Fan, C. Luo, C. Wang and K. Xu, *Science,* **350** 938-943 (2015)
2. P. Navalpotro, J. Palma, M. Anderson and R. Marcilla, *Angew. Chem. Int. Ed.* **129**, 12634-12639 (2017)
3. N. Dubouis, C. Park, M. Deschamps, S. Abdelghani-Idrissi, M. Kanduč, A. Colin, M. Salanne, J. Dzubiella, A. Grimaud and B. Rotenberg, *ACS Cent. Sci.* **5** 640-643 (2019)
4. H.O. Wood, H.M. Burnett, R.A.W. Dryfe and P. Carbone, *Faraday Disc.*,**253,** 212-232 (2024)
5. E. Pedraza, C. de la Cruz, A. Mavrandonakis, E. Ventosa, R. Rubio-Presa, R. Sanz, S. Thangavel Senthilkumar, P. Navalpotro, and R. Marcilla, *Adv Energy Mater*. **13** 2301929 (2023)
6. H.M Burnett, H.O. Wood, P. Carbone, A. Elgendy, A. Ejigu and R.A.W. Dryfe, submitted.

High-performance nanozymes: rational design and biomedical applications

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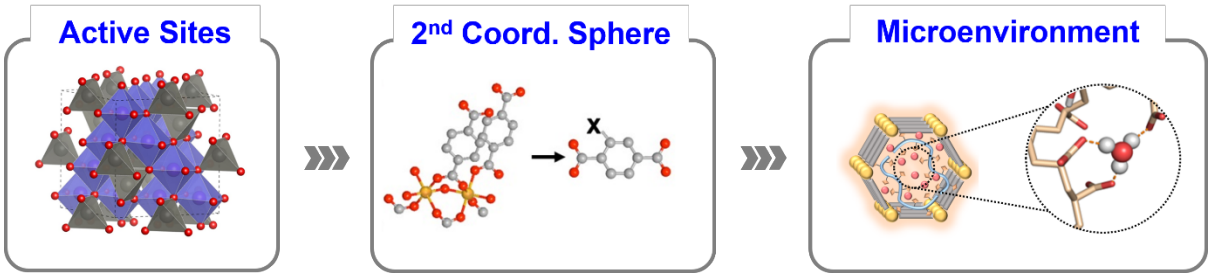
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Abstract

Nanozymes are functional nanomaterials with enzyme-like activities. They are superior to natural enzymes and conventional enzyme mimics in several aspects, including high stability, enduring catalysis, tunable activity, facile engineering, etc. The design of high-performance nanozymes is challenging because of the complicated structures and ambiguous active sites. To this end, we developed several cross-material design rules for guiding the design of high-performance nanozymes. Specifically, we were able to design and tune the active sites, 2nd coordination sphere, and microenvironment of nanozymes, achieving 1-2 orders of magnitude higher activity compared with the reported nanozymes. For example, peroxidase-like nanozyme design rule was developed, which uses e_g orbital occupancy as a predictive descriptor. A volcano relationship peaking at ~1.2 was identified. Notably, $LaNiO_{3-\delta}$ nanozyme exhibits 10-100 times higher activity than previously reported peroxidase-like nanozymes was obtained, demonstrating the effectiveness of volcano relationship. We further explore their biomedical applications, particularly focused on reactive oxygen species-related diseases. For example, a probiotic nanozyme hydrogel was designed to regulate vaginal microenvironment for Candida vaginitis therapy; an orally administered CeO2@montmorillonite nanozyme was designed to target inflammation for inflammatory bowel disease therapy, including Crohn's Disease (CD) and ulcerative Colitis (UC). Our studies demonstrate the promise of nanozymes for precision medicine.

Keywords: nanozymes, enzyme mimics, functional nanomaterials, rational design



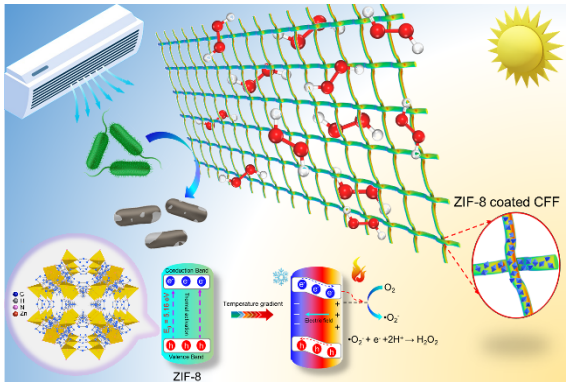
References

1. Wei, H. and Wang, E. *Chem. Soc. Rev.*, **2013**, 42, 6060.
2. Zhang, Y.; et al. *Nat. Rev. Methods Primers*, **2024**, 4, 36.
3. Li, T.; et al. *Nat. Commun.*, **2024**, 15, 10861.
4. Li, S.; et al. *Nat. Commun.*, **2022**, 13, 827.
5. Wang, X.; et al. *Nat. Commun.*, **2019**, 10, 704.
6. Wei, G.; et al. *Sci. Adv.*, **2023**, 9, eadg0949.
7. Liu, Y.; et al. *Sci. Adv.*, **2020**, 6, eabb2695.

Enhanced Hydrogen Peroxide Synthesis and Antibacterial Action via Thermocatalytic Metal-Organic Frameworks

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Reactive oxygen species (ROS) play a crucial role in diverse environmental and healthcare applications due to their high reactivity. While traditional methods such as photocatalysis and piezocatalysis generate ROS, their effectiveness is often hampered by environmental and physical limitations. This research introduces a novel application of metal-organic frameworks (MOFs) as efficient thermocatalysts that leverage slight ambient temperature variations to produce hydrogen peroxide (H_2O_2). Utilizing common daily temperature fluctuations, this approach harnesses a readily available and underexploited energy source for thermocatalytic reactions. In our experimental setup, MOFs are integrated onto carbon fiber fabrics (MOF@CFF) to create a thermocatalytic antibacterial filter. We evaluate the performance of three distinct MOFs—CuBDC, MOF-303, and ZIF-8—against bismuth telluride (Bi_2Te_3), a traditional thermocatalyst, in generating H_2O_2. Notably, ZIF-8 exhibits exceptional efficacy, producing significant H_2O_2 under minimal temperature differentials and achieving up to 96% antibacterial effectiveness through cyclic temperature variations. This investigation not only underscores the potential of MOFs in thermoelectric applications but also opens new interdisciplinary pathways for employing thermoelectric phenomena in catalysis and beyond. The ability to generate H_2O_2 in situ presents substantial opportunities for real-time environmental purification and disinfection, suggesting a promising future for MOFs in sustainable and portable antibacterial applications.



Schematic illustration of the ZIF-8–coated carbon fiber fabric (CFF) system for H_2O_2 generation driven by temperature gradient. The inset shows the ZIF-8 coating on CFF and the proposed mechanism of O_2 reduction to H_2O_2.

Acknowledgements

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References

1. A. Pal†, S. Suresh†, A. Khan, L. H. Kuo, L. T. Chi, A. Ganguly, C.-Y. Kao, M. K. Sharma, T.-S. A. Wang, D.-Y. Kang*, Z.-H. Lin* *Science Advances*, **11**, eads4711 (2025).
2. Y.-J. Lin†, I. Khan†, S. Saha, C.-C. Wu, S. R. Barman, F.-C. Kao, Z.-H. Lin* *Nature Communications*, **12**, 180 (2021) (Editors' Highlights).
3. S. R. Barman, S.-W. Chan, F.-C. Kao, H.-Y. Ho, I. Khan, A. Pal, C.-C. Huang, Z.-H. Lin* *Science Advances*, **9**, eadc8758 (2023).

Aptamer-Enabled Strategies for Sensitive and Versatile Detection of SARS-CoV-2 in Point-of-Care Settings

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Point-of-care (POC) diagnostics demand molecular recognition tools that are sensitive, rapid, and functional in minimally equipped settings. Through in vitro selection and post-selection engineering, we developed high-affinity DNA aptamers targeting the SARS-CoV-2 spike protein and applied them across colorimetric and electrochemical sensing platforms. In colorimetric assays using clinical saliva, we showed improved performance with increasing aptamer affinity—from monomeric to trimeric constructs. A urease-mediated litmus test coupled with rolling circle amplification achieved 83.8% sensitivity and 100% specificity with results visible to the naked eye, while a nanozyme-linked trimeric aptamer assay (trimer-NLAA) using palladium–iridium nanocubes reached 86.7% sensitivity and 100% specificity, outperforming a commercial ELISA kit by 16.7% in sensitivity. These advances build on our previously developed homotrimeric aptamer (TMSA52), designed to complement the trimeric spike protein for ultra-high-affinity binding. In electrochemical sensing, a dimeric aptamer (DSA1NS) enabled impedance-based detection in unprocessed saliva with 80.5% sensitivity and 100% specificity, while a machine learning-assisted kinetic profiling method achieved 100% sensitivity and specificity in clinical classification. Together, these aptamer-enabled strategies provide sensitive, versatile, and accessible platforms for SARS-CoV-2 detection and establish a general framework for future molecular diagnostics in decentralized and resource-limited settings.

Fundamental Studies of Aptamer Selection for Biosensors

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Aptamers are single-stranded nucleic acids that are highly useful for designing biosensors. They were obtained by using a combinatorial selection method called SELEX. Most of the previous aptamer selections were performed using immobilized target molecules and the binding studies often relied on heterogeneous assays or gold nanoparticle based assays. We articulate the importance of homogeneous binding assays. Currently, many some new DNA aptamers were selected using immobilized DNA library and this method is called capture-SELEX. We studied the effect of target concentration in aptamer selection and found that a lower target concentration is more favorable for the selection of aptamers with higher affinities.(1) However, if the target concentration is too low, it may take many rounds to select aptamers or the selection may fail.(2) In addition, a longer incubation time is also favorable. The effect of pH and salt concentration was further studied, and a lower pH led to faster enrichment of aptamers for kanamycin.(3) This research provides fundamental insights into aptamer selections and has led to the generation of many high affinity aptamers for metal ions(4) and small molecules.(5)

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References

1. Ding, Y., and Liu, J. (2023) *Journal of the American Chemical Society* **145,** 7540–47.
2. Ding, Y., Zhang, Z., and Liu, J. (2024) *ChemBioChem* **DOI: 10.1002/cbic.202400570,** e202400570.
3. Zhao, Y., and Liu, J. (2025) *Analysis & Sensing* **n/a,** e202400099.
4. Wang, J., Kaiyum, Y. A., Li, X., Lei, H., Johnson, P. E., and Liu, J. (2025) *Journal of the American Chemical Society* **147,** 1831-39.
5. Gu, L., Ding, Y., Zhou, Y., Zhang, Y., Wang, D., and Liu, J. (2024) *Angewandte Chemie International Edition* **63,** e202314450.

Advanced voltammetric techniques derived from square-wave voltammetry

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This lecture presents the development of innovative electroanalytical techniques aimed at advancing applications in electroanalytical chemistry. Following a review of the fundamental principles of electrochemical experiments and the factors influencing analytical sensitivity, several novel methods are introduced, with a focus on square-wave voltammetry (SWV). Two new variants—double-sampled differential SWV and multi-sampled SWV—are described, both employing a novel current sampling strategy. This methodology is further extended to simplify SWV into a pulse-based chronoamperometric format, yielding square-wave chronoamperometry,a versatile technique that allows multi-frequency and multi-amplitude characterization of electrode processes within a single experiment. Additionally, a new pulse-voltammetric method is proposed, combining features of differential pulse voltammetry and SWV. Theoretical analyses of various electrode mechanisms are conducted using these techniques, enabling the identification of the most suitable method for specific applications based on analytical performance and the ability to rapidly characterize reaction kinetics and mechanisms. Experimental data from model systems are also presented to validate the theoretical findings.

Nanomaterial-Based Electrochemical Sensors and Biosensors for the Detection of Pharmaceuticals and Biomarkers

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C-reactive protein (CRP) is a common biomarker of cardiovascular disease, which is one of the leading causes of premature death worldwide. The determination of CRP from human serum is thus important for the diagnosis of cardiovascular disease. In this talk, we report on developing an electrochemical immunosensor for the detection of CRP antigens, where the CRP antibodies were immobilized on graphene oxide-based nanomaterials. Various electrochemical methods, such as cyclic voltammetry (CV), differential pulse voltammetry (DPV), square wave voltammetry (SWV), and electrochemical impedance spectroscopy (EIS), were employed to assess the performance of the prepared electrochemical immunosensor, showing high selectivity and sensitivity for the efficient detection of the CRP. In addition, the development of advanced nanomaterial-based electrochemical sensors and biosensors for the detection of pharmaceutical compounds has garnered immense attention due to their advantages, such as high sensitivity and selectivity, real-time monitoring, and ease of use. Strategies for the design of high-performance electrochemical sensors and biosensors tailored towards specific pharmaceuticals will be discussed.

Fabrication of Implantable Hydrogel Neural Probes and Their Applications in Brain-Computer Interfaces

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Implantable neural probes show the potential to acquire brain information, modulate neural circuits, and treat various brain disorders. Conventional implantable probes face great challenges for practical applications such as the tradeoff between sensitivity and biocompatibility and the issue of in situ neural information monitoring and neuromodulation. Aiming to these challenges, this study fabricated an implantable hydrogel probe that is capable of recording neural signals, modulating neural circuits, and treating stroke. Amylopectin was incorporated into the hydrogels to generate unique performance for the implantable probes. The amylopectin can induce PEDOT chain reorientation and form compliant interfaces with brain tissues via abundant hydrogen bonds, which leads to high conductivity and transparency promoting both sensitivity and biocompatibility. The hydrogel probe shows the capability of continuously recording brain signals for eight weeks by implanting them into rat brain tissues. The hydrogel probe was successfully used to investigate the deep brain signals of various physiological activities in awake and sleeping conditions and response to tail clamp stimulation and whisker stimulation. In situ, neuromodulation and neural signal monitoring were conducted in the primary motor cortex of rats, and the evoked signals by neuromodulation are capable of controlling rat limb behaviors. Finally, the neuromodulation was applied in the primary motor cortex region of stroke rats, which significantly reduced brain infarct area, promoted synaptic reorganization, and restored locomotion functions and balance ability. This research demonstrates a tremendous scientific advancement in the design concept of neural probes for monitoring brain information, modulating neural circuits, and exploring brain disease therapies.

Keywords: Implantable probes, Conductive hydrogels, Neural signal recording, Neuromodulation, Brain-machine interfaces

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References

1. Yanxia Qin, Hao Zhao, Qi Chang, Yan Liu, Zhen Jing, Dehai Yu, Samuel M. Mugo, Hongda Wang, and Qiang Zhang, Amylopectin-based hydrogel probes for brain-machine interfaces, Adv. Mater. 2025, 37, 2310365.

2. Zhenzhen Shen, Quanduo Liang, Qi Chang, Yan Liu, and Qiang Zhang, Topological Hydrogels for Long-Term Brain Signal Monitoring, Neuromodulation, and Stroke Treatment, Adv. Mater. 2024, 36, 2310365.
3. Yanan Li, Hao Zhao, Guanghong Han, Ze Li, Samuel M. Mugo, Hongda Wang, and Qiang Zhang, Portable Saliva Sensor Based on Dual Recognition Elements for Detection of Caries Pathogenic Bacteria, Anal. Chem. 2024, 96, 9780-9789.

Determining Electrochemiluminescence Reaction Rate Constants in $Ru(bpy)_3^{2+}$/Tri-*n*-propylamine Coreactant System

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Herein, we present our study on ECL transients and kinetic properties of the $Ru(bpy)_3^{2+}$/tri-n-propylamine (TPrA) coreactant system. In 2002, Miao, Choi and Bard well summarized three mechanisms for this system, as shown in Figure 1.[1] The first mechanism involves generating the excited state $Ru(bpy)_3^{2+*}$ through a reaction between $TPrA^{\cdot+}$ and the reduced $Ru(bpy)_3^{+}$ species. In this process, $Ru(bpy)_32^{+}$ is reduced by TPrA· rather than by the working electrode, since the CV scan is only in the anodic direction. The second mechanism generates the excited state $Ru(bpy)_3^{2+*}$ through a reaction between TPrA· and the oxidized $Ru(bpy)_3^{3+}$ species, following the general coreactant mechanism. The third mechanism produces the excited state $Ru(bpy)_3^{2+*}$ through a reaction between the oxidized $Ru(bpy)_3^{3+}$ species and the reduced $Ru(bpy)_3^{+}$ species via the annihilation reaction but in the coreactant system.

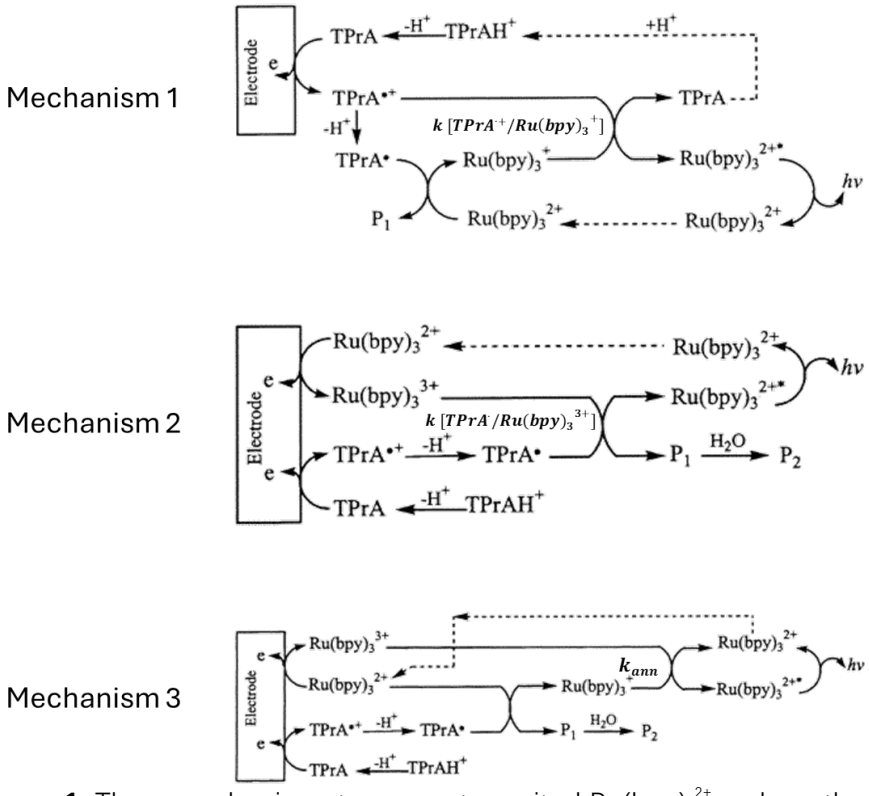


Figure 1. Three mechanisms to generate excited $Ru(bpy)_3^{2+*}$, where the three reaction rate constants are indicated.

We first recorded ECL transients of the first ECL peak using a photon counting head along with fast data acquisition system Stanford Research SR-340,[2] which involves only the first mechanism in the $Ru(bpy)_3^{2+}$/TPrA system. COMSOL simulation transients for this mechanism were overlayed with the experimental one to determine the the rate constant, $\boldsymbol{k\ (TPrA^{\cdot+}/Ru(bpy)_3^{+})}$. We then recorded and simulated the ECL transients for the

second ECL peak, which involves all three mechanisms in **Figure 1**. These allowed us to determine the rate constant for the second mechanism, $\boldsymbol{k}$ ($\boldsymbol{TPrA^{\cdot}/Ru(bpy)_3^{3+}}$), as we already have had the rate constant values for both the first mechanism and the third mechanism (L_{800}). It is anticipated that we will also be able to determine the coreactant rate constant values for other compounds, as described above.

Acknowledgements

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References

1. Miao, W.; Choi, J.-P.; Bard, A. J., Electrogenerated Chemiluminescence 69: The Tris(2,2'-bipyridine)ruthenium(II), $[Ru(bpy)_3]^{2+}$/Tri-n-propylamine (TPrA) System RevisitedA New Route Involving $TPrA^{\bullet+}$ Cation Radicals. *J. Am. Chem. Soc.* **2002,** *124*, 14478-14485.
2. Chu, K.; Adsetts, J. R.; Ma, J.; Zhang, C.; Hesari, M.; Yang, L.; Ding, Z., Physical Strategy to Determine Absolute Electrochemiluminescence Quantum Efficiencies of Coreactant Systems Using a Photon-Counting Photomultiplier Device. *J. Phys. Chem. C* **2021**, *125*, 22274-22282.

Electrochemiluminescence Biosensor Based on an Efficient Antifouling Cell Membrane Hydrogel for the Direct Detection of Alkaline Phosphatase in Human Serum and Cell Lysate

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Electrochemiluminescence (ECL) biosensors are an ideal choice for real-time and sensitive detection of biomarkers. However, there are many interfering biomolecules in human serum or cell lysate that can affect the ECL signal through non-specific interface adsorption.

To solve this issue, an efficient ECL antifouling biosensor based on red blood cell membrane (RBCM) hydrogel was developed for the direct detection of alkaline phosphatase (ALP) in human serum and cell lysate. Among them, RBCM hydrogel was prepared by embedding the purified RBCM vesicles into [1,2-distearoyl-sn-glycerol-3-phosphoethanolamine]-[polyethylene]-[acrylamide] (DSPE-PEG-AM), which endowed the antifouling interface with high stability and biocompatibility. Meanwhile, compared with RBCM, the constructed RBCM hydrogel improved the electron transfer rate of the antifouling interface. Furthermore, luminescent copper nanosheets (Cu NSs) and quencher MnO_2 NSs were encapsulated in RBCM hydrogel, which greatly reduced the distance between Cu NSs and MnO_2 NSs, thereby effectively improving the signal quenching efficiency. In the presence of ALP, L-ascorbic acid 2-phosphate trisodium salt was hydrolyzed to ascorbic acid, thus disrupting the structure of MnO_2 NSs to restore the ECL signal. Based on the above sensing strategies, the constructed ECL biosensor achieved an ultrasensitive detection of ALP with a wide linear range (10^{-5} ~ 10^{4} $U{\cdot}L^{-1}$) and a detection limit as low as 3.4 × 10^{-6} $U{\cdot}L^{-1}$ ($3\delta/k$), demonstrating potential application value in clinical diagnosis.

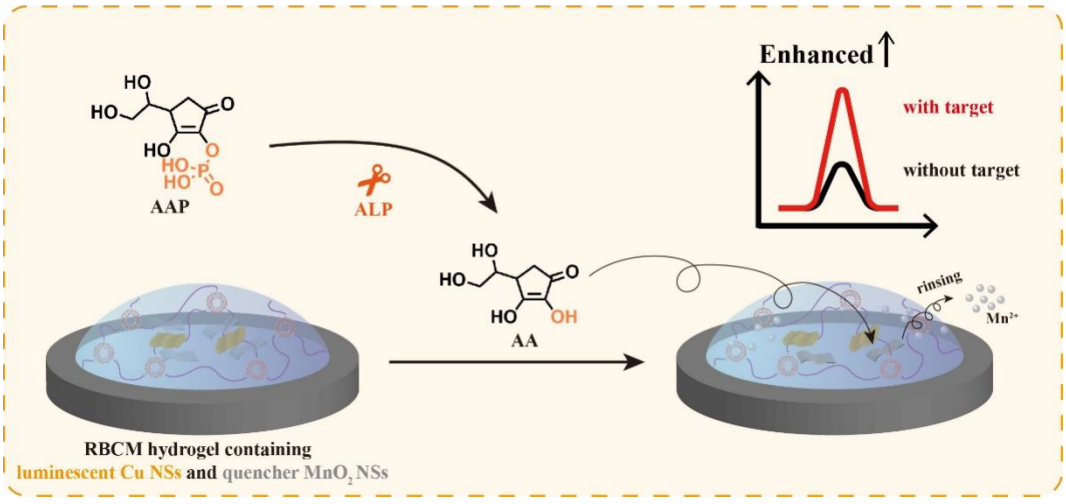


Fig.1 Diagram of the construction process of the biosensor.

Acknowledgements

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References

1. Q. Sun, Z. Ning, E. Yang, F. Yin, G. Wu, Y. Zhang and Y. Shen*, *Angew. Chem. Int. Ed.*, **62**, 202312053 (2023)
2. E. Vargas, F.Zhang, A. Ben Hassine,V. Ruiz-Valdepenas Montiel, R. Mundaca-Uribe, P. Nandhakumar, P. He, Z. Guo, Z. Zhou, Z. Fang, R. Fang, W. Gao, L. Zhang,* and J. Wang*, *J. Am. Chem. Soc.* , **144**, 17700-17708 (2022)
3. F. Wu, Y. Ren, W. Lv, X. Liu, X. Wang, C. Wang, Z. Cao, J. Liu*, J. Wei* and Y. Pang*, *Nat. Commun.* **15**, 802 (2024)

Heterogeneous Electrochemiluminescence in Film-modified Electrodes

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Electrochemiluminescence (ECL) is a non-optically excited luminescence generated by sequential electron transfer electrochemical and recombination processes in solution upon electrolysis. Due to its extreme sensitivity ECL is gaining attention as a powerful analytical tool in biology, medicine, environmental monitoring, etc. This unique technique combines the advantages of electrochemical and chemiluminescent methods of assay and eliminates their main drawbacks [1]. ECL detection of a large number of analytes, including biomolecules and pollutants can be carried out in a solid phase format where analytes/luminophores/recognition elements are immobilized in the film on the electrode surface, i.e. using ECL sensors [2].

Such films can be functionalized with recognition elements (e.g., antibodies, aptamers) to selectively bind target analytes, enhancing assay specificity [1]. Incorporating luminescent species can stabilize luminophores, protect them from degradation, and enhance ECL efficiency by facilitating electron transfer [3]. Nanostructured materials (e.g., carbon nanotubes, graphene nanosheets, metal nanoparticles) or conductive polymers increase electrode surface area and amplify ECL signal, making these systems adaptable for diverse applications [4]. Integration of luminescent species and recognition elements into stable platforms enable portable sensors for point-of-care diagnostics or environmental monitoring, reducing the cost and complexity of the assay [5]. Also, heterogeneous ECL supports multiplexed detection by patterning different luminescent species or recognition elements on electrodes, ideal for high-throughput screening [6]. Studying ECL in film-modified electrodes drives innovation in material design, such as developing luminescent nanomaterials or hybrid films with enhanced ECL properties [4]. Quantum dots or plasmonic nanoparticles can enhance ECL intensity via resonance energy transfer or surface plasmon effects, improving analytical performance of sensors [3]. Hence the study of heterogeneous ECL in film-modified electrodes with incorporated luminescent species is pivotal for analytical sciences, since it enables advanced sensors and imaging platforms for biomedical diagnostics, environmental monitoring, and fundamental research.

In this work we present brief overview of our research in the field of solid-phase ECL, critical analysis of the obtained results and future perspectives in this area. The discussed questions include fundamental studies and applied aspects, the role of films structure and

deposition technology, co-reactants for heterogeneous ECL, the role of ECL reaction kinetics and parameters of electrode polarization program.

In particular the discussed ECL systems include Langmuir-Blodgett films of poly(methyl methacrylate) with rubrene and 9,10-diphenylanthracene fluorophores on ITO substrates. Due to unique features of Langmuir-Blodgett technique (deposition of multiple layers of single molecule thickness with controlled structure) such system facilitates comprehensive study of the role of film thickness and structure in their ECL behavior, allows revealing the details of charge transfer, excited state quenching and excitation energy transfer processes (Fig. 1) [7]. Also we discuss ECL in films of polyvinyl butyral with 9,10-diphenylanthracene luminophore deposited using spin-coating technique on glassy carbon substrates [8]. Such systems are much simpler to produce but with less accurate control of thickness and structure. Special attention is paid to the proper choice of co-reactant. We discuss the use of tetraphenylborate co-reactant for heterogeneous ECL generation. Due to its reaction mechanism and kinetics that determine optimal choice of electrochemical experiment parameters, this co-reactant it is especially suitable for heterogeneous ECL in pulsed mode, where strong signal is observed at nanomolar - micromolar range of tetraphenylborate concentrations (Fig. 2) [8, 9].

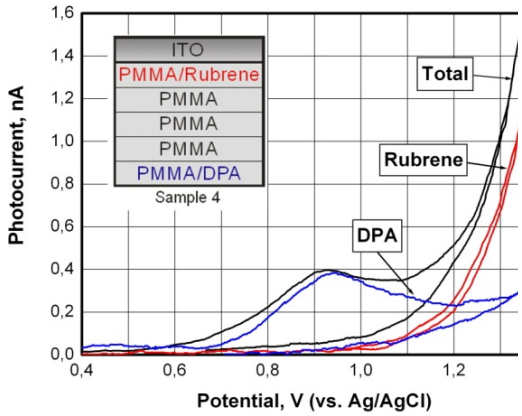


Fig.1 Example of ECL response from composite 5-layer Langmuir-Blodgett film of poly(methyl methacrylate) (PMMA) with rubrene and 9,10-diphenylanthracene (DPA) fluorophores

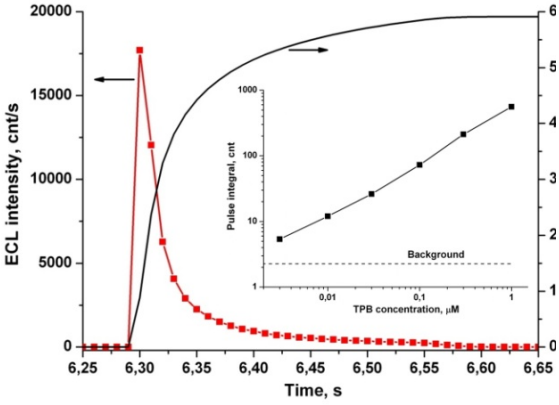


Fig.2 Kinetics of ECL response from polyvinyl butyral/DPA film with tetraphenylborate co-reactant in pulsed excitation mode. Inset: ECL response vs. tetraphenylborate concentration

Acknowledgements

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References

1. W. Miao, *Chem. Rev.*, **108**, 2506-2553 (2008)
2. L. Hu and G. Xu, *Chem. Soc. Rev.*, **39**, 3275-3304 (2010)
3. P. Bertoncello and R. Forster, *Biosens. Bioelectron.*, **24**, 3191-3200 (2009)
4. J. Zhou, X. Lv, J. Jia, Z. Din, S. Cai, J. He, F. Xie, and J. Cai, *Biosensors*, **12**, 1046 (2022)

5. J. Zhang, S. Arbault, N. Sojic, and D. Jiang, *Annu. Rev. Anal. Chem.*, **12**, 275-295 (2019)
6. H. Huang, J. Li, and J.-J. Zhu, *Anal. Methods*, **3**, 33-42 (2011)
7. Y. Zholudov, D. Snizhko, A. Kukoba, H. Bilash, and M. Rozhitskii, *Electrochim. Acta*, **54**, 360-363 (2008)
8. Y. Zholudov and G. Xu, *Analyst*, **143**, 3425-3432 (2018)
9. Y. Zholudov, O. Bilash, A. Kukoba, and M. Rozhitskii, *Analyst*, **136**, 598-604 (2011)

Electrical Catalysis of Forbidden Reactions in Single-Molecule Devices

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Incredible strides have been made in the development of single-molecule electronic systems that possess unique functionality. By combining chemical design with physical modeling and electrical characterization techniques it has become clear that molecules are capable of a wide range of impressive electronic functions that extend far beyond the development of standard devices such as transistors and diodes. But, despite these possibilities, direct electrical characterization of the reactions that drive device function at the single-molecule level remains a difficult challenge. In this talk we will focus specifically on how to characterize electrically-controlled single-molecule reactions by integrating single-molecule Raman Spectroscopy with single-molecule charge transport measurements to simultaneously control and track reactions.

Specifically, we will focus on controlling reactions that are conventionally considered forbidden by molecular orbital symmetry selection rules. Molecular orbital symmetry plays a pivotal role in determining chemical reaction mechanisms. The process of changing chemical reactants into products must transition along a pathway that conserves molecular orbital symmetry to ensure continuity. This principle is so fundamental that reactions that do not conserve symmetry are typically considered "forbidden" due to the high resultant energy barriers. Here, we demonstrate that it is possible to electrically catalyze these forbidden transitions when a single molecule is bound between two electrodes in a nanoscale junction. We induce a cycloaddition reaction in a norbornadiene (NBD) derivative, converting it to quadricyclane (QC) by utilizing nanoconfinement to place the molecule into a configuration that is far from equilibrium and applying a small voltage to the molecular junction. Traditionally, this reaction can only be induced photochemically due to orbital symmetry selection rules. By directly tracking the reaction dynamics *in situ* using single-molecule Raman spectroscopy, we demonstrate that for this reaction to be electrically catalyzed the molecule must be sterically maneuvered into a configuration near the transition state at the peak of the energy barrier prior to applying the voltage needed to successfully induce the forbidden transition. By utilizing single-molecule Raman spectroscopy to track the molecular configuration we are able to directly observe the reaction dynamics and determine the primary mechanisms that enable the reaction.

Regulation of the electrical double layer: Contact-electro-chemistry

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The relationship between charge and chemical reactivity, captured by $\Delta G = -nFE$, links Gibbs free energy, cell potential, and reaction spontaneity. Building on electrochemistry's foundation, our team extended this paradigm to triboelectric charge, exploring how contact electrification (CE)-generated triboelectric charges initiate, modulate, and direct chemical reactions across interfaces. We proposed the concept of contact-electro-chemistry (CE-Chemistry) by regulating electron transfer in the Stern layer of the electrical double layer during dielectric solid-liquid CE, enabling tunable radical generation through selective dielectric and liquid pairing. We mapped triboelectric series to electronegativity and electrochemical potentials, revealing triboelectric charge-driven chemical transformations. CE-induced radicals could drive chemiluminescence, polymerization, and redox reactions solely via mechanical forces or flow electrification, eliminating the need for external power or catalysts. In nonaqueous solutions like DMSO, phenol degradation is 40 times faster than mechanochemistry and 30 times faster than aqueous CE, while luminol oxidation sustains luminescence for 3 months without traditional catalysts. CE-Chemistry is emerging as a versatile, catalyst-free strategy for pollutant degradation, metal reduction, and sustainable chemical synthesis. This proposed perspective will be among the first to highlight CE-induced triboelectric charge at liquid–gas–solid interfaces in interfacial chemical reactions, offering new insights into charge transfer mechanisms across phases and a paradigm for tailoring chemical reactions.

The triboelectric charge from CE readily generates high surface potentials, sometimes leading to gas breakdown and even micro-lightning. CE-driven charge transfer offers valuable insights into natural lightning formation and biological electrical activity etc. However, its role in chemical reactions has been largely overlooked. Recent studies have confirmed that CE between water droplets and gas, as well as water and solid dielectrics, can generate superoxide and hydroxyl radicals. This breakthrough introduces triboelectric charge into chemistry and provides new insights into the origins of life.

References

1. Li, S.; Zhang, Z.; Peng, P.; Li, X.; Wang, Z. L.; Wei, D. A green approach to induce and steer chemical reactions using inert solid dielectrics. Nano Energy 2024, 122: 109286.
2. Wang, Z.; Dong, X.; Tang, W.; Wang, Z. L. Contact-electro-catalysis (CEC). Chem. Soc. Rev. 2024, 53(9): 4349-4373.
3. Berbille, A.; Li, X.-F.; Su, Y.; Li, S.; Zhao, X.; Zhu, L.; Wang, Z. L. Mechanism for Generating H2O2 at Water-Solid Interface by Contact-Electrification. Adv. Mater. 2023, 35(46): 2304387.
4. Zhao, J.; Zhang, X.; Xu, J.; Tang, W.; Lin Wang, Z.; Ru Fan, F. Contact-electro-catalysis for Direct Synthesis of H2O2 under Ambient Conditions. Angew. Chem. Int. Ed. 2023, 62(21): e202300604.
5. Wang, Z.; Berbille, A.; Feng, Y.; Li, S.; Zhu, L.; Tang, W.; Wang, Z. L. Contact-electro-catalysis for the degradation of organic pollutants using pristine dielectric powders. Nat. Commun. 2022, 13(1): 130.

6. Wang, Z.; Dong, X.; Li, X.-F.; Feng, Y.; Li, S.; Tang, W.; Wang, Z. L. A contact-electro-catalysis process for producing reactive oxygen species by ball milling of triboelectric materials. Nat. Commun. 2024, 15(1): 757.
7. Li, H.; Berbille, A.; Zhao, X.; Wang, Z.; Tang, W.; Wang, Z. L. A contact-electro-catalytic cathode recycling method for spent lithium-ion batteries. Nat. Energy 2023, 8(10): 1137-1144.
8. Wang, N.; Jiang, W.; Yang, J.; Feng, H.; Zheng, Y.; Wang, S.; Li, B.; Heng, J. Z. X.; Ong, W. C.; Tan, H. R.; Zhang, Y.-W.; Wang, D.; Ye, E.; Li, Z. Contact-electro-catalytic CO2 reduction from ambient air. Nat. Commun. 2024, 15(1): 5913.
9. Li, S.; Liu, J.; Wang, Z. L.; Wei, D. Mechano-driven chemical reactions. Green Energy & Environment 2024.
10. Xu, C.; Li, S.; Yang, Z.; Willatzen, M.; Lin Wang, Z.; Wei, D. Contact-electro-luminescence triggered by triboelectric charge. Chem. Eng. J. 2024, 501: 157754.
11. Xu, C.; Li, S.; Zhang, Y.; Wang, Z.; Wang, Z. L.; Wei, D. Contact-electro-chemistry Induced by Flow Electrification in Dielectric Tubes. Nano Energy 2025, 134: 110526.
12. Liu, J.; Yang, Z.; Li, S.; Du, Y.; Zhang, Z.; Shao, J.; Willatzen, M.; Wang, Z. L.; Wei, D. Nonaqueous Contact-Electro-Chemistry via Triboelectric Charge. J. Am. Chem. Soc. 2024, 146(46): 31574–31584.

Single Cell Analysis for the Elucidation of Intracellular Events & Interactions

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2D cytometry/ICPMS system was developed for evaluating drug uptake and induced protein expression in individual cells. The nanoprobes conjugating 6-FAM-Sgc8 aptamers on a single AuNP were engineered to selectively bind PTK7 on target cells. PTK7 expression induced by oxaliplatin (OXA) uptake was assayed with LIF, while ICP-MS measurement of ^{195}Pt and ^{197}Au revealed OXA uptake and AuNPs conjugation in individual cells. Using a machine learning algorithm to cell-lines signature based on agent uptake and marker expression, it enables simultaneous online profiling PTK7 response to OXA at single-cell resolution from tumor cell lines and breast cancer patients.

The related techniques were used for the study of dissecting exosomal-tumoral-vascular interactions of singlet tumor cells or cell clusters by using a tumoral-transendothelial migration microfluidic chip.

Acknowledgements

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References

1. C.-X. Wu, X. Wei, X. Men, X. Zhang, Y.-L. Yu, Z.-R. Xu, M.-L. Chen, J.-H. Wang. *Anal. Chem,* **93**, 8203-8209 (2021).
2. J.-J. Bai, X. Zhang, X. Wei, Y. Wang, C. Du, Z.-J. Wang, M.-L. Chen, J.-H. Wang. *Anal. Chem,* **95**, 2523-2531 (2023).
3. X. Zhang, Y.-N. Zhao, X. Wei, X. Men, C.-X. Wu, J.-J. Bai, T. Yang, M.-L. Chen, J.-H. Wang. *Lab. Chip,* **22**, 4238-4245 (2022).
4. X. Zhang, X. Wei, C.-X. Wu, X. Men, J. Wang, J.-J. Bai, X.-Y. Sun, Y. Wang, T. Yang, C.T. Lim, M.-L. Chen, J.-H. Wang. *ACS Nano*, **18**, 6612-6622 (2024).

Single-cell metabolomics platforms and their applications

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Cellular heterogeneity plays an important role in many key biological processes such as tumor, aging, immunity and development, etc. From the perspective of metabolites, single-cell metabolomics helps to reveal the precise life activities and physiological states of individual cells, and achieve the analysis of cell heterogeneity and interactions in complex microenvironments of tissues [1]. Based on the single cell work in our group, for example, single cell organic mass spectrometry [2] and in-depth organic mass cytometry [3], a dynamic single-cell metabolomics platform and an automated single-cell dynamic metabolomic data analysis platform were constructed. A total of 50 isotopic labeled metabolites were traced in single cells, disclosing the heterogeneity of metabolic activity among single cells. A linear neural network machine learning model based on metabolic features was successfully established for binary classification of tumor cells and macrophages. The analysis results not only disclosed the metabolic alterations of the two interactions but also unveiled the heterogeneity of macrophage differentiation in the tumor microenvironment [4].

Acknowledgements

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References

1. S. J. Qin, D. Y. Miao, X. Zhang, Y. Zhang, Y. Bai*, *TrAC Trends in Anal. Chem.*, **158**, 117086 (2023).
2. S. T. Xu, M. X. Liu, Y. Bai*, H. W. Liu, *Angew. Chem. Int. Ed.*, **60**, 1806-1812 (2021).
3. S. J. Qin, Y. Zhang, M. Y. Shi, D. Y. Miao, J. S. Lu, L. Wen and Y. Bai*, *Nat Commun.*, **15**, 4387 (2024).
4. Y. Zhang, M. Y. Shi, M. X. Li, S. J. Qin, D. Y. Miao and Y. Bai,* *Nat Commun.*, **16**, 4582 (2025).

Development and Application for Novel Functionalized Open-Tubular Capillary Microcolumn-Mass Spectrometry Online Coupling Technology

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Capillary electrophoresis-mass spectrometry (CE-MS), which synergistically combines the high-resolution separation capabilities of capillary electrophoresis with the superior sensitivity and structural elucidation advantages of mass spectrometry, has emerged as a pivotal analytical platform in separation science. However, the analysis of trace targets within complex matrices remains a persistent challenge for CE-MS, primarily due to cumbersome sample pretreatment, inadequate separation specificity, and limited sensitivity, thereby constraining its practical applicability. To address these limitations, this study focuses on the development of innovative open-tubular capillary microcolumn-MS systems through the design of functionalized stationary phases, aiming to optimize the performance of CE-MS. Methodologically, open-tubular (OT) capillary columns were strategically chosen to ensure compatibility with the CE-MS workflow. Surface area enhancement of the microcolumns was achieved through modifications involving porous-layer (PL) coatings and nanoparticles, effectively mitigating the low capacity inherent to OT columns. For seamless in-line coupling with MS, the microcolumn outlet was engineered with a porous tip to serve as an electrospray ionization (ESI)-MS spray source. To attain high efficiency, specificity, sensitivity, and rapid analysis across a diverse range of targets, a series of functional stationary phases were developed for the functionalization of OT capillary microcolumns. This research not only provides insights for expanding the application scope of CE-MS technology in analytical chemistry and related fields but also underscores its significant research importance and promising application prospects in trace substance detection, bioanalysis, and pharmaceutical research and development.

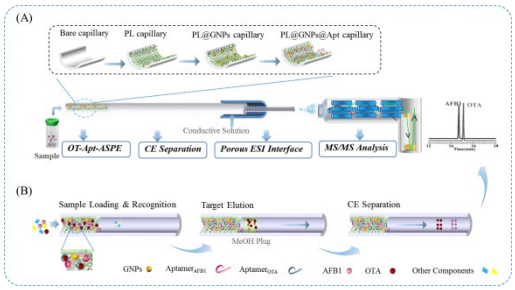


Fig.1 Aptamer affinity-based microextraction in-line coupled to CE-MS using a porous layer/ nanoparticle-modifed open tubular column

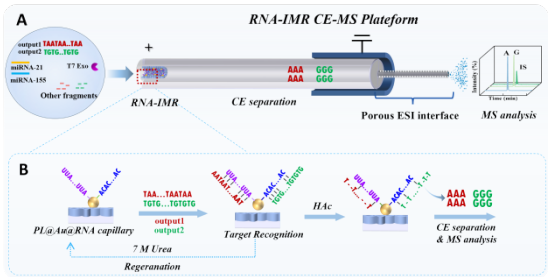


Fig.2 RNA microreactors coupled with CE-MS online technology for highly sensitive simultaneous detection of multiple miRNAs

Acknowledgements

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References

1. J.Q. Yang, X.T. Hu, J. Xu, L. Yang,* *Anal. Chem.*, 90, 4071 (2018).
2. Z. Chi, S. Zhao, Y. Feng, L. Yang,* *J. Chomatogr. A*, 1646, 462145 (2021).
3. A.P. Wang, K.X. Liu, M.M. Tian, L. Yang,* *Anal. Chem.*, 94, 9252. *(*2022); A.P. Wang, J.N. Liu, L.
4. Yang,* *Anal. Chim. Acta*, 1239: 340750 (2023).

Dual-Signal Electrochemical Biosensor Based on Aptamer Recognition and Cbago-Mediated Amplification for Ultrasensitive Detection of Coxsackievirus A6

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Coxsackievirus A6 (CVA6), a major pathogen responsible for hand, foot, and mouth disease (HFMD) in Asia, is characterized by severe symptoms and distinct clinical manifestations, including herpes and onychomadesis (nail shedding). As CVA6 has emerged as a dominant epidemic strain, the development of an efficient detection method is critical for early diagnosis, outbreak prevention, and control[1]. Herein, we developed a novel dual-signaling electrochemical biosensor based on nanocomposites and microgels, enabling highly sensitive CVA6 detection through the integration of advanced materials and molecular recognition systems. For the construction of the sensing platform, this study adopted a multilevel optimization design: first, by coupling molybdenum disulfide (MoS_2) with multi-walled carbon nanotubes (MWCNTs), the excellent catalytic performance of MoS_2 and the high electrical conductivity of MWCNTs were brought into full play, which effectively solved the problems of poor electrical conductivity and easy buildup of MoS_2[2]. The surface of the composite was further modified with silver nanoparticles (AgNPs), which significantly increased the active sites and enhanced the electron transfer efficiency. Secondly, N-isopropylacrylamide (NIPAm) and sulfobetaine methacrylate (SBMA) were innovatively utilized to construct three-dimensional networked microgel materials, whose unique amphiphilic ionic properties not only endowed the materials with excellent hydrophilicity and anti-pollution ability, but also stabilized immobilized biomolecules and maintained their activities, which provided an ideal platform for complex sample detection[3]. In the design of the molecular recognition system, this study cleverly combines the advantages of nucleic acid aptamer and Argonaute (Ago) protein: the nucleic acid aptamer, as a short-stranded DNA/RNA fragment, has high specificity and affinity, while the CbAgo protein from Clostridium butyricum does not need to rely on the RNA guidance, and only needs the DNA guide sequence to recognize the target, which is more cost-effective compared with the CRISPR/Cas system[4]. The CbAgo protein cuts the target DNA under the guidance of gDNA, and the resulting 5' phosphorylated single-stranded DNA (5'P-ssDNA) can be recycled as a new gDNA for signal amplification through cascade cutting[5].

Based on the above advantages, a dual signaling pathway detection strategy was designed in this study: in the aptamer recognition pathway, the MoS_2/MWCNTs/AgNPs nanocomposite modified electrode prepared by one-step hydrothermal method was used to induce electrochemical signal changes through the 5′-mercapto-modified capture probe (SH-DNA) binding specifically to the target; in the enzyme-assisted recognition pathway, the CbAgo enzyme system amplifies the signal through cascade cleavage and specifically cuts off the SH-DNA probe on the electrode surface, further

enhancing the detection sensitivity. Through the systematic evaluation of cyclic voltammetry (CV), differential pulse voltammetry (DPV) and electrochemical impedance spectroscopy (EIS), the sensor can realize the accurate quantification of CVA6 in serum samples, which provides a highly efficient and reliable molecular detection platform for rapid identification of hand-foot-and-mouth disease (HFMD) pathogens and epidemiological surveillance, and is of great value for application.

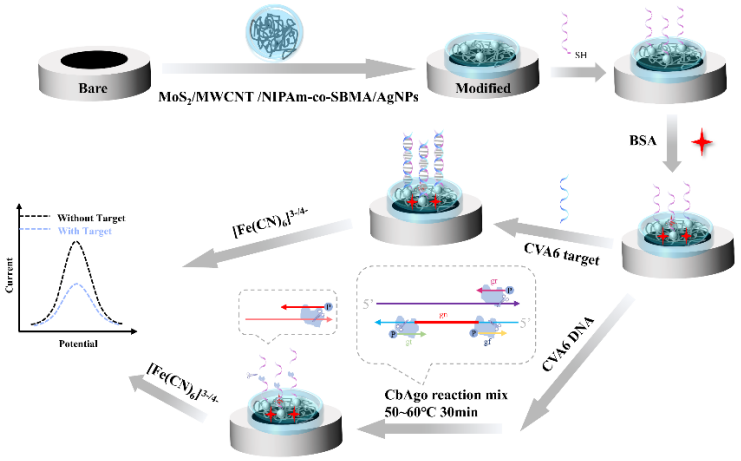
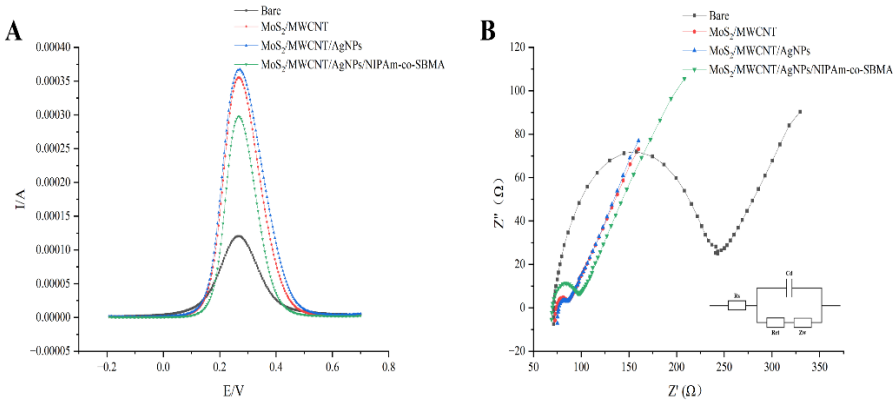


Fig.1. Different steps of manufacturing the CVA6 aptasensor



1. **Fig.2.** DPV and EIS responses obtained at the different steps of manufacturing the CVA6 aptasensor (Experimental conditions: 0.1 M PBS solution (pH=7.40); 5 mM K3[Fe(CN)6]/K4[Fe(CN)6] solution)

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References

1. E. Kamau, B. Lambert, D. J. Allen, C. Celma, S. Beard, H. Harvala, P. Simmonds, N. C. Grassly and M. Pons-Salort, *PLOS Pathogens,* **11**, 20:e1012703 (2024)
2. A. K. Yadav, D. Verma and P. R. Solanki, *Materials Today Chemistry,* 22:100567 (2021)
3. C. Aksoy, P. Kaner, A. Asatekin and P. Z. Çulfaz-Emecen, *ACS Applied Materials & Interfaces,*

20, 11:18711-18719 (2019)
4. Q. Lin, X. Ye, H. Chen, X. Fang, H. Chen and J. Kong, *Analytical Chemistry,* **2**, 96:620-623 (2024)
5. R. Vaiskunaite, J. Vainauskas, J. J. Morris, V. Potapov and J. Bitinaite, *Nucleic Acids Research,* **8**, 50:4616-4629 (2022)

A Three-Biomarker Electrochemiluminescence immunoarray Coupled with Machine Learning for Diagnosis of Acute Myocardial Infarction

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Acute myocardial infarction (AMI) is a cardiovascular disease characterized by myocardial necrosis resulting from acute and persistent obstruction of a coronary artery, which represents a leading cause of death globally. AMI accounts for one third of overall cardiovascular diseases deaths, exceeding the mortality of any single tumor. It shows an increasing trend year by year[1-2]. Key to AMI recovery is timely diagnosis and initiation of treatment, ideally within three hours of symptom onset. Cardiac troponin T is the gold standard for diagnosis of AMI, but has insufficient specificity at early times[3-4]. Herein, we report a three-biomarker strategy, including cardiac troponin I, heart type fatty acid binding protein, and copeptin, for rapid, accurate and early diagnosis of AMI via a multiplex electrochemiluminescence immunoarray coupled with robust machine learning[5]. In a >200 subject pilot trial, the three-biomarker joint model achieved 100% sensitivity and specificity across a broad patient population with chest pain, including those patients within three hours of symptom onset. The proposed three-biomarker joint strategy is obviously superior to cardiac troponin T for early and accurate diagnosis of AMI. This study is very important for the diagnosis, medical treatment and prognoses of AMI, which holds the potential to minimize AMI mortality as well as to lower medical expenditure.

Keywords: Acute Myocardial Infarction, Electrochemiluminescence, Sensor, Diagnosis.

References

1. G. W. Reed, J. E. Rossi, C. P. Cannon, *Lancet*, **389**, 197-210 (2017).
2. K. Sarkar, Z. Q. Cai, R. Gupta, et al. *Proc. Natl. Acad. Sci. USA*., **109(26)**, 10504-10509 (2012).
3. L. K. Mullany, A. D. Rohira, J. P. Leach, et al. *Proc. Natl. Acad. Sci. USA*, **117(49)**, 31353-31364 (2020).
4. K.Thygesen, S. A. Joseph, S. J. Allan, et al. *Circulation*, **13**, e618-e651 (2018).
5. M. Guo, D. Du, J. Wang, et al. *Chem. & Biomed. Imaging*, **1**,179-185 (2023).

Coupled Scanning electrochemical and Fluorescence microscopies for analyzing plasmon driven chemistry

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Plasmonic strategies are emerging promising methodologies to efficiently activate photocatalytic conversion using low intensity light sources – an important step towards the development of solar driven photocatalysts. As the field of "plasmon driven chemistry" becomes well stablished [1], so does the need to develop flexible and versatile setups to quantitatively analyze the different physico-chemical phenomena taking place during and following excitation of surface plasmon modes.

In this contribution, we combine scanning electrochemical microscopy monitoring of reduction products with electroflurochromic redox mediators to analyze different phenomena taking place in the nanoparticle-solution interface. A coupled operando approach will first be presented, associating fluorescence spectroscopy, scanning electrochemical microscopy and quantitative phase microscopy to probe plasmon driven reactions. We first analyze plasmon driven charge transfer to a model electrofluorochromic mediators, showing how different aspects of plasmon induced reactivity can be scrutinized. Then, we confine such probes to the surface of nanoparticles [3] to enable analysis of charge transfer reactions involving more general, non-emissive, targets.

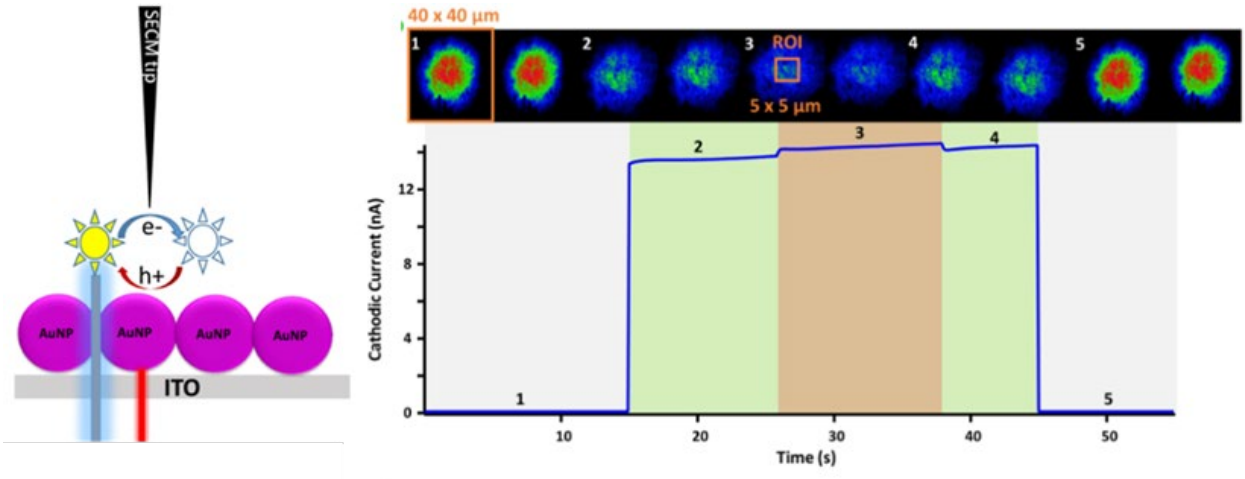


Fig.1 Schematic view over the coupled SECM fluorescence approach for analyzing plasmon driven reactions, and representative results of simultaneous electrochemical and fluorescence monitoring of the reaction.

References.

1. Zhang, Y.; He, S.; Guo, W.; Hu, Y.; Huang, J.; Mulcahy, J.R.; Wei, W.D.* Surface-Plasmon-Driven Hot Electron Photochemistry Chem. Rev. 118, (2018) 6, 2927–2954
2. Miranda, L.; Maillot, B.; Bosmi, M.; Galmiche L.; Audibert J.F.; Decorse, P.; Brasiliense V. ; Berthelier, L. ; Bonnamour I. ; Darbost, U. ; Miomandre F.* Photophysical and Electrochemical Study of New Luminescent and Redox-Active Tetrazine Derivatives Grafted on Gold Nanoparticles J. Phys Chem C. (2023) 127 (7), 3660-3670
3. Dabbous, A.; Maillot B.; Audibert, J.F.; Brasiliense V.; Miomandre F. Plasmon-Induced Simultaneous Electrochemical and Fluorescence Switches Probed by Combined SECM and Fluorescence Microscopy J. Phys Chem C.(2024) 128 (46), 19829-19838

Smart Hydrogel-Based Bioseparation and Biosensing Systems

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Smart soft materials, such as smart hydrogels, exhibit stimuli-responsiveness, excellent biocompatibility, and tissue-mimetic "soft and wet" characteristics, making them highly promising for various biomedical and biosensing applications. By introducing sequence-programmable DNA structures into the hydrogel matrix, smart DNA hydrogels that can respond to different types of biochemical targets can be obtained; upon the presence of a specific biochemical target, the hydrogel matrix can undergo substantial physicochemical property changes, enabling the specific separation and sensing of the target. However, conventional hydrogel-based bioseparation and biosensing systems also encounter challenges such as slow response, low efficiency and high costs, which limit their widespread application. Our group has recently focused on the development of highly efficient hydrogel-based separation and biosensing systems: (1) We constructed a series of hierarchically structured and anisotropic macroporous DNA hydrogels, which allow the rapid mass transfer of biomacromolecular substances within the hydrogel matrix, and the development of fast-response hydrogel-based systems for biomacromolecular targets were achieved. (2) Different active mass transfer mechanisms were introduced to enhance the performance of hydrogel-based separation and biosensing systems, such as the stimuli-triggerred swelling-shrinking cycles of the hydrogel matrix and the solar-powered evaporation processes, significantly enhancing the response speed of the hydrogel-based biosensing systems to biotargets and the enrichment of trace substances with the hydrogel-based separation systems. (3) A series of smart DNA microgels and hydrogel films were developed, which allowed the low-cost, anti-biofouling and fast POCT detection of different targets, such as ions, small ligands, nucleic acids and proteins.

References

1. F. Li, D. Lyu, S. Liu, W. Guo * *Adv. Mater.,* **32**, 1806538 (2020).
2. X. Du, Y. Bi, C. Wang, W. Guo * *Adv. Funct. Mater.,* **30**, 2006305 (2020).
3. X. Du, P.-P. He, C. Wang, X. Wang, Y. Mu, W. Guo* *Adv. Mater.*, **35**, 2206302 (2023).
4. H. Liang, Y. Mu, M. Yin, P.-P. He, W. Guo* *Sci. Adv.,* **9**, eadj1677 (2023).
5. Y. Zhang, C. Wang, M. Yin, H. Liang, Q. Gao, S. Hu, W. Guo* *Angew. Chem. Int. Ed.,* **63**, e202311678 (2024).
6. M. Yin, Y. Zhang, H. Liang, C. Liu, Y. Bi, J. Sun, W. Guo* *Anal. Chem.*, **13**, 5215–5222 (2024).
7. Y. Mu, X. Wang, X. Du, P.-P. He, W. Guo* *J. Am. Chem. Soc.*, **146,** 5998−6005 (2024).

Nanofluidic sensing and energy conversion systems

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Nanofluidics has become a popular rearch area in the last decades and shown great importance in the field of energy conversion and storate, sensing and logic devices. As the channel size decreases to (sub)nanometer scale, its surface chemistry properties dominate the mass transport, showing nanoconfinement effect. This report will first describe the precise fabrication of nanochannels with controllable size and surface properties. After detailed exploration of the unqiue mass transorpt properties under nanoconfined systems, richement, sensing and energy concervion/storage nanofluidic devices were established.

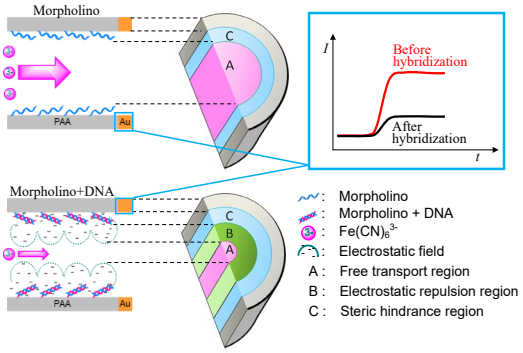


Fig.1 nanofludic device for DNA ssensing

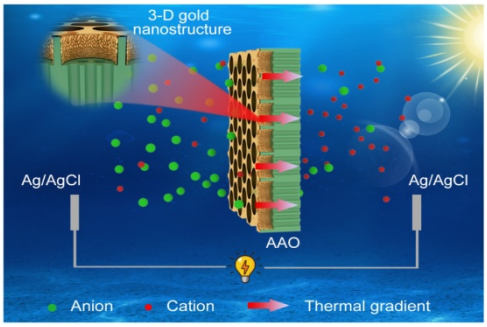


Fig.2 Nanofluidic device for Solar-Thermoelectric Conversion

References

1. R.J. Mo, S. Chen, L.Q. Huang, X.L. Ding, S. Rafique, X.H. Xia and Z.Q. Li, *Nat. Commun.*, **15**, 2145 (2024)
2. Z.Q. Li, L.Q. Huang, R.J. Mo, S. Chen, S. Rafique, K. Wang and X.H. Xia, *Acc. Mater. Res.*, **5**, 761 (2024)
3. M.Y. Wu, R.J. Mo, S. Chen, S. Rafique, S.J. Bian, Y.J. Tang, Z.Q. Li and X.H. Xia, *Anal. Chem.*, **96**, 17665 (2024)
4. M.Y. Wu, R.J. Mo, X.L. Ding, L.Q. Huang, Z.Q. Li and X.H. Xia, *Small*, **19**, 2301460 (2023)
5. Z.Q. Li, G.L. Zhu, R.J. Mo, M.Y. Wu, X.L. Ding, L.Q. Huang, Z.Q. Wu and X.H. Xia, *ACS Appl. Mater. Interfaces*, **15**, 23922 (2023)
6. C.F. Shi and X.H. Xia, *J. Phys. Chem. Lett.*, **13**, 1330 (2022)
7. Z.Q. Li, G.L. Zhu, R.J. Mo, M.Y. Wu, X.L. Ding, L.Q. Huang, Z.Q. Wu and X.H. Xia, *Angw. Chem. Int. Ed.*, e202202698 (2022)
8. Y.L. Hu, Y. Hua, Z.Q. Pan, J.H. Qian, X.Y. Yu, N. Bao, X.L. Huo, Z.Q. Zeng and X.H. Xia, *Nano Lett.*, **22**, 2678 (2022)

Exploiting Single Nanoparticle and Spectro-Electrochemistry to Explore the Solid/Liquid Interface at Electrocatalysts

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The advancement and enhancement of sustainability-focused systems, such as electrosynthesis, renewable energy conversion and storage devices, requires a molecular level comprehension of solid/liquid interfaces. At the interface of a charged metal with an electrolyte, electrons, solvent molecules, and ions form an electric double layer (EDL). Advancing the limited understanding of the EDL we have to date, is one of the key aspects in improving charge transfer reactions. This demands advanced electrochemical approaches, such as single entity electrochemistry and spectro-electrochemistry.

Nano-impact electrochemistry is a high-throughput single entity technique that enables studying EDL properties at individual nanoparticles. [1] In this method, nanoparticles dispersed in the electrolyte solution of interest make electrical connection with a potentio-stated electrode upon collision.[2] Consequently, the nanoparticle's potential equilibrates with that of the electrode, and a transient current signal results. This allows us to determine the EDL capacitance of the nanoparticle avoiding the various ambiguities caused by typically used nanoparticle ensemble measurements. Here, we investigate the EDL capacitance of platinum and gold nanoparticles, shedding new light on the molecular structure of the EDL at these metals.

Advancing from this, the role of anion adsorption on electrosynthesis, that is electro-chemical reactions, will be discussed. To this end classical competitive adsorption studies at rotating disc electrodes are complemented by differential electrochemical mass spectrometry (DEMS) and surface enhanced IR spectroscopy (SEIRAS). This reveals the impact of redox-inactive anions and molecular backbones on the selective electrocatalytic oxidation of aldehydes on gold surfaces, a class of reactions that will be crucial to produce former “petro” chemicals from renewable feedstocks.[3]

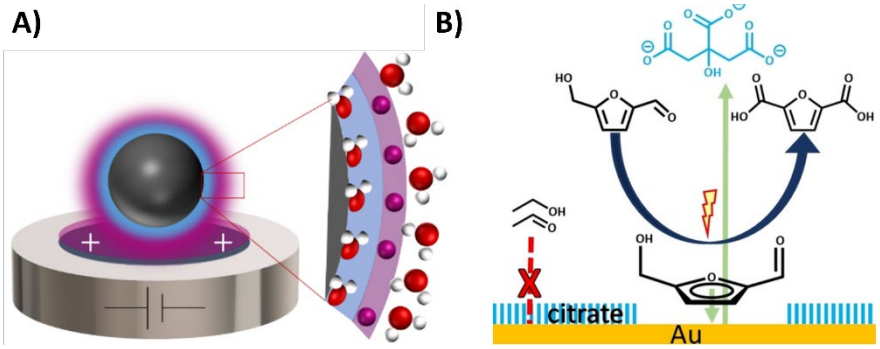


Fig.1 A) Single nanoparticle impact electrochemistry to investigate the EDL structure at metal NPs and B) Influence of anion effects on reaction rates during organic electrocatalysis.

References

1. M. Azimzadeh Sani, N. G. Pavlopoulos, S. Pezzotti, A. Serva, P. Cignoni, J. Linnemann, M. Salanne, M.-P. Gaigeot, K. Tschulik, *Angew. Chem. Int. Ed.*, **61**, e202112679 (2022).
2. M. Azimzadeh Sani, K. Tschulik, Curr. Opin. in Electrochem., **37**, 101195 (2022).
3. L. Sobota, C. J. Bondue, P. Hosseini, C. Kaiser, M. Spallek, K. Tschulik, ChemElectroChem, **11**, 202300151 (2024).

Electrochemiluminescence Microscopy for Analytical Application

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Electrochemiluminescence (ECL) is a controllable form of chemiluminescence where emission intensity is affected by a voltage imposed at an electrode surface. By the combination with optical microscopes, the recently developed ECL imaging techniques show tremendous application potential to study bio-related events with highly temporal and spatial resolution. Recently, our group developed a series of techniques for visual evaluation of single particle and cells based on a homemade ECL microscope. For example, the protein corona formation kinetics is monitored by a self-regulated ECL microscopy.[1] After comparing the protein corona formation kinetics in different complex systems and different nanomedicine carriers, the universality and accuracy of this technique were well demonstrated via the protein corona formation kinetics curves regulated by competitive adsorption of $Ru(bpy)_3^{3+}$ and multiple proteins on surface of various carriers. To improve the sensitivity of ECL imaging, we employed a temperature-regulated ECL imaging strategy.[2] Because the ECL emission layer is influenced by the ECL reactions route, we recorded the ECL images of cells with the elevated temperature, thus providing a flexible approach to adjust the imaging scope within specific heights. To improve the spatial selectivity, we report a site-selective heat boosting electrochemiluminescence microscopy.[3] By generating a micron-scale heat point in situ at the electrode–solution interface, we achieved an enhancement of luminescence intensity up to 63 times, along with an advance of 0.2 V in applied voltage. To increase the spatial resolution, we developed a stimulated emission route for single cell imaging.[4] This microscopy uses a focused red-shifted beam to transfer spontaneous ECL into stimulated ECL, which enables selective and reversible tuning of ECL emission from homogeneous solution, single particles, and single cells. In addition, the sharpness of single-cell matrix adhesion is improved 2 to 3 times compared with the counterpart in confocal ECL mode. Furthermore, we designed ECL patterning for renewable and enhanced bioimaging.[5] The above results suggest that the ECL microscopy provides an unprecedented approach to visualization of single particle and cells, sufficiently expanding the application of ECL technique in the realms of bio-analysis.

References

1. Zejing Xing, Xiaodan Gou, Li-Ping Jiang, Jun-Jie Zhu, Cheng Ma, Angew. Chem. Int. Ed., 2023, 62, e202308950.
2. Cheng Ma, Zejing Xing, Xiaodan Gou, Li-Ping Jiang, Jun-Jie Zhu, Chem. Sci., 2022, 13, 13938-13947.
3. Xiaodan Gou, Yiwen Zhang, Zejing Xing, Cheng Ma, Changjie Mao, Jun-Jie Zhu, Chem. Sci., 2023, 14, 9074-9085.
4. Cheng Ma, Xiaodan Gou, Zejing Xing, Min-Xuan Wang, Wenlei Zhu, Qin Xu, Dechen Jiang, Jun-Jie Zhu, Research, 2023, 6, 0257.
5. Xiaodan Gou, Zejing Xing, Zhichen Zhang, Rong Jin, Qin Xu, Neso Sojic, Jun-Jie Zhu, Cheng Ma, Angew. Chem. Int. Ed., 2025, 64, e202410825.

Coreactant-Free Electrochemiluminescence from Nanocluster and Its Immunoassay Application

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Electrochemiluminescence (ECL), a promising analytical tool, typically uses the electrochemical redox of luminophores to create excited states and emit photons. All commercial ECL immunoassays are automated using the classic coreactant ECL system, i.e., tris(2,2'-bipyridine)ruthenium(II) ($Ru(bpy)_3^{2+}$)/tripropylamine (TPrA), which is usually performed at +1.40 V (vs Ag/AgCl) with the assistance of precisely designed magnetic separation procedure. In recent years, there has been a push to simplify commercial ECL immunoassay procedures by eliminating the exogenous effects of coreactants and electrochemical interferences. Promisingly, coreactant-free ECL can be achieved by directly and electrochemically oxidizing certain nanoparticle luminophores without the need for a coreactant. Advancing nanoparticle ECL immunoassays to be coreactant-free holds significant scientific value and commercial application prospect.

Our research group has developed a sulfur-vacancy-involved and free-electron strategy to utilize methionine-capped Au nanoclusters (Met-AuNCs) as anodic electrochemiluminophore. Benefit to the negative-charged surface state and sulfur-vacancy enabled electron-rich nature, Met-AuNCs can be electrochemically injected with exogenous holes and recombine with endogenous free-electron, ultimately emitting coreactant-free ECL with the maximum triggering-potential of +0.86 V. The efficient coreactant-free ECL is eventually utilized for the selective and sensitive detection of human carcinoembryonic antigen (CEA) with the LOD of 5 pg/mL. This approach shows promise in designing nano-electrochemiluminophore with improved immunoassay performance. By eliminating both the exogenous effects of coreactants and electrochemical interferences, this strategy is expected to simplify operational procedures for commercial ECL immunoassays.

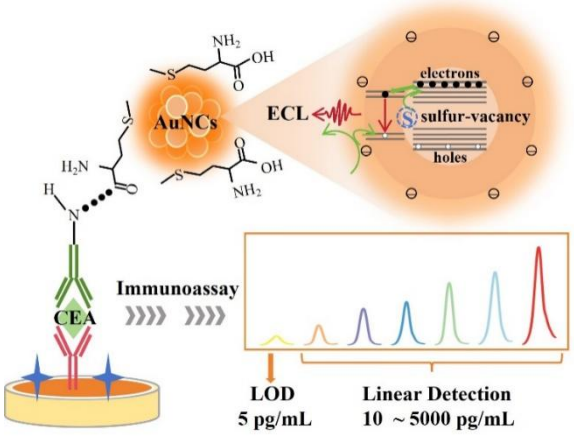


Fig. 1 Schematic Illustration for Coreactant-Free ECL Immunoassay with Met-AuNCs as Tag

Acknowledgements

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References

1. Y. Zhou, Y. Wu, Z. Luo, L. Ling, M. Z. Xi, J. S. Li, L. Y. Hu, C. L. Wang, W. L. Gu and C. Z. Zhu, *J. Am. Chem. Soc.* **146** (17), 12197−12205 (2024)
2. L. Fu, X. W. Gao, S. T. Dong, J. N. Jia, Y. Q. Xu, D. Y. Wang and G. Z. Zou, *Anal. Chem.* **94** (2), 1350−1356 (2022)
3. X. W. Gao, X. X. Ren, Y. J. Ai, M. W. Li, B. Zhang and G. Z. Zou, *Anal. Chem.* **95** (17), 6948-6954 (2023)

Ultrasensitive Electrochemiluminescence Immunoassay via Cerasome within MXene-Modified Single Electrode Electrochemical Systems For the Multiplex Diagnosis of Circulating Tumor Cells

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Breast cancer (BC) is a widespread malignant condition worldwide. The primary cause of mortality is not the original tumor but the dissemination of tumor cells to remote locations, with circulating tumor cells (CTCs) serving as the source of metastases. CTCs, having detached from primary tumors, reach the peripheral bloodstream. The precise and sensitive detection of CTCs is crucial for cancer diagnosis. This study introduces the development of an integrated MXene-modified single-electrode electrochemical system (SEES) for visible and high-throughput electrochemiluminescence (ECL) immunoassays. The ECL immunoassay has garnered substantial interest in recent years due to its visual detection capabilities and capacity to facilitate high-throughput analysis. Antibodies were efficiently immobilized utilizing the bioaffinity and adsorption characteristics of the carbon ink screen-printed electrode. Moreover, carriers serve as cerasomes for encapsulated luminol, which, alongside their superior encapsulation capacity and stability, can enhance ECL due to a siloxane group on their surface. The devised system comprises 24 fully separated reaction cells that simultaneously analyze several samples from Trree BC cell lines ((MCF-7, MDA-MB-231, and SK-BR-3)) while preserving sample separation. This method attained a notable minimum detection limit of 5, 5, and 10 cells mL^{-1}, respectively. The multiplex cytosensor can evaluate several cell-surface receptors, which would be beneficial for creating a more effective diagnostic tool for BC disorders.

References:

1. Wu P, He X, Fan J, et al (2025) Electrochemical cytosensors for non-invasive liquid biopsy : Detection procedures and technologies for circulating tumor cells. Biosensors and Bioelectronics 267,116818
2. D. Han, B. Goudeeau, D. Jiang, D. Fang, N.Sojic, (2021) Electrochemiluminescence microscopy of cells: Essential role of surface regeneration, Analytical chemistry 93, 1652-1657
3. Firoozbakhtian A, Hosseini M, Guan Y, Xu G (2023) Boosting Electrochemiluminescence Immunoassay Sensitivity via Co–Pt Nanoparticles within a Ti3C2 MXene-Modified Single Electrode Electrochemical System on Raspberry Pi. Anal Chem 95:15110–15117.

Importance of Advanced Diagnostics for Unlocking Complexity of Electrocatalytic Water Splitting

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Widespread deployment of renewable energy technologies is facing limitations due to relatively low efficiency of systems utilized for conversion of renewable energy to electricity as well as conversion of renewable electricity to chemical energy. One of the essential technologies to convert renewable electricity to chemical energy is water electrolysis. It is based on two electrocatalytic conversion reactions: facile and complex hydrogen evolution reaction (HER) at the cathode and sluggish and very complex oxygen evolution reaction (OER) at the anode. [1] Making water electrolysis more efficient translates into designing of electrode/electrolyte interface at which conversion reactions will have substantially enhanced kinetics. [2] Enhancement of reaction kinetics requires existence of straightforward structure-activity relations. In that way, it is possible to tune material properties and interfacial properties of electrode/electrolyte boundary, to achieve high electrocatalytic rates. Precondition for creating link: material properties (e.g. work function) – interfacial properties (e.g. potential of zero charge) – reaction kinetics (e.g exchange current) is to have advanced analytical tools that will allow relevant view on reacton mechanism.

In this work, new relevant insights into electrocatalytic mechanisms of HER and OER are gathered using: electrochemical measurements, Kelvin probe (KP), scanning flow cell combined with inductively coupled plasma mass spectrometer (SFC-ICPMS) as well as scanning electrochemical microscopy (SECM). Analysis will be presented related to several important fundamental questions: 1) can we evaluate experimentally metal-hydrogen bond strength, how that relates to HER electrocatalytic rate (i.e. “volcano”-plot or linear or···) and how it relates to computational density functional theory (DFT) predictions [3,4]. 2) what are relevant stability descriptors for OER catalysts [5]. 3) how gas evolution impacts stability of OER catalysts. [6]

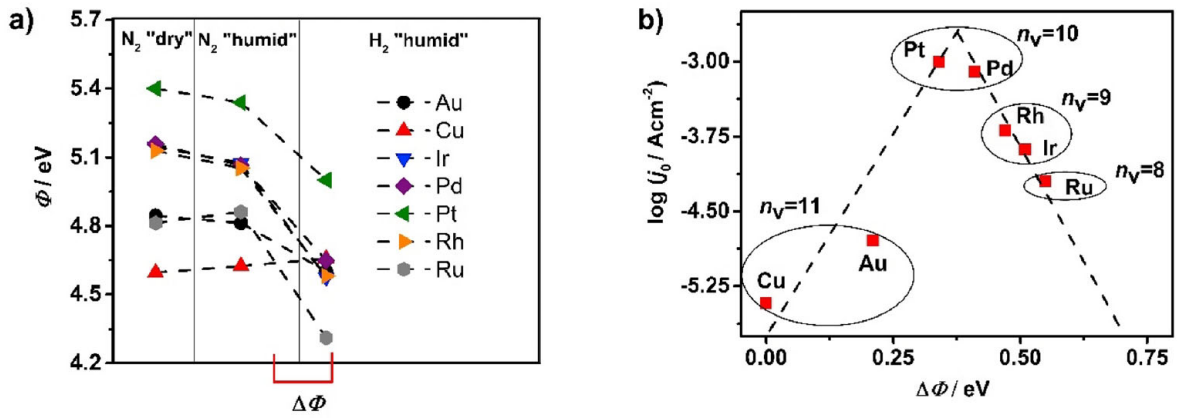


Fig.1 a) Change in the work function of a group of metals under various atmospheres measured by KP at room temperature. b) Experimental "volcano" plot where the exchange current for HER (values taken from [6]) is related to the experimentally determined change in the work function of the metal upon adsorption of hydrogen through the water layer. For various metals, the number of valence electrons (n_v) is indicated. Fig.1a and Fig.1b are from [2] under the terms of the Creative Commons CC BY license, Springer Nature (2020).

References

1. A. Zeradjanin, *J. Electrochem. Sci. Eng.* **15**, 2634 (2025)
2. A. R. Zeradjanin, *Nat. Energy* **9**, 514 (2024)
3. A. R. Zeradjanin, I. Spanos, J. Masa, M. Rohwerder, R. Schlögl, *J. Solid State Electrochem.* **25**, 33 (2020)
4. A. R. Zeradjanin, in *Encyclopedia of Solid-Liquid Interfaces*. 36 (2024)
5. A. R. Zeradjanin, A. Lim, I. Spanos, J. Masa, *ChemElectroChem* **11,** e202300832 (2024)
6. A. R. Zeradjanin, P. Narangoda, I. Spanos, J. Masa, R. Schlögl, *Current Opinion in Electrochemistry* **30**, 100797 (2021)

Functional Nanomaterials – Tuning the Size and Surface Chemistry for Applications in Electrocatalysis

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Advances in catalysis critically depend on the ability to design nanomaterials with precise control over size, composition, shape, and surface chemistry. Our research focuses on the tailored synthesis of metal nanoparticles and atomically precise metal nanoclusters (Au, Ag, Cu, Ni, Pt, Pd, and their alloys) spanning size regimes from sub-nanometer to ~100 nm. These nanomaterials are synthesized with exceptional monodispersity and structural tunability using chemical reduction approaches. We have also developed hybrid nanostructures incorporating supports such as titania nanosheets, carbon-based materials, and other conductive or photoactive materials to enhance catalytic stability and charge transfer.

In electrocatalysis, these nanomaterials demonstrate remarkable activity and selectivity for key reactions including the hydrogen evolution reaction (HER), oxygen evolution reaction (OER), oxygen reduction reaction (ORR), and CO_2 electroreduction. By engineering surface ligands, oxidation states, and metal-support interactions, we tune catalytic pathways to optimize performance under various conditions. In parallel, our nanostructures have shown promising results in electrochemical sensing and photocatalysis, particularly in HER and in the oxidation of small molecules such as methanol, where light-induced charge separation enhances overall efficiency.

Through combined spectroscopic, electrochemical, and microscopic techniques, we elucidate structure–property relationships and catalytic mechanisms, contributing to the rational design of next-generation electrocatalysts for clean energy applications, which will be discussed during this invited talk.

Highly active sites of $FeTe_2$ nanosphere encapsulated with graphene nanosheets towards efficient electrocatalysts for overall water splitting applications

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One of the most important, environmentally friendly, and sustainable ways to meet the growing need for renewable energy sources is through electrocatalytic water splitting, which produces hydrogen (H_2) and oxygen (O_2). However, the process is still challenging because of the uphill reaction during the overall water-splitting process. Here, using a simple hydrothermal method, we fabricated high-performance two-dimensional electrocatalysts for pH-universal water splitting, based on $FeTe_2$ nanospheres/reduced graphene oxide (rGO) hybrid ($FeTe_2$/rGO). For the oxygen evolution reaction (OER) and hydrogen evolution reaction (HER), the as-prepared $FeTe_2$/rGO hybrid requires relatively low overpotentials of 272 and 109 mV to attain a current density of 10 mA cm^{-2} and corresponding Tafel slopes of 41 and 83 mV dec^{-1} in 1 M solution of KOH. These factors can be attributed to increased exposure to surface active sites, excellent electron transfer capability, and strong electronic coupling. This confirms the excellent electrocatalytic performance among the most advanced TMD electrocatalysts for overall water splitting. Thus, a new path toward the development of bifunctional, economical, and effective electrocatalysts for overall water splitting may be opened up by interfacial modification based on the incorporation of active heterostructure.

Analysis, measurement and application of interfacial charge transfer

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Photoelectrochemical water decomposition is still facing the critical bottleneck of slow water oxidation kinetics in practical applications, which leads to the difficulty of breaking through the 10% threshold of energy conversion efficiency for industrial applications. The photo - and electro-active sites on photoelectrode surfaces, along with interfacial charge transfer processes, play a pivotal role in energy conversion efficiency. Therefore, we have proposed a series of charge modulation strategies and developed an in situ scanning photoelectrochemical microscopy (SPECM) technique, enabling dynamic visualization of interfacial photoelectrochemical reactions at the micro/nano scale with spatiotemporal resolution beyond conventional characterization methods.

This technology provides a powerful tool for elucidating charge transfer kinetics at material interfaces, not only deepening the mechanistic understanding of photoelectrocatalysis but also offering critical guidance for designing advanced materials. For instance, SPECM revealed that charge recombination at semiconductor/transition metal hydroxide (solid/solid) interfaces is the primary limiting factor for PEC performance enhancement [1]. Introducing porphyrin molecules as “volleyball setter” significantly facilitates hole transfer, leading to remarkable PEC performance improvements [2]. Moreover, SPECM enables in situ monitoring of charge transport processes from micro- to macro-scales, demonstrating that Fe-based interlayers ($Fe(OH)_x$)) exhibit the highest hole transfer kinetics, outperforming $Ni(OH)_x$ and CoPi counterparts [3]. By optimizing small-molecule ligand anchoring sites, we developed a molecularly functionalized layer, 4-ethyl-carbazole copper phthalocyanine (4EtCz-Pc), featuring a strong dipole moment, a large internal electric field, and surprisingly positive electrostatic potential at the edge, which significantly enhances photogenerated carrier separation and migration rates [4].

Acknowledgements

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References

1. Ning, M. et al. Insight into the Transition-Metal Hydroxide Cover Layer for Enhancing Photoelectrochemical Water, *Angew. Chem. Int. Ed.*, **60**, 3504-3509 (2021)
2. Ning, M. et al. An Efficient Strategy for Boosting Photogenerated Charge Separation by Using Porphyrins as Interfacial Charge Mediators, *Angew. Chem. Int. Ed.*, **58**, 16800-16805

(2019)
3. Ning, M. et al. In Operando Visualization of Charge Transfer Dynamics in Transition Metal Compounds on Water Splitting Photoanodes, *Adv. Energy Mater*. e2405137 (2025)
4. Luo, W. et al. Phthalocyanine Grafting Strategy Induces Strong Intrinsic Electric Fields and Molecule-Edge Carrier Transport Pathways for Photoelectrochemical Water Splitting, *Angew. Chem. Int. Ed*. e202504589 (2025).

NPY-based Nanoprobes in Cancer Boundarics

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"Boundarics in biomedicine" or "biomedical boundarics" is a cutting-edge interdisciplinary discipline involving in multiple fields (such as bioscience, medicine, chemistry, materials science, and information science) dedicated to investigating and solving key scientific questions in the formation, identification, and evolution of living organism boundaries [1]. Particularly, it includes three levels: (1) the boundary between the living organism and the external environment; (2) internal boundary within living organism; and (3) the boundary related to disease in living organism. The advancement of research in biomedical boundarics is of great scientific significance for understanding the origin of life, the interaction between internal and external environments, and the mechanism of disease occurrence and evolution, thus providing novel principles, technologies, and methods for early diagnosis and prevention of major diseases, personalized drug development, and prognosis assessment, etc.

Neuropeptide Y (NPY) is one of the most widely distributed neuropeptides in the central and peripheral nervous systems and plays important roles in physiology and pathology. However, it has a short half-life, difficulty to cross physiological barriers, and therefore poor performance for targeting of nanosystems for tumor imaging and therapy. We therefore developed NPY analogs and focused on those that bind to the Y1 receptor (Y1R) subtype. We found that Y1R ligands could form tetramers in physiological conditions, which effectively avoids premature drug release from the nanoprobes, thereby increasing accumulation in tumors. Furthermore, novel Y1R ligands with high specificity were designed and applied for tumor targeting of nanoprobes, thereby providing a new approach for imaging and therapy of targets that overexpress Y1R. In this talk, we will discuss the details on cancer boundarics driven by its diagnosis and therapy based on NPY Nanoprobes, particularly on imaging probe materials for the recognition and detection in the cancer boundary [2-3].

References:

1. QS Du, J Li, F Yang, H Dai, AG Wu, Boundarics in Biomedicine, *Research* **2024**;7, 0430.
2. XL Duan, P Wang, LL He, Z He, SW Wang, F Yang, CY Gao, WZ Ren, J Lin, TX Chen, C Xu, J Li, AG Wu, Peptide-Functionalized Inorganic Oxide Nanomaterials for Solid Cancer Imaging and Therapy, *Advanced Materials* **2024**, 36, 2311548.
3. WZ Ren, J Li, J LYao, J Xing, H Bao, L Sun, AG Wu, Research Progress of Molecular Probes Driven by Tumor Boundary Imaging, *Chinese Journal of Analytical Chemistry* **2025**, 53(1), 1-13.

Raman spectroscopy analysis of nanoplastics and the challenges

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Micro- and Nanoplastics (NMPs) are globally prevalent environmental contaminants with documented ecological risks and toxicological effects [1]. The biological uptake amount and toxicity of MNPs are significantly related to their size [2]. Nanoplastics, in particular, carry greater concern because of their higher ability to cross biological barriers and more serious immune toxicity [3]. It is particularly important to develop a common method for sampling and characterizing nanoplastics to realize the chemical identification, visualization and quantification of nanoplastics because of the low environmental levels and small size. Surface-enhanced Raman spectroscopy (SERS) provides sensitive, non-destructive and characteristic fingerprint Raman spectra [4]. Because the electromagnetic enhancement declines exponentially with increasing the distance from targeted molecules to the SERS substrate [5], nanoplastics must approach the surface of the SERS substrate so as to acquire meaningful SERS response. Moreover, the interference from sample matrices and the high dispersion index of the nanoplastics particle size distribution make it challenging to selectively and accurately characterize and quantify nanoplastics. Integrating pre-treatment and SERS is the premise and key to realizing ultra-sensitive and size-resolved quantitative SERS analysis of nanoplastics [6].

An integrated method of pre-treatment and SERS can be constructed to achieve separation, enrichment, and detection of the nanoplastics in one step. Based on the morphological characteristics of particulate matter, a hyphenated method was proposed involving membrane filtration and SERS for trace nanoplastics in water. In this method, a bifunctional Ag nanowire membrane was employed to enrich nanoplastics and enhance their Raman spectra in situ, which omitted sample transfer and avoided losing smaller nanoplastics. Using this hyphenated method, approximately 95.0% of the PS nanoplastics with a size of 100−1000 nm were trapped by the AgNW membrane. The detection of nanoplastics down to 50 nm (down to 10^{-7} g/L for PS NPs, 10^{-6} g/L for PMMA NPs) and the visual analysis on the film were realized. Moreover, PS MNPs in environmental water samples collected from the seafood market were also detected at the μg/L level [7].

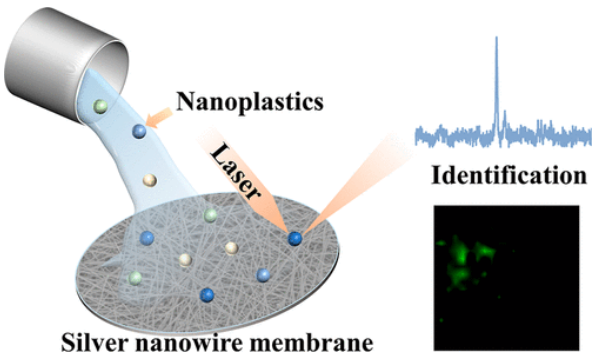


Fig. 1 Application of silver nanowire filter membrane in separation and enrichment of nanoplastics and SERS detection

The Raman and SERS responses of MNPs depend on both mass concentration and size, and the size distribution of MNPs is unknown and non-uniform in real samples. Based on one-step filtering, a systematic quantitation method incorporates Raman or SERS hyphenated to size-fractionated filtration (SFF-R/S) and a slope-matching strategy for enhancing quantitative accuracy in both spectral data acquisition and data handling was proposed. By categorizing them into 4 size fractions by three sequential membrane filtrations, accurately quantifying micro- and nanoplastics across 20 nm–5 μm was achieved. The SFF-R/S effectively eliminated spectral interference, achieving high sensitivity for nanoplastics (detection limit 2×10^{-5} g/L), and excellent accuracy (relative errors <10% for each fraction). A slope-matching approach was employed to estimate particle size and improve quantitative accuracy. This method was successfully applied to determine the simulated release of MNPs from PS cups, revealing promising potential for analyzing MNPs mixtures [8].

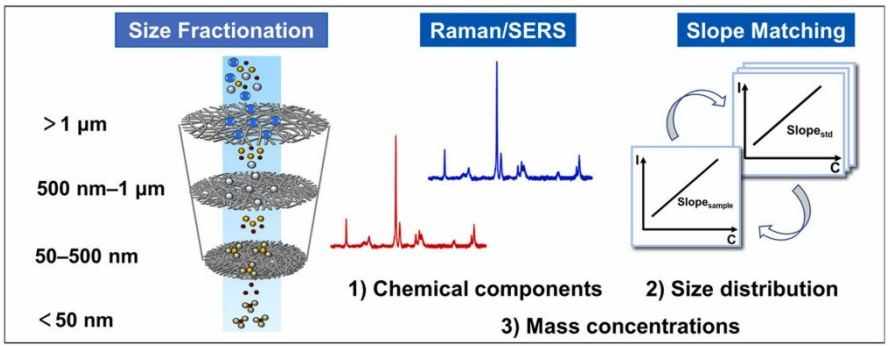


Fig. 2 The SFF-R/S and slope-matching strategy systematic method for micro- and nanoplastics analysis

For the faster size-resolved enrichment and sensitive detection of nanoplastics at the trace level, the hyphenated electrosorption and SERS (ES-SERS) method was established based on the nanoscaled plastic particles are often charged on the surface and exhibit distinct colloidal behavior. The ES-SERS method enables rapid enrichment and detection of trace PS nanoplastics with detection limits lowered to 100 ng/L for 300 and 100 nm PS, 50 ng/L for 50 nm PS, and 30 ng/L for 20 nm PS nanoplastics. By adjusting the electrosorption time, the PS nanoplastics under a certain diameter can be selectively adsorbed and detected, so as to realize the size resolve of nanoplastics. The release of PS nanoplastics from the disposable beverage cup lid was demonstrated by ES-SERS. This method offers a straightforward and efficient SERS-based strategy for the size-resolved detection of nanoplastics [9].

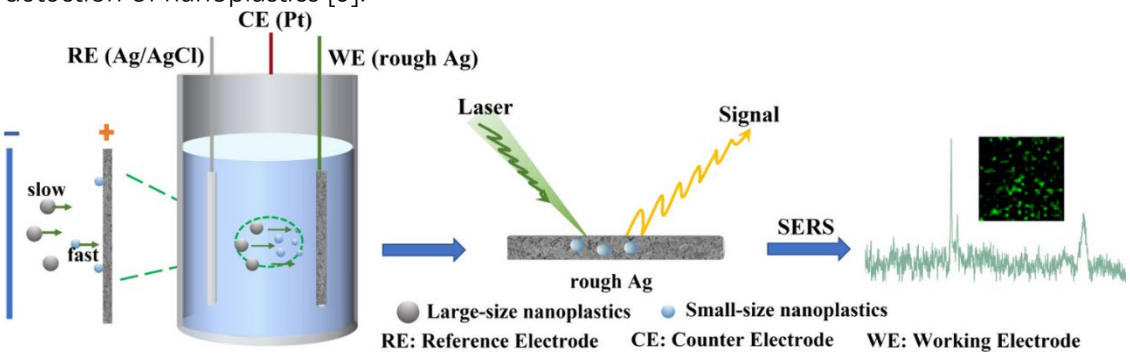


Fig. 3 The ES-SERS method for enrichment and size-resolved SERS detection of nanoplastics

The above integrated technologies were demonstrated to be ultrasensitive and

selective for accurate SERS characterization and quantification of nanoplastics in environmental matrices.

Acknowledgements

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References

1. X. Lim, *Nature*, **593**, 22–25 (2021)
2. M. Revel, A. Chatel; C. Mouneyrac, *Curr. Opin. Environ. Sci. Health,* **1**, 17–23 (2018)
3. W. J. Liu, H. P. Liao, M. C. Wei, M. Junaid, G. L. Chen, J. Wang, *Trac, Trends Anal. Chem.*, **170**, 117477 (2014)
4. C. Zong, M. Xu, L.-J. Xu, T. Wei, X. Ma, X.-S. Zheng, R. Hu, B. Ren, *Chem. Rev.*, **118**, 4946–4980 (2018)
5. W. Wang, Z. Li, B. Gu, Z. Zhang, H. Xu, *ACS Nano*, **3**, 3493–3496 (2009)
6. R. C. Thompson, W. C.-Jones, J. Boucher, S. Pahl, K. Raubenheimer, A. A. Koelmans, *Science*, **386**, 6720 (2025)
7. Q. Yang, S. Zhang, J. Su, S. Li, X. Lv, J. Chen, Y. Lai, J. Zhan, *Environ. Sci. Technol.*, **56**, 10818-10828 (2022)
8. X. Guo , S. Li , T. Wang , J. Su , Y. Liu , J. Chen, J. Zhan, J. Harzard. Mater., **494**, 138488 (2025)
9. T. Wang, S. Li, R. Mu, Z. Lu, J. Su, J. Chen, J. Zhan, *Anal. Chem.*, **96**, 19545-19552 (2024)

A Fluorescence/Colorimetric Synergistic-Enhanced Type-I Heterostructured MOF@QDs for Both Multi-Depth Food-Freshness Prediction and Extra Preservation

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Spoiled food has significantly impacted on the global economy and public health, which increases worldwide concern about monitoring and preserving food freshness.[1,2] Current methods for assessing food freshness require experimental personnel and complex, time-consuming procedures,[3-5] which hinder their widespread adoption in households, supermarkets, and other daily settings. Moreover, most commercially available food preservers or packages lack the indication function, especially for the decay inside the food. Herein, a type-Ⅰ heterojunction (Eu@ZMC) for food-freshness prediction and preservation is designed by europium metal-organic framework (EuMOF), zinc oxide quantum dots (ZnO QDs), and chlorogenic acid (CGA). Eu@ZMC achieves ratiometric fluorescent/colorimetric sensing of pH and biogenic amines to detect freshness, which is synergistic-enhanced by the energy transfer triggered by ZnO QDs-promoted colorimetry and the type-Ⅰ heterostructure of fluorescent EuMOF and ZnO QDs (**Fig.1**). To enhance portability, a paper-based platform (PEu@ZMC) is prepared and can detect histamine with the LOD of 0.0142 and 0.0136 μg mL^{-1} in fluorescent and colorimetric modes, respectively (**Fig.2**). The release of low-toxic zinc ions inhibits various bacterial growth, including *Salmonella typhimurium* (**Fig.3**). According to raw fish evaluation, Eu@ZMC not only effectively monitors spoilage externally and internally aligning with commercial kit, but also reduces spoilage speed, which cannot be achieved through the classical detection strategy (**Fig.4**). Besides, an advanced OR/NOT-gate logic device is further constructed to distinguish freshness into three levels (fresh, less fresh, and spoiled) (**Fig.5**). This original work provides a simple, convenient, and reliable method for multi-depth and real-time visual food monitoring with extract freshness preservation, contributing to economic benefits and human health assurance.

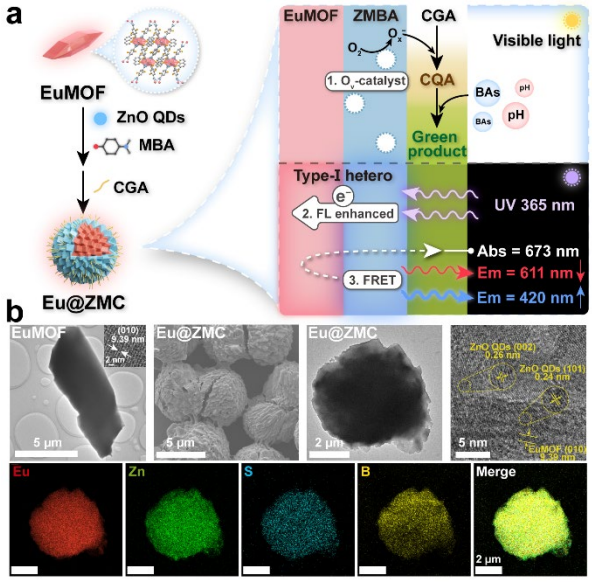


Fig.1 Preparation, sensing mechanism, and characterization of Eu@ZMC.

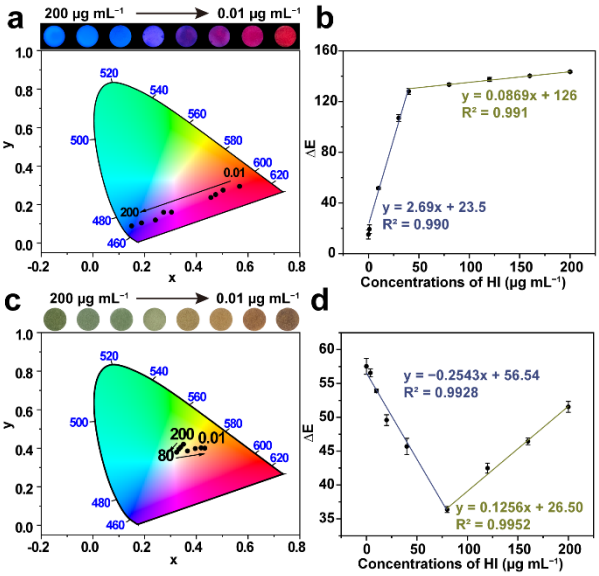


Fig.2 Fluorescent and colorimetric response of PEu@ZMC.

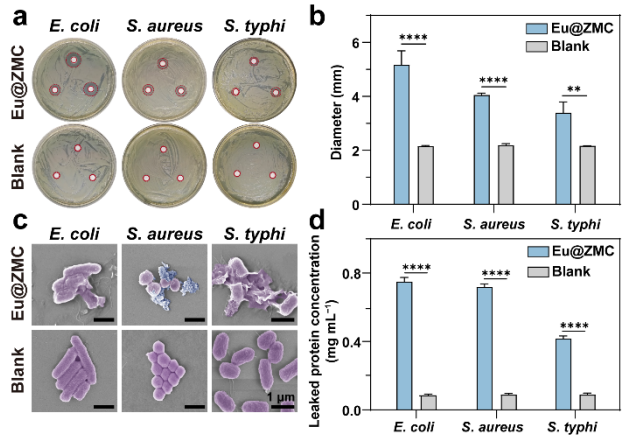


Fig.3 Antibacterial properties of Eu@ZMC.

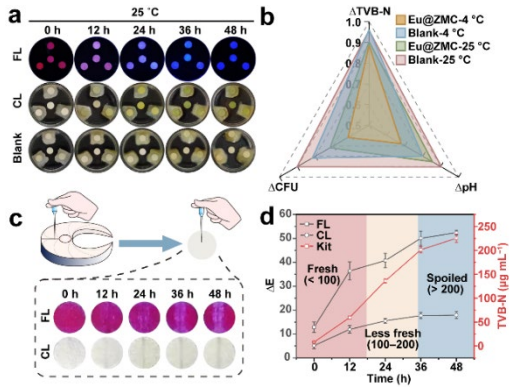
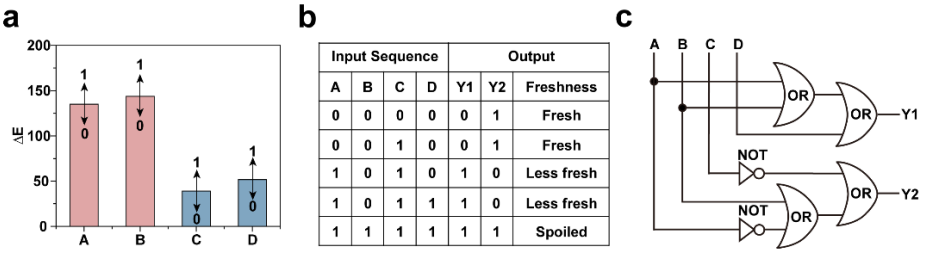


Fig.4 Practical sample freshness detection and preservation.



Input Sequence				Output		
A	B	C	D	Y1	Y2	Freshness
0	0	0	0	0	1	Fresh
0	0	1	0	0	1	Fresh
1	0	1	0	1	0	Less fresh
1	0	1	1	1	0	Less fresh
1	1	1	1	1	1	Spoiled

Fig.5 The combined logic gate based on the dual-mode freshness monitoring platform.

Acknowledgements

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Interdiscipline Innovation Fund Project of Nanchang University (PYJX20230001 to Xiaolei Wang).

References

1. T. Ben Hassen, H. El Bilali, M. S. Allahyari, S. Berjan, T. Osaili, D. Cvijanovic, A. Despotovic, D. Šunjka, *Br. Food J.*, **126**, 2149 (2024).
2. B. Marelli, *Science*, **376**, 146 (2022).
3. P. Chakraborty, E. Borras, M. Y. Rajapakse, M. M. McCartney, M. Bustamante, E. J. Mitcham, C. E. Davis, *Appl. Food Res.*, **3**, 100308 (2023).
4. M. Gu, C. Li, L. Chen, S. Li, N. Xiao, D. Zhang, X. Zheng, *Food Chem.*, **424**, 136341 (2023).
5. Y. Xu, Y. Lu, J. Yu, W. Liu, G. Jing, W. Li, W. Liu, *Food Anal. Methods*, **16**, 909 (2023).

Nanobiosensing Pomotes the Development of Life Analytical Chemistry

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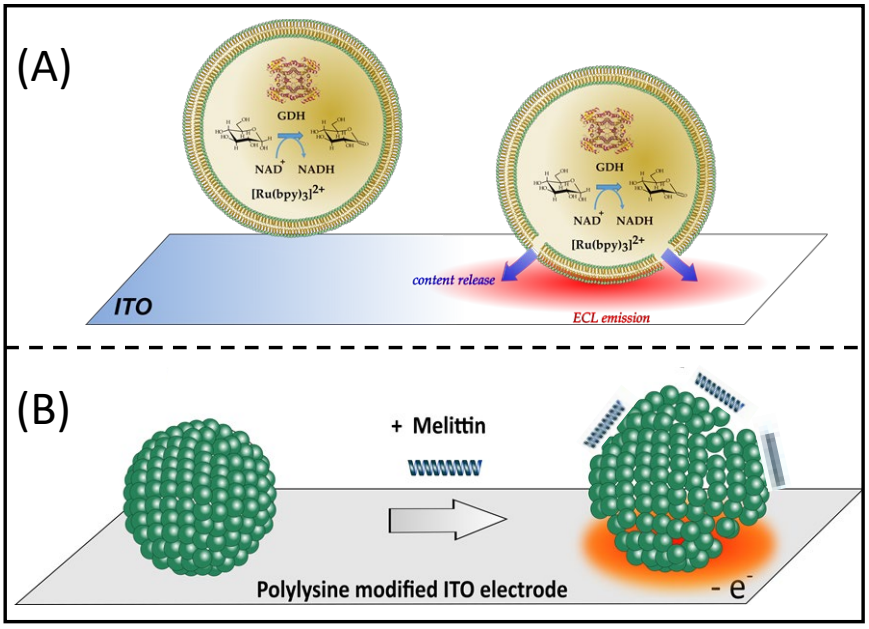
The first decade of the 21st century was labeled as “the sensing decade”. Among sensing, nanobiosensing is one of the hottest topics due to the unique properties of nanomaterials, which offer excellent platforms as electronic and optical signal transduction to design biosensing devices. The first application of nanoparticle materials in biosensing can be dated back to the late 1990s and early 2000s, with the employment of Au colloids by Ju and his coworkers in Nanjing University to improve the bioaffinity and direct electron transfer of enzyme at the electrode surface of an electrochemical biosensor for the detection of hydrogen peroxide. Since then, the electrochemical biosensing field has witnessed a rapid development of nanostructured materials, offering high performance and versatility for various applications, especially, in life analytical chemistry. Life analytical chemistry, a research field formed since the late 90s of last century through the permeation of analytical chemistry into life science and first proposed by the researchers from Nanjing University in 2003, is a new branch of analytical chemistry discipline. It is a cross cutting area to investigate various compositions and structure units of substances in life systems as well as their changes in the interaction processes, to establish new principles, methods and techniques for detection and tracing of biomolecules in biological processes, to quantitatively and qualitatively monitor the biological matters with short time, high sensitivity, good specificity and high accuracy, and to realize molecular recognition and biological information extraction. At present, the research of life analytical chemistry in China has been flourishing, and made great achievements. This talk will introduce the key research progress and tendency of life analytical chemistry through the research achievements of the reporter, focusing on the driving role of nanobiosensing in this field.

Development of An Electrochemiluminescence Imaging Strategy To Analyse Giant Liposome Release Events

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Combining electrochemistry and luminescence offers the opportunity to study biological processes, such as the monitoring and quantification of transmembrane trafficking. In this context, we recently developed an electrochemiluminescence (ECL) imaging strategy to characterize the release events from liposomes [1]. The strategy consisted first in the encapsulation of ECL reagents ($[Ru(bpy)_3]^{2+}$ and tripropylamine (TPrA)) in sealed giant asymmetrical liposomes (100 µm in diameter) made of DOPG/DOPC phospholipids. Then, liposome permeabilization was triggered at the surface of a polarized transparent ITO electrode, allowing the electrochemical oxidation of the content and the visualization of the leaking process. The simultaneous ECL, photoluminescent and amperometric monitoring provided information on the liposome shape during permeabilization, the assignment of the corresponding signals to a specific liposome, as well as the quantification of the TPrA released.



Alternatively, we also developed an original method allowing imaging of giant liposome opening, but in a negative optical contrast (i.e., by shadow electrochemiluminescence) [2]. Compared to the previous approach, the ECL reagents are no longer inside the liposomes, but diffuse freely into the solution outside the liposomes. Under polarization, and as long as the liposome remains intact, light is generated around the liposome, but not at the point of contact between the liposome and the electrode surface, as the latter is blocked. In case of membrane permeabilization the dark zone expands over time on the electrode surface due to dilution of the ECL reagents by the release of the inactive internal solution. The positive ECL approach was recently successfully used to image the permeabilization of liposomes by melittin, a representative antimicrobial peptide (AMP) [3] and to image a NADH-based enzymatic reaction confined within giant liposomes [4] (See Figure (A) and (B)).

References

1. F. Ben Trad, V. Wieczny, J. Delacotte, M. Morel, M. Guille-Collignon, S. Arbault, F. Lemaître, N. Sojic, E. Labbé, O. Buriez. *Anal Chem.* **94**, 1686-1696 (2022)
2. F. Ben Trad, J. Delacotte, F. Lemaître, M. Guille-Collignon, S. Arbault, N. Sojic, E. Labbé, O. Buriez. *Analyst*, **149**, 3317-3324 (2024)
3. F. Ben Trad, J. Delacotte, M. Guille-Collignon, F. Lemaître, S. Arbault, N. Sojic, F. Burlina, E. Labbé, O. Buriez. *Chem. Biomed. Imaging*. **1**, 58-65 (2023)
4. F. Ben Trad, B. Carré, J. Delacotte, F. Lemaître, M. Guille-Collignon, S. Arbault, N. Sojic, E. Labbé, O. Buriez. *Anal. Bioanal. Chem*. **416**, 7385-7394 (2024)

Imaging and biosensing in the brain of freely behaving animals

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The brain is the most complex and advanced part of the nervous system, and its functions rely on precise regulation at the molecular level. Real-time observation of dynamic changes in neurochemicals in living brain is crucial for understanding the molecular mechanisms of brain function and neurological diseases. However, brain function involves numerous neurochemicals with dynamic change. Additionally, it is also closely related to the interactions between different organelles, nerve cells, and various brain regions. Face to address the key scientific issues of in vivo brain imaging and precise measurements, our group achieved innovative research results in developing efficient strategies for recognizing chemical molecules in the living brain, creating a library of accurate probes, and establishing new devices and methods for imaging and biosensing of multiple molecules with high spatiotemporal resolution in the brain.[1] Firstly, multiple-recognition and self-calibrated strategies were proposed, and a set of selective and accurate probes were created for real-time quantifying of chemical signals in the living brains with high accuracy. [2-3] Secondly, to challenge the long-term determination in the complicated brain, the new self-assembled surface with Au-C ≡ C bond was established, which exhibits high stability under thiol-rich biological conditions. Furthermore, a more reliable sensing platform with long-term stability and anti-biofouling was constructed through rational integrating highly stable graphene-layered molecular interface, remarkably elongating the time dimension for real-time tracking of the dynamic changes in free-moving animals up from several hours to a record-long 60 days.[4] More significantly, the concept of optophysiological probes was first proposed, and in vivo measurements system was created based on highly sensitive non-metallic Raman enhancement, which enabled simultaneous measurements of electrical and chemical signals in the mice brains.[5-7] An ultrafast Raman fiber photometry was built up for quantifying multiple chemical species in living brain. It provided new methods and approaches for real-time tracking and spatial imaging of neurochemicals in vivo. Using our developed methods, the qualitative and quantitative relationship between chemical molecules was first discovered in ischemia-reperfusion model. In addition, the lack of functional networks related to L-cysteine, dopamine and acetylcholinesterase in 32 brain regions of depressed mice was found. Moreover, we discovered that hypoxia-induced mitochondrial superoxide burst was regulated by acid-sensing ion channel 1a, resulting in mitochondrial Ca^{2+} overload and hypoxic brain injury. It was also discovered oxidative stress caused by the conversion of Cu^{+} to Cu^{2+} was the leading event and caused neuron death at the early stage (< 9 h) of cuproptosis.

References

1. Y. Liu, Z. Liu, and Y. Tian, *Acc. Chem. Res.*, **55**, 2821 (2022)
2. Y. Wang, Y. Qian, L. Zhang, Z. Zhang, S. Chen, J. Liu, X. He, and Y. Tian, *J. Am. Chem. Soc.*, **145**, 2118 (2023)

3. S. Wang, Y. Liu, L. Peng, W. Duan, Y. Shu, and Y. Tian, *Angew. Chem. Int. Ed.*, e202422602 (2025)
4. Y. Mei, W. Zhang, Q. Gu, Z. Liu, X. He, and Y. Tian, *J. Am. Chem. Soc.*, **144**, 2351 (2022)
5. Y. Liu, Z. Liu, F. Zhao, and Y. Tian, *Angew. Chem. Int. Ed.*, **60**, 14429 (2021)
6. Z. Liu, Z. Zhang, Y. Liu, Y. Mei, E. Feng, Y. Liu, T. Zheng, J. Chen, S. Zhang, and Y. Tian, *Angew. Chem. Int. Ed.*, **61**, e202111630 (2022)
7. S. Zhang, Y. Mei, J. Liu, Z. Liu, and Y. Tian, *Nat. Commun.*, **15**, 3246 (2024)

High-throughput biosensors with increased sensitivity and specificity

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Summary

Sensitive high-throughput (simultaneous) screening for tens to hundreds of analytes in real samples could dramatically reduce the analysis time and cost for clinical analysis and diagnostics (personalized medicine), food safety control, drug development, environmental monitoring, forensic analysis, etc (1).

Milk safety is a relevant example, since each milk sample has to be screened for antibiotics (from various classes), and for different pathogenic bacteria. The maximum residual levels (MRL) allowed for antibiotics are in the ppb range (2) and the current analytical methods (ELISA or chromatography-mass spectrometry) are expensive and time-intensive. For pathogenic bacteria, besides their detection, the tracking of their antibiotic resistance along the food chain is paramount for human health. To this end, methods enabling not only the detection of bacteria, but also the evaluation of their interaction with antibiotics in real time are particularly beneficial (3).

For addressing this challenges, we introduce a novel label-free sensing platform, with increased sensitivity and specificity, based on the integration of surface plasmon resonance (SPR) and electrochemical impedance spectroscopy (EIS)(4), via the plasmonic based EIS (P-EIS) detection scheme (5–7). Such integration is possible because SPR is sensitive to refractive index variations near the interface and also to surface charge density variations (8,9) as a response to AC field modulation.

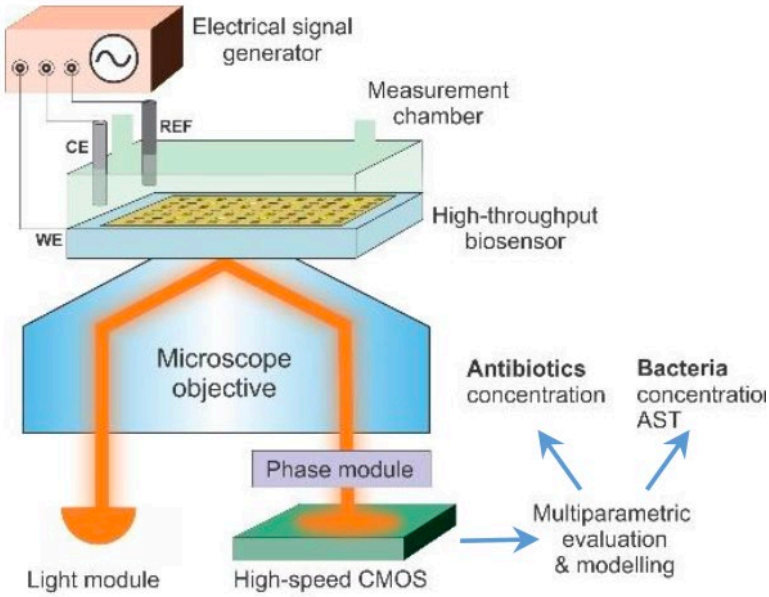


Fig. 1 – Schematic representation of the P-EISi concept

In the proposed platform, the enhanced performace is achieved by using:

- a more sensitive SPRi technique based on SPR phase measurements

- a smart functionalization of sensing interfaces and efficient assay design. Various receptors (e.g., antibodies, aptamers, nanobodies etc.), for antibiotics or bacteria commonly found in milk are investigated as biorecognition strategies.

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References

(1) Kokkinos, C.; Economou, A.; Prodromidis, M. I. TrAC Trends Anal. Chem. 79,88–105. (2015)
(2) Gaudin, V.; Hedou, C.; Soumet, C.; Verdon, E. Food Addit. Contam. - Part A Chem. Anal. Control. Expo. Risk Assess. 35 (12), 2348–2365. (2018,)
(3) Syal, K.; Iriya, R.; Yang, Y.; Yu, H.; Wang, S.; Haydel, S. E.; Chen, H. Y.; Tao, N.ACS Nano, 10 (1), 845–852. (2016)
(4) Ribeiro, J. A.; Sales, M. G. F.; Pereira, C. M. TrAC - Trends Anal. Chem. 157. (2022)
(5) Polonschii, C.; David, S.; Gáspár, S.; Gheorghiu, M.; Rosu-Hamzescu, M.; Gheorghiu, E.Anal. Chem., 86 (17) (2014)
8553–8562. https://doi.org/10.1021/ac501348n.
(6) Lu, J.; Wang, W.; Wang, S. P.; Shan, X. N.; Li, J. H.; Tao, N. J. Anal. Chem., 84,327–333. (2012)
(7) Wang, W.; Foley, K.; Shan, X.; Wang, S.; Eaton, S.; Nagaraj, V. J.; Wiktor, P.; Patel, U.; Tao,N.. Nat. Chem. 3 (3), 249–255.(2011,)
(9) Foley, K. J.; Shan, X.; Tao, N. J. Surface Impedance Imaging Technique. Anal. Chem. 80 (13),

5146–5151(2008),
(10) McIntyre, J. D. E. Surf. Sci., 37 (0), 658–682. (1973)

Single Particle Electrochemiluminescence Imaging

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Single-molecule measurement has emerged as an ideal tool for developing ultrasensitive biosensors. This makes it possible to detect low-abundance molecules more accurately in complex samples. We introduced a single-particle imaging by electrochemiluminescence using $Ru(bpy)_3^{2+}$-doped silica/Au nanoparticles as the nanoemitters, leading to a significant enhancement in the intensity. Furthermore, we developed the nanoreactors based on the nanoporous nanoparticles for direct visualization of nanoconfinement-enhanced ECL reactions. By labeling individual proteins of living cells with single nanoreactor, the distribution of membrane proteins at low-expressing cells is imaged. More importantly, the efficient capture of ECL photons generated inside the nanoreactor results in a stable ECL emission up to 1hr, allowing the in operando visualization of protein movements at the cellular membrane. Additionally, we further developed a stimuli-responsive self-assembled nanomachine that enables the ECL imaging of intracellular target biomolecules in single cells. The ECL nanoprobe consists of an ECL nanoemitter constructed from $Ru(bpy)_3^{2+}$-doped metal-organic framework as the nanoreactor core, with a DNA polymer hydrogel shell (DNAgel) acting as the stimuli-gated layer. As compared with the fluorescence observation, near-zero ECL background surrounding the target protein with the ECL emitter gives a better contrast for the dynamic imaging of discrete protein movement. This could provide a sensitive tool for imaging individual biomolecules in biological applications.

Acknowledgements

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References

1. B. Li, Y. Lu, X. Huang, N. Sojic, D. Jiang and B. Liu. *Angew. Chem. Int. Ed.* **64**, e202421658 (2025).
2. Y. Lu, Y. Ning, B. Li and B. Liu. *Anal. Chem.* **96** , 463 (2024)
3. Y. Lu, X. Huang, S. Wang, B. Li and B. Liu, *ACS Nano,***17**, 3809 (2023).
4. X. Huang, B. Li, Y. Lu, Y. Liu, S. Wang, N. Sojic, D. Jiang and B. Liu, *Angew. Chem. Int. Ed.*,**62**, e202215078(2023).
5. B. Li, X. Huang, Y. Lu, Z. Fan, B. Li, D. Jiang, N. Sojic andB. Liu, *Ad. Sci.*, **9**, 2204715 (2022).
6. Y. Liu, H. Zhang, B. Li, J. Liu, D. Jiang, B. Liu and N. Sojic, *J. Am. Chem. Soc.*,**143**, 17910 (2021)

Brain Chemistry in Vivo Iontronic Sensing

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Brain chemistry in vivo iontronic sensing is not only important for the knowledge and understanding of ion channels for life processes, but also brings new opportunities for the development of new electrochemical analysis principles and methods. For example, single-molecule sequencing techniques developed based on protein pores have attracted increasing attention. We have been focused on basic and applied research on ion transport for a long time, and this report intends to combine the research foundation of many years, and intends to elaborate on the development of electrochemical analysis principles and methods for brain chemistry in vivo iontronic sensing in terms of the modulation of ion transport on the micro- and nanoscale, and the solid-phase ion transport.

1) Using the tip-domain-limited effect of glass micro-nanotubes, the in vivo analysis of non-electrochemically active species can be achieved by rationally designing and regulating the size and inner-wall modification of the tip. Meanwhile, using the collision technique of the developed glass nanotubes, we have developed a new principle and method of electrochemical analysis that can be used for single-particle analysis, and investigated its applicability in the in situ analysis of intracellular vesicles and sizes. Meanwhile, the rectification of micrometer tubes was discovered and a model of micrometer tube rectification was proposed, and based on this, a new principle of in vivo analysis was established.

2) Based on the domain-limiting effect of solid-phase ion transport, novel sensing modes that can be used for gas-phase sensing were developed by modulating the behaviour of solid-phase ion transport. By designing and synthesising novel ionic compounds of imidazole cations and anions, it was found that their ionic transport resistance was different in gases with different humidity, based on which humidity sensors regulating solid-phase ion transport were developed. On this basis, the binding ability of graphyne oxide with protons was further exploited to develop ultrafast humidity sensing, which can be used for real-time monitoring of respiratory rate in rats.

References

1. T. Xiong, C. Li, X. He, B. Xie, J. Zong, Y. Jiang, W. Ma, F. Wu, J. Fei, Ping Yu*, L. Mao*, Science, 379.156-161(2023).
2. K. Zhang, H. Wei, T. Xiong, Y Jiang, W. Ma, F. Wu, P. Yu*, L. Mao, Chem. Sci., 12, 7369 (2021).
3. T, Xiong, K. Zhang, Y. Jiang, P. Yu*, L. Mao*H, Wei, Sci China-Chem., 61, 1346 (2019).
4. X. He, Y. Liu, K. Zhang, F. Wu, P. Yu*, L. Mao, Angew. Chem. Int. Ed., 57, 4590 (2018).
5. He X., Zhang K., Li T., Jiang Y., Yu P.*, Mao L., J. Am. Chem. Soc., 139, 1396-1399(2017).

The Electrode/Electrolyte Interface Study Using Rotating Ring Disk Electrode

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Electrocatalytic reactions play essential roles in electrochemical energy conversion and storage technologies. The reaction pathways and electrochemical interfaces have been barely understood due to lack of direct molecular level information, especially when there are competitive reactions in the same potential window. In this talk, we will present the studies using the rotating ring disk electrode on the electrode/electrolyte interface during the competitions between CO_2 reduction and hydrogen evolution reaction in acidic electrolytes on Cu, hydrogen evolution reaction and oxygen reduction reaction on Au.

References

1. Y. Yao*, J.P. Xu, M.H. Shao*, "Competitions between hydrogen evolution reaction and oxygen reduction reaction on an Au surface", Chinese Journal of Catalysis, 2025, accepted.
2. Y. Yao*, E. Delmo, M.H. Shao*, "The electrode/electrolyte interface study during the electrochemical CO2 reduction in acidic electrolytes", Angewandte Chemie International Edition, 2024, e202415894.

Intelligent bio-imaging and monitoring of cancers via bio-responsive self-assembly and electrochemical nanointerface

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Abstract

The ultrasensitive biorecognition for the early diagnosis / monitoring of some important disease like cancers has attracted much attention in the relevant fields. In this study, we have explored the possibility of the application of some biomolecular probes combining with the bio-responsive self-assembly supramolecules or nano-scaled agents in targeting bio-recognition and high-sensitive biosensing / bioimaging of the diseased locations like tumors. Especially, we have developed some novel strategies for the rapid imaging and highly sensitive recognition of the targeted biomolecules and cancer cells / exosomes by combining the active agents and functionalized nanointerfaces for multiscale theranostics. Our observations demonstrate that the *in situ* self-assembly of the specific biomolecules with the nano-probes could provide a multifunctional interface for the rapid identification and precise imaging of cancer cells / exosomes, with a broad detection range and low detection limit. It is evident that different types of cancer cells or relevant bacteria can be readily distinguished on the bio-responsive spectra-electrochemical nano-interfaces, which have the promising application to be adopted as a significant way to detect various kinds of mutant cells / tissues or related exosomes *in vivo* and advance the clinic diagnosis and treatment of some important diseases like cancers. Moreover, some ultrasensitive and intelligently multi-functional nanoscale bio-robots based on the *in vivo* bio-responsive self-assembly of bio-synthetic nanoclusters through utilizing the peculiarities of the microenvironment and relevant redox homeostasis from cancer cells or bacteria have been also explored for the real-time multi-scale monitoring and multi-modality / or panoramic imaging of cancer cells and relevant exosomes as well as affected tissues for precise theranostics.

Size-selective Enzyme Adsorption Electrode Using Interlayer Distance Control of Monolayer Graphene and Graphene Oxide

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Enzymes and other proteins that are used in biosensors can be size-selectively combined within the molecular adsorption sites of porous carbon [1]. However, by using monolayer graphene (MG) that does not have a pore structure, it is impossible to provide a size-selective molecular adsorption site. In this study, we created a size-selective enzyme adsorption electrode by stacking graphene oxide (GO) micro sheets on MG to realize molecular adsorption sites between the layers (Fig. 1). By forming double-stranded DNA (dsDNA) between the MG and GO layers, size-controlled interlayer can be obtained because dsDNA is a strong polymer and its chain length can be precisely controlled by the number of bases. Here we made two types of MG-GO electrode by using 15- or 30-base-pair dsDNA to form the interlayer. We adsorbed bilirubin oxidase (BOD), an enzyme that catalyzes the oxygen reduction reaction [2], which has a molecular size roughly the same as that of 15-base-pair dsDNA. We used cyclic voltammetry (CV) measurements to compare whether the catalytic effect of the enzyme changes depending on the he number of base paers of dsDNA. These results confirmed that larger numbers of BOD molecules were adsorbed on MG-GO electrode prepared by 15-base-pair dsDNA (MG-15bp-GO) than that of MG-GO electrode prepared by 15-base-pair dsDNA (MG-30bp-GO) .

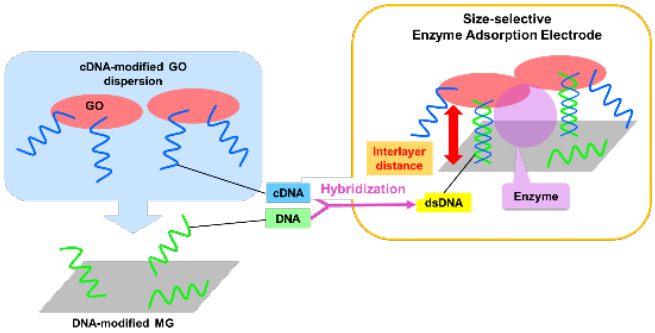


Fig.1 Schematic illustration of the fabrication method (left) and structure (right) of the size-selective enzyme adsorption

The experiment was carried out as follows. An aqueous dispersion of GO modified with DNA complementary to DNA (cDNA) was dropped onto the surface of DNA-modified MG fixed on a glass substrate, and the electrode was left at room temperature for 30 minutes to hybridize the DNA and cDNA, completing fabrication of MG-15bp-GO and MG-30bp-GO. The MG-15/ or 30bp-GO electrode was modified with BOD by immersing it in a BOD aqueous solution. We measured the CV of phosphate buffer solution (0.1 M PBS pH = 7.4) bubbled with oxygen.

We analyzed the results of the CV measurements and determined the potential at which the oxygen reduction reaction begins (E_{onset}). The values of E_{onset} and the current values at -0.4 V ($I_{-0.4V}$) are summarized in Table 1. The results show that E_{onset}.and $I_{-0.4V}$ were highest for MG-15bp-GO, followed by MG and MG-30bp-GO. It inditaces that the reaction activity was highest in that order. The MG-GO interlayer distance for MG-15bp-GO was estimated to be approximately 5.1 nm, which is roughly the same as the molecular size of BOD (5 nm). This suggests that BOD was adsorbed in a size-selective manner, resulting

in the highest activity for the oxygen reduction reaction. On the other hand, the MG-GO interlayer distance for MG-30bp-GO was estimated to be approximately 10.2 nm, which is considerably larger than the molecular size of BOD, and therefore it is believed that adsorption did not occur effectively.

Table.1 Comparison of E_{onset} and $I_{-0.4V}$ analyzed by the results of CV measurements

	MG	MG-15bp-GO	MG-30bp-GO
E_{onset} / V	-0.165	-0.094	-0.240
$I_{-0.4V}$ / μA	0.953	1.637	0.246

References

1. A. Ueda et al., *J. Am. Chem. Soc.*, **133**, 4840-4846 (2011).
2. S. Shiba et al., *Electrochem.*, **83**, 332-334 (2015).

Improving The Selectivity of Electrochemiluminescence-Based Sensors by Applying Molecularly Imprinted Polymers

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The detection methods based on electrochemiluminescence (ECL) system has attracted a lot of attention due to its advantages, including low background signal, controllable reactions, high sensitivity as well as rapid responses with relatively economic-cost and simple instruments [1]. The ECL systems involves two steps, including electrochemical reactions to perform the excitation of the luminophore and the subsequent luminescence process [1]. Furthermore, the generate luminescence (ECL signals) can increase with the increase of specific reaction between the luminophore and the analyte [1]. In this case, a very selective sensor could be developed. However, ECL signals can also decrease with the presence of analyte due to the quenching reaction of the luminophores [2]. This kind of ECL system can also be developed for sensors although the selectivity is not very high [2].

This work introduces a strategy to increase the selectivty of ECL sensor through incorporation of molecularly imprinted polymers (MIPs) to the sensor by creating template-specific cavities in a polymer matrix, mimicking recognition systems [3]. A novel and high selectivity of ECL-based sensor of 3-monochloropropane-1,2-diol (3-MCPD) was developed employing MIP of polyaniline (PANI) film formed on a screen-printed carbon electrode (SPCE). 3-MCPD is a food processing contaminant formed in high temperatur reaction between lipids and chloride ions [4]. The presence of 3-MCPD in food has high health risks beause of its nephrotoxic, genotoxic, and carcinogenic properties. PANI was selected as the MIP matrix due to its electrical conductivity and environmental stability as well as its simple preparation [5]. Synthesis of PANI on the surface of SPCE was electrohemically conducted by using cyclic volammetry technique in 0.1 M H_2SO_4 consisted of 0.5 mM aniline and 10 µM 3-MCPD. A potential range from −0.2 V to +1.2 V at a scan rate of 50 mV/s for 15 cycles was applied, followed by 3-MCPD template removal through an elution process using methanol-water (2:1). A non-imprinted polymer (NIP-PANI) was prepared under identical conditions with the absence of 3-MCPD in the solution.

The morphological of the modified electrodes examined using SEM showed no significant different on the modified surface with the presence and the absence of 3-MCPD. On the contrary, the elemental mapping results observed the presence of chlorine as one of the 3-MCPD component on the electrode matrix, which then significantly reduced after template removal. The distributions of carbon, nitrogen, and oxygen remain consistent, indicating stable formation of PANI matrix on the SPCE surface. These results confirm that the molecular imprinting and template removal processes were successfully achieved. It was expected that the formation of specific recognition cavities can act as the molecular recognition sites to improve the sensor's selectivity toward 3-MCPD.

Figure 1(a-c) illustrates the ECL responses of various combinations of 0.1 M phosphate buffer solution (PBS) consisting tris(2,2'-bipyridyl)ruthenium(II) ($[Ru(bpy)_3]^{2+}$) as the luminophore, triethylamine (TEA) as co-reactant, and 3-MCPD as the analyte. The emitted light was recorded at 620 nm, corresponding to the characteristic emission wavelength of $[Ru(bpy)_3]^{2+}$. Electrochemical oxidation of $[Ru(bpy)_3]^{2+}$ produces $[Ru(bpy)_3]^{3+}$, whereas TEA produces TEA radical cation ($TEA^{+\cdot}$), which is unstable and readily loses a proton to form a neutral radical ($TEA^{\cdot}$). This radical serves as a strong reducing agent to regenerate $[Ru(bpy)_3]^{2+}$ in its excited state ($[Ru(bpy)_3]^{2+*}$). The return of this excited-state complex to its ground state is accompanied by photon emission, which is the basis of the ECL signal [1,2].

The ECL curves shows a significant signal enhancement in the presence of both $[Ru(bpy)_3]^{2+}$ and TEA (**Figure 1b**), confirming the efficient co-reactant pathway. However, the addition of 3-MCPD decreases in the ECL intensity, suggesting 3-MCPD acts as a signal quencher in the system (**Figure 1c**). It seems the interaction of 3-MCPD with reactive intermediates—such as $TEA^{\cdot}$ or $[Ru(bpy)_3]^{2+*}$— deactivates the excited species before photon emission. These results indicate that the ECL intensity of the $[Ru(bpy)_3]^{2+}$/TEA system is sensitive to the presence of 3-MCPD, allowing for its detection based on luminescence quenching. Furthermore, at the optimum condition of pH 7 with 3 mM $[Ru(bpy)_3]^{2+}$ and 10 mM TEA, the ECL system demonstrated a linear callibration curve (R^2=0.99) in the concentration range of 25–250 nM with a sensitivity of 4.65 a.u/nM and limit of detection of 25 nM. The developed sensor also shows high selectivity for interference of glycerol and glycidyl palmitate. The results indicates that integration of MIP with ECL sensing offers a highly selective methods for 3-MCPD detection, which is promising to develop other ECL-based sensors with high sensitivity.

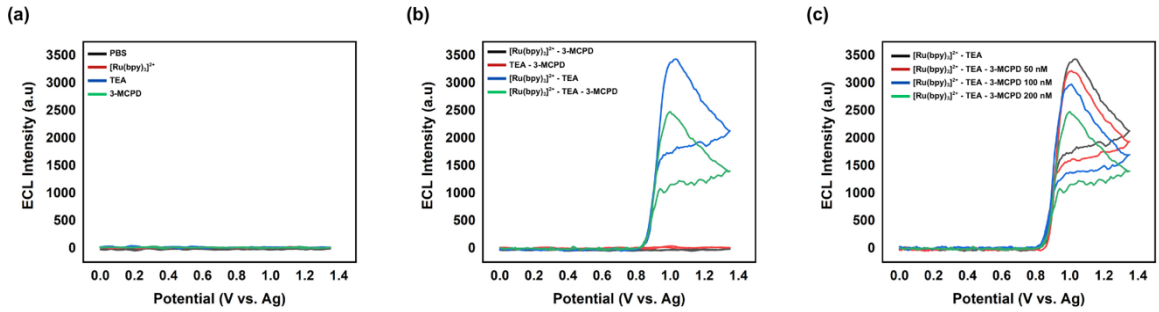


Fig.1 ECL signals of 0.1 M phosphate buffer solution (a) in the absence and in the presence of each 3 mM $[Ru(bpy)_3]^{2+}$, 10 mM TEA, and 200 nM 3-MCPD; (b) in the presence of 3 mM $[Ru(bpy)_3]^{2+}$, 10 mM TEA, and 200 nM 3-MCPD in various combinations; and (c) in the presence of various concentrations of 3-MCPD.

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References

1. L. Zheng, Y. Chi, Z. Dong, L. Zhang, and G. Chen, *J. Phys. Chem. C* **112**(39), 15570–15575 (2008).
2. D. Kong, Y. Liu, Z. Wang, L. Jiang, J. Cheng, L. Xu, Q. Zhuang, C.-H. Lu, Y. Chi, and Q. Wei, *J.*

Electroanal. Chem. **801**, 1–6 (2017)
3. X. Sun, L. Zhang, H. Zhang, H. Qian, Y. Zhang, L.Tang, and Z. Li, *J Agric. Food Chem.* **62**(20), 4552–4557 (2014)
4. D. He, W. Wei, and Z. Guo, *J. Am. Oil Chem. Soc.* **97**(11), 1277–1279 (2020)
5. S. Mahalakshmi and V. Sridevi, *Electrocatalysis* **12**(4), 415–435 (2021)

Single-molecule chemiluminescence imaging

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Dut to the weak signals and randomness of the reaction paths and locations, it is difficult to effectively control and track single-molecule processes. Direct imaging of single-molecule chemical processes has been a long-standing challenge. Single-molecule fluorescence is a widely used approach for single-molecule imaging; however, it relies on the use of excitation light that intrisically introduces laser effects. We developed single-molecule electrochemiluminescence microscopy and directly observed single-molecule electrochemical reactions. The biological imaging capability of this technique can be complementary to single-molecule fluorescence microscopy. Recently, we further developed single-molecule chemiluminescence microscopy that does not rely on electrochemical excitation, allowing to perform single-molecule metrology at deep levels in solution. This reaction based single-molecule microscopy can be applied to biological bioimaging, catalysis characterization and single-molecule immunoassay, providing a new tool for chemical metrology and biological imaging.

Acknowledgements

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References

1. Ziqing Zhang, Jinrun Dong, Yibo Yang, Yuan Zhou, Yuang Chen, Yang Xu, and Jiandong Feng*. *Nature Communications*, 2023, 14, 7993.
2. Jinrun Dong#, Yuxian Lu#, Yang Xu, Fanfan Chen, Jinmei Yang, Yuang Chen, Jiandong Feng*. Nature, 2021, 596, 244-249.

Chemical Modulation of Carbon Nitride for Electrochemiluminescent Sensing

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As an emerging luminophore, metal free 2D carbon nitride demonstrates the advantages of low-cost, high biocompatibility and stability, easy functionalization, strong electrochemiluminescent (ECL) emission, and an unambiguous luminescence mechanism. Many ECL biosensors based on carbon nitride have been developed, with very promising performances. As chemical tailoring of 2D materials can effectively control the properties thus guiding their applications, our group recently explored the modulation of a diverse range of carbon nitrides with different dopants and nanostructures of nanosheets, nanofibers, and quantum dots. It not only tunes the optical properties of carbon nitride but also offer an effective way to engineer the surface of them are important in addressing the challenges of biosensing such as the development of new strategies for higher sensitivity and selectivity that involves signal transducer and multiscale interfaces.

References

1. Zhao, T.; Zhou, Q.; Lv, Y.; Han, D.; Wu, K.; Zhao, L.; Shen, Y.; Liu, S.; Zhang, Y. Ultrafast Condensation of Carbon Nitride on Electrodes with Exceptional Boosted Photocurrent and Electrochemiluminescence. *Angew. Chem. Int. Ed.* **2020**, *59* (3), 1139-1143. DOI: 10.1002/anie.201911822.
2. Hong, Q.; Yang, H.; Fang, Y.; Li, W.; Zhu, C.; Wang, Z.; Liang, S.; Cao, X.; Zhou, Z.; Shen, Y.; et al. Adaptable graphitic C6N6-based copper single-atom catalyst for intelligent biosensing. *Nat Commun* **2023**, *14* (1), 2780 DOI: 10.1038/s41467-023-38459-9.
3. Wu, K.; Chen, R.; Zhou, Z.; Chen, X.; Lv, Y.; Ma, J.; Shen, Y.; Liu, S.; Zhang, Y. Elucidating Electrocatalytic Oxygen Reduction Kinetics via Intermediates by Time-Dependent Electrochemiluminescence. *Angew. Chem. Int. Ed.* **2023**, *62*, e202217078. DOI: 10.1002/anie.202217078.
4. Fang, Y.; Yang, H.; Hou, Y.; Li, W.; Shen, Y.; Liu, S.; Zhang, Y. Timescale correlation of shallow trap states increases electrochemiluminescence efficiency in carbon nitrides. *Nat Commun* **2024**, *15* (1), 3597. DOI: 10.1038/s41467-024-48011-y.
5. Wang, Y.; Zhou, S.; Zheng, Y.; Wang, Y.; Hou, Y.; Wu, K.; Huang, C.; Liu, S.; Shen, Y.; Chen, R.; Zhang, Y. Measurements of Local pH Gradients for Electrocatalysts in Oxygen Evolution Reaction by Electrochemiluminescence. *J. Am. Chem. Soc.* **2025** accepted.

Electrically Modulated Calcium Nanodynamics in High-Speed AFM: Toward a New Paradigm for Imaging Stimulated Biointerfaces

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The precise spatiotemporal control of calcium ion (Ca^{2+}) concentration is essential for a wide range of membrane-associated biological processes, including protein – lipid interactions, intracellular signaling, and cytoskeletal dynamics. While high-speed atomic force microscopy (HS-AFM) [1] enables real-time visualization of such events at molecular resolution, it lacks built-in tools for manipulating local ionic environments dynamically [2].

Here, we propose and theoretically assess a novel strategy for electrically modulating calcium availability at the nanoscale using an electrochemical setup compatible with HS-AFM. This configuration enables field-driven ion redistribution across a biologically relevant membrane–electrolyte interface, offering a new platform to explore Ca^{2+}-dependent molecular dynamics under precisely controlled electrostimulation.

We present initial computational results based on Poisson–Nernst–Planck (PNP) modeling of calcium transport in buffered physiological media under low-voltage pulses (–50 to –200 mV). Simulations capture realistic ion redistribution timescales and field screening effects, and provide predictive insight into voltage-triggered annexin V–membrane interaction [3]. The model also identifies practical limits in electric field penetration due to Na^+/Cl^- screening and highlights critical design parameters such as electrode spacing, buffer composition, and pulse duration.

By integrating physics-based modeling with HS-AFM, this work lays the foundation for a new class of bioelectrochemical imaging experiments, where nanoscale ionic microenvironments are shaped in real time to trigger or modulate biological function. While experimental validation is underway, this approach opens new avenues for studying calcium-regulated systems with nanometer and millisecond precision — with potential applications in mechanobiology, biosensing, and electrochemically tunable nanomedicine [2].

.**Keywords**: bioelectrochemistry, calcium ion dynamics, high-speed AFM, Poisson–Nernst–Planck modeling, nanointerfaces, electrostimulation, annexin–lipid interaction

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of the author(s) only and do not necessarily reflect those of the European Union. Neither the European Union nor the MSCA4Ukraine Consortium as a whole nor any individual member institutions of the MSCA4Ukraine Consortium can be held responsible for them

References

1. T. Ando, T. Uchihashi, N. Kodera, High-speed AFM and applications to biomolecular systems, *Annu. Rev. Biophys.* **42**, 393–414 (2013).
2. K. Muzyka, F. Rico, G. Xu, I. Casuso, *J. Electroanal. Chem.* **938**, 117448 (2023).
3. A. Miyagi, C. Chipot, M. Rangl, S. Scheuring, *Nature Nanotechnology* **11**(9), 783–790 (2016).

Reversibility of Disproportionation Reaction of Superoxide Species for Li-O_2 Batteries

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The lithium-oxygen (Li-O_2) battery has emerged as a promising candidate for next-generation energy storage systems due to its exceptionally high theoretical energy density (3150 Wh/kg), which significantly exceeds that of conventional lithium-ion batteries (LIBs).[1-3]

The superoxide (O_2^-) disproportionation reaction in Li-ion-containing solutions, a critical process governing aprotic lithium-oxygen (Li-O_2) battery chemistry, has long been regarded as irreversible due to the formation of solid precipitation lithium peroxide (Li_2O_2) and gaseous oxygen (O_2).[4-7] However, this study reveals reversible disproportionation behavior (2 $LiO_2 \rightleftharpoons Li_2O_2 + O_2$) in conventional Li-$O_2$ cells employing Li-ion-based dimethyl sulfoxide (DMSO) electrolytes, through a systematic investigation that combines in situ UV-Vis spectroscopy, online mass spectrometry, laser diffraction, surface-enhanced Raman spectroscopy (SERS), and atomic force microscopy. DMSO's relative stability toward O_2^- minimizes solvent decomposition side reactions under short-term, low-concentration conditions. Online mass spectrometry quantifies O_2 evolution during disproportionation, consistently showing yields below theoretical stoichiometric predictions. UV-Vis spectroscopy detects residual O_2^- species after disproportionation, even in excess Li-ions in DMSO. Notably, O_2^- persists in O_2-saturated Li_2O_2 suspension solutions. Laser diffraction analysis reveals micron-scale suspended Li_2O_2 particles (1–20 μm) in solution, contrasting with the absence of visible Li_2O_2 deposits on substrates. These findings demonstrate equilibrium-driven disproportionation. These insights alter traditional cathode reaction paradigms, particularly regarding the contribution of chemical disproportionation reactions.

Detailed results and discussions will be given in the presentation.

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References.

1. Luntz, A. C.; McCloskey, B. D. Chem. Rev. 2014, 114, 11721.
2. Kwak, W.-J.; Rosy; Sharon, D.; Xia, C.; Kim, H.; Johnson, L. R.; Bruce, P. G.; Nazar, L. F.; Sun, Y.-K.; Frimer, A. A.; Noked, M.; Freunberger, S. A.; Aurbach, D. Chem. Rev. 2020, 120, 6626−6683.
3. Aurbach, D.; McCloskey, B. D.; Nazar, L. F.; Bruce, P. G. Nat. Energy 2016, 1, 16128.
4. Johnson, L.; Li, C.; Liu, Z.; Chen, Y.; Freunberger, S. A.; Ashok, P. C.; Praveen, B. B.; Dholakia, K.; Tarascon, J.-M.; Bruce, P. G. Nat. Chem. 2014, 6, 1091.
5. Zhang, Y.; Zhang, X.; Wang, J.; McKee, W. C.; Xu, Y.; Peng, Z. J. Phys. Chem. C 2016, 120, 3690.
6. Zhang, Y.; Cui, Q.; Zhang, X.; McKee, W. C.; Xu, Y.; Ling, S.; Li, H.; Zhong, G.; Yang, Y.; Peng,

Z. Angew. Chem. Int. Ed. 2016, 55, 10717.
7. He, L.; Huang, J.; Chen, Y. J. Phys. Chem. Lett. 2022, 13, 2033.

The structure and energetics of graphite intercalation compounds of alkaline metal: van der Waals DFT calculation

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More than 10 years ago we have reported the first-principles calculation for Li-GIC by the CA-type LDA (M. Yamamoto and H. Imamura, Tanso, 2004 No.212 81-90.) The vdW interaction between the graphite layers is crucial, but we cannot obtain them by FP calculation at that time. Since then the vdW-DFT method was proposed by M. Dion, H. Rydberg, E. Schroder, D. C. Langreth, B. I. Lundqvist,*Phys. Rev. Lett.* **92**, 246401 (2004). The non-local correlation energy can describe the vdW interaction very well, and the method has been ported to the VASP (Vienna Ab initio simulation Package) simulation code. In the present study we have used the Projector Augmented method for pseudo-potential and plane waves up to 550 eV were used. The vdW-DF2(rPW86) method is used for vdW calculation.

To check the vdW interaction is accurately included, we have calculated the energy dependence of the graphite interlayer distance. The calculation results are shown in Fig.1. If the non-vdW DFT is used the graphene single layer structure become the most stable structure, but the vdw DFT calculation give the stable interlayer distance that is close the experimental value as shown in Fig.1.

The energetics and structure of graphite and LiC_6 (Fig.2) and LiC_{12} are in good agreement with the results by Wang et al.(Z. Wang et al. Rsc. Adv. 2014, 4, 4069-4079). The have shown that energetics and structures for Li, K, Na GIC are in good agreement with the experimental results. In the present study we have calculated 1) C atom, diamond, graphite (non-vdW, vdW), 2) Li atom, Li bcc metal (non-vdW, vdW) 3)Na atom, Na bcc metal (non-vdW, vdW), 4) LiC_6- and LiC_{12}-GIC non-vdW and vdW.

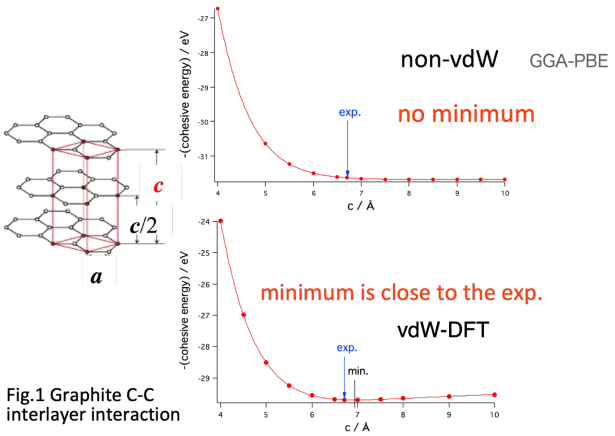


Fig.1 Graphite C-C interlayer interaction

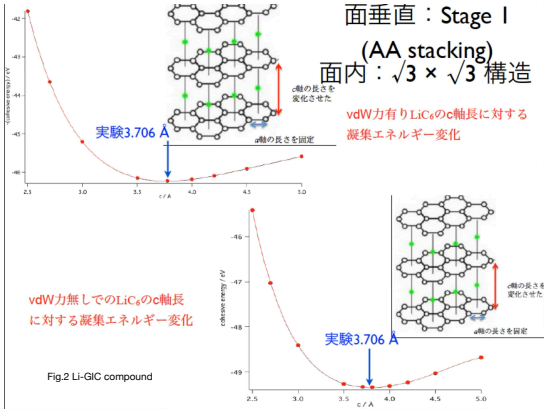


Fig.2 Li-GIC compound

As shown in Fig. 3 the energy barriers of the diffusion for lithium in LiC_6 GIC have been calculated. The energy barrier in the parallel direction of the grapheme plane is 0.3 eV per Li ion without vdW interaction, which is in good agreement with our previous calculation. In the vdW-DF2 calculation the energy barrier is increased up to 0.8 eV, the origin of which may be the attractive character of the vdW interaction between the Li and C. If we expand the C-C interplane distance up to 1 nm which corresponds to the distance between the GIC that contains the solvated intercalants, we have found that the calculated energy barrier in plane direction can be neglected. The dependence of the charged state on the diffusion barrier is not so significant.

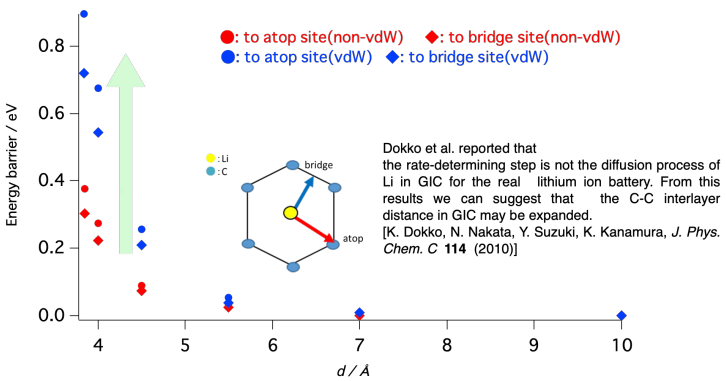


Fig.3 dependence of the diffusion barrier on the C-C interlayer distance

Using vdw-DFT we also calculated the intercalant on the energy change $E(\theta) = E_{total}\ (MC_x)_{cell}$-$x[E_{total}\ (4C_{grhaphite})_{cell}/4]$- $E_{total}\ (M\ metal)_{solid}$ and found that for LiC_6 -0.18 eV (exothermic) and for NaC_6 +0,18 eV (endothermic). This is the reason why graphite is not usable as an anode in sodium ion batteries. Now we are calculating the Na intercalation energy for the more open structure of graphite material.

KOVAR as Promising Anode Material for Lithium-ion-Batteries

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Transition metal oxide (TMO)-based anodes have gained attention as promising candidates for lithium-ion batteries (LIBs) due to their high theoretical capacity and potential to improve energy storage. This research investigates KOVAR alloy nanoparticles (NPs) as prospective TMO-based anode materials for LIBs. The NPs were synthesized using an electrochemical anodization technique, which allows for easy and quick large-scale production. The synthesised material displayed both nanoparticle and nanosheet morphologies. X-ray diffraction analysis uncovered a mixed-metal oxide structure with lattice planes corresponding to $NiFe_2O_4$, Co_3O_4, and Co_2MnO_4. X-ray photoelectron spectroscopy verified the presence of Mn, Fe, Ni, Co, Si, and O in the NPs. Galvanostatic discharge/charge profiles revealed high initial discharge and charge capacities of 1800 $mAhg^{-1}$, which subsequently decreased due to solid electrolyte interface layer formation and irreversible reactions. In extended cycling performance tests at 0.3 C showed an initial capacity of 430 $mAhg^{-1}$, which gradually declined to 314 $mAhg^{-1}$ after 42 cycles, before rising significantly to a peak value of 1373 $mAhg^{-1}$. This capacity enhancement is ascribed to the activation process, electrode balancing, and synergistic effects of the multicomponent TMO anode. The KOVAR-based anode demonstrated good rate capability, achieving discharge capacities of 1800, 825, 575, 500, 325, 250, and 175 $mAhg^{-1}$ at current rates of 0.05, 0.1, 0.2, 0.3, 0.5, 1, and 2 C, respectively. These findings highlight the promise of KOVAR materials as high-performance anode for LIBs.

In situ Monitoring of Photocatalytically Generated Species via Scanning Electrochemical Probe Microscopy

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The direct photocatalytic energy conversion of solar irradiation energy into chemical bond energy using molecular photosensitizers (PS) and catalysts (CAT) has gained attention as an environmentally friendly approach for e.g., water splitting for hydrogen production [1]. To stabilize the PS and CAT molecules, store photogenerated charges and mitigate degradation of the active components, they can be embedded in functional matrices. Typically, catalytic studies to determine the light-driven catalytic activity in homogeneous and heterogeneous catalysis are performed at the bulk level, e.g. using headspace gas chromatography or spectroscopic measurements [2]. Insight into heterogeneities of molecule-in-matrix systems, information on possible degradation and in situ monitoring of activity can be obtained by scanning electrochemical probe microcopy. The use of functionalized miniaturized electrochemical sensors e.g., for hydrogen (H_2) [3] or hydrogen peroxide (H_2O_2) [4] allows the electroanalytical determination of light-driven products under operando conditions.

In this contribution, we use scanning electrochemical probe microscopy (SEPM) techniques in combination with miniaturized sensors, such as platinum black (Pt-B)-modified microelectrodes or tipless AFM-cantilever-integrated hemispherical Pt-B sensors, to enhance the sensitivity of H_2 detection compared to bare Pt microelectrodes, due to their increased surface area and improved electron transfer properties [5]. In addition, the latter submicron sensors can be used for colloidal force spectroscopy [4], which allows the determination of nanomechanical properties of the investigated materials (Fig. 1) for poly(heptazine imide) (PHI) films and provides insight into possible changes of such photocatalytically active materials during illumination. Figure 1 shows such AFM-cantilever integrated hemispherical Pt-B sensors along with the calibration for H_2 and force measurements on PHI.

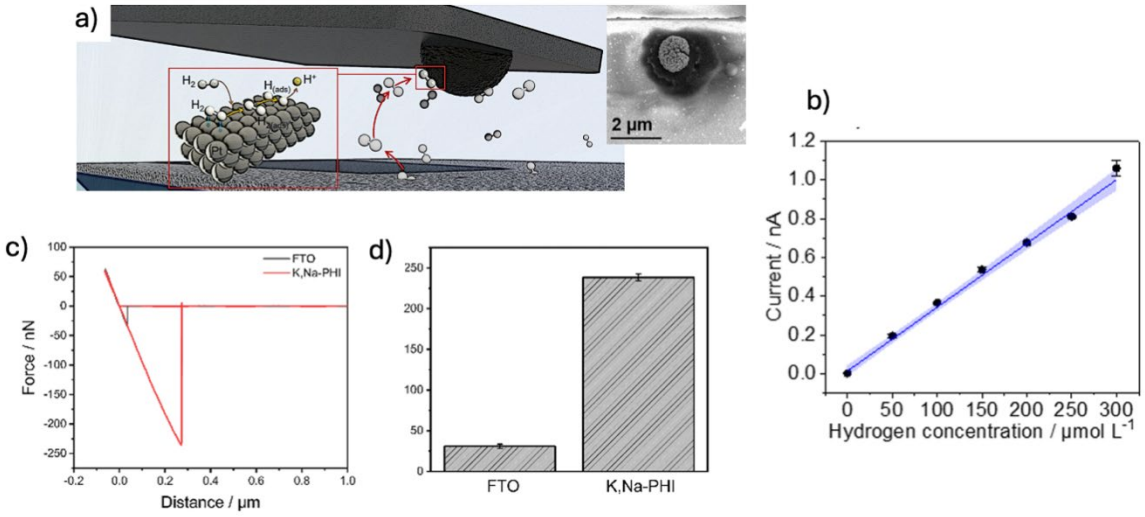


Fig.1 a) Scheme of the AFM-cantilever integrated hemispherical Pt-B sensor with SEM image and H_2 detection scheme. b) Calibration curves at a Pt-B modified probe (d = 1 µm) in 0.1 M ascorbic acid at pH 4 (E_{probe} = - 0.05 V vs. Ag/AgCl). c) Exemplary force curves on FTO and K,Na-PHI recorded with the hemispherical Pt-B probe in air. b) Bar chart of the measured adhesion forces (error bars reflect 150 measurements).

We will present the thorough characterization of the different electrochemical probes, including H_2 microsensors for combined local illumination, in terms of sensitivity and film morphology as a function of the deposition parameters. In addition, we will demonstrate their application for various photocatalytic materials. For example, for light-driven H_2 evolution at PS (RuC_9)-CAT ($[Mo_3S_{12}]^{2-}$)-modified Langmuir-Blodgett and Langmuir-Schaefer films, focusing on the H_2 evolution rates, and at illuminated structured poly(heptazine imide) films for the H_2O_2 production.

Acknowledgements

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References

1. N. S. Lewis, D. G. Nocera, *Proc. Natl Acad. Sci. USA* 103, 15729–15735 (2006).
2. C. Kranz, M. Wächtler, *Chem. Soc. Rev.* **50**, 1407-1437 (2021).
3. J. Kund, J. Romer, E. Oswald, A. Gaus, M. Küllmer, A. Turchanin, M. von Delius, C. Kranz, *ChemElectroChem 9, e202200071 (2022).*
4. A. Hellmann, G. Neusser, S. Daboss, M. M. Elnagar, J. Liessem, D. Mitoraj, R. Beranek, S. Arbault C. Kranz, A*nal. Chem.* 96, 3308–3317 (2024)
5. G. Caniglia, S. Horn, C. Kranz, *Faraday Discussions* 257, 224 (2025).

In situ probing the electrochemical interfaces

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Different types of interfaces(solid/electrolyte, liquid/liquid and solid/solid) have been the key for electrochemical investigation and applications due to they are related strongly to the performance of electroelectrochemical devices and reaction activity. However, in-situ probing the electrochemical interface is still very challenge. In this presentation, we will introduce briefly the historic development of various interface models, classical electrochemical and optical tools, and computer simulations for investigation, and current status of this filed.

In addition, we will focus on the introduction of our strategies to probe behaviors of liquid/liquid interfaces, which include the development of novel techniques, such as the applications of scan ion conductance microscopy (SICM) combined with scan electrochemical microscopy (SECM), and liquid- scan electron microscopy combined a glass nanopipette in recent years in our group.[1-5] Some experimental results of SICM-SECM studies of the liquid/liquid interfaces are presented, and we probably proposed an experimental method which can be used to distinguish which theoretical model can be employed to explain the results. Currently, we are trying to work out how to combine the pipette-cell liquid- scan electron microscopy with electrochemical workstation, and try hard to record the dynamic process on the nanoparticle collision on an electrode surface.

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References

1. T. Ji, Z. Liang, X. Zhu, L. Wang, S. Liu, Y. Shao. Chem.Sci.,15239(2011)
2. D. Zhang, Y. Shao, J. Zhou, Q. Zhan, Z. Wen, S. Mao, J. Wei, L. Qi, Y. Shao, H. Wang. PNAS, 121(28), e2314320121(2024)
3. I. Benjamin. Science, 261, 1558(1993)
4. W. H. Steel, R. A. Walker. Nature, 424, 296(2003)
5. G. Luo, S. Malkova, J. Yoon, D. G. Schultz, B. Lin, M. Meron, I. Benjamin, P. Vanysek, M. L. Schlossman. Science, 311, 216(2006)

Are all battery particles created equally?: How scanning electrochemical microscopy can help answer this question.

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Electrochemical materials react, evolve and degrade. Material activity is often tied to their inhomogeneities in the chemical, physical and mechanical properties. As such to understand, track, and inform the material design, in-situ spatial temporal microscopies are needed. This talk will focus on the good, the bad and the ugly of electrochemical microscopies. I will specifically discuss our efforts in scanning electrochemical imaging microscopies applied to battery materials.

For example, while searching for ultra-safe high-power anodes for Li-ion batteries, $TiNb_2O_7$(TNO) emerged as a promising material for higher energy density compared to the current state-of-the-art $Li_4Ti_5O_{12}$ (LTO). Here, the electrochemistry of isolated carbon coated particles of both anode materials were for the first time studied using scanning electrochemical cell microscopy (SECCM). Interestingly, stochastic current event observations were made possible because of the small electrochemical cell created by SECCM and were designated as potential-driven stochastic events (PDSEs). The PDSEs were especially prominent in TNO compared to LTO. Metrics for judging the frequency and intensity of PDSEs were developed to compare the impact of different C-rates, particle masses and sizes of SECCM landings. The frequency and/or intensity of PDSEs increases with higher C-rates and larger overpotentials. Possible theories for the PDSEs were explored, including droplet electrowetting/spreading, gas evolution, (de)lithiation mechanisms, mass transfer limitations and inter-/intra- particle cracking. We speculate that the propensity of TNO to undergo PDSEs as compared to LTO is mainly related to the fact that TNO is known to crack extensively during cycling.

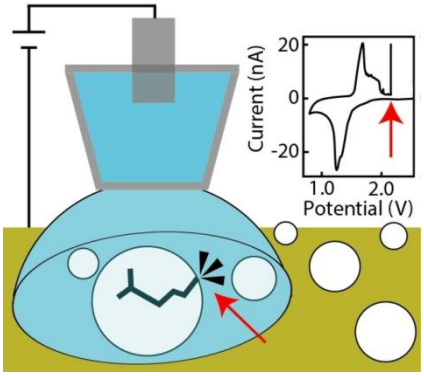


Fig.1 Lithium is inserted into isolated $TiNb_2O_7$ particles during scanning electrochemical cell microscopy. Stochastic current events are observed, and several theories are experimentally explored. From stochastic current event quantification, scan-rate testing, identical experiments with commercialized $Li_4Ti_5O_{12}$ and literature, we propose these stochastic current events arise during $TiNb_2O_7$ intra-particle cracking.

Acknowledgements

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References

1. Adsetts, J.; Eisnor, M.; Raju, A.; Bazylevych, S.; Sieffert, M.; Hui, Y.; McCalla, E.; Schougaard, S.; Mauzeroll, J. Associating Mechano-electrochemical Phenomena to Stochastic Current Events in Micro-Electrochemical Cells Containing TiNb2O7 Particles. *ChemElectroChem.* 2025. e202400640.
2. Snowden, M.; Dayeh, M.; Payne, N.; Gervais, S.; Mauzeroll, J.; Schougaard, S.; Measurement on isolated lithium iron phosphate particles reveals heterogeneity in material properties distribution. *Journal of Power Sources* 2016, 325, 682-689.

Photocurrents as analytical tool – principles and advancements based on semiconductor nanostructures

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Photoelectrochemical detection systems have gained considerable interest since they allow a spatially resolved read-out by light illumination [1]. This is based on charge carrier generation within the semiconductor nanostructures by excitation and coupled electron transfer reactions leading to defined photocurrent generation [2,3]. This transduction method provides good sensitivity and allows a detailed analysis of a sensing surface and a multiplexing of the detection. Often semiconductor nanoparticles (quantum dots QDs) are applied since they are characterized by rather simple synthesis strategies, proper surface modification protocols and easy immobilization. Advantageously they can be combined with very specific enzyme reactions. Some limitations may occur however, in practical applications, mainly due to rather small sensor output, drift in the signals and also for measurements where a close contact of the sensing surface with biological entities is essential.

These bottlenecks have been addressed by different approaches [4-6]. In one approach InGaN nanowires have been genererated on the sensing surface allowing a defined detection of analytes. In another work a second semiconductor has been applied on top of the light-sensitive electrode - TiO_2. This high band gap material is not excited under visible light conditions, but it supports charge carrier separation within the QDs. The TiO_2 was deposited by the atomic layer deposition method. This new approach has been combined with a layer-by-layer deposition of the QDs as was introduced previously [7,8]. The electrode system shows significantly increased current signals upon illumination, an enhanced signal to noise ratio, a very small drift in the sensor output and in addition, an improved sensing performance with respect to hydrogen peroxide which can be converted at the illuminated system. It is further demonstrated that cells can be cultivated on top of the developed electrode structure without impacting the cell viability. This has been exemplified with HeLa cells [9]. After proper stimulation the release of hydrogen peroxide could successfully be verified.

By these investigations we can demonstrate that the advantages of photoelectrochemical sensing systems provided by the light-directed read-out can be combined with improved analytical performances such as enhanced sensitivity and stability - and therefore, resulting in improved applicability.

References

1. Yue, Z.; Lisdat, F.; Parak, W. J.; Hickey, S. G.; Tu, L.; Sabir, N.; Dorfs, D.; Bigall, N. C.
2. *ACS Appl. Mater. Interfaces* **5** (2013) 2800−2814.
3. M. Riedel, W.J. Parak, A. Ruff, W. Schuhmann, F. Lisdat*, ACS Catalysis* **8** (2018) 5212
4. S. Zhao, J. Völkner, M. Riedel, G. Witte, Z. Yue, F. Lisdat, W. J. Parak,
5. *ACS Applied Materials & Interfaces*, **11 (24**), (2019) 21830-21839
6. M. Riedel, S. Hölzel, P. Hille, J. Schörmann, M. Eickhoff and F. Lisdat,
7. *Biosensors & Bioelectronics*, (2017) Vol. **94**, p. 298-304
8. M. Riedel, F. Lisdat, *ACS Applied Materials & Interfaces*, 2018, Vol. **10 (1),** p. 267-277
9. S. Zhao, M. Riedel, J. Patarroyo, N. Bastus, V. Puntes, Z. Yue, F. Lisdat, W. J. Parak,
10. *Nanoscale* **13** (2021) 980-990
11. G. Göbel, K. Schubert, I. W. Schubart, W. Khalid, W. J. Parak, F. Lisdat,
12. *Electrochimica Acta* **56 (18)** (2011) 6397-6400
13. S. Zhao, M. Riedel, J. Patarroyo, N. Bastús, V. Puntes, Y. Zhao, F, Lisdat, W. Parak,
14. *Nanoscale* **14** (2022) 12048
15. S. Zhao, Z. Yue, D. Zhu, J. Harberts, R. H. Blick, R. Zierold, F. Lisdat, W. J. Parak, *Small*, (2024), 2401703

Development of Elecctrochemical Tip-enhanced Raman Spectroscopy for Nanoscale Characterization of Electrocatalytic Reactions

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Surface and interface are key to electrochemistry and determine the reaction mechanism, electrode process and performance of electrochemical devices. They are a region where nanoscale active sites play the key role and the multiple species undergo dynamic change over time and spaces. It requires characterization techniques with high sensitivity, high spatial resolution and at the same time molecular fingerprint information.

Electrochemical tip-enhanced Raman spectroscopy (EC-TERS), which combines electrochemical scanning probe microscopy (EC-SPM) and plasmon-enhanced Raman spectroscopy (PERS), is a powerful technique for the in-situ characterization of the electrochemical interface at the nanoscale and molecular level [1]. It is challenging to realize this technique since both a high sensitivity and a high stability are required. In the past 10 years, we have been developing EC-TERS so that it becomes possible to study the electrochemical interface [2-4]. We introduced water-immersion objectives to EC-TERS to avoid the optical path distortion between air and water, which allowed us to achieve a higher sensitivity. Both home-designed rigid EC-TERS cells and SPM heads were adopted to achieve a high stability. TERS tips with high TERS activity were fabricated by electrochemical method or nanofabrication (focused ion beam, FIB) method. These tips were then carefully insulated or protected for EC-TERS to give a long-time TERS enhancement. A leakage-free micro reference electrode ensures the long-term stability of potential during EC-TERS measurement. Benefited from the above improvements, we achieved EC-TERS imaging with a spatial resolution around 4 nm, for characterization of CO oxidation and Pd and Pt surfaces and for visualization of the structural evolution of individual active sites of MoS_2 during hydrogen evolution reaction (HER).

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References

1. S. C. Huang, et al. Annu. Rev. Phys. Chem., **72**, 213-234 (2021).
2. Z. C. Zeng, et al. J. Am. Chem. Soc., **137**, 11928-11931 (2015).
3. T. X. Huang, Nat. Catal., **7**, 646-654 (2024).
4. M. Y. Zhu, et al. Anal. Chem., **96**, 16109–16114 (2024)

Confinement Controlled Electrochemistry for Single Entity Analysis

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Single-entity electrochemistry (SEE) describes a recent trend in state-of-the-art electrochemistry applied to the investigation of individuals at a time. SEE is particularly appealing as it integrates different branches of modern electrochemistry and combines diverse fundamental approaches and techniques towards the ultimate limits of measurements. It provides powerful means to measure single cells, single particles, and even single molecules at the nanoscale through various well-defined interfaces. The confinement controlled interface significantly enhances electrical, and electromagnetic characteristics for electrochemical analysis, thereby greatly affecting the assay limitation and selectivity of single-entity measurement. Herein, we demonstrate how to achieve controllable nanoelectrochemistry through micro/nano interfaces and nanopore interfaces. We then present a fundamental understanding of how dynamic interactions control the features of the electrochemical interface and thus the stochastic and discrete electrochemical responses of single entities under nanoconfinement. Both stochastic collision electrochemistry and nanopore electrochemistry, as examples in this presentation, explore how these interactions alter the transient charge transfer and mass transport at the microscopic scale. Finally, we discuss further challenges and opportunities in SEE, ranging from the design of sensing interfaces to hybrid spectro-electrochemical methods, theoretical models, and advanced data processing.

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References

1. M.-Y. Li, J. Jiang, J.-G. Li, H. Niu, Y.-L. Ying, R.-J. Tian, & Y.-T. Long, Nanopore Approaches for Single-Molecule Temporal Omics: Promises and Challenges. *Nat. Methods*, **22**, 241-253 (2025).
2. H. Niu, M.-Y. Li, Y. Gao, J.-G. Li, J. Jiang, Y.-L. Ying, & Y.-T. Long, Direct Mapping of Tyrosine Sulfation States in Native Peptides by Nanopore. *Nat. Chem. Biol.*, **21**, 716-726 (2025).
3. F. Gao, J.-H. Wang, H. Ma, B.-Q. Xia, L.-Q. Wen, Y.-T. Long, & Y.-L. Ying, Identification of Oligosaccharide Isomers Using Electrostatically Asymmetric OmpF Nanopore. *Angew. Chem. Int. Ed.*, **64**, e202422118 (2025).
4. M.-Y. Li, H. Niu, J. Jiang, X.-Y. Wu, Y.-L. Ying, & Y.-T. Long, Real-Time Recording the Dynamic Catalytic Heterogeneity of Enzymatic Reactions Using a Nanopore. *J. Am. Chem. Soc.*, **147**, 17121-17131 (2025).
5. J. Wang, S.-C. Liu, Z.-L. Hu, Y.-L. Ying, & Y.-T. Long, Dynamic Features Driven by Stochastic Collisions in a Nanopore for Precise Single-Molecule Identification. *J. Am. Chem. Soc.*, **147**,

1781-1791 (2025).

Speciation of Nanoparticles: Nanoparticle-Imprinted Matrices (NAIM)

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The development of precise tools for measuring nanoparticles (NPs) in air and water is critical for environmental safety, regulatory compliance, and public health. Regulatory frameworks like the EU's nanomaterial definition mandate identifying materials with ⩾50% nanoparticles <100 nm, requiring accurate concentration data to classify and regulate environmental or industrial emissions. Furthermore, the toxicity of NPs, i.e., nanotoxicity, depends not only on the materials they are made of but also on their size, shape, and surface chemistry. This requires developing analytical tools capable of detecting different species of NPs very selectively. Hence, the speciation of NPs, which is still in its infancy, is becoming of utmost importance.

This contribution deals with a new approach developed by us, which aims at detecting NPs selectively.

This new concept is termed NAnoparticle-Imprinted Matrix (NAIM).[1-6] It is analogous to the well-known concept of molecularly imprinted polymers (MIP) in which the molecular analyte is imprinted in a polymer by polymerization of proper monomers with which it chemically associates (Fig. 1). The removal of the template forms complementary cavities capable of selective recognition of the analyte. Instead of molecular species, we imprint NPs in various matrices. The NPs are then removed to form nanometric voids that can selectively recognize the originally imprinted NPs.

We will present a few new systems and approaches by which we show how NPs can be imprinted inside a matrix.[1-5] We will deal with the conditions required for their removal and reuptake and what makes the matrix selective and sensitive towards the originally imprinted NPs. For example, we will demonstrate that we can selectively detect identical core NPs stabilized by capping agents of different isomers. Approaches for studying the NP-matrix interactions, the imprinting of non-spherical NPs, and the detection of NPs from the gaseous phase, will also be presented and discussed.

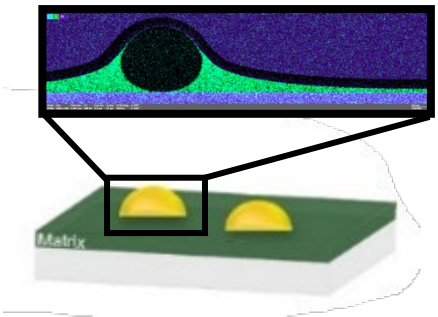


Fig. 1: HR-TEM of a cross-section of a NP embedded in an organic matrix

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References

1. Zelikovich, D.; Savchenko, P.; Mandler, D. High Recognition of Isomer-Stabilized Gold Nanoparticles through Matrix Imprinting. ACS Appl. Mater. Interfaces 2023, 15, 32687-32696.
2. Zelikovich, D.; Dery, L.; Sagi-Cohen, H.; Mandler, D. Imprinting of nanoparticles in thin films: Quo Vadis? Chem. Sci. 2023, 14, 22.
3. Dery, L.; Shauloff, N.; Turkulets, Y.; Shalish, I.; Jelinek, R.; Mandler, D. Size-Selective Detection of Nanoparticles in Solution and Air by Imprinting. ACS Sens. 2022, 7, 296-303.
4. Zelikovich, D.; Dery, S.; Bruchiel-Spanier, N.; Tal, N.; Savchenko, P.; Gross, E.; Mandler, D. Shell-Matrix Interaction in Nanoparticle-Imprinted Matrices: Implications for Selective Nanoparticle Detection and Separation. ACS Appl. Nano Mater. 2021, 4, 10819-10827.
5. Kraus-Ophir, S.; Witt, J.; Wittstock, G.; Mandler, D. Nanoparticle-Imprinted Polymers for Size-Selective Recognition of Nanoparticles. Angew. Chem.-Int. Edit. 2014, 53, 294-298.

Electrochemical Detection of Organic Compounds in Flowing Systems

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Ever increasing demands on modern electroanalytical methods resulted in their frequent application flowing systems. Possibilities and limitations of this approach will be demonstrated on several recently developed measuring protocols in our UNESCO Laboratory of Environmental Electrochemistry at Charles University in Prague. Main advantages of electroanalytical methods in flowing systems can be summarized as follows:

i) Increased sensitivity given by more efficient transport of an analyte to working electrode surface via convection as shown in our paper on flow injection analysis of 5-aminoquinoline on microcrystalic natural graphite [1] or in our review [2]
ii) Increased selectivity given by possible combination with high performance separation techniques (HPLC, CZE etc.). See our paper on monitoring of veterinary drug nicarbazin capillary electrophoresis with amperometric detection [3]
iii) Decreased problems with working electrode passivation because of removal of possibly passivating products of electrode reaction from working electrode surface by flowing solution [4]
iv) Easy automation resulting in lower cost of analysis. See possible combination of sequential injection analysis with electrochemical detection [5]
v) Easy miniaturization resulting in better compatibility with green analytical chemistry. See paper from our lab on solid reference electrodes used in miniaturized flow electrochemical cells [6]
vi) Possible combination with enzymatic methods using separate enzymatic and electrochemical reactor as documented in our paper on monitoring of lactic acid using easily replaceable lactate oxidase-based mini-reactor connected in front of a silver amalgam screen-printed electrode acting as a transducer [7]
vii) In some cases, the possibility to use simple instrumentation without mechanical pumps (see our paper on batch injection analysis [8])

Acknowledgements

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References

1. I. Jiranek and J. Barek, *J. Electroanal. Chem.* **885**, 115085 (2021)
2. J. Barek and P. Smejkal, *J. Solid. State Electrochem.* **28**, 643 (2024)

3. S. Ivakh, M. Koall, J. Barek and F.M. Matysik, *Talanta* **288**, 127729 (2025)
4. J. Barek, *Chemosensors* **9**, 12 (2021)
5. J. Labuda, C.E. Banks, J. Barek, et al, *Pure Appl. Chem.*, submitted for publication
6. M. Baroch and H., Dejmkova, Electroanalysis 37, e202400139 (2025)
7. S. Tvorynska, J. Barek, and B. Josypcuk, *Electrochim. Acta* **445**, 142033 (2023)
8. P. Dvořák and V. Vyskočil, *Chem. Listy* **113**, 703 (2019)

Interfacial properties of non-conventional electrochemical liquid/liquid interfaces

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Liquid/liquid interfaces between two dielectric liquids can be electrochemically polarizable by adding a supporting electrolyte in each liquid phase, with which we can control/measure the phase-boundary potential and the current originating from the ion and electron transfers across the interface. Liquid/liquid electrochemistry has been extensively studied at oil (O)/water (W) interfaces for several decades. This science has been extended to other non-conventional liquid/liquid interfaces, such as ionic liquid (IL)/W interfaces [1,2] in the noughties and IL/O interfaces [3,4] more recently. In the present paper, we will introduce our recent experimental and simulational studies on the static and dynamic properties at other two types of non-conventional electrochemical liquid/liquid interfaces: fluorous solvent (F)/W interfaces [5-7] and IL/IL interfaces [8], both of which exhibit non-conventional behaviors. Neutron reflectometry [5] and molecular dynamics simulation [7,8] unveiled unusual ionic distributions at and around these non-conventional electrochemical liquid/liquid interfaces. We will also present a novel approach to switch interfacial rheological properties via the external control of the phase-boundary potential [6].

References

1. N. Nishi et al., *Anal. Chem.*, 78 (2006) 2726.
2. T. Kakiuchi and N. Nishi, *Electrochemistry*, 74 (2006) 942.
3. Y. Kuroyama et al., *J. Electroanal. Chem.*, 881 (2021) 114959.
4. K. Miyazato et al., *J. Electroanal. Chem.*, 954 (2024) 118038.
5. K. Ishii et al., *Electrochim. Acta*, 513 (2025) 145563.
6. K. Ishii et al., *ChemRxiv*, (2025) doi:10.26434/chemrxiv-2025-2b8b2.
7. K. Ishii et al., *submitted*.
8. K. Yamaguchi et al., *to be submitted*.

Modification and Functionalization of Hydrogel Materials for Motion Sensing

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Hydrogels, characterized by high-water absorption capacity and sensitivity to environmental stimuli of volume phase transition, are widely used in various scientific disciplines, including biomedicine, soft robotics, and environmental monitoring. Conventional hydrogels often fail to meet the demanding standards for current applications, including wearable sensors, tissue engineering scaffolds, and drug delivery systems [1,2]. We aimed to solve these problems by developing innovative multifunctional hydrogels with better mechanical properties and improved electric performance.

In one approach, a hydrogel with two nets was prepared from poly(acrylic acid) and alginate, and both chemical (BIS) and physical (ferric ions) crosslinkers were employed. The obtained hydrogel exhibited higher mechanical strength, motion sensitivity and also relatively rapid selfhealing. The interaction between the carboxylic groups of alginate and poly(acrylic acid) with ferric ions created switchable bonds, which enabled selfhealing just after 10 minutes. Finally, the gel fracturing occurred under higher stress at 85% strain. These features made this hydrogel a promising candidate for skin motion sensors, capable of accurately monitoring joint movements in humans and robotic systems.

In the next attempt, gold nanoparticles (AuNP) were incorporated into a PNIPA-laponite matrix. A nanocomposite hydrogel with high mechanical stability, satisfactory conductivity, and motion sensitivity was formed. The optimized hydrogel exhibited a tensile strength of approximately 80 kPa and a conductivity of 4.24 mS·cm-1. Its motion sensitivity, illustrated by a gauge factor (GF) of 8, made it very suited for advanced sensors and actuators in wearable technology, offering reliable performance under prolonged use and cyclic deformations.

The third approach focused on a hydrogel based on amino acid monomers, gelatin and either cupric or ferric ions coordinated with amino acids. These hydrogels demonstrated improved stretchability (more than double), conductivity (approximately 95% improvement), and strain sensitivity. While the cupric-modified hydrogels exhibited consistent sensing behavior, the ferric-modified hydrogels offered higher mechanical strength and stretchability, achieving conductivity ranging from 3.3 to 4.4 mS·cm-1. The obtained properties indicate the hydrogels' potential in wearable motion sensors capable of withstanding deformations.

References

1. M. Karbarz, M. Mackiewicz, K. Kaniewska, K. Marcisz, Z. Stojek, *Applied Materials Today*, 516-532 (2017)
2. G. Cai, J. Wang, K. Qian, J. Chen, S. Li, P.S. Li, *Advanced Science*, 4:1600190 (2017)

Molecularly Imprinted Polymer-Based Potentiometric Sensors

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Ionophore-based polymeric membrane ion-selective electrodes (ISEs) play an important role for potentiometric detection of ionic species in various fields including clinical diagnosis, environmental monitoring and food analysis due to their advantages of excellent selectivity, ease of operation, portability and low cost [1]. When coupled with bioreceptors such as antibodies, enzymes, aptamers and peptides, ISEs can be further explored for detection of organic neutral molecules (e.g., organic pollutants) and biological species (e.g., proteins and cells) [2-5].

Molecularly imprinted polymers (MIPs) have been shown to be ideal candidates as new molecular recognition materials in chemical sensors, since they are more stable, less costly and easier to produce as compared to their biological counterparts such as antibodies and enzymes, and they are also general materials for selectively binding a wide range of analytes [6]. In recent years, varous MIP-based polymeric membrane potentiometric sensors have been developed for sensing of organic and biological species [7,8]. For these MIP-based sensors, MIP materials can be prepared by bulk polymerization, precipitation polymerization, surface imprinting, and electro-polymerization, while zero-current potentiometry and chronopotentiometry have been employed as detection modes.

In this presentation, recent studies of our group on MIP-based polymeric membrane potentiometric sensors will be presented, including a mussel-inspired surface-imprinted sensor for potentiometric label-free detection of biological species [9], a chronopotentiometric nanopore sensor based on a stimulus-responsive MIP for label-free dual-biomarker detection [10], and a surface blocking-based potentiometric biosensor for detection of SARS-CoV-2 using a surface epitope-imprinted polymer as a receptor.

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References

1. E. Bakker and E. Pretsch, *Angew. Chem. Int. Ed.*, **46**, 5660 – 5668 (2007)
2. K.Y. Chumbimuni-Torres, Z. Dai, N. Rubinova, Y. Xiang, E. Pretsch, J. Wang and E. Bakker, *J. Am. Chem. Soc.*, **128**, 13676-13677 (2006)
3. Y. Li, J. Ding and W. Qin, *J. Am. Chem. Soc.*, **146**, 24389−24397 (2024)

4. J. Mou, J. Ding and W. Qin, *Angew. Chem. Int. Ed.*, **62**, e202210513 (2023)
5. E. Lv, Y. Li, J. Ding and W. Qin, *Angew. Chem. Int. Ed.*, **60**, 2069-2613 (2021)
6. S.C. Zimmerman, M.S Wendland, N.A. Rakow, I. Zharov and K.S. Suslick, *Nature*, **418**, 399–403 (2002).
7. R. Liang, D. Song, R. Zhang and W. Qin, *Angew. Chem. Int. Ed.*, **49**, 2556-2559 (2010)
8. J. Wang, R. Liang and W. Qin, *Trac. Trends Anal. Chem.*, **130**, 115980 (2020)
9. R. Liang, J. Ding, S. Gao and W. Qin, *Angew. Chem. Int. Ed.*, **56**, 6833 –6837 (2017)
10. J. Wang, H. Zhou, R. Liang and W. Qin, *Anal. Chem.*, **96**, 9370−9378 (2024)

Smart Electrochemical Platforms for Environmental and Biomedical Diagnostics: Toward Practical and Portable Analysis

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Recent advancements in electrochemical analysis have enabled the development of portable, user-friendly platforms for real-time monitoring of environmental contaminants and disease-related biomarkers. Emphasizing practical deployment and high analytical performance, our recent work focuses on integrating microfluidic systems, biodegradable materials, and wireless interfaces into compact sensing devices. An automated microfluidic electrochemical platform was developed for the speciation analysis of inorganic arsenic, allowing rapid differentiation between As(III) and As(V) in environmental samples with minimal manual operation [1]. In parallel, a sustainable, pectin-based gel electrolyte has been designed for the wireless electrochemical detection of cadmium and lead, utilizing screen-printed electrodes and smartphone-based readout for in-field heavy metal monitoring [2]. For biomedical applications, a dual-mode capillary-driven microfluidic device has been engineered to enable simultaneous electrochemical and colorimetric detection of Δ^9-tetrahydrocannabinol (THC) and cannabidiol (CBD) in cannabis flower [3]. Furthermore, an ultrasensitive electrochemical DNA sensor employing multiple signaling probes and an NFC-enabled interface has been introduced for the early diagnosis of leptospirosis, supporting battery-free operation and direct data transmission to smartphones [4]. These innovations demonstrate the potential of novel electrochemical platforms to deliver accessible, accurate, and decentralized analytical solutions for both environmental and healthcare applications.

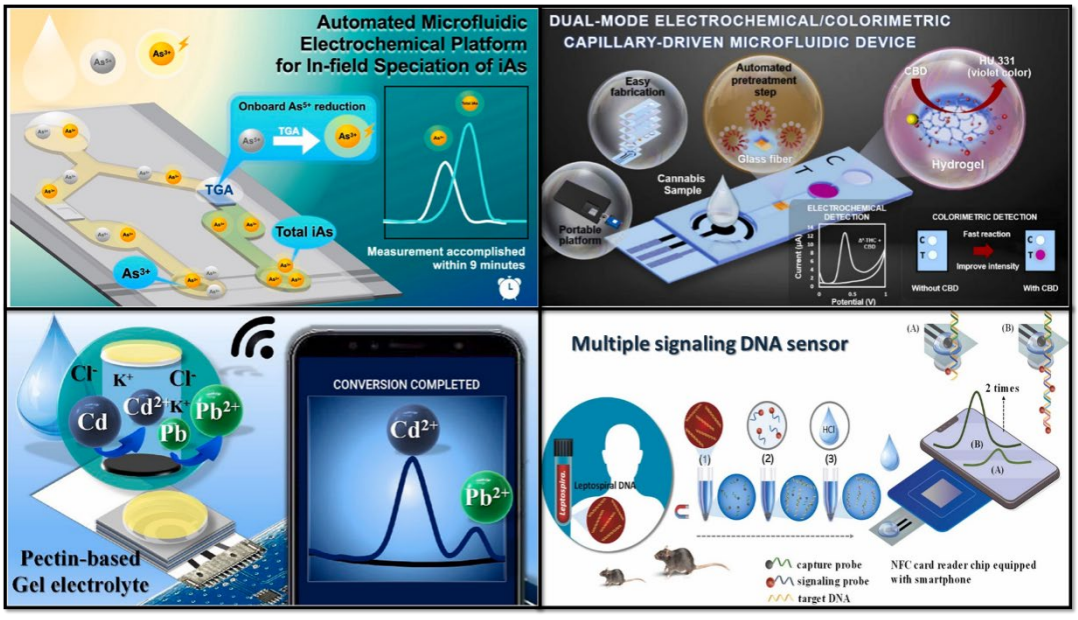


Fig.1 Smart electrochemical platforms for environmental and biomedical diagnostics.

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References

1. K. Pungjunun, N. Praphairaksit and O. Chailapakul, *Talanta*, **265**, 124906 (2023).
2. N. Lersanansit, K. Pungjunun, O. Chailapakul and N. Praphairaksit, *Talanta*, **276**, 126211 (2024).
3. T. Pholsiri, W. Khamcharoen, A. Suksuwan, S. vimolmangkang, W. Siangproh and O. Chailapakul, *Sens Actuators B: Chem*, **417**, 136152 (2024).
4. S. Jampasa, B. Jikul, C. Kreangkaiwal, W. Khamcharoen, W. Jesadabundit, W. Waiwinya, P. Saelim, T. Phanbunmee, K. Patarakul and O. Chailapakul, *Sens Actuators B: Chem*, **406**, 135411 (2024).

Nanoelectrochemical Monitoring of ROS/RNS Homeostasis During Macrophages Immune Stress

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Macrophages play a crucial role in immune defense by eliminating pathogens, cellular debris, and necrotic or damaged cells. Upon encountering a pathogen, macrophages activate and extend pseudopods that encapsulate the pathogen within phagolysosomes[1-3]. To efficiently digest these inclusions while minimizing damage to themselves, the enzyme pools within phagolysosomes, including NADPH oxidase (NOX) and inducible nitric oxide synthase (iNOS), is activated to generate reactive oxygen species and reactive nitrogen species (ROS/RNS) which effectively shred pathogens down to molecular levels. Therefore, precise regulation of ROS/RNS homeostasis during phagocytosis is essential for both the effective killing of pathogens and the self-protection of macrophages.

To elucidate the immune homeostatic mechanisms of phagolysosomes, we employed platinum nanoparticle-coated nanowire sensors (SiC@Pt NWSs) to quantitatively analyze the levels of ROS/RNS within individual phagolysosomes (*Fig.1a*)[4]. The submillisecond resolution of the nanosensor allowed confirmation and measurement of the rapid ability of phagolysosomes to differentially mobilize their enzyme pools of NOX and iNOS to finely regulate their homeostasis. To investigate the ROS/RNS leakage hypothesis during frustrated phagocytosis, SiC@Pt NWs were applied to quantitatively assess the release dynamics of reactive species throughout frustrated phagocytosis (*Fig. 1b*)[5]. Our findings reveal a significant and prolonged release of ROS/RNS at the phagocytic cups in single macrophages. This excessive and sustained leakage of ROS/RNS results in damage to surrounding cells and ultimately contributes to lung injury. By leveraging the large number of active lysosomes distributed along the phagocytic lumen during frustrated phagocytosis, we monitored the intensity of ROS/RNS release fluxes to uncover the crucial role of intra-lysosomal pH in regulating ROS/RNS fluxes following pharmacological modulations (*Fig.1c*). Our results quantitatively demonstrate for the first time the precise mechanism by which lysosomal pH regulates ROS/RNS.

Overall, these findings offer valuable new insights into the essential role of ROS/RNS homeostasis in modulating immune responses, and this series of quantitative studies may pave the way for advancements in immunotherapeutic strategies.

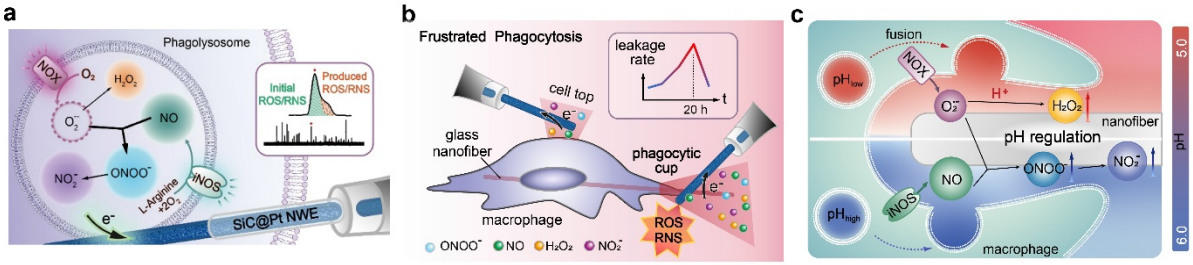


Fig.1 a) Schematic diagram the quantitative monitoring of initial and freshly produced ROS/RNS released by individual phagolysosomes. **b**) Schematic diagram describin SiC@Pt NWS for differentiating the ROS/RNS released at different loci of the macrophage surface and quantifying their fluxes during frustrated phagocytosis of a glass nanofiber. **c)** Schematic diagram describing ROS/RNS fluxes emitted at a macrophage phagocytic cup being monitored with a SiC@Pt NWS after pharmacological modulation of lysosomal pH in the frustrated phagocytosis of a glass nanofiber.

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References

1. Muri, J.; Kopf, M. Redox regulation of immunometabolism. *Nat. Rev. Immunol.* **2020**, 21 (6), 363-381.
2. Russell, D. G.; VanderVen, B. C.; Glennie, S.; Mwandumba, H.; Heyderman, R. S. The macrophage marches on its phagosome: dynamic assays of phagosome function. *Nat. Rev. Immunol.* **2009**, 9, 594-600.
3. Lazarov, T.; Juarez-Carreño, S.; Cox, N.; Geissmann, F. Physiology and diseases of tissue-resident macrophages. *Nature* **2023**, *618 (7966)*, 698-707.
4. Qi, Y.-T.; Jiang, H.; Wu, W.-T.; Zhang, F.-L.; Tian, S.-Y.; Fan, W.-T.; Liu, Y.-L.; Amatore, C.; Huang, W.-H. Homeostasis inside single activated phagolysosomes: quantitative and selective measurements of submillisecond dynamics of reactive oxygen and nitrogen species production with a nanoelectrochemical sensor. *J. Am. Chem. Soc.* **2022**, *144 (22)*, 9723-9733.
5. Qi, Y.-T.; Zhang, F.-L.; Tian, S.-Y.; Wu, H.-Q.; Zhao, Y.; Zhang, X.-W.; Liu, Y.-L.; Fu, P.; Amatore, C.; Huang, W.-H. Nanosensor detection of reactive oxygen and nitrogen species leakage in frustrated phagocytosis of nanofibres. *Nat. Nanotechnol.* **2024**, *19 (4)*, 524-533.
6. Qi, Y.-T.; Gao, R.-X.; Chen, Y.; Guo, B.-Y.; Z; Wen, M.-Y.; Amatore, C.; Huang, W.-H.Nanoelectrochemical Monitoring of pH-Regulated ROS/RNS Homeostasis in Macrophages Lysosomes During Phagocytosis. *Research.* **2025**, Accepted.

Bioluminescence Biosensors for large protein complexes in programed cell death modalities

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We have developed different bioluminescence-based biosensors for identification and formation of large protein complexes in cell death. Major programed cell death like apoptosis, pyroptosis and necroptosis are crucial for homeostasis and implicated in several human disorders like cancer and neurodegenerative diseases and take place through formation of large protein complexes. Development of bioluminescence biosensors enables high-throughput assays which assess distinct cell death modalities to identify potential therapeutic agents that control these cellular responses. Split luciferase complementary assays have been widely developed for assessing protein- protein interactions in regulated cell death. Split luciferase reconstitution assays have been used to probe role of NLRP3, ASC, Apaf-1 and other player protein structure and the regulation in cell death induction. A similar tactics were used to probe the interactions of RIPk1, and RIPk3 in necrosome formation, which occur in necroptosis. Bioluminescence Biosensors which simultaneously distinguish between the various cell death phenomena will be discussed.

Porous Electrodes for Cell Analysis in Microphysiological Systems

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In vitro assays using cultured human cells have gained considerable attention as an alternative to animal testing. To reconstruct functional organ-like environments for the assays, cells are three-dimensionally cultured or mechanically/chemically stimulated within microfluidic devices to mimic in vivo conditions. These advanced culture platforms are referred to as microphysiological systems (MPS). Porous membranes are commonly utilized in MPS, as they enable the formation of biologically relevant interfaces, such as the gut, lung, skin, and vasculature, by culturing cells on their surfaces. For drug analysis, cells in MPS are evaluated using gene expression analysis and histological examinations. However, they often damage cells and are unsuitable for real-time and in situ analysis. To address this issue, electrochemical sensors are being explored, because these sensors can measure cell activity in a non-invasive manner [1].

In this study, we fabricated porous electrodes that enable both the formation of organ-like surfaces and in situ monitoring of cellular activity. As a demonstration, human umbilical vein endothelial cells (HUVECs) were cultured to create vascular models. Nitric oxide (NO) released from the cells was electrochemically detected using the device (Fig. 1). Thus, this device serves as a useful platform for both cell culture and sensing applications. This platform is also applicable to the preparation and analysis of intestinal and cancer models. Endogenous enzymatic activity and glucose consumption [3], which are potential biomarkers in microphysiological systems (MPS), were electrochemically monitored.

In summary, porous electrode devices have been applied for cell analysis in MPS. The porous structures facilitate organ-like formation, while the electrodes serve as effective electrochemical sensors. Using this approach, vascular, gut, and cancer models were successfully developed and evaluated. Although this study focuses on amperometric detection, electrochemiluminescence techniques also offer valuable tools for cell analysis in MPS [4, 5]. This topic is presented at the upcoming 40th topical meeting of the International Society of Electrochemistry (ISE). In the future, these electrochemical MPS platforms are expected to be widely utilized for drug screening.

Acknowledgements

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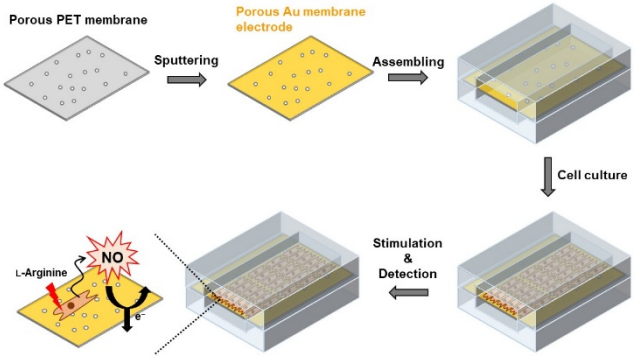


Fig. 1. Schematic illustration of the fabrication process of porous electrodes. These electrodes are used for culturing cells and electrochemical detection. Reprinted with permission from Ref. 2. Copyright 2023 ACS.

References

1. Curr. Opin. Electrochem., 39, 101270, 2023
2. Anal Chem., 95, 49, 18158, 2023
3. ACS Sens., 9, 4248, 2024
4. Sens Actuators B Chem., 137944, 2025
5. Biosens. Bioelectron., 181, 113123, 2021

Smart mathematical separation empowers rapid qualitative and quantitative analysis of complex systems

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Aiming at the problem of direct, rapid, and accurate quantitative analysis of multiple components in the presence of unknown interference in complex analytical systems, it is very important to systematically and thoroughly carry out innovative basic research on relevant mathematical separation and efficient qualitative and quantitative methods with the aid of modern high-order analytical instruments. Chemical multi-way calibration has outstanding "second-order or higher-order advantages" and can be regarded as a green and smart "mathematical separation" means, thereby replacing or enhancing the traditional "physical/chemical separation". Even in the presence of unknown interferences in the background matrices, pure signals of multiple components of interest can be rapidly extracted to realize their green, simultaneous, and accurate qualitative and quantitative analysis. Therefore, the pretreatment process of samples can be avoided or greatly simplified, and the analysis time can be reduced effectively. Focusing on the unique analysis method of "mathematical separation", this report systematically and in-depth reviewed the innovative basic research on related green separation and efficient qualitative and quantitative methods. In the theoretical part, the multi-way data analysis methodology, efficient multi-way calibration algorithms, and multi-way data preprocessing methods developed by our laboratory are systematically introduced. The application part focuses on the basic application research of a variety of modern high-order analytical instruments combined with the "mathematical separation" method in quantitative aspects and solves problems in static and dynamic complex systems. To sum up, the "mathematical separation" strategy has achieved the rapid, simultaneous, and green qualitative and quantitative analysis of multiple components in various complex systems, and is expected to provide a theoretical and design basis for the construction of a new generation of intelligent analytical instruments, and empowers rapid qualitative and quantitative analysis of complex systems.

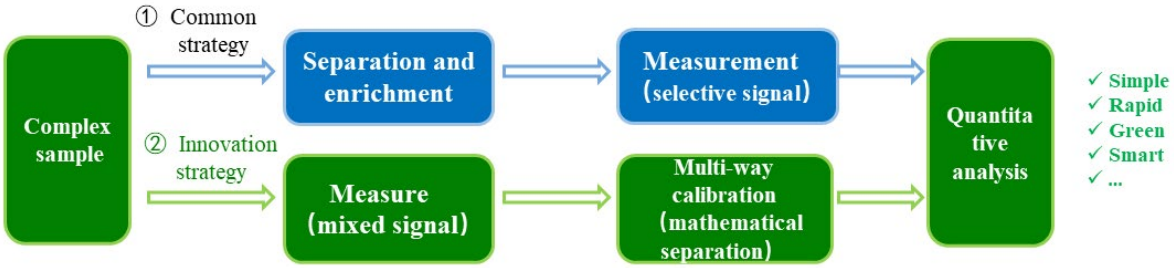


Fig. 1 Quantitative analysis strategies for complex systems

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References

1. H.L. Wu; T. Wang; R.Q. Yu, *Trends Anal. Chem.*, **130**, 115954 (2020).
2. H.L. Wu; M. Shibukawa; K. Oguma, *J. Chemom.*, **12**, 1-26 (1998).

Extending in situ Surface Enhanced Infrared Absorption Spectroscopy to Investigate Interfacial Adsorption and Functionality of Additives for Superconformal Copper Electrodeposition

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Organic additives accelerators, suppressors, and levelers, working in conjunction with chloride ions (Cl^-), ensure reliable copper (Cu) interconnect formation by copper electroplating technology in microelectronics manufacturing. Fundamental investigations into additive adsorption configurations at metal-electrolyte interfaces and their underlying mechanisms are essential for deciphering superfilling physics, rational design of next-generation additive systems, and process optimization. In situ surface enhanced IR absorption spectroscopy with attenudated total reflection (ATR-SEIRAS) in Kretschmann configuration with high surface sensitivity, straightforward surface selection rule and unrestricted mass transport has been recently extended to the study of the interfacial structures and properties of three types of organic additives at Cu electrodes in acidic solutions. In this talk, I will demonstrate the strength of the wide-frequency-detection ATR-SEIRAS using micromachined Si wafer IR windows combined with in situ EQCM measurement and DFT calculations in revealing the correlation of individual adsorption configurations of the accelerator SPS, the inhibitor PEG and the leveler JGB with their corresponding electrochemical properties in favor of or against Cu electrodeposition.

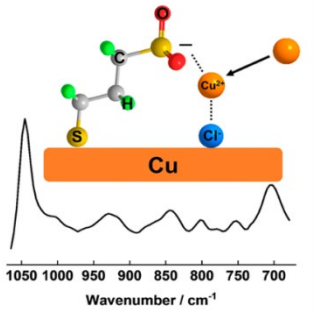


Fig.1 SPS adsorption on Cu

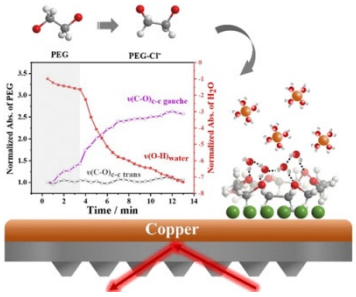


Fig.2 PEG adsorption on Cu

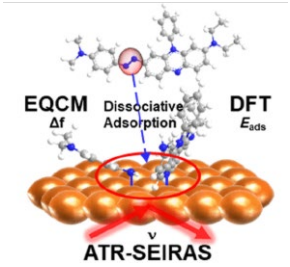


Fig.3 JGB adsorption on Cu

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References

1. Z.J. Mao, Y.C. Wu, X.D. Xu, Y. Chao, X.-G. Zhang, C Wang and W.-B. Cai, *J. Phys. Chem. Lett.*, 15(25), 6668–6675(2024)
2. Y.C. Wu, Z.J. Mao, T.-W. Jiang, X.-Y. Ma, L. Zheng, K. Jiang and W.-B. Cai, *J. Phys. Chem. C*,

127(44): 21695–21703(2023)
3. Z.J. Mao, Y.C. Wu, X.-Y. Ma, L. Zheng, X.-G. Zhang, W.-B. Cai, *J. Phys. Chem. Lett.*, 13(39): 9079-9084(2022)
4. Z.J. Mao, Y.C. Wu, K. Jiang, W.-B. Cai, *Sci. Sin. Chim.*, 53(10): 1812-1821(2023)

In situ monitoring of electrocatalytic hydrogen production reactions by using SERS

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Electrocatalytic chemical reactions take place at the electrode/electrolite interface, where the many different surface species cannot be separated and purified. Surface-selective analytical techniques are required for in situ detection of these reactions to disclose the interfacial mechanism of the chemistry. Surface-enhanced Raman spectroscopy (SERS) is a surface-selective technique with high sensitivity plus chemical specificity which fulfills the requirements for in situ characterization of the heterogeneous catalysis. However, catalytically active materials such as non-coinage metal nanoparticles usually do not provide sufficient plasmonic activity for the required SERS enhancement. Bifunctional nanostructures which integrate both plasmonic and catalytic materials can enhance molecular vibrational signal of chemical species involved in the catalytic reactions. As a proof-of-concept, we assembled catalyst-on-Au core-satellite superstructures to investigate interfacial chemical reactions on the nanoparticle catalysts [1].

We could characterize electrocatalytic hydrogen production reactions by using electrocatalytic SERS (Fig. 1). Important reaction intermediate species such as $OO^{\cdot}$ and $NNH^{\cdot}$ were detected [2-4]. From the vibrational frequencies of these adsorbates, we could deduce their adsorbing sites at the catalytic intersurfaces, and thus disclose the dual-center synergism. Furthermore, the in situ SERS detection is also capable of quantifying interfacial charge transfer on the catalysts [5]. The Raman band shift of molecular probes modified on the surface of Pt catalysts can be used as an identifier for the tendency of spontaneous electron transfer between the catalysts and supporting substrates. In situ monitoring of these reactions at the catalytic interfaces provides unique information about reaction intermediates and catalytically active sites, which is very helpful for understanding the reaction mechanisms toward rational design of high-performance electrocatalysts.

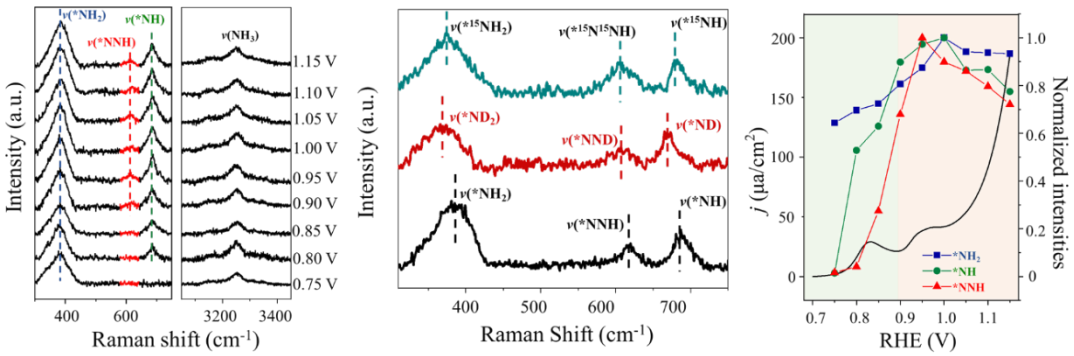


Fig.1 SERS detection of key reaction intermediates in electrocatalytic ammonia decomposition.

Acknowledgements

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References

1. K. F. Zhang, L. Yang, Y. F. Hu, C. H. Fan, Y.R. Zhao, L. Bai, Y. l. Li, F. X. Shi, J. Liu and W. Xie, *Angew. Chem. Int. Ed.*, **59**, 18003–18009 (2020)
2. C. J. Hu, Y. F. Hu, C. H. Fan, L. Yang, Y. T. Zhang, H. X. Li and W. Xie, *Angew. Chem. Int. Ed.*, **60**, 19774-19778 (2021)
3. X. M. Du, A. X. Du, D. Wang, Y. Mao, Z. Zhang and W. Xie, *J. Am. Chem. Soc.* **147**, 8083-8087 (2025)
4. Y. F. Hu, C. J. Hu, A. X. Du, T. T. Xiao, L. F. Yu, C. K. Yang and W. Xie, *Anal. Chem.*, **95**, 1703-1709 (2023)
5. L. Yang, R. Grzeschik, P. Jiang, L. F. Yu, C. J. Hu, A. X. Du, S. Schlücker and W. Xie, *Angew. Chem. Int. Ed.*, e202301065 (2023)

Copper-doped strontium metal-organic framework for oxygen evolution reaction

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Metal-organic frameworks (MOFs) incorporating two metal species have recently garnered significant attention for energy-related applications, owing to the enhanced synergistic interactions between the constituent metals. However, the practical application of MOFs is often hindered by their inherently low electrical conductivity and limited exposure of active sites. In this study, we report the synthesis of a copper-doped strontium MOF (Cu-doped Sr MOF) via a simple hydrothermal approach. The resulting material exhibits effeceint oxygen evolution reaction (OER) activity, the Cu-doped electrode shows a significantly reduced overpotential of 398 mV compared to 600 mV for the undoped counterpart, and a favorable Tafel slope of 58 mV dec^{-1}. The enhanced electrochemical performance and catalytic activity are attributed to the cooperative effects between Cu and Sr within the MOF framework. This work offers valuable insights into metal-doping strategies for MOFs and paves the way for the development of high-performance electrodes and catalysts for water-splitting technologies.

Development of Thin-Film Electrodes Using Shadow Masking for Precise Point-of-Care Measurement of C - Reactive Protein in Sepsis Diagnosis

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Abstract

The paper introduces a rapid and cost-effective method for fabricating disposable thin-film electrodes (TFEs) using a shadow mask technique on poly (methyl methacrylate) (PMMA) substrates. These electrodes are used to develop a biosensor for detecting C-reactive protein (CRP), a crucial biomarker for diagnosing sepsis. The sensor shows a linear detection range from 0.02 to 0.9 ng/ml.

Introduction

Microelectrodes, integral to micro-total analytical systems (μTAS) [1], have seen widespread use in diagnostics, fabricated through techniques such as screen printing, photolithography, and shadow mask lithography [2]. Traditional electrodes, like bulk electrodes, are durable and reusable, but their maintenance and the biohazard chemical use make them unsuitable for point-of-care (POC) applications [3]. Screen-printed electrodes (SPEs), while common, suffer from drawbacks such as reduced conductivity due to impurities and material complexity, impacting their sensitivity and durability [4]. To address these challenges, thin-film electrodes (TFEs) have been developed using physical vapor deposition (PVD), offering superior conductivity and sensitivity due to high-purity materials [5]. TFEs can be integrated with microfluidic devices without leakage, providing flexibility in substrate material choice and enabling use in lab-on-chip devices [6]. However, TFEs require sophisticated production facilities, and their complex fabrication can limit application diversity [7]. This study proposes a simpler method using a shadow mask technique on a PMMA substrate, which avoids complex photolithography, facilitating the development of efficient, disposable biosensors for sepsis detection by measuring biomarkers like C-reactive protein (CRP).

Materials and Methods

Materials and apparatus utilized from global suppliers for the fabrication and characterization of thin-film electrodes. Key materials included polymers from Year Long and Sigma-Aldrich, metals for sputtering from Sigma-Aldrich and Heegermaterials, and biochemical reagents from Sigma Aldrich and Molekula. Techniques involved include PVD

sputtering, AFM for surface analysis, and FESEM for imaging. Electrochemical measurements were performed using a potentiostat/galvanostat at room temperature, ensuring the reproducibility and precision of the results.

Construction of Thin-Film Electrode Cells

In this study, thin-film electrodes were fabricated on a PMMA substrate using a CO2 laser and CAD-designed layouts. The electrodes, arranged in a three-electrode setup (counter, working, and reference electrodes), were crafted from thin films of titanium and gold or silver, deposited through sputtering. A commercially available PVC sticker served as a shadow mask for precise material deposition. This method involved sequential mask applications and material sputtering, ensuring accurate alignment and adhesion of the materials. The step-by-step fabrication process ensured that each electrode's geometry was meticulously crafted and distinct layers were deposited for electrochemical performance.

Electrochemical Performance

This study utilized cyclic voltammetry (CV) and electrochemical impedance spectroscopy (EIS) to characterize biosensor, focusing on their electrochemical performance. A 5 mM potassium ferricyanide solution was used for the electrochemical assays, with experiments conducted in triplicate to ensure reliability. Data from the initial voltammetry cycle were excluded to avoid inaccuracies, setting the voltage change rate at 50 mV/s and a potential range from +0.6 to -0.6 V. In EIS, a constant DC potential of 200 mV and an AC amplitude of 5 mV were used across a frequency range of 1 Hz to 100 kHz. For surface modification, aptamers targeting the CRP biomarker were chemically bonded to electrode surfaces, featuring a 44-nucleotide sequence with a thiol group for strong adsorption to gold surfaces. The electrodes were prepared through rigorous cleaning, aptamer binding, and subsequent blocking of unoccupied sites with 6-mercapto-1-hexanol (MCH).CRP samples were diluted using phosphate-buffered saline (PBS), incubated overnight, and applied to the prepared electrodes to assess sensor performance. This meticulous approach ensured precise and stable detection of CRP concentrations ranging from 0.9 to 0.02 ng/ml.

Results

The thin-film electrodes (TFEs) fabricated using the shadow mask technique demonstrated excellent electrochemical performance for detecting C-reactive protein (CRP), a key biomarker for sepsis. The biosensor showcased a linear detection range from 0.02 to 0.9 ng/ml with a limit of detection (LOD) of 6.5×10^{-7} ng/ml. Testing with human serum samples revealed a recovery rate of 94.7–99.8%, indicating high accuracy and applicability in real-world conditions. These findings underscore the potential of the developed TFEs for point-of-care applications, particularly in the rapid and sensitive detection of sepsis.

Conclusion

This study introduces a novel, efficient method for producing multi-material thin-film electrodes (TFEs) using a shadow mask technique on both rigid and flexible substrates,

bypassing costly photolithography. Employing PVC sticker film as a disposable mask, the method facilitates the creation of electrodes on a PMMA substrate with enhanced properties compared to traditional screen-printed electrodes (SPEs). Characterization through FE-SEM, AFM, and EDS highlighted the TFEs' smoother surface and uniform conductive layer deposition, resulting in lower surface roughness and improved electron transfer efficiency. TFEs demonstrated superior electrochemical performance, higher elemental purity, and thinner conductive layers. These features were validated in biosensing tests for CRP, a sepsis biomarker, showing high selectivity, sensitivity, and accurate performance in human serum samples, making TFEs promising for medical diagnostic applications.

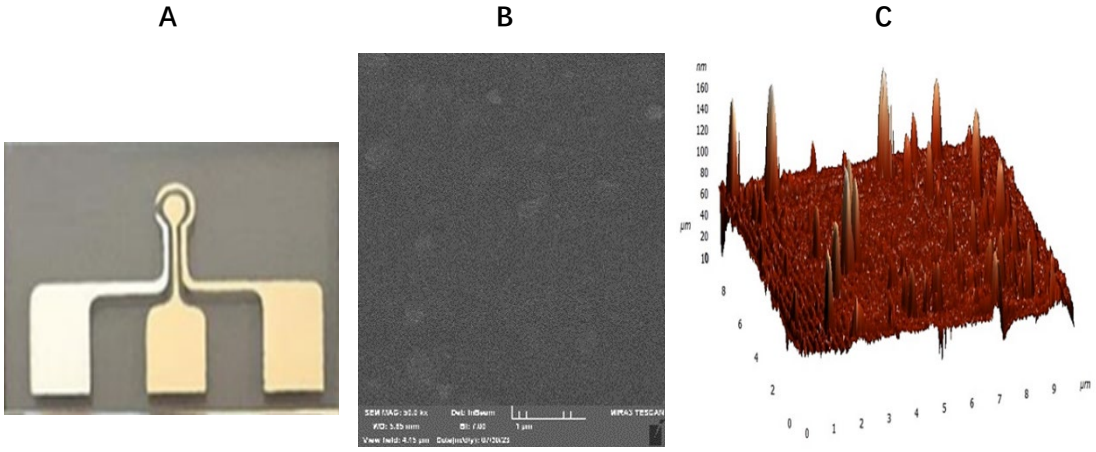


Fig.1 A) An actual image of fabricated electrode, B) FE-SEM, C) AFM.

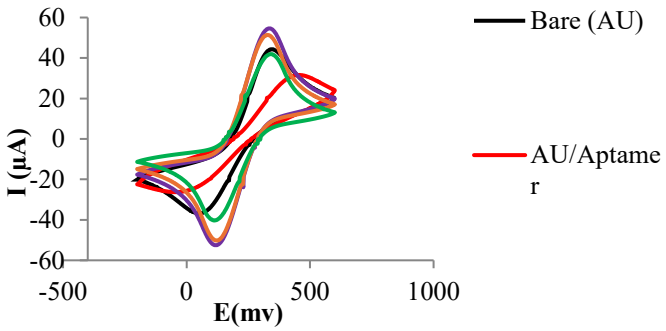


Fig.2 Describes the analysis of the biosensor after integrating the aptamer, conducted using cyclic voltammetry (CV).

Acknowledgements

We extend our gratitude to the Department of Nanobiotechnology and Biomimetics at the School of Life Science Engineering, College of Interdisciplinary Science and Technology, University of Tehran, for their support and contributions to this research.

References (see example below)

1. E. L. Amers *et al.,* "Embroidered Interdigitated Electrodes (IDTs) with Wireless Readout for Continuous Biomarker Monitoring," *Sensors*, vol. 24, no. 14, 2024, doi: 10.3390/s24144643.
2. M. S. I. Sozal *et al.,* "Fabrication and preliminary testing of patterned silver cathodes for proton conducting IT-SOFCs," *Materials Advances*, vol. 5, no. 5, pp. 1940–1951, Jan. 2024, doi: 10.1039/d3ma00793f.
3. M. Serafini *et al.,* "From Traditional to New Benchmark Catalysts for CO2 Electroreduction," *Nanomaterials*, vol. 13, no. 11, 2023, doi: 10.3390/nano13111723.
4. W. Wahyuni *et al.,* "A Brief Review on Fabrication of Screen-Printed Carbon Electrode: Materials and Techniques," *Indonesian Journal of Chemical Research*, pp. 210–218, Nov. 2021, doi: 10.30598//ijcr.2021.7-wul.
5. Y. Zhang and X. Chen, "Nanotechnology and nanomaterial-based no-wash electrochemical biosensors: from design to application," *Nanoscale*, vol. 11, no. 41, pp. 19105–19118, 2019, doi: 10.1039/C9NR05696C.
6. N. Lokar *et al.,* "Microfluidic Electrochemical Glucose Biosensor with In Situ Enzyme Immobilization," *Biosensors (Basel)*, vol. 13, no. 3, 2023, doi: 10.3390/bios13030364.
7. M. A. Mohd Asri *et al.,* "Low-cost and cleanroom-free prototyping of microfluidic and electrochemical biosensors: Techniques in fabrication and bioconjugation," *Biomicrofluidics*, vol. 15, p. 61502, Nov. 2021, doi: 10.1063/5.0071176.

Tumor Marker Detection Technologies, Equipment, and Theranostic Integration

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Cancer is a major disease that poses a serious threat to human health. in 2022, there were 4.82 million new cases of cancer and 3.21 million deaths in China. Tumor markers can be used for early diagnosis of tumors. However, most of the currently developed assays are deficient in sensitivity and specificity and cannot meet the requirements of clinical tumor marker detection, which requires further improvement of the detection rate of tumors for early diagnosis. Conventional nanomedicine carriers are limited by poor stability, short blood circulation time, low selectivity, and susceptibility to immune clearance. Early diagnosis and targeted precision therapy of tumors are major challenges today.

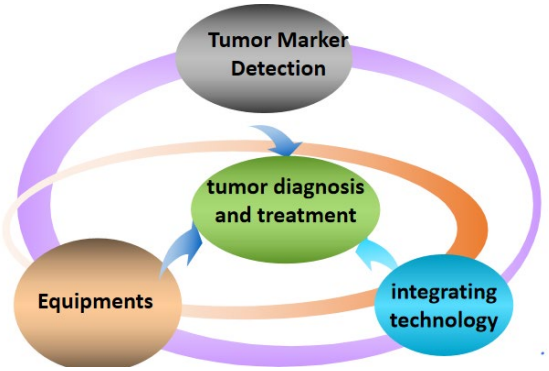


Fig.1 Tumor Marker Detection Technologies, Equipment, and Theranostic Integration

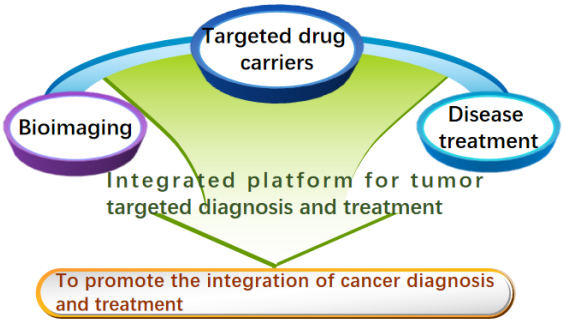


Fig.2 The drug delivery system developed by our research group

Acknowledgements

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References (see example below)

1. S. Nikkey. N. Swami, *RSC advances*, 14, 18907-18941(2024).
2. M. Han, Y. Xie, R. Wang, Y. Li, *Micromachines*, 14, 739(2023).
3. X. Wang, M. Xu, Y. Kuang, *Journal of Hazardous Materials*, 465, 133169(2024).
4. S Bi, S Z Yue, S S Zhang*. Chem. Soc. Rev., 46, 4281-4298 (2017).

Construction of functional artificial cells_

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Life begins with cells. Artificial cells are cellular like structures that can mimic some (or all) of cell structures and functions. Building artificial cells from the bottom up helps to reveal the working mechanism of cells and provide a theoretical basis for the origin of life. Targeting the key issues in this field, we carried out following projects in recent years.[1] Par system was reconstituted into GUVs to realize the even plasmids segregation and inheritance mimicry.[2] The mechanism of the influence of osmotic pressure on vesicular deformation was clarified to construct a divisible artificial "eukaryotic cell".[3]Glycolysis metabolic pathway was rebuilt inside an artificial cell for the synthesis of amino acid.[4] We developed a method to construct non spherical organelles[5] to mimic chloroplast grana capable of capturing light energy. The artificial cells capable of carbon fixation [8] and NO production [9] were built. We built spatial coded artificial tissues using magnetic[6,7] and acoustic fields. These tissues possessed the vasodilation and muscle contraction functions. [10,11]

References

1. X. Han*, et. al. *Adv. Mater.* **33,** 2002635 (2021)
2. X. Han*, et. al. *Nat. Commun.*, **15**, 4956 (2024)
3. X. Han*, et. al. *J. Am. Chem. Soc.* **139**, 9955 (2017)
4. X. Han*, et. al. *J. Am. Chem. Soc.* **146**, 21847−21858 (2024)
5. X. Han*, et. al. *Adv. Mater.* **30**, 1707482 (2018)
6. X. Han*, et. al. *Nat. Commun.* **11**, 232 (2020)
7. X. Han*, et. al. *Nat. Commun.* **13**, 2148 (2022)
8. X. Han*, et. al. *Angew. Chem. Int. Ed.* **64**, e202421827 (2025)
9. X. Han*, et. al. *Adv. Mater.* **37**, 2500242 (2025)
10. X. Han*, et. al. *Adv. Mater.* **34**, 2204039 (2022)
11. X. Han*, et. al. *Nat. Commun.* **14**, 7507 (2023)

Electrochemical control and detection of pathogenic microorganisms

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The efficient control and detection of pathogenic microorganisms are of great concern for preventing the spread of infectious diseases and maintaining public health security. However, traditional antibacterial and detection schemes, such as chemical disinfection and organic probe monitoring, usually face the impact of poor antibacterial performance, detection sensitivity, system stability, and biosafety. Several electrochemical examples to solve such dilemma will be presented herein. In aspect of microbial inactivation, we first developed a sustainable heterogeneous Fenton system, which is attainable by enhancing the ligand-to-metal charge-transfer (LMCT) excited-state lifetime in Fe–gallate complex. By engineering oxygen defects in the complex, the lifetime was improved from 10–90 ps. The lengthened lifetime ensures sufficient concentrations of excited-states for an efficient Fe cycle, realizing previously unattainable H2O2 activation kinetics and hydroxyl radical (•OH) productivity [1]. We also reported a facile Ni doping converted spin-state transition method to improve the electrocatalytic production of 1O2. The high-spin Ni-Co3O4 generate appropriate binding strength and enhance electron transfer between the Co centers with oxygen intermediates, thereby improving the catalytic activity of Ni-Co3O4 for generating 1O2. In neutral conditions, 1×106 CFU/mL ESBL-producing Escherichia coli (E. coli) could be inactivated by Ni-Co3O4 system within 5 min [2]. In terms of microbial detection, we develop a reversible fusion−fission MXene-based fiber microelectrode for G+/G− bacteria analysis. During the fissuring process, the spatial utilization, loading capacity, sensitivity, and selectivity of microelectrodes were maximized, and polymyxin B and vancomycin were assembled for G+/G− identification. The as-proposed sensing platform reached higher sensitivity toward E. coli (24.3 CFU/mL) and S. aureus (37.2 CFU/mL) in 20 min. A deep learning model was further applied for the electrochemical impedance spectroscopy (EIS) identification in diverse ratio concentrations of G+ and G− of (1:100−100:1) with higher accuracy (>93%) and gave predictable detection results for unknown samples [3].

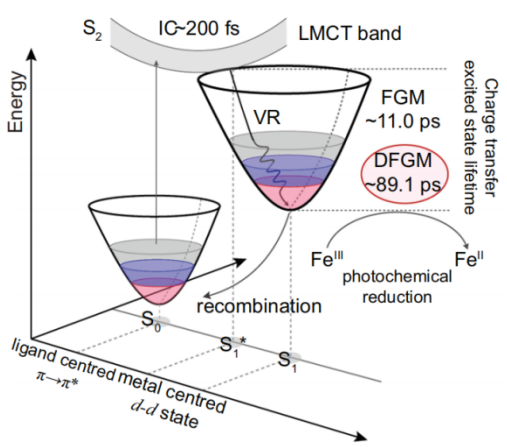


Fig. 1 Schematic illustration of potential energy surfaces involved in excited-state LMCT dynamics shown as a function of wavenumber and pump-probe delay times.

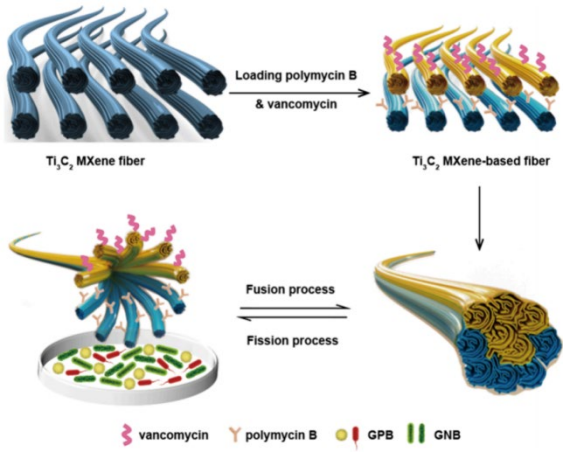


Fig. 2 Illustration of the MXene Fiber-Based Microelectrode for G^+ and G^- Identification

Acknowledgements

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References

1. Y. Shi, G. Zhang, C. Xiang, C. Liu, J. Hu, J. Wang, R. Ge, H. Ma, Y. Niu, Y. Xu, *Adv. Mater.*, **36**, 2305162 (2024).
2. M. Duan, C. Huang, G. Zhang, H. Shi, P. Zhang, L. Li, T. Xu, Z. Zhao, Z. Fu, J. Han, Y. Xu, X. Ding, *Angew. Chem. Int. Ed.*, **63**, e202318924 (2024).
3. L. Li, X. Ding, S. Shan, S. Chen, Y. Zhang, C. Zhang, C. Huang, M. Duan, K. Xu, X. Zhang, T. Wu, Z. Zhao, Y. Liu, Y. Xu, *Anal. Chem.*, **96**, 9317-9324 (2024).

The design of implantable biosensor for in vivo Electrochemical Sensing

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In vivo sensing based on implantable microelectrodes has been widely used to monitor biological chemicals due to its high spatial and temporal resolution, and engineering interface designability, which has become a powerful drive to understand the physiological and pathological process. Over the past few decades, with the development of a variety of advanced materials and technologies, encouraging progress has been made in quantifying various neurochemical transients. However, because the complex chemical atmosphere including thousands of small and large biomolecular, and inherent low mechanical property of body tissue, the design of compatible microelectrode for in vivo electrochemical tracking biological chemicals with high selectivity and stability still have great challenges. In this talk, I will introduce our recent progress in rational regulating of the microelectrode interface to resolve the questions of selectivity and sensitive decrease resulted from protein adsorption, and in how to decrease the mechanical mismatch of implanted electrode to that of brain tissue. We find the rule of the decrease in sensitivity resulted from protein adsorption and developed new strategy of anti-adsorption with modifying mimic cell membrane at the surface of microelectrode. we fabricate one support-free flexible polymer microelectrodes for in vivo neural recording with improved biocompatibility. We believe that these biocompatible electrochemical microelectrode with good performance will have a broad development prospect in in vivo analysis and help to unveil the molecular mechanism of physiological and pathological process.

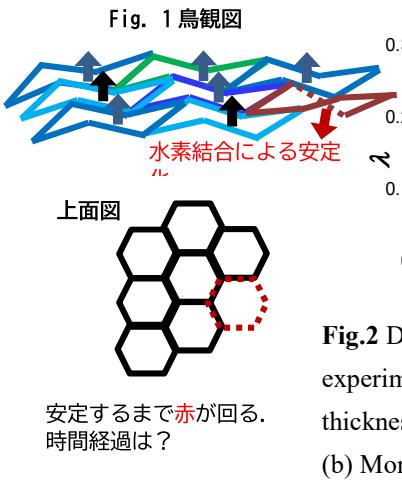
Double-layer capacitance properties suggestive of two-dimensional ice

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Frequency dispersion of a double layer capacitance or the constant phase element, obeying the power-law of the ac-frequency, is caused by long-distant interaction of solvent dipoles on an electrode. The calculation of the 2D Ising model demonstrates here that the number of the power, λ, increases with an increase in the interaction energy of the dipoles with the same orientation (homo-pairs), associated with formation of phases. The phase formation reminds us of phase transition such as in the recently reported 2D hexagonal ice with a bilayer on a metal surface. The concept of the icy structure is applied to the capacitance to explain the power-law in the context of the interaction. A value of λ is a measure not only of the dipole interaction but also of structure formation. The explanation can be supported with the four experimental results. i) Thick films of graphene flakes enhance λ -values because the ordering of the homo-pairs expands into the flakes perpendicularly to the electrode. ii) The conducting polyaniline films decrease λ-values because neighboring phenyl and quinoid moieties in the polyaniline prohibit formation of homo-pairs. iii) Miscible mixed solvents decrease also λ-values because they disturb formation of the homo-pairs. iv) Aqueous solutions including small fractions of ethanol show scattering values of capacitances because of unstable ordering of the phase. These experimental results support the concept of the dipole-dipole interaction with the hexagonal structure based on the 2D icy model.



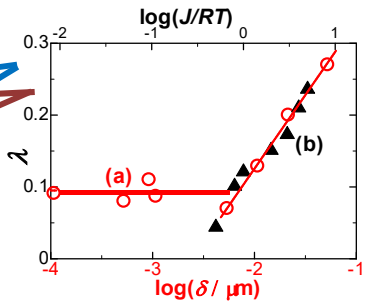


Fig.2 Dependence of (a) experimental values of logλ on thickness of the graphene flakes and (b) Monte Carlo-simulated values of λ on log(J/RT).

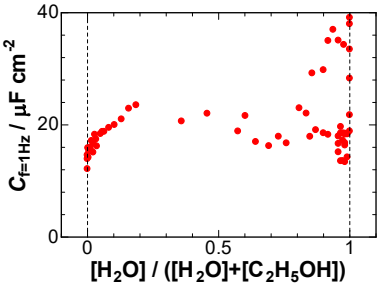


Fig.3 Variation of the DLC at f = 1 Hz with the fraction of ethanol in mixed aqueous solutions including 0.01 M TBAP at the Pt wire electrode.

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Atomically Dispersed Metal Interfaces for Analytical Chemistry

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Engineering sensing interfaces with functional nanomaterials has aroused great interest in constructing novel analytical platforms. The good catalytic abilities and physicochemical properties allow functional nanomaterials to perform catalytic signal transductions and synergistically amplify biorecognition events for efficient target analysis. However, further boosting their catalytic performances poses grand challenges in achieving more sensitive and selective sample assays. Besides, nanomaterials with abundant atomic compositions and complex structural characteristics bring about more difficulties in understanding the underlying mechanism of signal amplification. Atomically dispersed metal catalysts (ADMCs), as an emerging class of heterogeneous catalysts, feature support-stabilized isolated metal catalytic sites, showing maximum metal utilization and a strong metal–support interfacial interaction. These unique structural characteristics are akin to those of homogeneous catalysts, which have well-defined coordination structures between metal sites with synthetic or biological ligands. By integrating the advantages of heterogeneous and homogeneous catalysts, ADMCs present superior catalytic activity and specificity relative to the nanoparticles formed by the nonuniform aggregation of active sites. ADMC-enabled sensing platforms have been demonstrated to realize advanced applications in various fields. Notably, the easily tunable coordination structures of ADMCs bring more opportunities to improve their catalytic performance, further moving toward efficient signal transduction ability. Besides, by leveraging their inherent physicochemical properties and various detection strategies, ADMC-enabled sensing interfaces not only achieve enhanced signal transduction but also show diversified output models. Such superior functions allow ADMC-enabled sensing platforms to achieve the goal of high-performance detection of trace targets and make significant progress in analytical chemistry. Herein, regulating metal centers, integrating multisite synergy, and tuning charge transport pathways are highlighted to boost the catalytic activity and specificity of ADMCs as well as expand their multifunctionality. Combined with various transduction models, including colorimetry, electrochemistry, chemiluminescence, electrochemiluminescence, and photoelectrochemistry, ADMC-based sensors achieve efficient detection of diverse analytes.

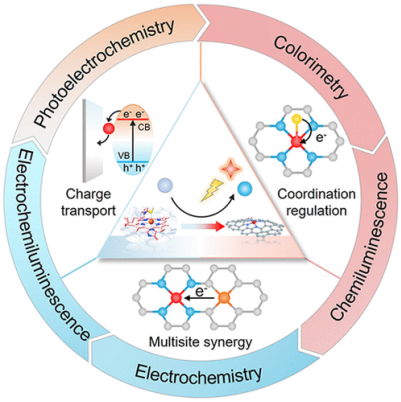


Fig.1 Tuning atomically dispersed metal interfaces for boosting sensing performance

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References

1. W. Xu, Y. Wu, W. Gu and C. Zhu, *Acc. Chem. Res.*, **58**, 1366-1378 (2025).
2. Y. Wu, W. Jiang, W. Xu, F. Lv, S. Song, L. Hu, C. Wang, L. Zheng, W. Gu, R. Zhang, S. Guo and C. Zhu, *J. Am. Chem. Soc.* **147**, 1356-1363 (2025).
3. Y. Zhou, Y. Wu, Z. Luo, L. Ling, M. Xi, J. Li, L. Hu, C. Wang, W. Gu and C. Zhu, *J. Am. Chem. Soc.*, 146, 12197-12205 (2024).
4. W. Xu, H. Zhong, Y. Wu, Y. Qin, L. Jiao, M. Sha, R. Su, Y. Tang, L. Zheng, L. Hu, S. Zhang, S. P. Beckman, W. Gu, Y. Yang, S. Guo and C. Zhu, *Proc. Natl. Acad. Sci. U.S.A.*, **120**, e2220315120 (2023).
5. W. Xu, X. Cai, Y. Wu, Y. Wen, R. Su, Y. Zhang, Y. Huang, Q. Zheng, L. Hu, X. Cui, L. Zheng, S. Zhang, W. Gu, W. Song, S. Guo and C. Zhu, *Nat. Commun.* **14**, 6064 (2023).

Programmable DNA-Nanomaterials for Biosensing and Bioimaging

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Developing high-performance biological nanoprobes with enhanced specificity, improved detection sensitivity, and reduced biotoxicity remains a significant challenge in the field of life science analysis. DNA molecules, owing to their unique double-helix structure, precise and stable complementary base pairing, sequence programmability, and structural versatility, serve as excellent biological templates for the synthesis of functional nanomaterials. Harnessing these intrinsic properties, we have designed and constructed a series of DNA-based nanomaterial probes for applications in biosensing and bioimaging.

Using a one-step synthesis approach, we successfully prepared DNA-quantum dot hydrogels, which demonstrated excellent performance in the specific identification of cancer cells, regulation of protein expression, and targeted drug delivery. In addition, we developed a composite nanostructure featuring a “core–shell” architecture, integrating DNA quantum dots with gold nanoparticles. By employing DNA strand displacement strategies, this system effectively overcame cellular drug resistance, thereby significantly enhancing the therapeutic efficacy against cancer.

Furthermore, we engineered activation-responsive DNA nanoprobes capable of dynamically modulating their sensing and imaging behavior in response to a variety of endogenous (e.g., pH shifts, redox levels, or enzyme activity) and exogenous (e.g., light, temperature, or chemical triggers) stimuli. These intelligent nanoprobes are constructed based on well-designed DNA circuits and conformational switches, such as hairpin structures, toehold-mediated strand displacement, and catalytic hybridization assembly (CHA), enabling them to perform logic-gated signal amplification or turn-on fluorescence imaging in complex biological environments, demonstrating their potential in precise molecular diagnostics and dynamic cellular analysis.

Carbon Dots: Separation strategy, photoluminescence mechanisms, and imaging analysis

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Carbon dots (C-dots) are luminescent carbon nanomaterials that have garnered increasing attention in recent years. To date, theories such as the quantum size effect, surface-state emission, molecular-state emission, and crosslink-enhanced emission have been proposed to explain the luminescence behavior of C-dots. However, these "theories" are largely derived from or inspired by other materials (e.g., semiconductor nanocrystals, AIE materials, etc.) and often rely heavily on empirical assumptions, intuition, or even speculation. The difficulty in understanding the photoluminescence mechanisms of C-dots primarily stems from: (1) The vast diversity of synthesis methods and precursors, leading to significant heterogeneity in the products; (2) Even within a specific synthesis system, C-dots products typically contain mixtures of particles, oligomers, and polymers; (3) The complex chemical compositions and surface structures of C-dots.

Thus, thorough separation and purification of C-dots are fundamental to studying and elucidating their luminescence mechanisms. In early research, separation techniques for C-dots were often overlooked, with dialysis being the primary method, which proved insufficient. Although the introduction of various chromatographic techniques has improved the situation, preparative-scale separation and purification methods/systems for C-dots remain underdeveloped compared to analytical characterization techniques.

In recent years, our group has focused on the preparative separation of C-dots. To address the complexity and high heterogeneity of C-dots products, we proposed a **combined separation strategy (coarse separation + fine separation)** and developed preparative thin-layer chromatography and polyamide column chromatography systems. These advancements have enabled the effective separation and purification of C-dots with diverse properties, including hydrophilic, amphiphilic, and lipophilic variants.

Building on this foundation and incorporating theoretical calculations, we proposed a **"unit emission" photophysical model** for C-dots. Furthermore, we investigated the **spatiotemporal imaging applications** of these purified C-dots at the cellular and in vivo levels.

Biological reaction network-based high-performance biosensing

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Nervous system diseases have become the leading cause of death and disability due to their high morbidity, mortality, disability and recurrence rates, and thus the heavy burden of nervous system diseases has brought serious challenges to society and medical treatment. The occurrence and development of nervous system diseases are closely related to the expression levels of some important biological functional molecules. Accurate detection of these biomolecules related to nervous system diseases is helpful to elucidate the molecular mechanism of nervous system diseases, and is of great significance for early diagnosis and clinical research of nervous system diseases. However, neurological diseases involve many substances and change dynamically. In addition, neurological diseases are closely related to different nerve cells, the blood-brain barrier, and the interaction between brain regions. Therefore, how to achieve accurate and real-time measurement of nervous system disease molecules is still a huge challenge.

We carry out relevant research on the diagnosis of nervous system diseases using clinical diagnostic markers of nervous system diseases as the target. By developing new design strategies based on competitive reactions and multivalent spatial pattern-recognition, the applicant developed a spatially localized biological probe with high-performance. Using this sensor, we visualize the real-time response of endogenous biomarkers in freely moving mice, brain slices, neuronal cells, and clinical samples with exceptional sensing speed, selectivity, and sensitivity. The studies revealed the intrinsic mechanism and important function of relevant molecules in acute ischemic stroke, and achieved systematic innovation results.[1-6]

References

1. Lin, N., Zhang, Y.,* Willner, I.,* Zhou, Z.,* J. Am. Chem. Soc. 2024, 146: 20685.
2. Zhou, Z., Han, B., Zhang, Y.,*, Yao, H.,* Nature Commun. 2024, 15: 10900.
3. Zhou, Z.,* Lin, N., Ouyang, Y., Zhang, Y.,* Willner, I.,* J. Am. Chem. Soc. 2023, 145: 12617.
4. Zhou, Z., Ouyang, Y., Wang, J., Willner, I.,* J. Am. Chem. Soc. 2021, 143: 5071.
5. Zhou, Z., Ouyang, Y., Wang, J., Willner, I.,* J. Am. Chem. Soc. 2021, 143: 241.
6. Zhou, Z., Yue, L., Wang, S., Lehn, J., Willner, I.,* J. Am. Chem. Soc. 2018, 140: 12077.

The ATPase cycle of the AAA-ATPase protein transporter Bcs1 is highly concerted

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Bcs1, a homo-heptameric transmembrane AAA-ATPase that belongs to the superfamily of AAA proteins, acts as essential translocation machinery for the folded Rieske iron-sulfur protein (ISP, a key redox-active subunit of the mitochondrial complex-III) across the inner mitochondrial membrane. This unique ATP-dependent process is critical for oxidative phosphorylation, as ISP must be properly positioned within complex III to mediate electron transfer. Cryo-EM structures depicted a ring-shaped transporter with two cavities, a cylindrical one formed by the ATPase domains on the matrix surface and a conical one formed by the transmembrane helices. Structures in different nucleotide states (ATPγS, ADP, APO) provided intuitive snapshots of the functional cycle, but the kinetics and structural transitions of the ATPase cycle remain entirely unknown. Here, using high-speed atomic force microscopy (HS-AFM) and line scanning (HS-AFM-LS), we characterized single-molecule Bcs1 ATPase cycling. While the ATP conformation had ~5600 ms lifetime, independent of the ATP-concentration, the ADP/apo conformation lifetime was ATP-concentration dependent and reached ~320 ms at saturating ATP-concentration, giving a maximum turnover rate of 0.17 s^{-1}. Importantly, Bcs1 ATPase cycle conformational changes occurred in concert. Furthermore, we propose that the transport mechanism involves opening the IMS gate through energetically costly straightening of the transmembrane helices, potentially driving rapid gate resealing. Overall, our results establish a concerted ATPase cycle mechanism in Bcs1, distinct from other AAA-ATPases that use a hand-over-hand mechanism.

Additive Manufacturing Approaches for Advanced Boron-Doped Diamond Electrodes

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Conductive boron-doped diamond (BDD) is recognized for its outstanding electrochemical properties, positioning it as a highly attractive material for electrode and sensor development [1]. Nevertheless, its intrinsic hardness presents significant challenges in terms of microstructuring and integration with flexible substrates. In this work, we address these limitations by employing cost-effective and accessible additive manufacturing methods, particularly inkjet and 3D printing.

We introduce, for the first time, a streamlined bottom-up strategy to fabricate a BDD-based three-electrode sensor chip (Fig. 1). This involves selective deposition of nanodiamond particles via inkjet printing, followed by chemical vapor deposition to form miniaturized BDD working and counter electrodes [2]. The system is completed with an inkjet-printed silver reference electrode. Electrochemical analysis of the fabricated chip was performed using standard redox probes and various organic compounds, with results benchmarked against commercial screen-printed BDD electrodes. Notably, the inkjet-fabricated devices demonstrated comparable performance without evident limitations.

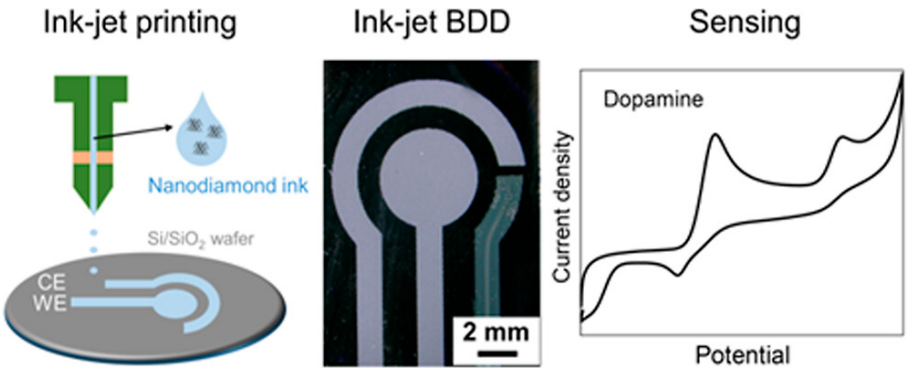


Fig. 1 Inkjet printing-manufactured BDD chip electrodes for electrochemical sensing [2].

Additionally, we present a novel route for producing flexible diamond-based electrodes. A composite material was engineered by integrating BDD microparticles and carbon nanotubes into a 3D-printable thermoplastic polyurethane matrix (Fig. 2). The resulting structure was validated through electrochemical testing and successful detection of dopamine, confirming its potential for flexible sensor applications [3].

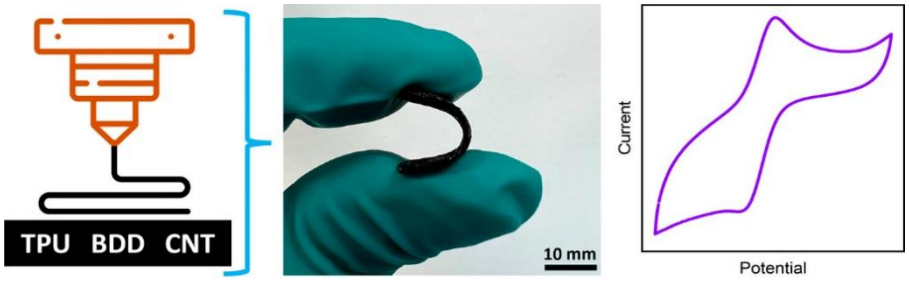


Fig. 2 3D-printed flexible composite electrodes of BDD particles, carbon nanotubes (CNT), and thermoplastic polyurethane (TPU) [3].

Acknowledgements

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References

1. S. Baluchová, A. Daňhel, H. Dejmková, V. Ostatná, M. Fojta, K. Schwarzová-Pecková, *Anal. Chim. Acta*, **1077**, 30–66 (2019). DOI: 10.1016/j.aca.2019.05.041.
2. Z. Liu, S. Baluchová, B. Brocken, E. Ahmed, K. Pobedinskas, K. Haenen, J. G. Buijnsters, *ACS Appl. Mater. Interfaces*, **15**, 39915–39925 (2023). DOI: 10.1021/acsami.3c04824.
3. S. Baluchová, S. van Leeuwen, B. Kumru, J. G. Buijnsters, *ACS Appl. Polym. Mater.*, **6**, 14638–14647 (2024). DOI: 10.1021/acsapm.4c02748.

Continuous In Vivo Pharmacokinetic Tracking via Implantable Aptamer-Based Sensors

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Structure-switching aptamer-based sensors have emerged as a powerful alternative to traditional enzyme- and antibody-based biosensing platforms. These electrochemical biosensors enable real-time, continuous monitoring of therapeutically relevant molecules in biological fluids with sub-minute temporal resolution, spanning hours to days. Typically, a redox-labeled aptamer undergoes a conformational change upon target binding, modulating the electrochemical signal. However, achieving high sensitivity and specificity remains a challenge when distinguishing target analytes from structurally similar metabolites or precursors in complex biological matrices. In this talk, I will introduce a novel electrochemical biosensing platform that leverages highly nanoporous electrodes to enhance detection sensitivity and selectivity in mass-limited biological samples. I will describe how coupled electron and ion transport within nanoconfined architectures improves sensor performance. Next, I will present a real-time sensing approach for in vivo monitoring, using surface-immobilized aptamers on nanoporous electrodes to continuously track analyte concentrations and reaction kinetics in live animal models. As

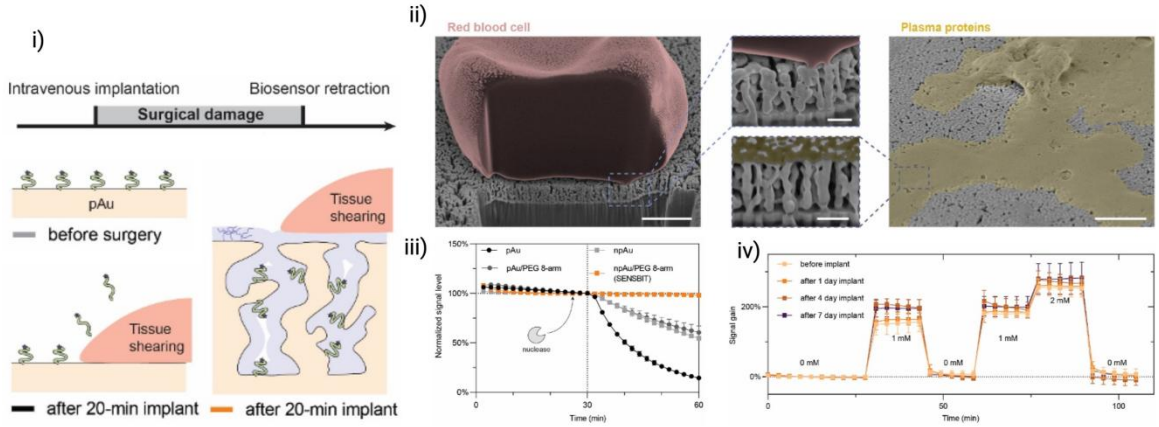


Fig.1 Stable Electrochemical Nanostructured Sensor for Blood In situ Tracking (SENSBIT) system. It features hyperbranched polyethylene glycol (PEG) uniformly deposited on nanoporous electrodes, effectively blocking proteins and blood cells while allowing the target molecules to pass. Taking inspiration from intestinal mucosal structure, SENSBIT remain stable after long-term implantation, whereas planar gold sensors fail in the whole blood environment. SENSBIT achieved month-long stability in the serum environment and week-long stability in rat femoral vein.

a case study, I will share an implantable biosensor designed to assess tissue-specific pharmacokinetics of chemotherapeutic agents at multiple tumor sites, revealing drug distribution patterns distinct from blood-based measurements. Finally, I will discuss recent advances in nano-bio interface engineering that balance molecular recognition with surface stability, enabling extended continuous monitoring in the bloodstream. Together, these developments represent a generalizable strategy to achieve in vivo, real-time biochemical sensing with clinical relevance, aligning with the symposium's goals of developing engineered, affinity-based continuous biosensing systems.

References

1. Chen, Y.#; Fu, K.X.#; Cotton, R.; Ou, Z.; Kwak, J.W.; Chien, J-C; Kesler, V.; Nyein, H.Y.Y.; Eisenstein, M.; Soh, H.T.*, Nature Biomedical Engineering, 2025, 01389.
2. Huldin, G. F.; Huang, J.; Fu, K. X.*, Current Opinion in Electrochemistry, 2025, 101695.
3. McGowan, M.P.; Trowbridge, A.J.; Reitemeier, J.; Jordan, K.M.^; Fu, K.X.*, Biosensors and Bioelectronics, 2025, 276, 117229.
4. Huldin, G. F.; Huang, J.^; Reitemeier, J.; Fu, K. X.*, Faraday Discussions, 2025, 257, 316-332.
5. Reitemeier, J.#; Metro, J.#; Fu, K. X.*, Sensors and Actuators Reports, 2024, 8, 100225.
6. Kesler, V.#; Fu, K.#*; Chen, Y.; Park, C.H.; Eisenstein, M.; Murmann, B.; Soh, H.T.*, Advanced Functional Materials, 2023, 1, 2208534.
7. Seo, J.-W.#; Fu, K#.; Correa, S.; Eisenstein, M.; Appel, E.A.*; Soh, H.T.*, Science Advances, 2022, 8, abk2901.
8. Fu, K#.; Seo, J.-W.#; Kesler, V.#; Maganzini, N.; Wilson, B.D.; Eisenstein, M.; Murmann, B.; Soh, H.T.*, Advanced Science, 2021, 8, 202102495.

New Electroanalytical Method for Solid-Contact Ion-Selective Electrodes - Coulometry/Impedance/Mass changes

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In recent years, instead of tradition potentiometric methods, some alternative electroanalytical transduction methods have been explored for solid-contact ion-selective electrodes (SCISEs), including coulometric and voltammetric method. In the year of 2015, a new coulometric transduction method was proposed for SCISEs by Prof. Johan Bobacka group. An advantage of the coulometric transduction method was the precision improvement for ISEs. The coulometric response signal was developed further to avoid the polarization the ISE membrane by utilizing SCISEs as reference electrode. Utilizing electronic capacitor for coulometric response instead of solid contact, and in combination with a voltage follower was capable for sensitivity improvement for ISEs. Application of coulometric response on wearable flexible ion sensors was also explored. The scientific novelty of the coulometric readout results are crucial for precision improvement for sensor science and electroanalytical chemistry with a promising application relevance.

In addition, use of mass changes Δm and low frequency capacitance C_{dl} (1 Hz) for Ag^+ ion detection, possibility of utilizing membrane resistance Z as analytical signal and single frequency effective capacitance C_{ec} principles were proposed for ion detection by utilizing quartz crystal microbalance (QCM), stripping voltammetry, and electrochemical impedance spectroscopy (EIS), which might give a possibility for calibration-free analytical method for SCISEs.

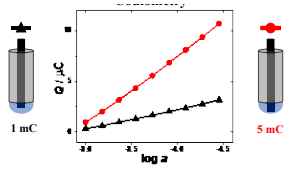


Fig. 1 Schematic illustration of coulometric transduction method.

References

1. J. Bobacka, A. Ivaska, A. Lewenstam, *Chem. Rev.*,**108**, 329 (2008)
2. Y. Tang, L. Zhong, W. Wang, Y. He, T. Han, L. Xu, X. Mo, Z. Liu, Y. Ma, Y. Bao, S. Gan, L. Niu, *Membranes*, 12, 504 (2022)
3. J. Bobacka, *Sens. Actuators B Chemical*, **410**, 135674 (2024)

4. E. Hupa, U. Vanamo, J. Bobacka, *Electroanal.*, **27**, 591–594 (2015).
5. U. Vanamo, E. Hupa, V. Yrjänä, J. Bobacka, *Anal. Chem.*, **88**, 4369–4374 (2016).
6. T. Han, U. Mattinen, J. Bobacka, *ACS Sens.*, **4**, 900–906 (2019).
7. T. Han, T. Song, Y. Bao, W. Wang, Y. He, Z. Liu, S. Gan, D. Han, J. Bobacka, L. Niu, *Talanta*, **262**, 124623 (2023).
8. R. Nussbaumm, S. Jeanneret, E. Bakker, *Anal. Chem.*,**96**, 6436-6443 (2024).
9. T. Han, T. Song, S. Gan, D. Han, J. Bobacka, L. Niu, A. Ivaska, *Chinese J. Chem.*,**2**, 207-213 (2023).
10. T. Han, S. Chen, T. Song, X. Lin, D. Han, J. Bobacka, L. Niu, *Electrochem. Commun.*, **175**, 107911 (2025).
11. T. Han, S. Chen, T. Song, S. Yang, X. Lin, Y. Ma, Y. Qin, D. Han, J. Bobacka, L. Niu, *Talanta*, 282, 127006 (**2025**).
12. T. Han, S. Chen, T. Song, D. Han, L. Niu, *ACS Meas. Sci. Au,* 5, 216-225 (**2025**).

A portable micro coulometric titration on open-surface droplet-based microfluidics with potentiometric end-point detection

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A portable micro coulometric titration in a liquid drop with a miniature potentiometric metal wire sensor for endpoint detection (metal oxide pH sensor) was fabricated. The semi-automated micro coulometric titration system with a stepwise applied constant current electrogenerated titrant was developed and operated via a low-cost microcontroller (Arduino, Uno). The miniature coulometric system was a compact setup and could operate with microliter-level samples without using a volumetric measuring tool, making it suitable for development as a portable system. Thiosulfate, sulfite, and citric acid were selected as model analytes to evaluate electrogenerated iodine and electrogenerated hydroxide, respectively. The potentiometric detection allows for the handling of colored samples. The proposed system was applied for the determination of sulfite in dried fruit extract solution and total acidity in fruit juice samples. The device shows a potential for use in other microtitration reactions in low-volume samples.

Acknowledgements

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References

1. T. Kanyanee, P. Fuekhad, K. Grudpan, Talanta, **115**, 258-262 (2013)

Construction of Anti-Fouling Polymeric Membrane Potentiometric Sensors for Marine Environmental Monitoring

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Marine environmental monitoring is of great significance for the assessment of marine ecological environments and sustainable development. Polymeric membrane ion-selective electrodes (ISEs) have advantages such as small size, simple operation, and resistance to turbidity, demonstrating promising application in in-situ monitoring of marine environments. However, lipophilic species, such as oil foulants and microorganisms, could be easily absorbed on the membranes due to the hydrophobic features of polymeric membranes, thus impairing sensors' performance and shortening the sensors' lifetimes. Herein, several anti-fouling strategies based on the surface functionalization of the sensors were developed. An oil-fouling resistance coating based on a zwitterionic polymer (poly(sulfobetaine methacrylate), SBMA) can be modified on the surface of a marine calcium sensor via a dopamine-assisted co-deposition method. The oleophilic sensor surface can be changed to an oleophobic one, which endows the sensor with excellent self-cleaning properties against oil foulants. In addition, an anti-biofouling coating based on graphene oxide (GO) can be formed on the calcium sensor via a layer-by-layer assembly technique. The GO coating works as a protective layer to impede the settlement of marine bacterial cells on the sensor surface due to its dual functionality of both antiadhesive and antimicrobial properties. To further improve the bactericidal efficacy, silver nanoparticles (Ag NPs) are used to modify the sensor surface via a simple in-situ reduction method. Ag NPs impart excellent antifouling capability to the sensor. The proposed method demonstrates good applicability to other polymeric membrane potentiometric marine sensors (e.g., carbonate sensor).

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References

1. G. A. Crespo. *Electrochim. Acta*., **245**, 1023-1034 (2017).
2. L. Qi, Z. Liao, Y. Liu, R. Liang. *Sens. Actuators, B*, **427**, 137170, (2025).
3. L. Qi, T. Jiang, R Liang, W. Qin. *Anal. Chem.,* **93**, 6932-6937 (2021).
4. T. Jiang, L. Qi, W. Qin. *Anal. Chem.,* **91**, 13268-13274, (2019).

Biocompatible Dots with Merged Catalyst and Coreactant for Enhanced Electrochemiluminescence

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Electrochemiluminescence (ECL) is a powerful tool for clinical diagnosis due to its exceptional sensitivity. However, the standard tripropylamine (TPrA) coreactant for $Ru(bpy)_3Cl_2$, the most widely studied and used ECL system, is highly toxic. Despite extensive research on alternative coreactants, they often fall short in poor efficiency. From a reaction kinetics perspective, accelerating electrooxidation rate of $Ru(bpy)_3Cl_2$ is an essential way to compensate the efficiency limitation of coreactants, but has been rarely reported. Here, we report a hybrid electrocatalyst@coreactant dots for the ECL of $Ru(bpy)_3Cl_2$. The preparation method for WSe_2@BSA dots is facile (RT, atmospheric conditions), rapid (5 min) and in large scale (for millions of bioassays). The as-prepared WSe_2@bovine serum albumin (WSe_2@BSA) dots is biocompatible, and demonstrate dual functions, i.e., the BSA shell works as a coreactant, meanwhile, the WSe_2 core effectively catalyzes Ru(bpy)3Cl2 oxidation. As a result, WSe_2@BSA dots exhibits an exceptionally high efficiency comparable to TPrA for the ECL of $Ru(bpy)_3Cl_2$. A biosensor utilizing WSe_2@BSA dots shows promise for highly sensitive detecting glypican-3 in clinical liver cancer serum samples, especially for alpha-fetoprotein-negative patients. This work opens exciting avenues for developing advanced ECL systems with improved performance and biocompatibility, ultimately contributing to early disease diagnosis and various clinical analysis.

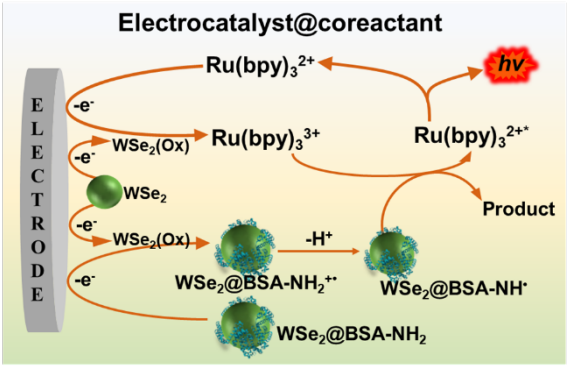


Fig.1 Scheme for the WSe_2@BSA dots-boosted ECL of $Ru(bpy)_3Cl_2$.

Acknowledgements

This work was supported by the National Natural Science Foundation of China (No. 22474018).

References

1. D. Pan, Z. Fang, E. Yang, Z. Ning, Q. Zhou, K. Chen, Y. Zheng, Y. Zhang, and Y. Shen*,

Angew. Chem. Int. Ed., **59**, 16747–16754 (2020).
2. F. Yin, E. Yang, X. Ge, Q. Sun, F. Mo, G. Wu, Y. Shen*, *Chin. Chem. Lett.*, **35**, 108753 (2024).
3. F.Yin, X. Zhou, M. Zhang, Q.n Sun, J. Zhao, G. Wu, Y. Zhang, and Y. Shen*, *Small*, **20**, 2406374 (2024).

Metal nanoparticles for sensitive colorimetric and electrochemiluminescent immunoassay

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Nanotechnology-based Electrochemiluminescent (ECL) and colorimetric bioassays are attractive and convenient in biosensor design for their simplicity, fast response time, high sensitivity, and convenient devices. Among them, metal nanoparticles have great potential in a broad range of applications because of their biochemical functionality, unique physical and optical properties. However, it is still a great challenge to synthesize small-size metal nanoparticles with good stability and high performance for biosensors. Therefore, developing simple and rapid synthesis strategies for fabrication of functionalized metal nanoparticles to improve the bioassay performances are urgenly needed. Triethanolamine (TEOA) has been proven to be a harmfulless, low-cost, and great water-solubility reducing agent for preparation of monodisperse metal nanoparticles [1-3]. Furthermore, TEOA can act as a coreactant to improve the anodic ECL response of $Ru(bpy)_3^{2+}$. For example, a facile synthetic method of TEOA-capped platinum nanoparticles (TEOA@PtNPs) for ECL and colorimetric immunoassay of SARS-CoV spike proteins (SARS-CoV S-protein) is developed (Fig. 1). In addition, TEOA and polyacrylic acid (PAA) modified silver nanoparticles (TEOA@AgNPs-PAA) with controllable size and high catalytic activity for sensitive detection of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) are reported (Fig. 2). The development of multifunctional metal nanoparticles offers an efficient sensing platform for the clinical diagnosis and biosensing application.

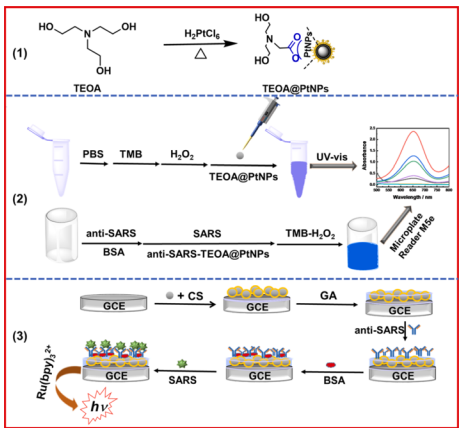


Fig.1 Schematic diagram of the synthesis of TEOA@PtNPs (1), colorimetric strategy (2) and ECL immunoassay of SARS-CoV S-protein (3).

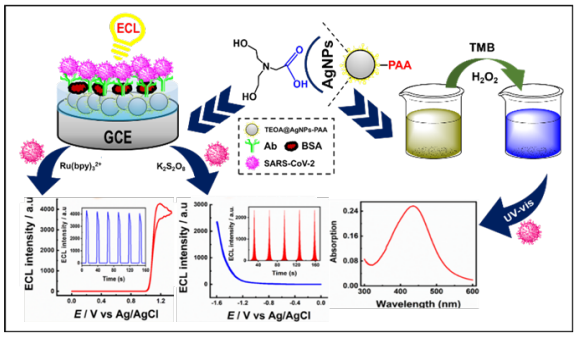


Fig.2 Schematic illustration for the synthesis of TEOA@AgNPs-PAA and the fabrication of the ECL and colorimetric immunosensor.

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References

1. X. Qin, C. Gu, M. Wang, Y. Dong, X. Nie, M. Li, Z. Zhu, D. Yang and Y. Shao, *Anal. Chem.*, **90**, 2826-2832 (2018)
2. X. Yang, X. Li, Q. He, Y. Ding, B. Luo, Q. Xie, J. Chen, Y. Hu, Z. Su, X. Qin, *Microchem. J.*, **186**, 108329 (2023)
3. X. Li, X. Yang, B. Liu, J. Luo, H. Chen, J. Chen, B. Wang, Y. Hu, Z. Su, X. Qin, *Anal. Chim. Acta*, **1342**, 343684 (2025)

Nanoconfinement-Enhanced Electrochemiluminescence for Machine Learning-Assisted Imaging Analysis of Biomarkers

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The domain-limited catalytic enhancement has opened novel avenues for the advancement of highly efficient aggregation-induced electrochemiluminescence (AIECL). Herein, a novel electrochemiluminescence (ECL) sensing platform is constructed through the in-situ encapsulation of aggregation-induced emission (AIE) molecules, tetraphenylethylene, within metal-organic frameworks (NH2-MIL-88). These frameworks are uniquely enriched with atomically dispersed active sites that serve as nanoconfined co-reactant accelerators. This innovative design leads to the creation of an integrated AIE nanoconfinement reactor. Within this reactor, the co-reactant accelerators catalyze co-reactants into reactive species (RS) in-situ, facilitating direct interaction with AIE molecules in a spatially confined composite. Additionally, by utilizing MATLAB-mediated image enhancement technology and deep learning algorithms, a smartphone-adopted self-reporting AIECL imaging system is designed to achieve an accurate and intelligent analysis of cardiac troponin I (cTnI). This innovative method presents an advanced strategy to enhance local RS concentrations via nanoconfinement catalysis. The developed smartphone-adopted AIECL imaging system offers a facile screening method for cTnI monitoring.

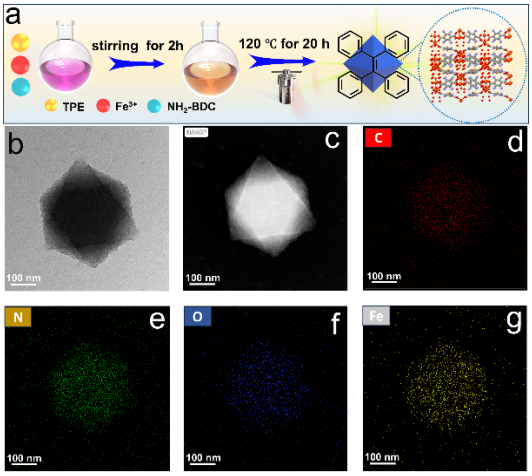


Fig.1 a) Illustration of the synthesis process of NH_2-MIL-88/TPE. b) TEM, c) HAADF, d–g) elemental mapping of NH_2-MIL-88/TPE.

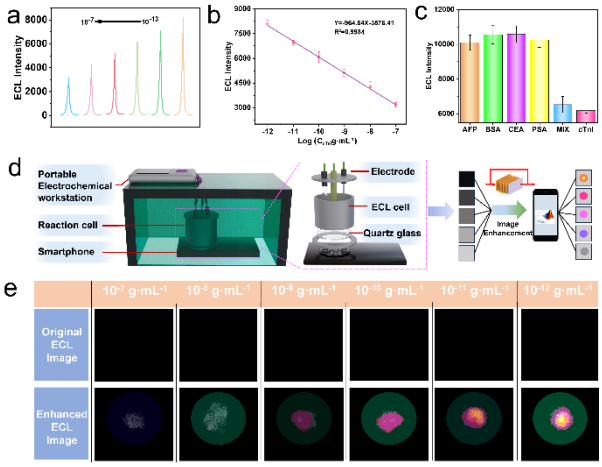


Fig.2 The ECL intensity a) and linear curve b) toward different concentrations of cTnI. c) The selectivity of the ECL immunoassays. d) The schematic diagram of the smartphone-adopted ECL imaging system. e) The original and enhanced ECL images in the detection of cTnI.

Acknowledgements

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References

1. C. P. Li, Z. Yang, J. Wang, H. Cheng, J. X. Liu, Y. J. Ding, J. J. Zhu, *Adv. Funct. Mater.*, 2504380 (2025).

Electrochemiluminescence of Atomically Precise Metal Nanoclusters and Their Biosensing Applications

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Electrochemiluminescence (ECL) is an analytical technique that integrates electrochemistry with chemiluminescence, in which the light-emitting process is initiated by electrochemical reactions at the electrode surface. Owing to the absence of an external excitation light source, ECL offers several advantages, including low background signal, high sensitivity, and excellent spatial and temporal controllability. These features have led to its widespread application in fields such as medical diagnostics, environmental monitoring, and food safety. Among the core components of ECL systems, luminophores play a pivotal role, as they determine the emission efficiency, stability, and overall analytical performance.

With the rapid development of nanotechnology, ECL luminophores have expanded beyond traditional organic molecules and inorganic complexes to include novel nanomaterials such as metal nanoclusters and quantum dots, opening up new opportunities for both fundamental research and practical applications. This report focuses on the design and controlled synthesis of atomically precise metal nanocluster-based ECL luminophores, highlighting their unique ECL properties and the structure–property relationships that govern their performance. Moreover, the underlying luminescence mechanisms will be investigated using a combination of electrochemical and spectroscopic techniques. Finally, novel biosensing strategies and technologies based on these advanced ECL luminophores will be presented, with the aim of promoting the development of ECL in precision medicine and bioanalytical applications.

Acknowledgements

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References

1. H. Ji, M. Chen, Y. Sun, W. Liu, M. Jiang, Y. Liu, R. Qin, J. Liu, Z. Hao, F. Zhang, X. Li, L. Zhang, R. Zhang. Sens. Actuators B Chem., **439**, 13740 (2025).
2. Y. Sun, W. Liu, M. Chen, H. Ji, M. Jiang, Z. Hao, X.Li, S. He; Zhang L.; Zhang R. Green. Chem., **26**, 7123-7131(2024)
3. M. Chen, Y. Sun, H. Ji, M. Jiang, W. Liu, M. Shao, Z. Hao, H. Zhang, X. Li,Y. Dang, R. Zhang, and L. Zhang Chem. Eng. J., **478**, 147397 (2023).
4. H. Lv, R. Zhang, S. Cong, J. Guo, M. Shao, W. Liu, L. Zhang and X. Lu. Anal. Chem., **94**, 4538 (2022).
5. S. Cong, Z. Jiang, R. Zhang, H. Lv, J. Guo, L. Zhang and X. Lu. Anal. Chem., **94**, 6695 (2022).
6. Y. Zhang, Y. Zhao, Z. Han, R. Zhang, P. Du, Y. Wu and X. Lu. Angew. Chem. Int. Ed., **59**, 23261 (2020).
7. R. Maar, R. Zhang, D. Stephens, Z. Ding and J. Gilroy. Angew. Chem. Int. Ed., **58**, 1052

(2019).

Peptide Sequence Modulating Analytical Performance of Electrogenerated Chemiluminescence Peptide-Based Biosensor for Matrix Metalloproteinase2

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Electrogenerated chemiluminescence (ECL) method has been widely used in clinical diagnosis [1]. Although ECL peptide-based biosensors continue to grow with good sensitivity and signal flexibility, little emphasis has been focused on the sequence of peptide over the ECL sensitivity [2-4]. We herein studied the nuanced effects of different peptide sequences on the analytical performance of ECL peptide-based biosensors for matrix metalloproteinase 2 (MMP-2) assay, in which $[(pbz)_2Ir(DMSO)Cl]$ (pbz=3-(2-pyridyl)benzoic acid) was used as ECL emitter while peptide was used as molecule recognition element. $[(pbz)_2Ir(DMSO)Cl]$ was labeled onto peptide by coordination-based site-specific labeling strategy to form the ECL probe. It was found that the incorporation of one histidine (H) or two H at the terminal of peptide has great increase of ECL signal and negligent effect on the cleavage ability of the ECL probe while the incorporation of H at the middle of peptide has slight increase of ECL signal and great inhibition effect on cleavage ability of the ECL probe. One type of ECL peptide-based biosensor was fabricated for the determination of MMP-2 at gold nanoparticle modified glassy carbon electrode. MMP-2 can be detected with a detection limit of 0.9 ng/mL and recoveries between 97.0%±2.5%~106.0%±6.0% in HeLa cell culture mediums. This work provides some information for the synthesis of efficient ECL probe and for the designing of ECL peptide-based biosensors, which are promising in clinical diagnosis.

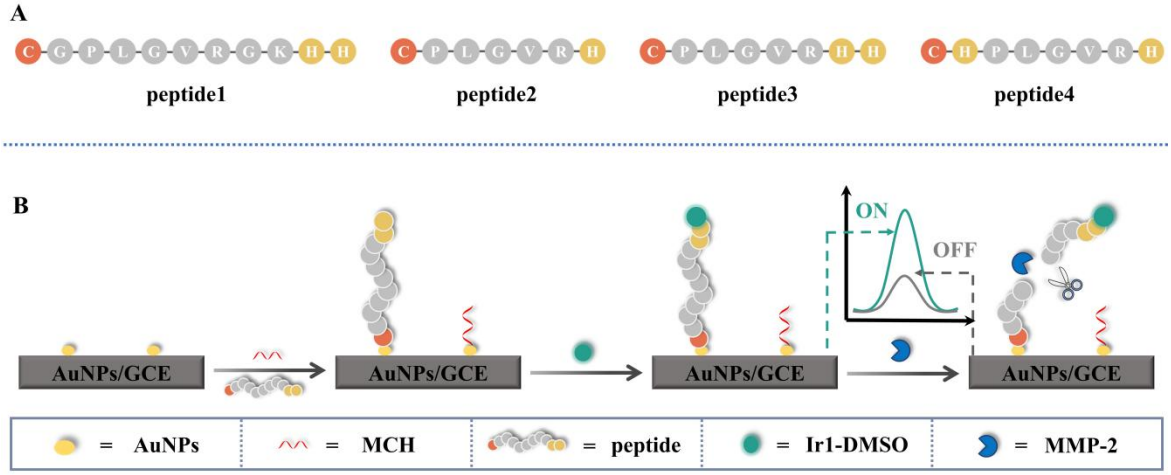


Fig.1 (A) Sequences of the four peptides used in this work. (B) Fabrication process of the ECL peptide-based biosensor and its response mechanism

Acknowledgements

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References

1. F. Tong ; Y. Wang ; Y. Xu ; Y. Zhou ; S. He ; Y. Du ; W. Yang ; T. Lei ; Y. Song ; T. Gong and H. Gao, *Nat. Commun.*, **15**, 10382 (2024)
2. J. Hu ; F. Liu ; Y. Chen ; J. Fu ; G. Shangguan and H. Ju, *Anal. Chem.*, **94**, 6380-6386 (2022)
3. J. Hu ; F. Liu ; Y. Chen ; J. Fu and H. Ju, *Anal. Chem.*, **95**, 8974-8981 (2023)
4. L. Liu ; H. Chu ; J. Yang ; Y. Sun ; P. Ma and D. Song, *Biosens. Bioelectron.*, **212**, 114389 (2022)

Development of Electrospun Fibrous Electrode Materials: Influence of Processing Parameters on Structure and Electrochemical Performance

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The advancement of flexible and high-performance energy storage systems requires electrode materials with tailored architectures and robust electrochemical properties [1]. Fibrous electrodes, particularly those fabricated via electrospinning, offer interconnected porous structures, high surface areas, and tunable morphologies ideal for efficient ion/electron transport [2].

In this work, electrospun composite fibers based on transition metal phosphide/phosphate systems were developed and investigated for lithium-ion and lithium-sulfur battery applications. Special attention was paid to the influence of precursor composition, drying temperature, pre-oxidation, and annealing on the structure and electrochemical properties of the resulting materials.

In the case of $LiCoPO_4$/C fibers, varying the pre-oxidation temperature (360–430 °C) before annealing at 700 °C allowed for tuning the carbon content and porosity. The optimized fiber mat exhibited a high surface area (338 $m^2 g^{-1}$) and delivered 126 mAh g^{-1} as a free-standing cathode (**Fig. 1**) [3].

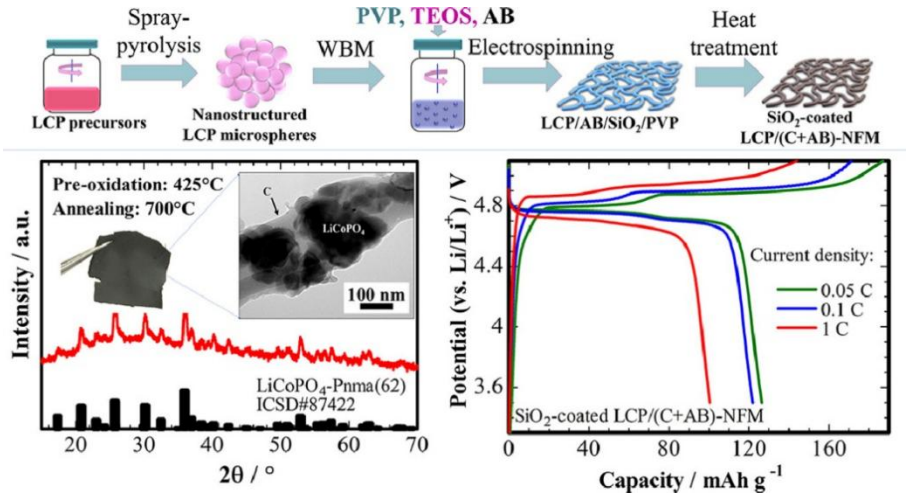


Fig. 1 Synthesis procedure and characteristics of $LiCoPO_4$/C fibers [3].

For Ni_xP/C composite fibers, drying temperature was used to control the extent of in situ steam oxidation, which in turn tailored the surface oxide layer and microstructure. When applied as anodes in lithium-ion batteries, the optimized Ni_xP/C showed an initial capacity of 719.5 mAh g^{-1} with stable performance over 100 cycles, as illustrated in **Fig. 2** [4]. In lithium–sulfur batteries, the same Ni_xP/C nanofibers—used as a free-standing interlayer—effectively suppressed the polysulfide shuttle and enhanced redox kinetics,

resulting in stable cycling with discharge capacities up to 800 mAh g^{-1} over 200 cycles at 2C [5].

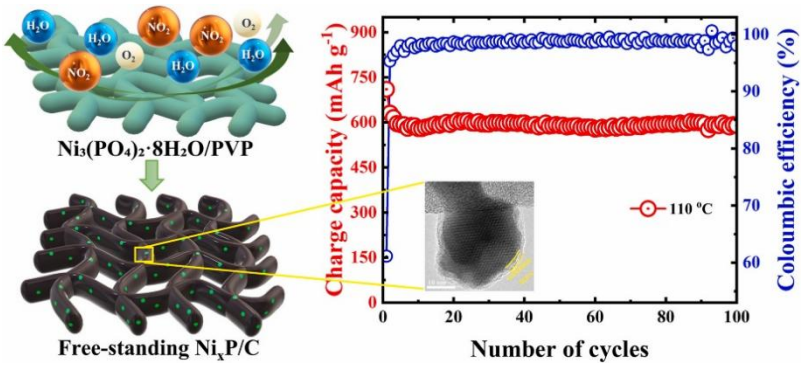


Fig. 2 Illustration of the *in situ* steam oxidation and electrochemical performance of Ni_xP/C fibers [4].

Furthermore, electrospun Sn-P/C nanofibers with controlled Sn:P ratios demonstrated excellent performance as low-temperature lithium-ion anodes, with the 1:1 composition delivering 1141 mAh g^{-1} at room temperature and maintaining superior capacity even at 0 °C and –20 °C [6]. These results highlight the critical role of processing conditions in tailoring the electrochemical behavior of fibrous electrodes for diverse battery chemistries.

Acknowledgements

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References

1. Y. Zhao and J. Guo, InfoMat, 2, 866–878 (2020).
2. B. Joshi, A. K. Singh, M. Kumar, H. J. Kim and S. J. Kim, Chem. Eng. J., 430, 132876 (2022).
3. A. Belgibayeva, T. Nagashima and I. Taniguchi, Electrochim. Acta, 419, 140400 (2022).
4. G. Turarova, I. Taniguchi, Z. Bakenov and A. Belgibayeva, J. Power Sources, 613, 234933 (2024).
5. A. Belgibayeva, G. Turarova, A. Dangaliyeva, F. Sultanov, A. Nurpeissova, A. Mukanova and Z. Bakenov, RSC Adv., 14, 36593–36601 (2024).
6. A. Belgibayeva, M. Rakhatkyzy, A. Rakhmetova, G. Kalimuldina, A. Nurpeissova and Z. Bakenov, Small, 19, 2304062 (2023).

Nano-Impact Electrochemistry Reveals Kinetics Information of Metal-Ion Battery Materials

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As an efficient energy storage device, the secondary ion battery has been widely used in daily life. Many kinds of electrode materials of the batteries have been explored by researchers, including oxides, polyanion, carbon, alloy material, etc. In order to develop new high-performance materials or operate as close as possible to the theoretical limits of the existing battery materials, it is crucial to understand the electrochemistry mechanism comprehensively underlying those electrode materials. However, the evaluation of active materials in most published studies involved in constructing porous composite electrodes by mixing the active materials with conducting materials and polymeric binder. It is a complicated analysis system with multiple variables, which might cover up the intrinsic electrochemical properties of the electrode materials and hinder the in-depth understanding of battery working mechanism. Therefore, it is of great theoretical significance to directly study the battery active electrode materials at the single particle scale without additional influencing factors. Our group utilized the single-particle collision method to study the ion transport mechanism in battery materials. Single particle collision method is a kind of electrochemical method for the study of the electrochemical activity of single particles. Briefly, a microelectrode, attached with additional controlled potential, is immersed into an electrolyte with dispersive particles, followed by the collision of particles on the surface of the microelectrode through Brownian motion. Then the electrochemical reaction occurred (Fig.1), including the direct redox reaction of the particle and the electrochemical catalytic reaction on the particles. By analyzing the generated current signals, the electrochemical properties of individual particles can be directly studied. The Li-ion desertion process of a single particle (including $LiFePO_4$[1], $LiNi_{0.8}Co_{0.1}Mn_{0.1}O_2$[2], Prussian blue[3]) was investigated by the stochastic collision of the particle at a microelectrode, and the kinetic of the charge and discharge process was revealed.

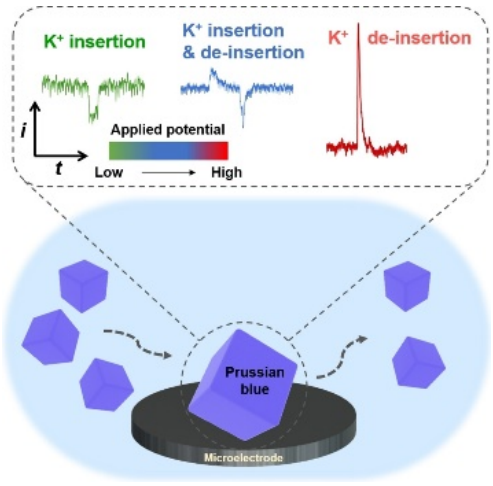


Fig.1 Schematic representation of single particle collision.

References

1. W. Xu, Y. Zhou, X. Ji, *J. Phys. Chem. Lett.*, **9**, 4976-4980 (2018).
2. W. Xu, Y. Zhou, J. Chen, Y. Tian, L. Yang, S. Yin, G. Zou, H. Hou and X. Ji, *J. Power Sources*, **506**, 230228 (2021).
3. W. Xu, J.-J. Zheng, Y.-A. Li, X. Gao, X. Ji and Y.-G. Zhou, *Angew. Chem. Int. Ed.*, **62**, e202306185 (2023).

Elucidation of Formation Mechanism of Solid Electrolyte Interphase (SEI) in Alkali Metal Ion Batteries

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Lithium-ion batteries (LIBs) have evolved into advanced energy storage systems based on lithium intercalation electrodes and Li^+-conducting electrolytes. However, as the global transition toward renewable energy intensifies has become increasingly critical, the high cost and limited availability of lithium resources present major barriers to their future application. In contrast, sodium-ion batteries (SIBs) have emerged as a strategically viable alternative due to their natural abundance, cost-effectiveness, and comparable chemical properties as the second-lightest/smallest alkali metal. Despite these advantages, the commercial viability of SIBs remains limited due to their relatively low energy density and inferior cycle performance.

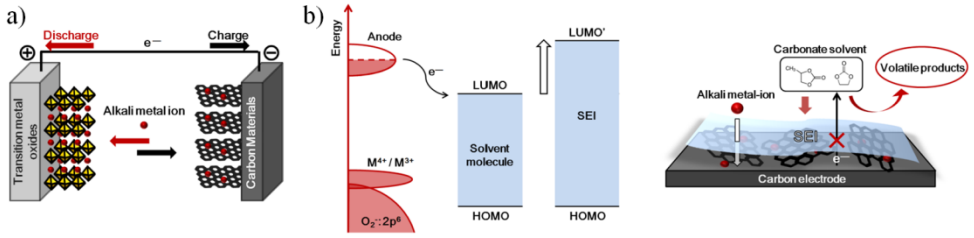


Figure 1. a)Schematic illustration of alkali metal-ion batteries. b) The relationship between the anode and solvent LUMO energy levels and electron filling during the reduction reaction.

A critical factor contributing to these limitations is the formation and stability of the solid electrolyte interphase (SEI) on the anode surface. SEI is a surface passivation film formed through electrolyte decomposition on the electrode surface which plays a vital role in determining battery performance by preventing continuous electrolyte decomposition. In alkali metal-ion batteries, including LIBs and SIBs, when carbonate-based electrolytes (e.g., ethylene carbonate (EC) and diethyl carbonate (DEC)) are used as solvents, the energy level of the anode can exceed the lowest unoccupied molecular orbital (LUMO) of the solvent. This situation leads to the LUMO's electron occupation, triggering the solvent molecules' reductive decomposition, as shown in Figure1b. The decomposition products form a SEI on the anode surface. The LUMO energy level of the SEI-covered anode rises, preventing further solvent degradation in the subsequent charging. Therefore, the SEI is critical for stabilizing the electrode-electrolyte interface and SIBs cycle proforemance.

Herein, we employ a home made in situ online electrochemical mass spectrometry[1] (shown in Figure2) and attenuated total reflectance infrared spectroscopy (ATR-FTIR) to elucidate the SEI formation in carbonate-based electrolytes on carbon electrode surface. In situ online electrochemical mass spectrometryanalytical method allows for the precise detection of gaseous decomposition products evolved during electrochemical cycling. By analyzing SEI composition, reaction products in volatile products and surface deposits under different operation enviroment, we reveal new mechanistic of SEI foramtion.

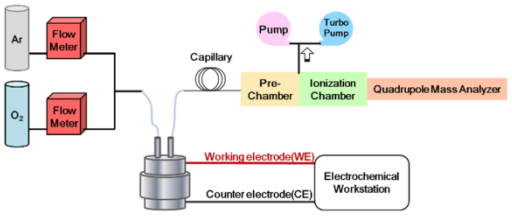


Figure 2. Setup of online electrochemical mass spectrometry. The setup consists of four components: a gas flow controller, an alkali metal ion battery, an electrochemical workstation, and an online mass spectrometer.

Our findings reveal that SEI formation in Na^+ and Li^+-based electrolytes follows similar reaction pathways. However, the process involving Na^+ results in significantly higher ethylene (C_2H_4) release which is a characteristic product of EC decomposition, indicating a greater extent of electrolyte decomposition,as shown in Figure3. This observation suggests that the SEI formed in SIBs is relatively unstable compared to LIBs.

By introducing additives, vinylene carbonate (VC) and fluoroethylene carbonate (FEC), to the electrolyte, it can be found that these additives significantly reduce the generation of C_2H_4 (shown in Figure4) during the SEI formation process in SIB, indicating that it promotes the formation of a denser and more chemically stable SEI film. Combined with

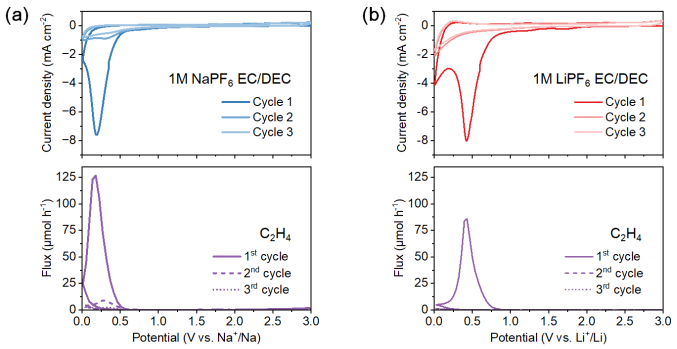


Figure 3. C_2H_4 evolution during the first three cycles of CNT electrode in (a) 1 M $NaPF_6$ in EC/DEC (1:1, v/v) and (b) $LiPF_6$ in EC/DEC (1:1, v/v) at a scan rate of 1 mV s^{-1}. The upper panel displays CVs corresponding to the potential cycles.

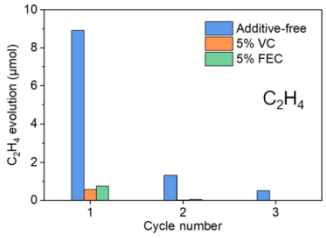


Figure 4. The evolution of C_2H_4 during the first CV scan in additive−free, 5% vol. VC, or with 5% vol. FEC –containing 1 M $NaPF_6$ EC/DEC (1:1, v/v) electrolyte.

the analysis of other volatile products and the investigation of the solid components on the electrode surface, we have proposed the mechanism by which additives help form a stable SEI.

In addition, we also investigated the oxygen concentrations and potential region dependences of SEI formation. We demonstrated that introducing O_2 into the electrolyte during initial cycles in Li-ion batteries can form an SEI film with a similar composition to that formed in Ar. However, compared with argon, less C_2H_4 was produced during the formation of the SEI film in an oxygen environment, and the generation of CO_2 and water was also found, as sown in Figure5. Our results show that in the case of O_2, the superoxide generated during the ORR process can induce the decomposition of the EC molecules.

As a result, the EC degradation products can deposit on the electrode surface to form a low-coverage SEI film. When the potential is further reduced, the ERR process will further lead to the electrochemical reduction of EC molecules, and the superoxide radical, the reduction product of oxygen, will change the decomposition pathway of EC.

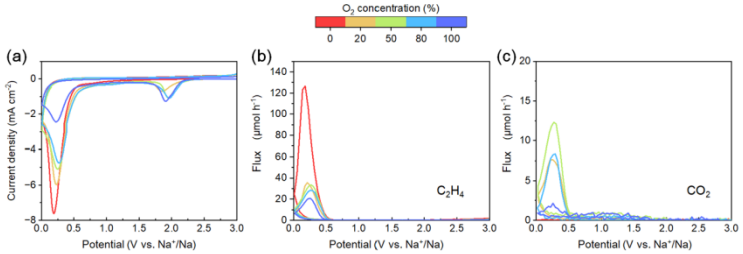


Figure 5. (a) First cycle CV curves for CNT electrode in 1 M $NaPF_6$ EC/DEC with the environment of different Ar/O_2 ratios. Molar flow rate of (b) C_2H_4 and (c) CO_2 during the first CV cycle with different Ar/O_2 ratios.

The present research highlights the influence between different alkali metal ion, gas environment, and additives in SEI formation. This investigation can help develop more stable SEI for SIBs in the future. For more information and details please follow my presentation.

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References

1. B. Peng, et al. *J. Phys. Chem. C*, **127**(26), 12528–12540(2023)

Peroxidase-like nanozymes: peculiarities of redox catalysis and analytical applications

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Nanozymes with peroxidase-like catalytic activity are promising candidates to replace natural enzymes in biotechnology and analysis. Despite numerous reports on peroxidase mimicking nanomaterials, the mechanism of their action, which may differ from the enzyme counterpart, is generally omitted.

Herein, we critically compared catalytic pathways of the most widely used peroxidase-like nanozymes based on Fe_3O_4, CeO_2, $LiFePO_4$ and Prussian Blue. Prussian Blue based nanozymes sizing from 30 to 360 nm were synthesized catalytically upon hydrogen peroxide activation [1]. Due to incomplete coordination sphere of nitrogen-coordinated iron atoms by -CN- ligands in the resulting structures and their high BET surface area (above 300 $m^2 \cdot g^{-1}$), such approach provides the record (electro)catalytic activity of nanoparticles. As shown, half-wave potentials of H_2O_2 reduction at the electrodes modified with the abovementioned nanomaterials almost coincide with their redox potentials and, thus, is determined by the properties of the electroactive material. Namely, such materials act as redox catalysts: whereas their ground state is silent in electrocatalysis, the reduction of H_2O_2 is catalyzed only with their reduced form.

Using the steady-state kinetics approaches, the catalytic rate constants (k_{cat}) of H_2O_2 reduction catalyzed by different nanomaterials in the presence of common peroxidase substrates were estimated. For all nanomaterials the catalytic rate constant (k_{cat}) for reducing substrate is increased as the redox potential of nanozyme itself is increased: 100 mV rise in catalyst's redox potential provides 1000 times higher k_{cat}. Logarithm of the catalytic constant as a function of both nanozyme and substrate redox potentials for Prussian Blue belongs the same trend as for enzyme peroxidase, whereas other materials display significantly lower activity.

For Prussian Blue based nanozymes the size-dependence of k_{cat} in double logarithmic plots is linearized with the slope from 2.6 to 2.8 indicating penetration of hydrogen peroxide to the bulk of nanozymes [2]. For nanoparticles with $d \approx 300$ nm k_{cat} in the presence of $K_4[Fe(CN)_6]$ reach the values of $\sim 1 \cdot 10^8$ s^{-1}, which is 3-4 orders of magnitude higher than for peroxidases.

On the contrary, the electrochemical rate constants (k_{el}) are much higher for smaller nanozymes. For the coatings based on 30 nm nanoparticles, the limiting k_{el} values ($2 \cdot 10^{-2}$ $cm \cdot s^{-1}$) are 6 times higher than those for nanoparticles with $d \approx 300$ nm. The achieved values are an order of magnitude higher than those for the known peroxidase-like nanozymes and the enzyme.

The record performances of the Prussian Blue nanoparticles allowed to apply them as electrochemical labels for immunosensors. As the sensor response the direct (mediator-free) electrocatalytic current of H_2O_2 reduction can be measured, which is proportional to the concentration of antigens detected. According to preliminary data, the S-shaped dependence of the sensor response on the logarithm of cardiac troponin T concentration displays a linear dynamic range from 1 to 100 $ng \cdot ml^{-1}$ and an antigen-antibody dissociation constant of about 7 $ng \cdot ml^{-1}$. In the presence of the diffusion-free mediator sensitivity is only doubled, indicating high efficiency of direct electrocatalysis with the elaborated labels.

Acknowledgements

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References

1. Komkova, M. A.; Karyakina, E. E.; Karyakin, A. A., *J. Am. Chem. Soc.*, **140** (36), 11302–11307, (2018)
2. Komkova, M. A.; Kostyukov, A. A.; Shneiderman, A. A.; Kuzmin, V. A.; Karyakin, A. A., *J. Phys. Chem. Lett.*, **15** (34), 8642–8649 (2024)

Nanozyme Sensing: Exploration of Microdisturbance Factors and Immobilization Study

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Since its emergence, nanozyme sensing technology has captivated widespread attention. By ingeniously exploiting the direct or indirect interactions between target substances and nanozymes, it instigates specific signal changes, thereby enabling the precise detection of analytes. Thanks to the explosive progress in materials science, a vast array of nanozymes has been successfully engineered, accommodating the detection requirements of entities across diverse scales, from small molecules to macromolecules and cellular organisms. Yet, the translational application of nanozyme sensing technology encounters numerous hurdles. Both the exploration of its fundamental principles and the development of device construction demand further in-depth investigation and expansion. Regarding mechanism exploration, certain easily overlooked interference factors in nanozyme sensing necessitate thorough analysis. Most peroxidase (POD)-like nanozymes typically also exhibit catalase (CAT) activity. As CAT and POD share hydrogen peroxide as a common substrate, we have deeply analyzed the beneficial role of CAT in enhancing the upper limit of POD's linear detection range and uncovered its underlying mechanisms. Moreover, in the "signal-off" detection process based on POD-like nanozymes, the reactivation of already "quenched" signaling molecules can severely impact detection sensitivity. By precisely controlling the on-off process of POD catalytic reactions, we have cleverly resolved the issue of substrate re-oxidation, thereby significantly enhancing detection sensitivity. In terms of device construction, developing portable nanozyme sensor devices without compromising accuracy holds great significance. We have conducted innovative research on gel carriers, successfully developing a series of immobilized nanozymes and constructing shape-memory aerogel nanozymes. This aerogel carrier can deeply synergize with nanozyme catalysis. By leveraging the carrier's adsorption effect on signaling molecules and its own shape-memory effect, nanozyme detection can achieve high sensitivity without reliance on large instruments for signal acquisition. This work lays a solid foundation for the portability and practical application of nanozyme sensor devices.

Precise Biomimetic Construction of Atomic-scale Nanozymes for Biosensing

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Nanozymes, as a paradigm of interdisciplinary research innovatively pioneered by Chinese scientists, represent a field of original contributions from China. Compared to traditional nanozymes, single-atom nanozymes (SAzymes) exhibit maximal atomic utilization efficiency and well-defined homogeneous structures, serving as a bridge between homogeneous and heterogeneous catalysis. This advancement facilitates the strategic advancement in pioneering theoretical innovations and applied research of nanozymes. Currently, the precision construction strategies for SAzymes have evolved from structure-oriented to function-oriented approaches. Nevertheless, several critical scientific challenges persist in their multidisciplinary applications: (1) How to synergistically integrate natural enzymatic catalytic mechanisms with single-atom catalysis, emulating nature to overcome the limitations of traditional nanozymes in matching the activity and specificity of natural enzymes; (2) How to establish novel research paradigms to refine the catalytic systems of nanozymes and systematically advance their interdisciplinary characteristics. To address these challenges, our research focuses on the precision engineering of atomic-scale nanozymes and biomimetic catalytic exploration. By employing advanced morphological characterization techniques and theoretical methodologies, we have achieved atomic-level precision in constructing and modulating the coordination environments of atomic-scale biocatalysts. Our work combines experimental and theoretical insights to elucidate structure-property relationships at the atomic scale, promoting the cross-disciplinary application of heterogeneous catalysts through homogenization strategies. Key innovations include: (1) Overcoming the activity-specificity gap: By systematically elucidating the relationship between metal centers/coordination environments and nanozyme performance, we established a rational design framework for synthesizing high-performance atomic-scale nanozymes. This opens new avenues for biomimetic nanozyme construction at the atomic scale[1]; (2) Mechanistic clarity in catalysis: Leveraging the interplay between atomic-scale metal centers and substrate interactions to mimic natural enzyme active sites and cofactor synergies, we revealed intrinsic relationship of atomic-scale nanozymes. This deepens the understanding of catalytic kinetics and mechanisms, providing foundational insights for next-generation nanozyme systems; (3) Diversification of atomic-scale nanozymes functionalities: By correlating atomic structures with multi-enzyme activities, we designed and developed multifunctional atomic-scale nanozymes. This breakthrough expands their applicability, offering novel solutions for diverse interdisciplinary demands[2].

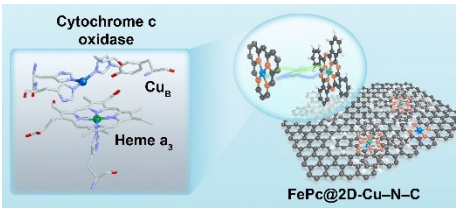


Fig.1 Precise biomimetic construction of atomic-scale nanozymes.

Acknowledgements

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References

1. Wang Y.; Jia G.; Cui X.; Zhao X.; Zhang Q.; Gu L.; Zheng L.; Li L. H.; Wu Q.; Singh D. J.; Matsumura D.; Tsuji T.; Cui Y-T.; Zhao J.; Zheng W., *Chem*, **7**, 436 (2021)
2. Wang Y.; Paidi V. K.; Wang W.; Wang Y.; Jia G.; Yan T.; Cui X.; Cai S.; Zhao J.; Lee K-S.; Lee L. Y. S.; Wong K-Y., *Nat. Commun.*, **15**, 2239 (2024)

Axial Oxygen Coordinated Iron Single-Atom Nanozyme: Highly Selective Peroxidase-Like Activity for Visual Cancer Detection

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Nanozymes, a class of nanomaterials with enzyme-like activity, offer several advantages over natural enzymes, such as ease of large-scale production, high stability, low cost, excellent reusability, and tunable catalytic properties [1]. However, traditional nanomaterials often suffer from poorly defined catalytic active sites and low atomic utilization, resulting in reduced activity and selectivity in enzyme-like reactions. Single-atom nanozymes (SAzymes) can effectively mimic the metal active centers of natural enzymes at the atomic level, holding great promise as the next generation of nanozyme materials [2]. Later studies first revealed that iron SAzymes exhibit dual oxidase-like and

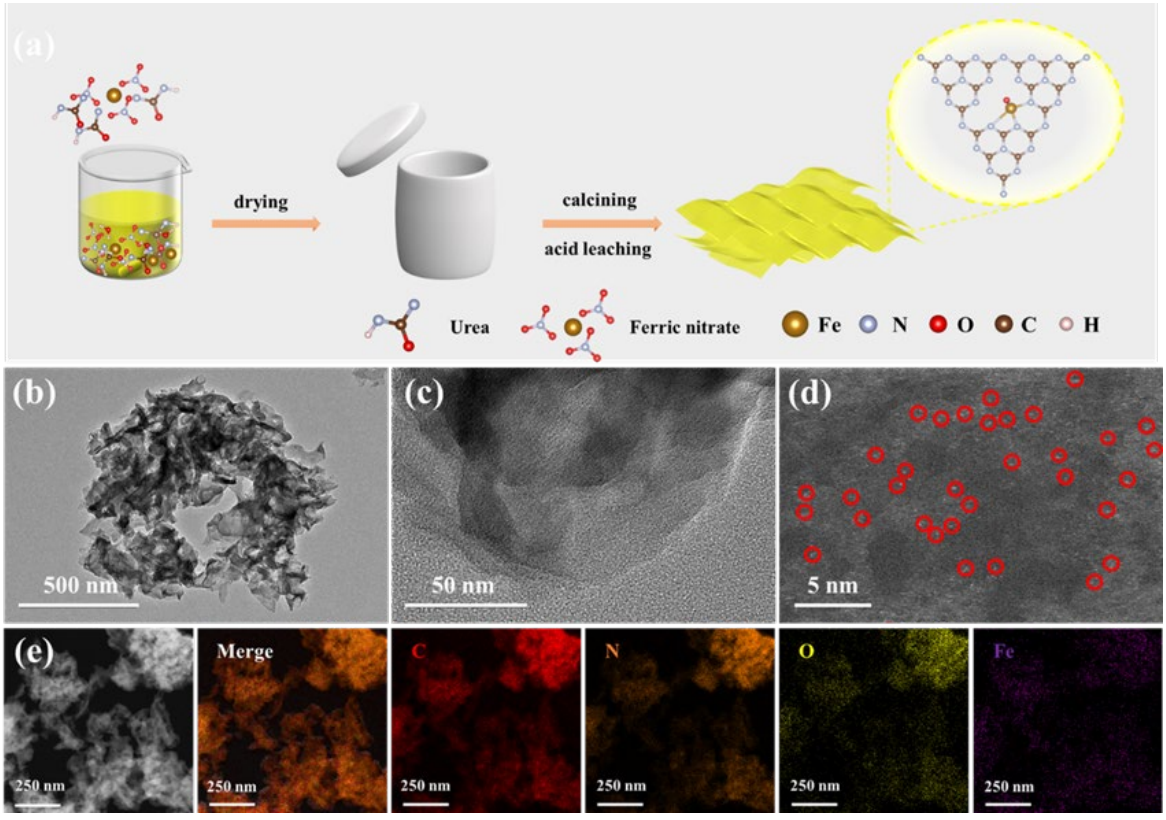


Fig.1 Synthetic strategy and morphological characterization of Fe-N_3O SAzyme. (a) Schematic illustration of synthetic process of Fe-N_3O SAzyme. (b, c) TEM and HR-TEM images of Fe-N_3O SAzyme. (d) AC-HAADF-STEM image of Fe-N_3O SAzyme. The red circles indicate the presence of single metal atoms. (e) EDS mapping of Fe-N_3O SAzyme.

superoxide dismutase-like activities, functioning as bifunctional antioxidative enzymes for oxidative stress cytoprotection [3]. This breakthrough has significantly bridged the gap between SAzymes and natural enzymes. However, the synthesis of SAzymes with high-selectivity peroxidase-like activity remains a significant challenge, limiting their application in biomarker detection.

In this work, through precise coordination regulation of SAzymes, axial oxygen-coordinated iron SAzyme (Fe-N3O SAzyme) with high peroxidase-like selectivity was

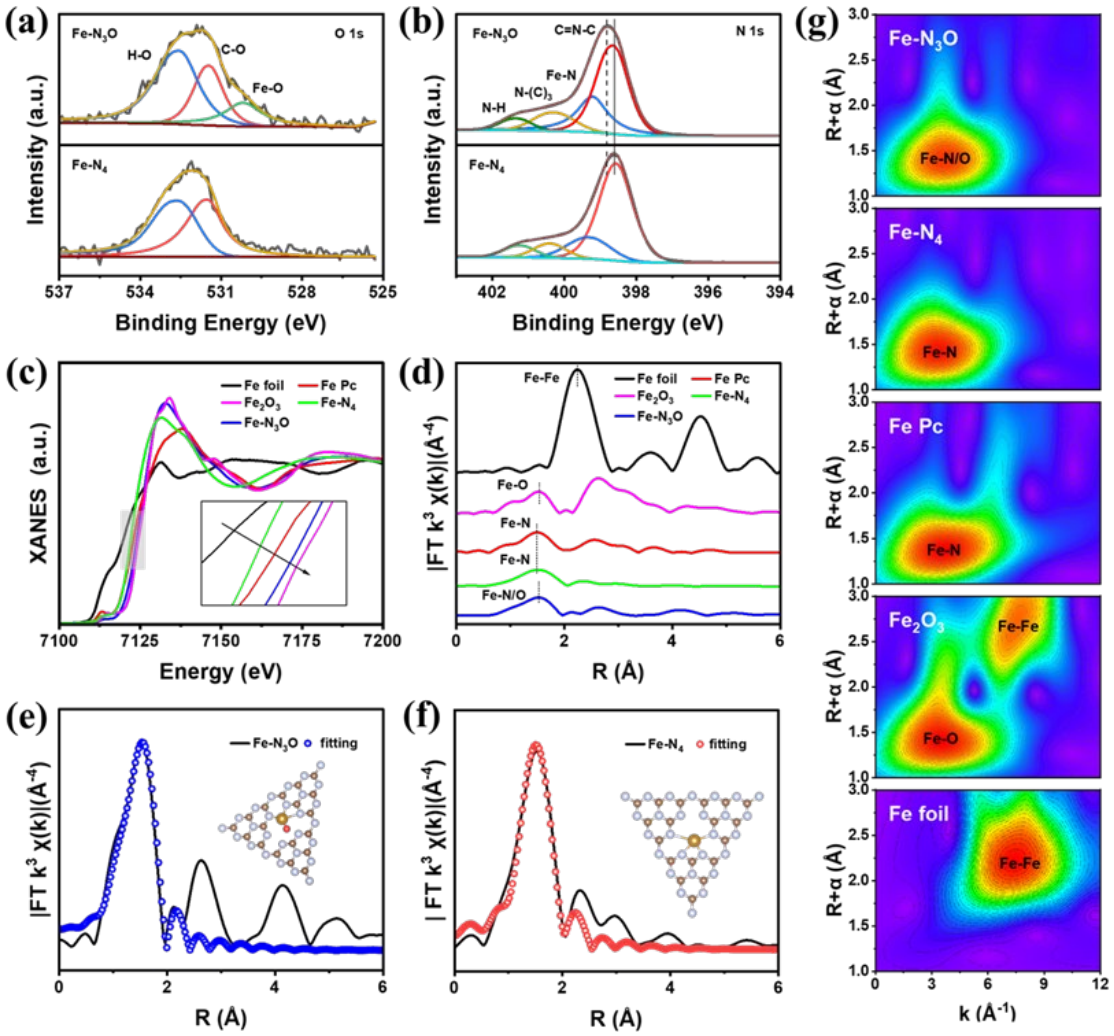


Fig.2 Chemical state and local atomic environment analysis of Fe-N_3O SAzyme. (a) The O 1s XPS spectra and (b) the N1s XPS spectra of Fe-N_3O SAzyme and Fe-N_4. (c) Fe K-edge XANES spectra (inset, enlarged view of the position of the rising edge) and (d) Fe K-edge EXAFS in R space of Fe-N_3O SAzyme, Fe-N_4, standard Fe foil, FePc, and Fe_2O_3. (e, f) Corresponding FT-EXAFS fitting in R space for Fe-N_3O SAzyme and Fe-N_4 (inset, the corresponding structure model). (g) WT images at the Fe K-edge of Fe-N_3O SAzyme, Fe-N_4, standard Fe foil, Fe Pc, and Fe_2O_3.

successfully synthesized. The synthesized Fe-N3O SAzyme shows maximum reaction rate (Vmax) about 4.5 μM min−1, which is approximately 12.7 times as high as that of Fe-N4 with symmetric N-coordination for H2O2. Density functional theory calculations reveal that the axial oxygen engineering of Fe-N3O SAzyme redistributes the charge distribution and optimizes the adsorption free energy of intermediates, lowering the reaction energy barrier. Due to its excellent peroxidase-like activity, Fe-N3O SAzyme was developed into a colorimetric biosensing platform for the selective detection of biomarkers (cysteine, homocysteine, and glutathione), enabling in vitro cancer and disease diagnosis. This work paves a new avenue for designing SAzymes with highly selective enzyme-like activity, offering promising potential for advanced disease diagnosis applications.

Acknowledgements

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References

1. Y. Wang, A. R. Cho, G. R. Jia, X. Q. Cui, J. Shin, I. Nam, K. J. Noh, B. J. Park, R. Huang, J. W. Han, Angew. Chem. Int. Ed., 62, e202300119 (2023).
2. Y. Wang, V. K. Paidi, W. Z. Wang, Y. Wang, G. R. Jia, T. Y. Yan, X. Q. Cui, S. H. Cai, J. X. Zhao, K. S. Lee, L. Y. S. Lee, K. Y. Wong, Nat. Commun., 15, 2239 (2024).
3. W. J. Ma, J. J. Mao, X. T. Yang, C. Pan, W. X. Chen, M. Wang, P. Yu, L. Q. Mao, Y. D. Li, Chem. Comm., 55, 159-162 (2019)

Structural Regulation of Au-Pt Bimetallic Aerogels for Catalyzing the Glucose Cascade Reaction

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Bimetallic nanostructures are promising candidates for the development of enzyme-mimics, yet the deciphering of the structural impact on their catalytic properties poses significant challenges.[1-2] By leveraging the structural versatility of nanocrystal aerogels, this study reports a precise control of Au-Pt bimetallic structures in three representative structural configurations, including segregated, alloy, and core-shell structures. Benefiting from a synergistic effect,[3-4] these bimetallic aerogels demonstrate improved peroxidase- and glucose oxidase-like catalytic performances compared to their monometallic counterparts, unleashing tremendous potential in catalyzing the glucose cascade reaction. Notably, the segregated Au-Pt aerogel shows optimal catalytic activity, which is 2.80 and 3.35 times higher than that of the alloy and core-shell variants, respectively. This enhanced activity is attributed to the high-density Au–Pt interface boundaries within the segregated structure, which foster greater substrate affinity and superior catalytic efficiency. This work not only sheds light on the structure-property relationship of bimetallic catalysts but also broadens the application scope of aerogels in biosensing and biological detections.

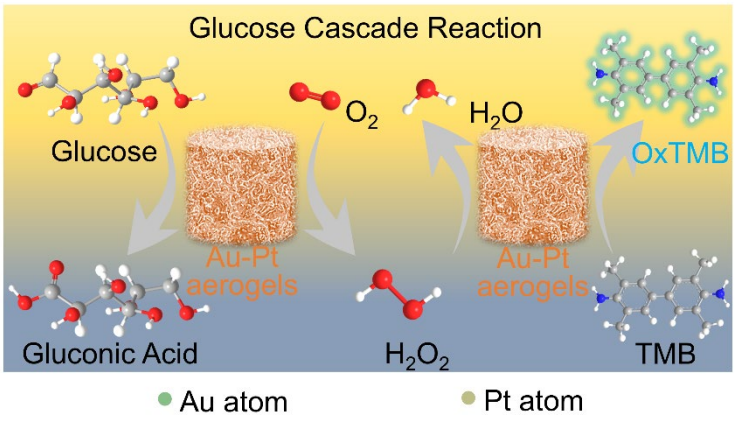


Fig.1 Scheme of glucose cascade reaction on Au-Pt

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References

1. J. Chen, Q. Ma, M. Li, D. Chao, L. Huang, W. Wu, Y. Fang, S. Dong, *Nat. Commun.* **12**, 3375 (2021)
2. C. Wang, J. Herranz, R. Hübner, T. J. Schmidt, A. Eychmüller, *Acc. Chem. Res.*, **56**, 237 (2023)
3. X. Huang, O. Akdim, M. Douthwaite, K. Wang, L. Zhao, R. J. Lewis, S. Pattisson, I. T. Daniel, P. J. Miedziak, G. Shaw, D. J. Morgan, S. M. Althahban, T. E. Davies, Q. He, F. Wang, J. Fu, D. Bethell, S. McIntosh, C. J. Kiely, G. J. Hutchings, *Nature*, **603**, 271 (2022)
4. M. Vafaeezadeh, W. R. Thiel, *Angew. Chem., Int. Ed.*, **61**, 202206403 (2022)

MicroRNA Bioanalysis

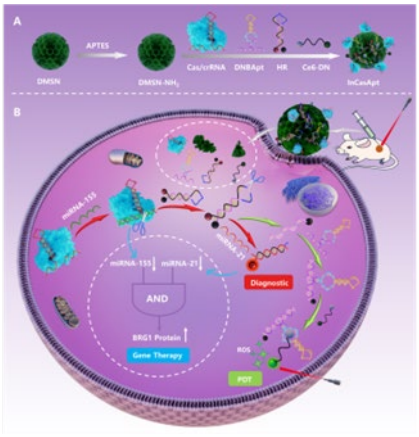
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The development of an engineered RNA device capable of detecting multiple biomarkers to evaluate pathological states and autonomously implement responsive therapies is urgently needed. Here, we report InCasApt, an integrated nano CRISPR-Cas13a/RNA aptamer theranostic platform capable of achieving both biomarker detection and biomarker driven therapy. Within this system, a Cas13a/crRNA complex, a hairpin reporter (HR), a dinitroaniline caged Ce6 photosensitizer (Ce6-DN), and a DN binding RNA aptamer precursor (DNBApt) are co-loaded onto dendritic mesoporous silicon nanoparticles (DMSN) in a controlled manner. While InCasApt remains inert in normal cells, its programmable theranostic capabilities get activated in tumor cells that have elevated expression of carcinogenic miRNA-155 and miRNA-21. These miRNAs act as an AND logic gate, generating fluorescence for disease condition evaluation and ROS for photodynamic therapy. This process also upregulates the antioncogene BRG1 and suppresses tumor migration by inhibiting the function of miRNA-155 and miRNA-21. These effects underscore the versatility of InCasApt as a miRNA targeting strategy for bridging the gap between diagnosis and therapy



References

1. Qiqi Yang, Ming-Jie Dong, Jianglian Xu, Yi Xing, Yue Wang, Jinlong Yang, Xiangdan Meng, Tianzhen Xie, Yingfu Li*, Haifeng Dong*. CRISPR/RNA Aptamer System Activated by an AND Logic Gate for Biomarker-Driven Theranostics. J. Am. Chem. Soc. 2025, 147(1):169-180.

Boosting Nanopore Electrochemistry for Protein Posttranslational Modification Identification at the Single-Molecule Level

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Post-translational modifications (PTMs) on protein significantly regulate protein functions and play critical roles in numerous biological processes and disease pathogenesis. However, their precise identification and characterization remain challenging due to structural similarities, instability, and low abundance. Nanopore electrochemistry offers a promising label-free, high-throughput strategy for detecting PTMs at the single-molecule level[1], especially for the isobaric PTMs which are an ongoing demand for mass spectrometry (MS). Here, we developed a universal noncovalent interaction-enhanced strategy to improve nanopore capabilities for isobaric PTMs identification. Taking proline hydroxylation as a model, by introducing a hydrophobic region inside nanopore, the hydrophobicity difference induced by hydroxylation was transduced to the change in current blockades. Precise identification of proline hydroxylation in hypoxia-induced factor protein was achieved without interference from adjacent oxidation that would result in the same mass shift in MS analysis[2]. Furthermore, to overcome the limitation of nanopore for PTM detection in unknown peptide fragments, we presented a sequence-independent framework to directly map and quantify the tyrosine sulfation states in universal native peptides using an engineered protein nanopore. We show such a framework to discover tyrosine sulfation in unknown peptide fragments digested from a native protein and determine the sequence of the sulfated fragment based on current blockade enhancement induced by sulfation. Moreover, our method allows direct observation of peptide sulfation in ultra-low abundance, down to 1%, and distinguishes it from isobaric phosphorylation[3]. Thus, the interaction-enhance nanopore design and sequence-independent detection strategy suggests the great potential of nanopore to explore specific PTMs in real-life samples and at the omics level.

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References

1. J. Jiang, M.-Y. Li, X.-Y. Wu, Y.-L. Ying, H.-X. Han and Y.-T. Long, *Nat. Chem.*, **15**, 578-586 (2023);
2. J.-W. Chang, Y. Gao, A.-H. Zou, M.-Y. Li, Y.-T. Long and J. Jiang, *Angew. Chem. Int. Ed.*, **64**, e202422692 (2025).
3. H. Niu, M.-Y. Li, Y. Gao, J.-G. Li, J. Jiang, Y.-L. Ying and Y.-T. Long, *Nat. Chem. Biol.*, **21**, 716-726 (2025)

Single Protein Study Based on Solid-State Nanonet

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Nanopore detection has attracted widespread attention due to its advantages such as high sensitivity, label-free detection, and strong universality, and has become a highly promising technique for single-particle and single-molecule detection. Nanoparticles (biological nanoparticles, synthetic nanoparticles) are widely distributed in fields such as biomedical science, energy catalysis, and sensing detection. Their unique properties and functions are determined by their size, morphology, charge, and surface chemical properties. Therefore, the development of technologies for single-particle characterization and manipulation is of great significance for both basic research and practical applications. The speaker will introduce the advantages of using nanopore-derived nanonet structure for single-protein analysis, specifically discussing the mechanism of trapping of single protein molecule in solution and the analysis of individual protein molecules.

By transforming photo-induced silicon nitride nanopores into nanonet structure, a stable and effective solid-state nanonet protein capture platform was constructed, and the capture of single protein molecule was studied based on electrophoresis and electroosmotic flow.

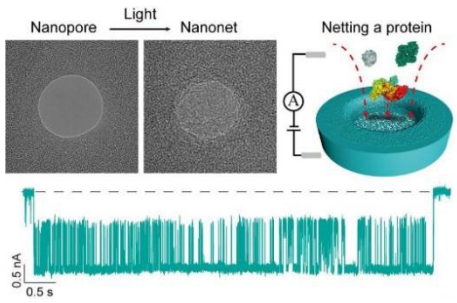


Fig.1 Analysis of a single protein with nanonet

Acknowledgements

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References

1. B. Huang, L. Miao, J. Li, Z. Xie, Y. Wang, J. Chai and Y. Zhai, *Nat. Commun.* **13**, 1402 (2022)
2. J. Li, B. Huang, Y. Wang, A. Li, Y. Wang, Y. Pan, J. Chai, Z. Liu and Y. Zhai, *Adv. Mater.* 2210342 (2023)

Wearable Sweat Biosensors for Personalized Medicine

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Abstract: The rising research interest in personalized medicine promises to revolutionize traditional medical practices. This presents a tremendous opportunity for developing wearable devices toward predictive analytics and treatment. In this talk, I will introduce our efforts in developing wearable biosensors for non-invasive molecular analysis. Such wearables can autonomously access body fluids (e.g., human sweat) across the activities and continuously measure a broad spectrum of analytes including metabolites, nutrients, hormones, and drugs. Laser engraving and inkjet printing are used to manufacture high-performance nanomaterials-based biosensors at large scale and low cost. The clinical value of our wearable systems is evaluated through various human trials toward precision nutrition, stress/mental health assessment, chronic disease management, and drug personalization. These wearable technologies could open the door to a wide range of personalized monitoring, diagnostic, and therapeutic applications.



Fig.1 Wearable Sweat Biosensors for Personalized Medicine.

Electrochemical aptamer-based biosensors for real-time monitoring of biomolecules in vivo in the living animals

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Electrochemical aptamer-based (EAB) biosensors have emerged powerful tools for real-time monitoring of biomolecules across diverse biological matrices, making them valuable for disease diagnostics and health management[1,2]. The mechanism of EAB sensors relies on a target-induced conformational change of aptamer probe, which alters the electron transfer kinetics of probe-tethered redox reporter and thus providing a measurable current signals. Due to their simple yet effective signaling mechanism, this sensor class have been diversly employed for a great variety of target analytes including ions, small molecules, nucleic acids, proteins and even cells. Over the past decade, EAB sensors have seen continuous optimization to detect analytes in complex environments, advancing the development of point-of-care devices for efficient, on-the-spot health monitoring.

However, when extended to complex biological matrices—such as blood, urine, cell lysates, or in vivo environments—such sensor platform faces several significant challenges, including nonspecific adsorption at the electrode surface, a limited repertoire of probe molecules, and substantial batch-to-batch variability in sensor fabrication that necessitates frequent calibration. To address the above-mentioned challenges, our group have recently devoting our efforts on the design of new EAB sensors including (1) surface modification, (2) the development of pH-stable redox reporters, and (3) calibration-free approach. Here I am describing these as below in details.

Surface modifications: Nonspecific adsorption in biological samples causes unstable signals and false positives. To address this, we designed an amphiphilic phospholipid that self-assembles via van der Waals forces into a biomimetic monolayer on electrodes, effectively blocking biomacromolecule adsorption[3]. We further engineered charged and hydrophobic/hydrophilic self-assembled monolayers (SAMs) to optimize small-molecule drug detection across biofluids[4,5]. To surpass monolayer limitations, we created hydrogel-protected sensors[6]. The hydrogel's 3D network enables analyte diffusion while blocking macromolecular deposition through steric hindrance. This design achieved stable in vivo performance in rat veins, muscles, and bladder, demonstrating reliable baseline stability and detection accuracy.

Redox reporters: The design of highly stable probe molecules is of critical importance for ensuring the long-term operational performance of EAB sensors. To expand the library of high-stable signal reporters, we developed a new derivative of tetrathiafulvalene (TTF) as a pH-independent redox reporter[7]. This molecule retained over 95% of its current response after 1,000 cycles over a 72-hour testing period, significantly outperforming commonly used redox labels such as methylene blue. These

results underscore the critical role of molecular engineering strategies in developing novel, highly stable electroactive molecules, which are essential for the realization of robust, real-time, in situ sensing platforms.

Calibration-free approach: To address the sensor-to-sensor variability, we developed a series of calibration-free strategy relying on the target-induced kinetics changes[8-11]. Leveraging the strengths of square wave voltammetry (SWV), we employed dual-frequency signal acquisition—using one frequency that does not respond to the target as a reference and the other that responds as the responsive signal[8]. By calculating the ratio between these two signals, we successfully achieved accurate quantification of variable target molecules across a 100-fold concentration range. Additionally, we reported a dual-signal detection strategy by introducing signal molecules through both covalent and intercalation methods[9]. This dual-signal system enabled calibration-free detection of kanamycin, tobramycin, and ATP in undiluted serum samples. These results highlight the potential of multi-signal strategies in enhancing the accuracy and robustness of molecular diagnostics in complex biological environments.

In summary, to overcome challenges in electrochemical aptamer-based (EAB) sensors—such as nonspecific adsorption, probe instability, and batch variability—we developed three core strategies including surface modifications, highly-stable redox reporter and calibration-free detection methods. These integrated advances enhance sensor accuracy, stability, and practicality, enabling reliable real-time diagnostics in blood, urine, and living animals.

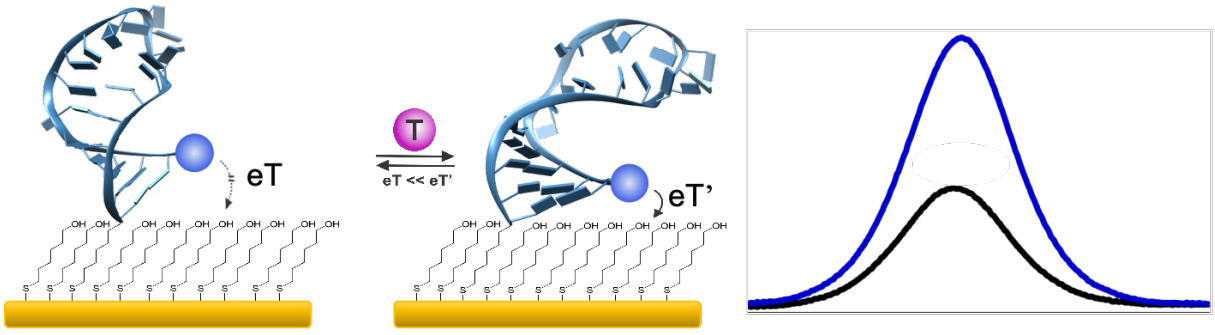


Fig.1 The scheme of EAB sensors.

Acknowledgements

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References

1. A.M. Downs & K.W. Plaxco. *Acs Sens*, **7**, 2823-2832 (2022)
2. C. Ye, H. Lukas, et al. *Chem. Soc. Rev*, **53**, 7960-7982 (2024)

3. H. Li, P. Dauphin-Ducharme, et al. *Angew. Chem. Int. Ed*, **56**, 7492-7495 (2017)
4. Z.S. Zhang, Y.Y. Wang, et al. *ACS Sens*, **7**, 2615-2624 (2022)
5. S.G. Li, Y.Y. Wang, et al. *Anal. Chem*, **93**, 5849-5855 (2021)
6. S.G. Li, J. Dai, et al. *Acs Nano*, **17**, 18525-18538 (2023)
7. S.G. Li, A. Ferrer-Ruiz, et al. *Chem. Sci*, **13**, 8813-8820 (2022)
8. H. Li, P. Dauphin-Ducharme, et al. *J. Am. Chem. Soc*, **139**, 11207-11213 (2017)
9. M. Zhu, S.G. Li, et al. *Anal. Chem*, **92**, 12437-12441 (2020)
10. H. Li, N. Arroyo-Currás, et al. *J. Am. Chem. Soc*, **138**, 15809-15812 (2016)
11. M. Zhu, C.Y. Xie, et al. *ACS Sens*, **10**, 1105-1112 (2025)

Individually-Addressable Multi-Channel Nanoelectrodes for Investigating Single-Cell Exocytosis

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Understanding single-cell exocytosis is essential for uncovering the mechanisms of neurotransmitter release. However, conventional single-channel electrode techniques are limited in resolving the spatial organization of intracellular vesicles and differentiating distinct release modes of neurotransmitters. In this work, we developed an individually-addressable multi-channel nanoelectrode system capable of probing subcellular vesicle distribution and capturing different exocytotic release patterns within single cells. This platform enables high spatial resolution and simultaneous multi-site detection, providing new insights into the dynamics and regulation of neurotransmitter release during exocytosis.

Acknowledgements

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References

1. K. Hu, K. L. V. Long, F. Wang, X. Zhang, C. Gu, N. Fang, N. T. N. Phan, and A. G. Ewing "Single Exosome Amperometric Measurements Reveal Encapsulation of Chemical messengers for Intercellular Communication", *J. Am. Chem. Soc.*, **145**, 11499-11503 (2023)
2. K. Hu, K. L. V. Long, A. Hatamie and A. G. Ewing "Quantifying Intracellular Single Vesicular Catecholamine Concentration with Open Carbon Nanopipettes to Unveil the Effect of L-DOPA on Vesicular Structure", *Angew. Chem. Int. Ed.* , **1**, e202113406 (2022)
3. K. Hu, E. Relton, N. Locker, N. T. N. Phan and A. G. Ewing "Electrochemical Measurements Reveal Reactive Oxygen Species in Stress Granules", *Angew. Chem. Int. Ed.* **28**, 15302-15306 (2021).
4. K. Hu, R. Jia, A. Hatamie, K. L. V. Long, M. V. Mirkin and A. G. Ewing "Correlating Molecule Count and Release Kinetics with Vesicular Size Using Open Carbon Nanopipettes", *J. Am. Chem. Soc.*, **40**, 16910– 16914 (2020)
5. K. Hu, Y. Li, S. Rotenberg, C. Amatore and M. V. Mirkin "Electrochemical Measurements of Reactive Oxygen and Nitrogen Species inside Single Phagolysosomes of Living Macrophages", *J. Am. Chem. Soc.*, **11**, 4564-4568 (2019)

Electroactive and electroresponsive hydrogel materials for soft electrochemical actuators

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Recently, a new and very interesting group of smart hydrogel materials has emerged. These hydrogels undergo a swelling/shrinking transition or a shape change in response to a redox process. This novel functionality, arising from the integration of redox-active groups, makes these materials particularly attractive for advanced applications. The unique property of electrosensitive hydrogels, combined with conductive surfaces, opens up new possibilities. Sensitivity to an electric signal is a very promising feature for the development of electrochemical actuators such as artificial muscles, electrochemical valves, and advanced drug delivery systems (Fig. 1).[1,2] Currently, soft gel actuators are primarily based on hydrogels that respond to environmental stimuli such as pH, temperature, and ionic strength. In contrast, electroresponsive hydrogels are mostly limited to materials that are directly sensitive to electric fields, leaving significant potential for exploring other electroactive mechanisms, such as redox processes, which remain underutilized. Despite their promise, electrosensitive, redox-responsive hydrogels face notable challenges. Existing examples are typically limited by slow reaction kinetics, inadequate mechanical durability, and incomplete reversibility, which hinder their practical application in soft electrochemical devices. Methods to overcome these limitations, along with examples of the synthesis and potential applications of electrosensitive thin layers and microgels attached to conductive surfaces, will be presented.[3-6]

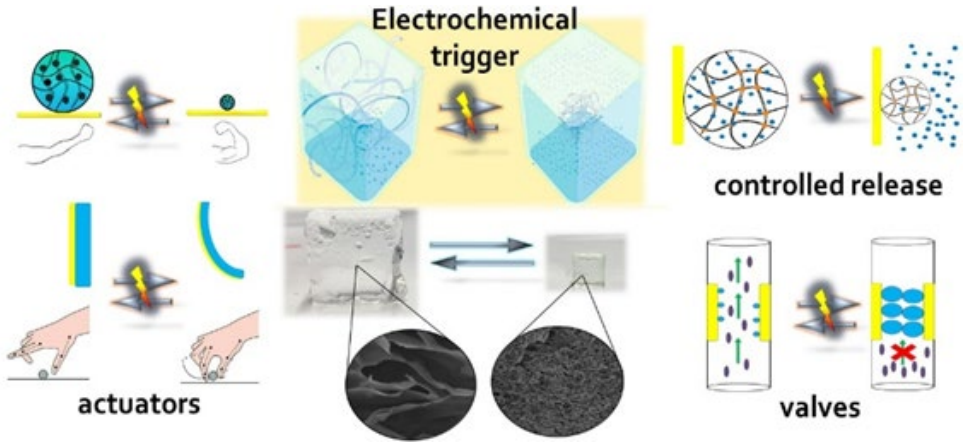


Fig. 1 Volume phase transition scheme, photos and electron microscope images of electro-sensitive gel, and example applications of electrosensitive gels.

References

1. K. Marcisz, K. Kaniewska, M. Karbarz, *Curr. Opin. Electrochem.*, 2020, **23**, 57.
2. K. Marcisz, E. Zabost, M. Karbarz, *App. Mater. Today*, 2022, 29, 101656.
3. K. Kaniewska, J. Nowakowski, P. Bacal, M. Karbarz, *Sens. Actuators B: Chem.* 2021, 344,

130114.
4. K. Kaniewska, K. Marcisz, M. Karbarz, *Langmuir* 2023, 39, 2398.
5. K. Marcisz, P. Gwardys, D. Jagleniec, J. Romanski, M. Karbarz, *Colloids Surf. A* 2025, 707 135839.
6. P. Gwardys K. Marcisz, D. Jagleniec, J. Romanski, M. Karbarz *ACS Appl. Mater. Interfaces* 2023 15 49865.

Graphitic Carbon Nitride: a promising material in electrochemical sensing

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Graphitic carbon nitride (GCN) belongs to a group of carbon nitride-based materials and represents a 2D polymeric material. The GCN structure contains frameworks of s-triazine or tri-s-triazine connected via tertiary amines (**Fig. 1**). The GCN structure resembles a graphite-like structure with a layer distance of ~3.3 nm. The semiconductor properties of GCN originate from the presence of a stable π-conjugated system within condensed tri-s-triazine rings (**Fig. 1**) and provide a band gap of 2.7 eV. The N-rich structure of the material contributes to GCN's catalytic activity. Additionally, the presence of the C-N network results in a high specific surface area, high chemical and thermal stability, and fast electron transfer, which are essential properties in electrochemical sensing. Also, GCN is considered a green semiconductor since it is a metal-free material. On the contrary, the high potential of chelation between N-rich GCN structure and metal ions leads to the synthesis/production of innovative materials (electrode modifiers). The GCN polymeric material can be synthesized by directly polymerizing the C-rich and N-rich precursors (melamine, thiourea, urea, ethylenediamine, or cyanuric chloride) at 550-600 degrees[1].

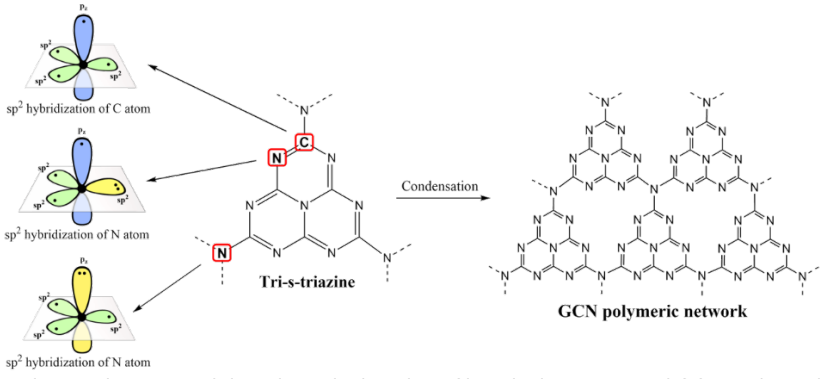


Fig. 1. π-conjugated system of the tri-s-triazine ring. Chemical structure of GCN polymeric material.

Our research group synthesized GCN using the polymerization of melamine at 550 degrees. We used the synthesized GCN material as an integral part of various electrochemical sensors to detect pesticides, food additives, and pharmaceuticals. In all these experiments, the contact surface and the material's catalytic effect contributed to the sensor's electrocatalytic effect and the improvement of electrochemical parameters during analyte detection. Additionally, the compatibility of GCN with other materials (metal-oxides, carbon black, ionic liquids) enables the synthesis of composites to design innovative electrochemical sensors for sensing a wide spectrum of analytes.

The GCP/**GCN**@Co-doped CeO_2 sensor for fenitrothion detection[2]

Fenitrothion (FNT) belongs to the group of organophosphate insecticides and has a wide range of applications in agricultural activities to control pests on fruits, vegetables, rice, and cereals. The electrochemical sensor for FNT detection was based on embedding Co-doped CeO_2 nanoparticles into GCN. The synthesized GCN@Co-doped CeO_2 composite was used to modify a glassy carbon paste (GCP), producing a GCP/GCN@Co-doped CeO_2 sensor. The developed sensor identified reversible oxidation of FNT (oxidation at 0.18 V and reduction at 0.13 V) and additional reduction at -0.62 V *vs.* Ag/AgCl in HCl solution (pH=1). Square wave voltammetry (SWV) was used to develop an electroanalytical method for FNT detection, where the oxidation peak at 0.18 V was evaluated. The GCP/GCN@Co-doped CeO_2 sensor detects FNT in the concentration range from 0.01 to 13.7 µmol/L. The method's limit of detection (LOD) was 3.2 nmol/L. Additionally, the sensor provided good precision, repeatability, and selectivity toward the analyte. The possibility of a practical application of the developed platform was explored by testing the sensor performance in real samples (tap water and apple samples).

The FTO/**GCN**@CB sensor for vanillin detection

Vanillin (VAN) is a widely used additive for flavoring food products. The electrochemical sensor for VAN detection was based on GCN and carbon black (CB) composite. The GCN@CB printing ink (prepared by mixing different ratios of GCN and CB with binder) was used in the screen-printing process of fluorine-doped tin oxide (FTO) to produce the FTO/GCN@CB sensor. Cyclic voltammetry identified two oxidation peaks (at 0.62 V and 0.92 V *vs.* Ag/AgCl) and three reduction peaks of VAN (at approximately 0.85 V, 0.50 V, and 0.25 V *vs.* Ag/AgCl) in Britton-Robinson buffer solution (BRBS) with pH 2. Differential pulse voltammetry (DPV) was used to develop a VAN detection method, where the oxidation peak at 0.92 V was examined. The working concentration range of the FTO/GCN@CB sensor toward VAN was from 0.02 to 16.20 µmol/L, with a LOD of 3 nmol/L. Additionally, the sensor provided good precision, repeatability, and selectivity during VAN detection. The developed FTO/GCN@CB sensor was successfully applied for VAN detection in commercial food samples (vanilla sugar, oatmeal, whey protein, and pudding).

The CPE/**GCN**@TBACl sensor for carbamazepine detection[3]

Carbamazepine (CBZ) is an anticonvulsant used in the treatment of epilepsy and bipolar

disorder. The electrochemical sensor for CBZ detection was based on GCN and ionic liquid tetrabutylammonium chloride (TBACl). The prepared GCN@TBACl composite was used to modify the carbon paste electrode (CPE). The CPE/GCN@TBACl electrode exhibited irreversible oxidation of CBZ at 1.06 V *vs.* Ag/AgCl in BRBS (pH 7). SWV was used to develop an analytical method for CBZ detection. The sensor detected CBZ in the linear range from 0.42 to 9.31 µmol/L. The LOD of the method was 0.13 µmol/L. Additionally, the sensor showed adequate sensitivity, precision, and repeatability toward the analyte. The practical applicability of the CPE/GCN@TBACl sensor was successfully examined in real samples (pharmaceuticals and a spiked human urine sample).

The CPE/**GCN**@Y_2O_3 sensor for triclosan detection[4]

Triclosan (TSC) is a broad-spectrum antibacterial and antifungal ingredient, which can be found in a variety of personal care products (for example, cosmetics, soap, or toothpaste). The electrochemical sensor for TSC detection was based on GCN@Y_2O_3 composite, where Y_2O_3 was previously synthesized by the *Pechini* method. The prepared GCN@Y_2O_3 composite was used to modify CPE. The CPE/GCN@Y_2O_3 sensor oxidized TSC at 0.62 V *vs.* Ag/AgCl in BRBS (pH 7). The SWV was selected to establish the analytical procedure for TCS detection. The sensor provided a linear concentration range from 0.5 to 100 µmol/L toward TSC, with a LOD of 0.137 µmol/L. The developed CPE/GCN@Y_2O_3 sensor was used for TSC detection in tap water and toothpaste samples.

Acknowledgements

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References

1. Đurđić, et al., *Graphitic Carbon Nitride in Biosensing Application*. In: Azad, U.P., Chandra, P. (eds) Handbook of Nanobioelectrochemistry. Springer, Singapore (2023). https://doi.org/10.1007/978-981-19-9437-1_8
2. Đurđić, et al., *Sci. Total Environ.*, **909**, 168483 (2024).
3. Mutić, et al., *Electrochim. Acta*, **500**, 144755 (2024).
4. Mijajlović, et al., Chemosensors, **12(12)**, 272 (2024).

Co_3O_4 based materials for Enhanced Acetone Gas Sensing Performance

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Co_3O_4, a p-type semiconductor, exhibits exceptional acetone sensing capabilities. However, Co_3O_4 based gas sensors usually require high operating temperatures, which hinder practical applications. Therefore, Co_3O_4 nanostructures were supported on different materials for reducing working temperature and enhancing acetone gas sensing performance. Here, we designed and synthesized Co_3O_4 nanowires assembled on the surface of hollow carbon spheres (Co_3O_4 NWs-HCSs) and Co_3O_4 nanosheets coated on $Ti_3C_2T_x$ MXene (MXene/Co_3O_4) to enhance acetone gas sensing performance.

Co_3O_4 nanowires assembled on HCSs were fabricated through a hydrothermal reaction and post-annealing process. With hydrothermal reaction temperature of 120 °C and reaction time of 40 min, short nanowires below 500 nm can be formed on HCSs[1]. As shown in Fig.1, the obtained Co_3O_4 NWs-HCSs is still sensitive to the concentration change of acetone at a relative low temperature of 75 °C. In addition, Co_3O_4 NWs-HCSs is probably a type of promising low-temperature sensing material for gas sensors.

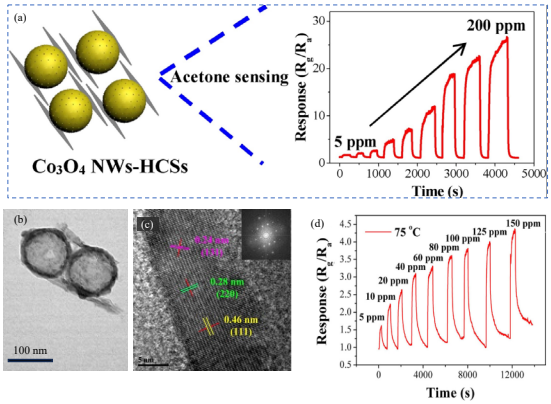


Fig.1 Scheme illustration, characterization and gas sensing performance of Co_3O_4 NWs-HCSs

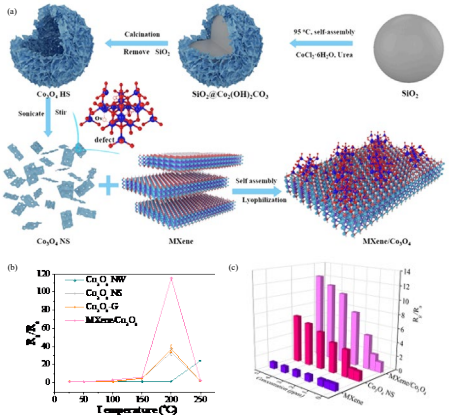


Fig.2 (a) Synthesis illustration of MXene/Co_3O_4. (b) Acetone sensing properties of MXene/Co_3O_4 and other materials.

Thin-layered MXene covered by Co_3O_4 nanosheets was successfully used for enhancing acetone sensing performance[2]. As shown in Fig.2a, MXene/Co_3O_4 can be prepared through self-assembly and lyophilization using thin-layered $Ti_3C_2T_x$ MXene and Co_3O_4 nanosheets as precursors. The interfacial engineering of atomically thin MXene with a conformal Co_3O_4 nanosheet coating not only enhances thermal stability at elevated temperatures (up to 200°C), but also synergistically improves acetone sensing

performance, achieving a 400% increase in response magnitude compared to pristine Co_3O_4 nanosheets (Fig.2b-c). Compared with Co_3O_4 nanosheets and MXene, MXene/Co_3O_4 displays enhanced selectivity (Fig.3a-c). Gas sensors combined with algorithms can improve the refinement results. AdaBoost algorithm and KPCA and GS were combined to classify the seven gases (Fig.3d). The AdaBoost algorithm trained multiple weak classifiers by calculating the error rate and adjusting the data weights step by step and finally composed a strong classifier. Acetone, DMF, ammonia, methanol, formaldehyde, and H_2O_2 can be recognized with 100%, and the recognition of chloroform was 98.3333% (Fig.3e). The confusion matrix for seven gases in Fig.3 f illustrates that 1 in 60 chloroform is identified as formaldehyde. For the entire system, the accuracy reached 99.76%, as shown in Fig.3g. The mechanism of MXene/Co_3O_4 is further investigated as seen in Fig.4. The UPS results show that the work function of MXene (4.31 eV) is lower than that of Co_3O_4 (6.36 eV). An electron accumulation layer and a depletion layer will form at the interface sides of Co_3O_4 and MXene, which leading an internal electric field is formed, and the electrons transfer from MXene to Co_3O_4. Therefore, MXene/Co_3O_4 exhibits a higher resistance than individual Co_3O_4. In acetone gas, electrons would be regenerated from acetone oxidation on the surface of the heterojunction (Fig.4d). The adsorption energies of acetone on the surface of Co_3O_4 (111), MXene (001) and MXene/Co_3O_4 heterojunction were estimated as −0.56, −0.17 eV, and −0.97 eV, respectively (Fig.4e). The 3D charge density image in Fig.4f (left) reveals a localized increase in electron density at the MXene/Co_3O_4 interface. Additionally, the planar average charge density difference in Fig.4 f (right) exhibits a significant oscillation at the interface, providing evidence for active electron exchange at this interface. This work offers a method to bolster the stability of thin-layered MXene and enhancement of the gas sensing ability for very promising practical acetone gas sensing applications while rendering theoretical light on fundamentals with universal significance for gas sensing.

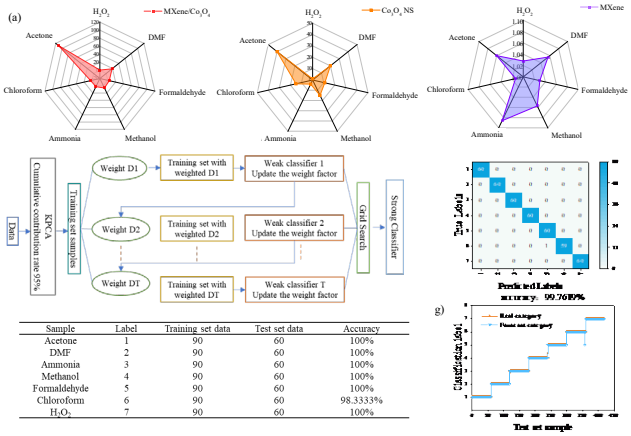


Fig.3 (a-c) Radar schematic response diagrams of materials. (d) Schematic diagram of data processing and algorithm analysis. (e) Types of gases, labels, amount of data in training and test sets, and classification accuracy for each gas. (f) Confusion matrix for seven gases. (g) Classification results of the AdaBoost algorithm.

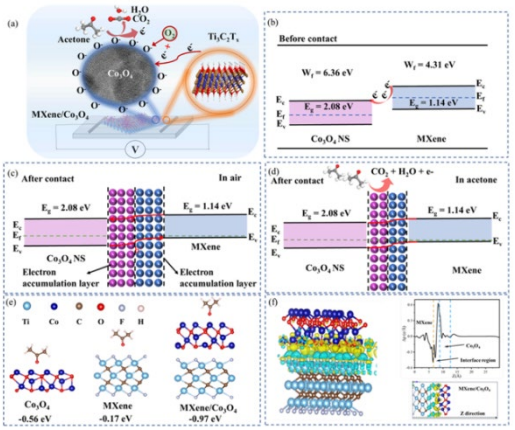


Fig.4 (a) Schematic illustration of the reaction between acetone and MXene/Co_3O_4. Schematic illustrations of energy band diagrams (b) before contact, (c) after contact in air, and (d) after contact in acetone. (e) Adsorption energy of acetone by Co_3O_4, MXene, and MXene/Co_3O_4. (f) MXene/Co_3O_4 3D charge density difference (left) and planar average charge density difference (right).

Acknowledgements

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References

1. C. Zhang, L. Li, L. Hou and W. Chen, *Sensor. Actuator. B-Chem.*, **291**, 130-140 (2019)
2. C. Zhang, X. Wu, C. Zha, et al., *ACS Appl. Nano Mater.*,**7**, 20690-20699 (2024)

Improved performance of Prussian blue solid contact allowing flow injection amperometric detection of potassium and sodium ions in biological fluids

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The development of rapid, precise, and cost-effective sensors for electrolyte analysis is critical in clinical diagnostics, particularly for conditions such as renal dysfunction, cardiovascular diseases, and electrolyte imbalances. Conventional ion-selective electrodes (ISEs) face limitations in scaling and leakage of ions from the internal solution [1].

This study introduces catalytically synthesized Prussian blue nanoparticles (PB NPs) as a highly efficient solid contact for potassium and sodium solid contact ion-selective electrodes (SC-ISEs), enabling ultrasensitive amperometric detection in biological fluids [2]. By utilizing PB's intrinsic selectivity for K^+ due to its size-selective ion intercalation during redox cycling, the developed sensors show a 2–4-fold higher response to K^+ compared to Na^+ in flow injection amperometry, even without an ion-selective membrane. When PB NPs are spin-coated with ion-selective membranes (valinomycin for K^+-ISE, calixarene for Na^+ISE), the sensors achieve high sensitivity (46 $mA{\cdot}M^{-1}{\cdot}cm^{-2}$ for K^+; 4 $mA{\cdot}M^{-1}{\cdot}cm^{-2}$ for Na^+) and a detection limit of $1{\times}10^{-6}$ M, the lowest reported for PB-based SC-ISEs. The flow injection system, using a wall-jet cell, ensures rapid response (15 seconds per injection), high reproducibility (RSD = 5%), and minimal interference, overcoming the limitations of traditional potentiometry and coulometry.

Validation using human serum demonstrates accurate quantification of K^+ and Na^+ in both pathological and normal samples, despite the 40-fold excess of Na^+ in physiological matrices. The applicability of the sensor for the analysis of sweat samples and exhaled breath condensate was demonstrated. The obtained results were compared with the data of the capillary electrophoresis system with photometric detection. Enhanced selectivity coefficients (log k(K/Na) = −3.2), outperforming conducting polymer-based SC-ISEs in amperometric mode. Electrochemical impedance spectroscopy confirmed stable charge transfer, while optimized PB surface coverage (1–2 $nmol{\cdot}cm^{-2}$) maximized sensitivity. Crucially, the low noise and drift in the amperometric mode enabled reliable detection in diluted serum, requiring only 2–5 μL of sample.

This work establishes PB NPs as a transformative solid contact for ISEs, merging the advantages of inorganic redox materials with flow injection analysis. The sensors' applicability for biological fluids analysis underscores their potential for rapid electrolyte monitoring in point-of-care diagnostics.

Acknowledgements

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References

1. L. Gao, Y. Tian, W. Gao, G. Xu, *Sensors*, 24, 4289 (2024)
2. V. Shavokshina, V. Nikitina, A. Karyakin, *J. Electroanal. Chem*, **962**, 118264 (2024)

Development of Electrodes Modified by Gold Nanostructures for Sensitive Detection of Ovarian Cancer Biomarker CA125 in clinical samples

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In this study, fluorine-doped tin oxide electrodes modified with gold nanostructures were fabricated for label-free detection of CA125 in serum. The gold nanostructures were uniformly deposited via an electrochemical process, and the effects of pH and surfactant concentration on their topography and electrochemical behavior were examined. Electrodes prepared under optimal conditions exhibited an increased active surface area and were utilized for the development of an aptasensor for CA125 tumor marker detection in human serum. Signal amplification was achieved using gold nanorods, resulting in a detection limit of 2.6 U/ml and a linear range of 10 to 800 U/ml. The findings demonstrate that the developed aptasensor can precisely measure clinically relevant concentrations of CA125 in human serum without the need for expensive antibodies.

Enhanced Voltammetric Detection of Tryptophan Using Nitrogen Defect-Rich Graphitic Carbon Nitride-Modified Electrodes

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A novel electrochemical sensor based on nitrogen defect-rich graphitic carbon nitride (ND-CN) was developed for the highly sensitive voltammetric detection of tryptophan (Trp). The ND-CN was synthesized and characterized using X-ray photoelectron spectroscopy (XPS), X-ray diffraction (XRD), Fourier-transform infrared spectroscopy (FTIR), scanning electron microscopy (SEM), and transmission electron microscopy (TEM), confirming the successful incorporation of nitrogen defects and a well-defined nanostructure. The ND-CN was immobilized on a glassy carbon electrode (GCE), resulting in a modified electrode (ND-CN/GCE) with significantly enhanced electrocatalytic activity toward Trp oxidation compared to both pristine g-CN/GCE and bare GCE. Electrochemical impedance spectroscopy (EIS) and cyclic voltammetry (CV) revealed reduced charge transfer resistance and improved electron transfer kinetics at the ND-CN/GCE interface. The oxidation process of Trp was found to be diffusion-controlled at pH 3.0, with a calculated transfer coefficient of 0.53, a heterogeneous rate constant of 2.24×10^3 M^{-1} s^{-1}, and a diffusion coefficient of 8.3×10^{-3} cm^2 s^{-1}. Using square wave voltammetry (SWV), the sensor exhibited a wide linear detection range from 0.01 to 40 µM and a low detection limit of 0.0034 µM (3σ/m). The sensor demonstrated excellent selectivity, repeatability, and reproducibility, and was successfully applied to the determination of Trp in milk and multivitamin tablet samples with recoveries ranging from 97.0% to 108%. These results highlight the potential of ND-CN/GCE as a robust and efficient platform for Trp sensing in complex matrices.

Acknowledgements

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References

1. E. Chimene, D. L. Alge, A. K. Gaharwar, Adv. Mater. 27, 7261– 7284, (2015)
2. J. Zhu, P. Xiao, H. Li, S. A. Carabineiro, *ACS Appl. Mater. Interfaces*, **6**, 16449– 16465 (2014).

Electrochemical Analysis of Single Nerve Vesicles

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Neuronal vesicles are the main subcellular organelles responsible for exocytosis, and the development of single vesicle analytical chemistry methods can provide powerful tools for neuroscience research. By effectively designing and constructing a nano tip carbon fiber cone electrode, we have developed a single vesicle in situ electrochemical counting method and achieved quantitative detection of dopamine, a neurotransmitter encapsulated within a single vesicle in PC12 cells. By comparing the amount of neurotransmitters released by vesicles during exocytosis with the single-cell current method, we found that most vesicles do not release all the neurotransmitters they contained during exocytosis, revealing that exocytosis is not an "All or None" quantum process. Recently, our team developed a fresh brain tissue single vesicle electrochemical analysis method and pioneered the construction of an IVIEC analysis method designed for fresh brain tissue slices to detect the storage of neurotransmitters within individual vesicles in fresh brain slices. Combining it with SCA reveals the complexity of neurochemical signal transduction mechanisms. For the first time at the single vesicle level, a significant decrease in the storage of neurotransmitters in dopamine neuronal vesicles was discovered in an animal model of Parkinson's disease, while the process of exocytosis and release was inhibited, providing insights into the potential pathogenesis of Parkinson's disease. In addition, the study also delved into the heterogeneity of single vesicle storage and exocytosis release of other neurotransmitters (norepinephrine, serotonin) in different brain regions (dorsal striatum, ventral tegmental area, locus coeruleus, and raphe nucleus). This study provides a new strategy for investigating the biological processes of chemical signal transmission and exploring the disruption mechanisms of neurological diseases at the level of single vesicles in fresh brain tissue.

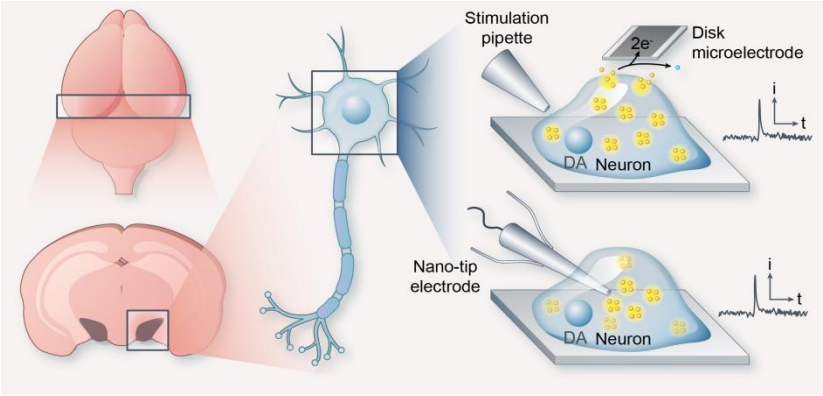


Fig.1 Single-vesicle electrochemical (SVE) platform for fresh brain tissue.

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References

1. Li, X.;# Majdi, S.;# Dunevall, J.; Fathali, H.; Ewing, A. G.* *Angew. Chem. Int. Ed.* **54**, 11978−11982 (2015)
2. Li, X.; Ren, L.; Dunevall, J.; Ye, D.; White, H. S.; Edwards, M. A.; Ewing, A. G.* *ACS Nano*, **12**, 3010−3019(2018)
3. Li, X.;# Dunevall, J.;# Ewing A. G.* *Acc. Chem. Res.* **49**, 2347−2354 (2016)
4. Phan, N.; Li, X.; Ewing A. G.* *Nat. Rev. Chem.* **1**, 0048 (2017)
5. Li, X.; Dunevall, J.; Ewing, A. G.* *Angew. Chem. Int. Ed.* **55**, 9041−9044 (2016)
6. Yue, Q.; # Li, X.;# Wu, F.; Ji, W.; Zhang, Y.; Yu, P.; Zhang, M.; Ma, W.; Wang, M.; Mao, L.* *Angew. Chem. Int. Ed.* **59**, 11061−11065 (2020)
7. Yue, Q.; # Wang, K.; # Guan, M.; Zhao, Z.; Li, X.;* Yu, P.; Mao, L.* *Angew. Chem. Int. Ed.* **61**, e202117 (2022)
8. Cao, L.; Zhang, J.; Li, M.; Zhou, J.; Liu, Y.; Liu, C.*; Li, X.*, *Anal. Chem.* **96**, 15248-15256 (2024)
9. Nan, X.; Wang, M.; Du, J.; Liu, Y.; Cao, L.; Zhou, J.; Liu, L.; Li, X.* *Talanta*, **271**,125637 (2024)
10. Liu, Y.; Cao, L Zhou, J.; Li, C.; Du, J.; Xue, Y.; Li, X.; * Mao, L. *J. Am. Chem. Soc.* **147**, 1, 149-160(2025)

Target-triggered autocatalytic amplification: a single-Cas12a enzyme-based ECL detection platform for ultrasensitive nucleic acid analysis

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CRISPR-Cas systems with dual functions offer precise sequence-based recognition and efficient catalytic cleavage of nucleic acids, making them highly promising for biosensing and diagnostic technologies[1]. However, the current approach face challenges such as complexity and low conversion efficiency, which hinder the further application of this technology. To better integrate the dual functions of Cas proteins, we proposed an autocatalytic amplification technology based on a target-triggered single Cas12a enzyme for ultra-sensitive detection of low-abundance EGFR L858R circulating tumor DNA (ctDNA) in plasma from non-small cell lung cancer (NSCLC) patients. By introducing double-stranded DNA probe (DSDP) for single Cas12a-mediated collateral cleavage and autocatalysis-driven amplification, combined with the host-guest recognition mediated by β-CD-AuNCs ECL sensing technology[2], we achieve precise recognition of ctDNA targets and cascade signal amplification. The linear range of the method was 1.0×10^{-18}~1.0×10^{-12} mol/L. Notably, the limit of detection of the proposed biosensor was as low as 0.36 aM, which was significantly lower than that reported in literature, demonstrating the significant potential of this sensing platform for achieving cascade signal amplification in molecular diagnostics. Therefore, the autocatalytic CRISPR/Cas-ECL technology proposed in this study enables rapid, cost-effective, and ultrasensitive nucleic acid quantification, potentially expanding the application scope of CRISPR/Cas systems in molecular diagnostics.

References

1. Chen, W.D.; Liu, L.; Cheng, L. Angew. Chem. Int. Ed. 2025, 64, e202506527.
2. Peng, H.; Lai, M.; Wang, H.; Weng, Z.; Yang, Y.; Huang, Z.; Sun, W.; Liu, J.; Chen, W. Anal. Chem. 2023, 95(29): 11106.

Construction of Electrochemiluminescence Biosensor for Mycotoxin Detection

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Electrochemiluminescence (ECL) is an analytical technique that triggers chemiluminescent signals through electrochemical reactions, combining the high controllability of electrochemistry with the high sensitivity of optical detection. ECL biosensors have been considered as efficient and effective approach for biomolecules detection without the utilization of costly instrumentation. Besides, various signal amplification strategies have been integrated to improve the sensitivity of the ECL biosensor.

In a recent work of our group, we fabricated MWCNTs-PDMS carbon fibers-based bipolar electrode (BPE) array to realize the ECL detection of mycotoxins [1]. This BPE exhibits exceptional flexibility, conductivity, and homogeneous texture. Electroactive species (methylene blue, MB) were embedded in metal-organic frameworks (MOFs) and then labeled on the terminal of cDNA on the cathode of BPE. The reduction of MB at the cathode can greatly improve the anodic ECL signal. Owing to the dual amplification effect of MB-MOFs and DNA walkers, the prepared array sensor enables the visual detection of FB_1 in the range of 5×10^{-5} ~ 0.5 ng/mL.

To further amplify the ECL signal, we constructed a novel ECL biosensor that takes advantage of the efficient signal amplification effect of PCR and DNA network-templated Ag NCs [2]. The sensing interface was built on a microparticle array (GCB) modified with area-controlled Au NPs, which facilitated biomolecular interactions and simplified the target recognition process. The recognition of OTA initiated the PCR process, leading to the formation of DNA nanostructures through cross-hybridization reactions among Au-P1, Au-P2, and PCR products. These DNA nanostructures provided numerous active sites for Ag NCs deposition, which catalyzed the luminol/H_2O_2 system, generating a strong ECL signal. With its high sensitivity, adjustable sensing interface, and simple operation, this platform would have great potential application in mycotoxin-polluted sample measurement.

References

1. L. Jin, H. Yu, W. Liu, Z. Xiao, H. Yang, B. Jin and M. Wu, Visual Measurement of Fumonisin B_1 with Bipolar Electrodes Array-Based Electrochemiluminescence Biosensor, *chemosensors*, 11(8), 451 (2023).
2. L. Jin, Q. Zhu, W. Xia, Z. Xiao and M. Wu, Ultrasensitive electrochemiluminescence biosensor for ochratoxin A detection based on the synergistic amplification of DNA network and silver nanoclusters, *Sensors and Actuators B: Chemical*, 429, 137330 (2025).

Endogenous and Exogenous Wireless Multimodal Light-Emitting Devices

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Multimodal imaging is based on the incorporation of two or more optical readouts of biological or chemical information within a single device. The design of such systems has gained considerable attention in different applications ranging from medicine to sensing. In this context, light-emitting systems based on fluorescence, electrochemiluminescence (ECL) or light-emitting diodes (LEDs), are presented as an alternative for the possible design of multimodal optical systems, due to the easy and straightforward visualization of chemical information in solution. However, most of the classic electrochemical systems require a direct electric connection to trigger the light emission.

An interesting approach is to take advantage of the wireless nature of bipolar electrochemistry (BE) to produce the optical readout [1]. The synergy between BE and the light emission triggered by ECL or originating from a LED has been successfully studied [2-5]. Since ECL is an interfacial redox process and the switching-on of a LED is caused by a flux of electrons, we designed several wireless multimodal systems where both light-emitting processes (ECL and LED) were coupled. In these devices, the concept of BE, which is the driving force to trigger light emission, was expanded by designing non-spontaneous (exogenous) and spontaneous (endogenous) systems (Figure 1). In exogenous systems, by applying an electric field, the redox reactions leading to ECL take place at the anode or cathode of the hybrid bipolar electrode, composed of two metallic wires directly connected to a LED. Such a flux of electrons passing through the device switches on the electrochromic device (Figure 1a). Thus, the bipolar electrode produces the characteristic red or blue emission of the $Ru(bpy)_3^{2+}$, or of the luminol luminophore, with the concomitant green emission of the LED. Finally, we developed wireless endogenous light-emitting devices without external power supply by taking advantage of the thermodynamically favored oxidation of Mg in acid media, acting as the source of electrons (Figure 1b). In this case, the oxidation reaction triggers both ECL and LED light emission processes.

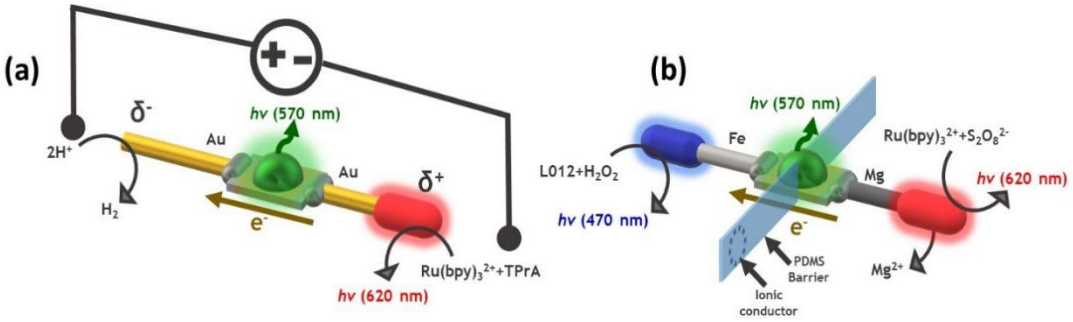


Fig. 1 Schematic illustration of two different wireless multimodal light-emitting configurations based on (a) exogenous and (b) endogenous bipolar electrochemistry.

Acknowledgements

This work has been funded by the European Research Council (ERC) under the European Union's Horizon 2020 research and innovation program (grant agreement no 741251, ERC Advanced grant ELECTRA). The authors thank the International Research Network ELECTROSENS funded by the CNRS. M. Liu acknowledges the China Scholarship Council for her PhD scholarship.

References

1. L. Bouffier, D. Manojlovic, A. Kuhn, N. Sojic. *Curr. Opin. Electrochem.*, **16**, 28-34 (2019).
2. G. Salinas, I. A. Pavel, N. Sojic, A. Kuhn, *ChemElectroChem*, 7, 4853-62 (2020).
3. S. M. Beladi-Mousavi, G. Salinas, L. Bouffier, N. Sojic, A. Kuhn, *Chem. Sci.*, **13**, 14277-84 (2022).
4. G. Salinas, A. L. Dauphin, C. Colin, E. Villani, S. Arbault, L. Bouffier, A. Kuhn, *Angew. Chem. Int. Ed.*, **59**, 7508-13 (2020).
5. G. Salinas, A. L. Dauphin, S. Voci, L. Bouffier, N. Sojic, A. Kuhn, *Chem. Sci.*, **11**, 7438-43 (2020).

Water-responsive Xerogel-Based Flood Alarm Device Utilizing Smartphone Electrogenerated Chemiluminescence Imaging

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The global incidence of flash floods has increased, leading to fatalities and significant economic losses. Hence, development of cost-effective, timely and efficient flood early warning systems holds significant economic and social value. In this work, a flash flood alarm device was fabricated that employed water-responsive xerogel as a core material and utilized smartphone electrogenerated chemiluminescence (ECL) imaging as detecting technique. The water-responsive xerogel was derived from the drying process of conductive ECL hydrogel, where the conductive ECL hydrogel materials was prepared by doping both the $Ru(bpy)_3Cl_2$ luminophore and conductive indium tin oxide nanoparticles into the flexible hydrophilic polymer matrix via the cross-linking of poly(vinyl alcohol) with borax and sucrose. Intriguingly, the ECL xerogel exhibits a rapid response to water and displays significantly enhanced ECL behavior in the presence of water. Moreover, one floods alarm device was fabricated by the incorporation of one serrate FTO electrode as the anode, five piece of the ECL xerogels, a strip-type FTO electrode as the cathode, a battery group as the power supply and a smartphone as the detection device. This flood alarm device demonstrates effective performance in water level alarming functionalities even in dim or nocturnal conditions with cost-effective and timely, which are associated with the greatest risk of flooding. This work demonstrates a flood alarm device based on ECL xerogel utilizing smartphones as detectors, providing a promising solution for the early warning of catastrophic floods.

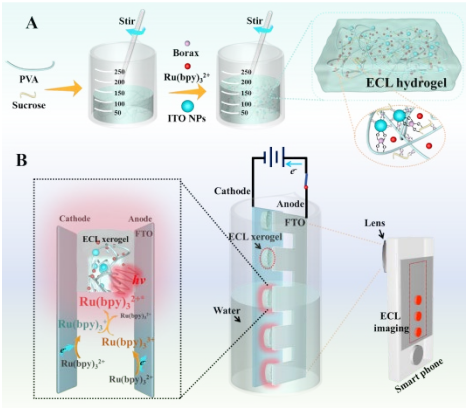


Fig.1 Schematic representation for (A) the preparation of ECL hydrogel and (B) the ECL xerogel-based flood alarm device using a smartphone as a detector.

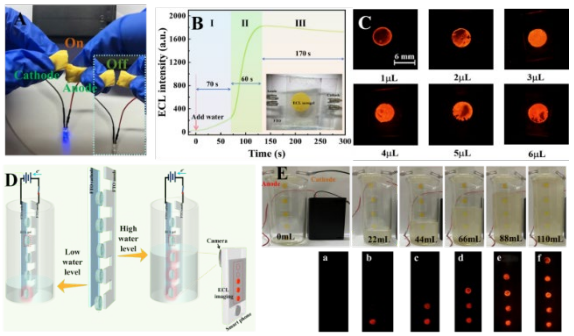


Fig.2 (A) Photographs of the conductivity validation for the conductive ECL hydrogel. (B) Dependence of the ECL intensity on response time for the ECL xerogel device. Inset: photographs of the ECL xerogel device. (C) Representative ECL imaging of the ECL xerogel device in different volume of muddy water utilizing smartphone as detector. (D) Schematic diagrams of the ECL xerogel-based floods alarm device. (E) Representative ECL imaging of ECL xerogel in various volumes of turbid water based on the designed ECL xerogel-based flood alarm device and smartphone as a detector.

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References

1. H. Ayat, J. P. Evans, S. C. Sherwood and J. Soderholm, *Science*, **378**, 655-659(2022)
2. H. J. Fowler, S. Blenkinsop, A.Green and P. A. Davies, *Nat. Rev. Earth Env.*, **5**, 250-252(2024)
3. W. J. Miao,*Chem. Rev.*, **108**, 2506-2553(2008)
4. H. L. Qi and C. X. Zhang, *Anal. Chem.*, **92**, 524-534(2020)

Modeling and cyclic voltammetry study of complicated electron transfer reactions: electrochemical oxidation of luminol and electrodeposition of copper

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Despite the recent progress in characterizing various electrocatalysts, unveiling the mechanisms of electrochemical reactions, especially the ones with multiple electron transfer steps and/or adsorption processes involved, still remained challenging, even though such electrochemical reactions play important roles in our life. Here, we show our two attempts to reveal the reaction mechanism of a complicated yet important electrochemical reaction and quantitatively analyze the reaction kinetics.

The first case is the electrochemical oxidation of luminol. Luminol is one of the most widely used electrochemiluminescence (ECL) reagent, yet the detailed mechanism and kinetics of the electrochemical oxidation of luminol remained unclear. We propose a model that describes the electrochemical oxidation of luminol, and applied finite element method simulation to analyze the electron transfer kinetics in alkaline solutions. Additionally, the adsorption of luminol on the glassy carbon electrode became noticeable in a less basic solution, and the adsorption effect was analyzed through a model with Langmuir isotherm. We also found that the molecular structure of luminol-derivatives had a large impact on the adsorption effect, and the ECL intensity could be boosted through the adsorption effect, especially at higher scan rates during CV[1].

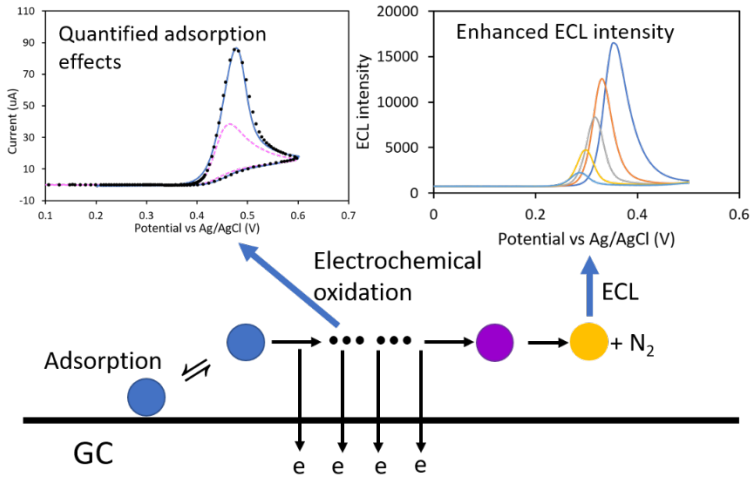


Fig.1 The analysis of the adsorption effect during the electrochemical oxidation of luminol, and the enhancing effect of the adsorption on the ECL behavior

The second case is the electrodeposition of copper from cupric ions in an acidic solution, which is the key reaction in copper electroplating. From cyclic voltammograms (CV) and chronoamperometry measurements, we found that the electrocrystallization step had a huge influence on the CV behavior, and the influence was less severe on glassy carbon

(GC) electrodes than on gold (Au) and platinum (Pt) electrodes. However, such effects have been neglected in the kinetic models describing the electrodeposition process of copper. We proposed a kinetic model to describe the effect of the electrocrystallization step on the CV, and extracted key parameters describing the strength of the effect. Based on this model, the CVs of electrodeposition of copper on Au, GC and Pt were successfully analyzed using finite element method simulation, revealing the difference in not only the electron transfer process, but also the electrocrystallization process[2].

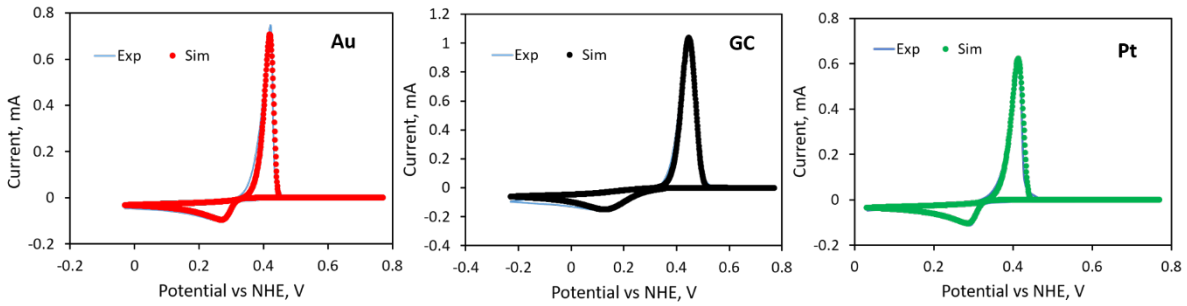


Fig.2 The experimental CV (solid lines) and simulated CV (dots) using our model considering the electrocrystallization process on Au, GC and Pt electrodes.

Acknowledgements

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References

1. R. Chen, X. Wang, K. Wu, S. Liu, and Y. Zhang, *Anal. Chem.*, **94**, 17625 (2022)
2. R. Chen, Q. Zhong, X. Wang, and Y. Zhang, *In preparation*

Non-covalent Interactions in Solid-State Molecular Charge Transport

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Molecular electronics involves applying molecules to electronic systems by constructing molecular junctions based on molecular charge transport, with the goal of developing functional molecular electronic devices. Owing to their high sensitivity to external environments, molecular junctions are well-suited for use in high-sensitivity sensing applications. However, the structure–function relationships between non-covalent interactions and charge transport in response to external stimuli remain poorly understood, limiting the rational design, performance optimization, and analytical application of molecular electronic devices.

To address this, we have designed molecular structures and fabricated ordered molecular self-assembled monolayers, while modulating the external environment of molecular junctions to constrain the modes of non-covalent interactions. The regulations and underlying mechanisms of non-covalent interactions on molecular charge transport were investigated from rigid small molecules, flexible peptides, to complex proteins. Building on this foundation, non-covalent molecular heterojunctions were developed to achieve controlled electrical behaviors such as rectification. Additionally, sensor arrays were constructed to explore novel electrical response signals and data analysis methods, thereby broadening the application of molecular electronics in functional molecular devices and bioanalytical sensing.

Acknowledgements

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References

1. Z. Zhang, J. Tang, Y. Zhang, P. Qi, X. Zhang, H. Fu, M. Wang, C. Guo, *Angew. Chem. Int. Ed.*, e202508443 (2025).
2. S. Lu, Z. Zhang, Y. Zhu, Y. Tao, Q. Lin, Q. Zhang, X. Lv, L. Hua, Z. Chen, H. Wang, G. Zhuang, Q. Zhang, C. Guo, X. Li, X. Yu, *Angew. Chem. Int. Ed.*, **63**, e202410710 (2024).
3. Y. Zhang, H. Liang, P. Qi, Z. Xu, H. Fei, C. Guo, *Nano Lett.*, **24**, 4178-4185 (2024).
4. X. Li, S. Zhou, Q. Zhao, Y. Chen, P. Qi, Y. Zhang, L. Wang, C. Guo, S. Chen, *Angew. Chem. Int. Ed.*, **62**, e202216987 (2023).

Design and Measurement of Photoelectrochemical Interface

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内容?

In Situ Electrochemical Titration of Catalytic Intermediates

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Although advanced instrumentation has significantly enhanced the ability to characterize the microscopic morphology and structures of materials, precisely measuring chemical behaviors at electrochemical interfaces remains challenging. Recent advances combining spectroscopy and electrochemical techniques have enabled the characterization of intermediates at electrochemical interfaces under operando conditions; however, limitations in spatial and temporal resolution still hinder accurate identification of critical intermediates during electrocatalytic processes. To address this fundamental scientific issue, we developed an in situ technique for measuring electrocatalytic intermediates based on surface interrogation scanning electrochemical microscopy (SI-SECM). Using this approach, quantitative analytical methodologies for several model electrocatalysts were established, yielding significant insights into interfacial processes [1]. Specifically, we proposed a quantitative analysis method for active sites in single-atom catalysts, revealing and validating the atomic site-distance effect in fuel cell catalysts, thus providing theoretical support to overcome energy efficiency bottlenecks in fuel cells [2-3]. Additionally, we established an in situ analytical approach to probe competitive reactions occurring during electrocatalytic ammonia synthesis, obtaining quantitative information on adsorption kinetics of multiple intermediates and thus facilitating mechanistic understanding of renewable-energy-driven resource recycling technologies [4-5]. Finally, we developed an in situ analytical platform for radical-mediated electrocatalysis at interfaces under multiphysical coupling conditions, providing experimental evidence crucial for elucidating the mechanisms of active hydrogen generation and stabilization under thermal and photothermal enhancement, thereby expanding the application potential for efficient transformation of carbon- and nitrogen-containing small molecules [6].

Acknowledgements

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References

1. Z. Jin, *Anal. Chem.*, **95**, 6477 (2023).
2. Z. Jin, P. Li, Y. Meng, Z. Fang, D. Xiao, and G. Yu, *Nat. Catal.*, **4**, 615 (2021).
3. J. Xiang, P. Wang, P. Li, M. Zhou, G. Yu, and Z. Jin, *Angew. Chem. Int. Ed.*, **64**, e202500644 (2025).
4. P. Li, L. Liao, Z. Fang, G. Su, Z. Jin, and G. Yu, *Proc. Natl. Acad. Sci. U.S.A.*, **120**, e2305489120 (2023).
5. P. Li, R. Li, Y. Liu, M. Xie, Z. Jin, and G. Yu, *J. Am. Chem. Soc.*, **145**, 6471 (2023).
6. P. Wang, P. Li, Z. Pan, K. Liu, M. Xie, L. Zhou, M. Zhou, G. Yu, and Z. Jin, *Nat. Commun.*, **16**, 5581 (2025).

Electrospun nanofibers for energy-related electrocatalytic small molecules conversion

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Electrospun nanofiber materials exhibit unique oriented electron transport characteristics and exceptional mass transfer properties, demonstrating significant applications in the field of electrocatalysis. Utilizing electrospinning technology, we have fabricated a series of metallic, oxide, carbon-based and multicomponent composite nanofiber materials as electrocatalysts. Through precise modulation of their composition and electronic structures, the adsorption of small molecules/intermediates and desorption of products on catalyst surfaces are optimized, achieving synergistically enhanced catalytic effects in various small molecule electrocatalytic conversion systems [1-8]. This work provides crucial insights for practical energy conversion applications of these materials.

References

1. M. Zhong, M. Xu, S. Ren, W. Li, C. Wang, M. Gao, X. Lu, Energy Environ. Sci., 2024, 17, 1984-1996.
2. L. Zhang, W. Li, S. Ren, W. Song, C. Wang, X. Lu, Adv. Energy Mater., 2025, 2403136.
3. W. Li, L. Zhang, L. Ma, J. Wang, R. Qi, Y. Pang, M. Xu, C. Zhao, C. Wang, M. Gao, X. Lu, Nano Lett., 2025, 25, 443-452.
4. W. Li, C. Wang, X. Lu, Nano Lett., 2024, 24, 11779-11792.
5. R. Qi, L. Zhang, S. Ren, B. Shi, M. Zhong, Z. Chen, X. Lu, Nano Lett., 2024, 24, 8964-8972.
6. R. Qi, Q. Jiang, L. Deng, X. Yu, B. Shi, M. Zhong, Y. Wang, X. Lu, Chem. Sci., 2025, 16, 378-385
7. W. Li, W. Gou, L. Zhang, M. Zhong, S. Ren, G. Yu, C. Wang, W. Chen, X. Lu, Chem. Sci., 2024, 15, 11890–11901.
8. X. Yu, M. Xia, R. Qi, Y. Wang, M. Gao, M. Zhong, X. Lu, Chem. Sci., 2025, DOI: 10.1039/D5SC00248F.

Electrocatalytic oxidation of protein amino acids by transition metal hexacyanoferrates

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Electrochemistry of proteinogenic amino acids is generally limited to sulfur-containing methionine (Met), cysteine (Cys), and cystine (Cys-Cys), and aromatic tryptophan (Trp), histidine (His), and tyrosine (Tyr) which can be oxidized on solid electrodes. In anodic voltammograms, Cys, Tyr, and Trp demonstrate well-defined peaks (at 0.5–0.8 V), while His, Met, and Cys-Cys exhibite fuzzy waves (at high positive potentials of 1–1.5 V, *vs.* Ag/AgCl, neutral pH). Electrochemical oxidation reactions of amino acids on solid electrodes are irreversible and pH dependent [1]. For many years a lot of various modifiers of electrode surfaces have been tested to improve electrochemical activity of amino acids, but the list of oxidizable amino acids has not been significantly extended.

However, the stereotype about six "electroactive" ("easily oxidizable") amino acids is outdated now. Recently, the specific electrochemical oxidation, both direct and electrocatalytic, of nearly all protein amino acids (except for glutamic acid, Glu) was shown by our group [2]. Particularly, the oxidation signals of amino acids were demonstrated at potentials below 1 V by cyclic voltammetry (CV) and amperometric flow injection analysis (FIA) on carbon screen printed electrodes (SPE) and SPE modified with Prussian blue (PB, $Fe_4[Fe(CN)_6]_3$) in phosphate buffer, pH 6.0. For 20 amino acids out of 21 tested, the electrogenerated Berlin Green ($Fe[Fe(CN)_6]$, fully oxidized form of PB) has been reduced back to PB, forming a catalytic cycle thus resulted in an increase of oxidation currents [2]. Moreover, protein molecules were shown to be oxidized via "non-electroactive" amino acid residues on unmodified and PB modified carbon SPE by amperometric FIA [2, 3]. Modification of carbon SPE with PB led to significant increase of sensitivity of protein and peptide detection. Interestingly, the pronounced catalytic effect of PB was found for amyloid-beta peptides (Aβ) lacking the Tyr-10 residues, while practically no effect of PB was observed for Aβ mutants contained Tyr-10 [3].

In the present work, we continue to study the electrooxidation reactions of proteinogenic amino acids on carbon SPE modified with transition metal hexacyanoferrates (MeHCF, where Me is varied as Fe(II), Cu(II), Co(II), or Ni(II)). The dependencies of the analytical signal on pH (5.0–9.0) and analyte concentration were investigated. Surprisingly, it has been found by CV and amperometric FIA that PB (FeHCF) is not the best electrocatalyst of amino acid oxidation due to its instability in alkaline solutions. Only for Cys and Cys-Cys, the highest values of anodic currents were observed with SPE/PB in acidic media. Interestingly, Cys was found to be a unique amino acid for which the optimal pH values of electrooxidation reactions on blank electrodes ($pH \geqslant 7.0$) and on PB modified electrodes ($pH \leqslant 5.0$) were significantly different. PB was shown to be the best

electrocatalyst for Cys oxidation (pH 5.0). Cys-Cys was poorly soluble in neutral and alkaline solutions. Among the metal hexacyanoferrates tested, CuHCF was shown to be stable only in strong acidic media (KCl + HCl, pH ~ 1–3) and suitable only for Cys electrocatalytic oxidation. In most cases, CoHCF surpassed NiHCF and PB catalysts in their ability to catalyze the oxidation reactions of amino acids, especially in alkaline solutuins. It was found that the optimal pH value for these reactions is 8.0–8.5. Except for six "electroactive" amino acids, the responses of other proteinogenic amino acids were not obtained on blank SPE by CV. Using arginine (Arg) as an example, a representative voltammogram of the oxidation of a "non-electroactive" amino acid on SPE/CoHCF is shown in Fig. 1.

The expansion of the list of oxidazible protein amino acids opens new horizons for electrochemistry and analytical chemistry of proteins and peptides. Short chain bioactive peptides [4] are promising objects for future research using electrochemical methods.

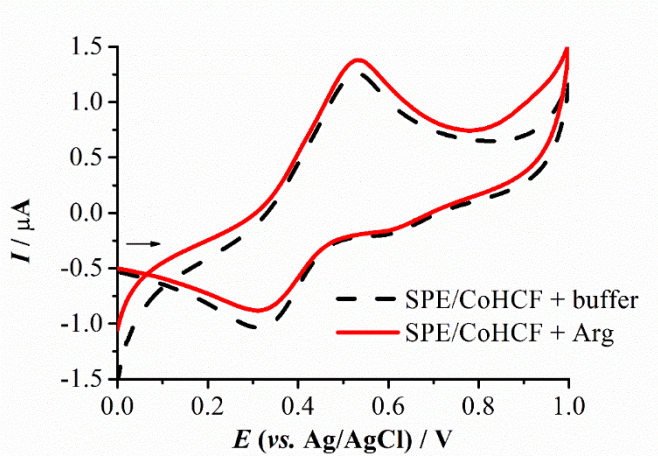


Fig.1 Anodic cyclic votammogram of 1 mM arginine (Arg) on a carbon screen printed electrode modified with cobalt hexacyanoferrate (SPE/CoHCF). Sweep rate, 5 mV s^{-1}; in 0.1 M K-phosphate buffer with 0.1 M KCl, pH 8.0. Surface concentration of CoHCF, 2.9 nmol cm^{-2}.

Acknowledgements

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References

1. E.V. Suprun, *Electrochem. Commun.,* **125**, 106983 (2021)
2. E.V. Suprun, E.V. Karpova, S.P. Radko, A.A. Karyakin, *Electrochim. Acta*, **331**, 135289 (2020)
3. E.V. Suprun, E.V. Daboss, V.M. Pleshakov, D.V. Vokhmyanina, S.P. Radko, A.A. Karyakin, S.A. Kozin, A.A. Makarov, V.A. Mitkevich. Electrochim. Acta, **406**, 139829 (2022)
4. A. Chawathe, V. Ahire, K. Luthra, B. Patil, K. Garkhal, N. Sharma, *Anal. Biochem.*, **696**, 115699 (2025)

Bioelectrocatalytic Carbon Dioxide Reduction by Formate Dehydrogenases

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The rapid emission of CO_2 has resulted in severe environment problems like global climate change, thus developing carbon fixation technologies is desired. Electrochemical CO_2 reduction is an effective way to convert CO_2 to fuels. In recent years, various electrocatalysts have been synthesized and tested. For instance, Bi-based complexes catalyze the formation of formate in a high rate and selectivity. However, they face the disadvantage of high overpotential. Enzyme electrocatalysis possess the merits of high specificity and nearly zero-overpotential, providing promising opportunities for practical CO_2 reduction.

Formate dehydrogenases (FDHs) are a class of enzymes capable of reversibly catalyzing the interconversion between formate and carbon dioxide. However, most FDHs preferentially catalyze the oxidation of formate and exhibit insufficient efficiency for. Therefore, mining and engineering high-performance FDHs towards CO_2 reduction, elucidating their electron transfer mechanisms, and then altering their catalytic prefences are of great significance for developing enzyme-based electrocatalytic carbon fixation technologies.

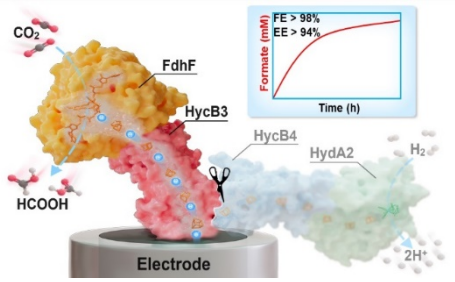


Fig.1 Truncation and engineering of HDCR for bioelectrocatalytic CO_2 reduction.

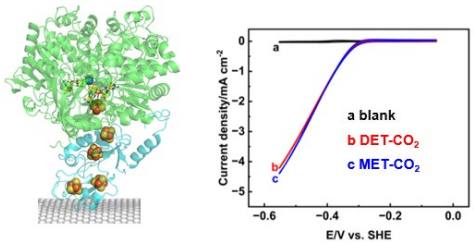


Fig.2 High-performance and oxygen-tolerent FDH for DET-type bioelectrocatalytic CO_2 reduction.

Recently, we studied three types of FDHs. The first one originates from the hydrogen-dependent CO_2 reductase (HDCR), which is reported to exhibit the highest activity towards CO_2 reduction[1]. Through overexpression and engineering, direct electrocatalysis was successfully achieved with a Faradaic efficiency close to 100% and a half-cell energy efficiency exceeding 94%[2]. To address the anaerobic limitations of the aforementioned FDH, we further screened out an oxygen-tolerant FDH with a CO_2 reduction activity of 26.6 U/mg and found it is a natural DET-type FDH with a highest formate production rate of approximately 10 mM h^{-1} cm^{-2}. Additionally, for a

multimeric FDH that is both oxygen-tolerant and exhibits a strong preference for CO_2 reduction[3], we employed protein engineering and cryo-electron microscopy to elucidate its electron transfer mechanism, providing theoretical support for the rational design of enzyme-electrode interfaces.

The systematic study of FDHs offers critical insights into overcoming challenges in CO_2 molecular activation and enhancing its biological utilization efficiency.

Acknowledgements

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References

1. H. Dietrich and V. Müller, *Nature*, **607**, 823-830 (2022)
2. W. Liu and L. Zhang, *Nat. Commun.* **15**, 9962 (2024)
3. K. Min and J. Lee, *Bioresour. Technol.* **305**, 123155 (2020)

Confinement and Heterointerface Re-construction in 2D Materials for Water Oxidation Catalysis

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implementation. Recently, 2D materials have emerged as promising candidates for catalyzing water splitting due to their unique electronic and structural properties. Here, we investigate the confinement and heterointerface reconstruction in 2D materials as a strategy to further enhance their catalytic performance for water splitting, resulting in improved charge transfer and enhanced water splitting performance. Moreover, we demonstrate that heterointerfaces can trigger water oxidation catalysis by providing active sites for oxygen evolution reaction (OER). Our results indicate that the heterointerface reconstruction in 2D materials is a promising approach to enhance their catalytic activity for green hydrogen production. The insights gained from this study can pave the way for the rational design and engineering of 2D materials for efficient energy conversion.

Iron-Based MOF with Peroxidase-Like Activity Enhances Synergistic Therapeutic Efficacy of PDT/Ferroptosis/Starvation Therapy by Alleviating Tumor Hypoxia

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Alleviating tumor hypoxia represents a crucial strategy for enhancing synergistic cancer therapy. In this study, we developed Ce6@HGMOF nanoparticles integrating a photosensitizer (Ce6), glucose oxidase (GOX), chemotherapeutic drug (HCPT), and an iron-based MOF [**Fig.1**]. These nanoparticles execute multimodal therapy by: (1) depleting glucose via GOX-mediated starvation therapy while generating H_2O_2; (2) converting H_2O_2 to oxygen through MOF's peroxidase-like activity to reverse hypoxia, thereby suppressing angiogenesis and drug resistance; (3) enhancing PDT efficacy through improved oxygen supply and ROS generation; while (4) simultaneously depleting protective GSH and inducing ferroptosis via Fenton reactions. This innovative PDT/ferroptosis/starvation therapy triad creates a self-reinforcing therapeutic cycle [**Fig.2**], demonstrating significant potential as a novel anti-tumor paradigm.

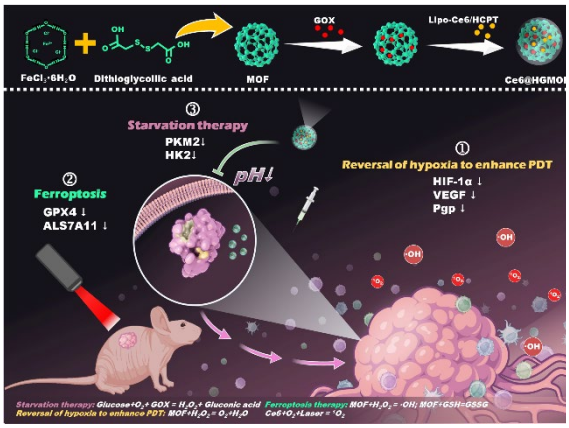


Fig.1 Schematic representation of the synthesis of Ce6@HGMOF NPs and reversal of tumor microenvironment synergistic PDT/ferroptosis /starvation therapy against tumors.

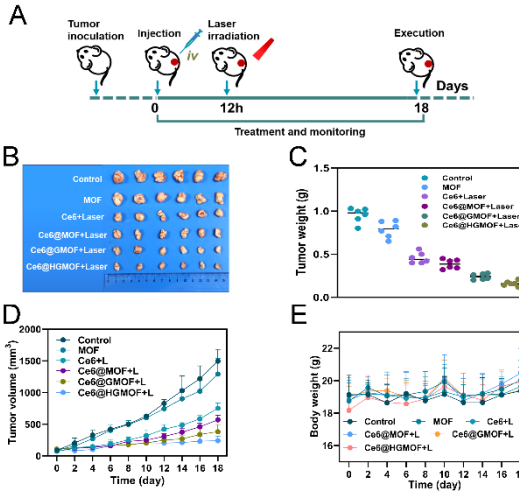


Fig. 2. In vivo antitumor effect of Ce6@HGMOF. (**A**) Schematic demonstration of the establishment and treatment of the EC109 bearing BALB/c mice model. (**B**) Digital photographs of the dissected tumors (n = 6). (**C**) Tumor weight (n = 6). (**D**) Tumor volume changes (n = 6). (**E**) Body weight (n = 6).

Acknowledgements

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References

1. Y. Chen, Y. Chen, Z. Wang, L. Yang, Y. Zhang, Z. Zhang and L. Jia, *J. Nanobiotechnol.,* **22**, 705 (2024).
2. M. Su, Y. Zhang, L. Yang, H. Li, X. Li, J. Feng, L. Jia and Z. Zhang, *J. Drug Deliv. Sci. Technol.,* **97**, 105657 (2024).

Facet-Selective Zirconium Doping in $LiLnF_4$ Enables Controlled Biodegradation and Bright Upconversion

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Abstract

The development of biodegradable upconversion nanoparticles (UCNPs) is critical for advancing their use in biomedical applications by mitigating long-term cytotoxicity associated with persistent nanomaterials. Conventional biodegradable UCNPs, typically based on alkali zirconium fluorides (A3ZrF7), exhibit limited control over degradation kinetics due to rapid hydrolysis of the [ZrF7]3- cluster and suffer from poor upconversion efficiency. Here, we present a new class of UCNPs based on LiLnF4 (Ln = Yb, Er) nanocrystals engineered with facet-selective zirconium doping. This doping strategy promotes localized hydrolytic activity by incorporating Zr ions preferentially at high-energy surface facets, while preserving the strong crystal fields of the inert host lattice. The resulting nanocrystals demonstrate slow and controllable degradation over three weeks in aqueous media, with upconversion brightness enhanced by a factor of five compared to conventional biodegradable counterparts. This approach provides a generalizable platform for designing UCNPs that integrate high optical performance with tunable biodegradability, advancing their potential for safe and effective in vivo applications.

Enhancing Signal-to-Noise Ratio in Nanopore Current Pulse Detection Using 3D DNA Nanostructures

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The main challenges impeding the practical usage of nanopore technique stems from the signal-to-noise ratio. Finding a carrier with huge signal-to-noise ratio is crucial to eliminate the interference of non-target and detect faint current signal from target simuataneouly. In our group, we have designed a series of DNA nanostructure including self-assembly of short-stranded DNA into 3D nanostructure and another unique structure. By analyzing these structures, it was found that 3D cubic nanostructure has the best signal-to-noise ratio. The DNA nanostructure can be extended to detect many targets. In my published research, targets including small molecules, metal ion, etc. have been analyzed. In the near future, this approach will be used to detect other important protein biomarker. Once the challenging issue is resolved, the full potential of nanopore technique can be futher explored. Not only using short-stranded DNA to assembly DNA nanostructure, we have also used computer-aided approach to design DNA origami with a cubic shape. This 3D structures have adjustable rigidity and current signal. By using glass nanopore, the translocation of 3D structure can be continuously monitored without interruption. Except the contribution in terms of structure innovation, we have adopted tailored 3D nanopore fabrication. It can be envisioned that with both 3D nanostructure and nanopore fabrication innovation, the nanopore technique can be further optimized. As mentioned earlier, this scenario can be used to detect a range of targets, including even clinical samples.

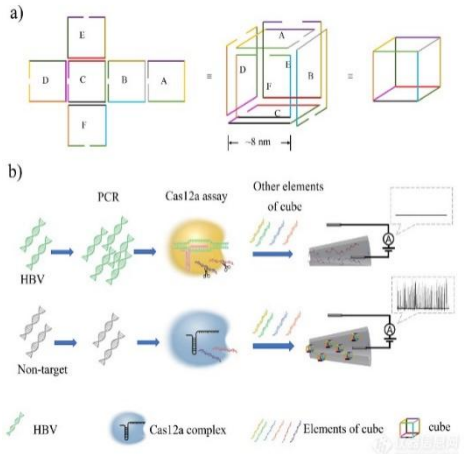


Fig.1 Self-assembly DNA nanostructure for nanopore application

Acknowledgements

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References

1. **Jiahai Wang***, Jianji Zhu, Yunhui Li, Cenlin Gui, Baian Zhu, Zhuobin Zhu, Daqi Chen*, Rational design of a 3D DNA origami cube as an ideal signal carrier for glass nanopore-based biosensors, Analytica Chimica Acta 2025, 1343, 343660.
2. Wenping Lv, Jianji Zhu, XiaoQin Huang, Mauro Chinappi, Denis Garoli, Cenglin Gui, Tao Yang, **Jiahai Wang***, Location and discrimiantion of GG mismatch in duplex DNA by synthetic ligand -enchanced protein nanopore analysis, Nucleic acids Research, 2024, 52 (20), 12191-12200. (IF=16.6)
3. Li, H.; Li, Y.; Gui, C.; Chen, D.; Chen, L.; Luo, L.; Huang, G.; Yuan, Y.; He, R*.; Xia, F.*; **Wang, Jiahai**.*, Bare glassy nanopore for length-resolution reading of PCR amplicons from various pathogenic bacteria and viruses. Talanta 2023, 256.
4. **Wang, Jiahai.**; Chen, L.; Gui, C.; Zhu, J.; Zhu, B.; Zhu, Z.; Li, Y.; Chen, D.*, A nanopore counter for highly sensitive evaluation of DNA methylation and its application in vitro diagnostics. Analyst 2023, 148 (7), 1492-1499.
5. Xie, Z.; Yang, M.; Luo, L.; Lv, Y.; Song, K.; Liu, S.; Chen, D.*; **Wang， Jiahai***, Nanochannel sensor for sensitive and selective adamantanamine detection based on host-guest competition. Talanta 2020, 219.
6. Xie, Z.; Lei, J.; Yang, M.; Li, Y.; Geng, X.; Liu, S.*; **Wang, Jiahai***, Conical nanofluidic channel for selective quantitation of melamine in combination with beta-cyclodextrin and a single-walled carbon nanotube. Biosensors & Bioelectronics 2019, 127, 200-206.

Lanthan's touch: designing GCE/La-Dy_2O_3/MWCNT sensor for electrochemical detection of metol in enviromental and bio-fluids samples

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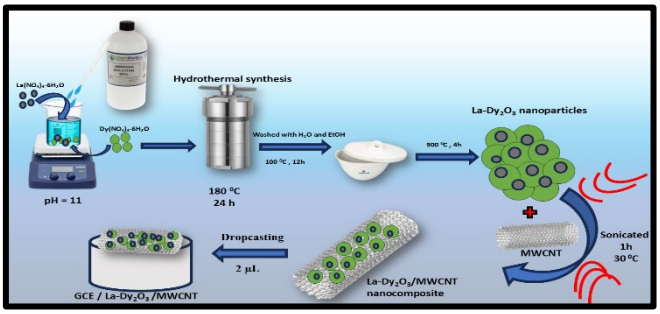
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Over the past few decades, the infiltration of aquatic ecosystems by aromatic organic pollutants—particularly aminophenols, aniline derivatives and phenolic compounds—has become a pressing environmental and public health issue. These substances, originating from industrial discharges, photographic processing residues, pharmaceutical manufacturing and dye production, exhibit high chemical stability and water solubility, enabling their persistence in both surface and groundwater systems. They can induce oxidative stress, nephrotoxicity, hepatotoxicity, mutagenic effects, and, in certain instances, carcinogenic outcomes in both aquatic organisms and humans. Conventional water treatment facilities often fall short in effectively eliminating these low-concentration yet biologically active contaminants, necessitating enhanced monitoring and detection strategies to mitigate their impact on environmental and human health [1-3]. Among such pollutants, MTL represents a structurally relevant aromatic amine, widely known for its use as a developing agent in black-and-white photography. In addition to its classical applications, MTL's electroactive properties, due to the presence of both phenolic and amino functional groups, have made it a compound of interest in electrochemical sensing and analytical chemistry. Its ability to undergo oxidation reactions on various electrode surfaces enables its utilization in developing sensitive and selective sensors, particularly for environmental analysis [4-6]. In recent literature, various strategies have been employed to tailor the properties of catalytic materials, including composite formation, heterojunction engineering, and particularly, elemental doping. Among these, doping is recognized as a highly effective and versatile approach to improve electrocatalytic behavior by modifying surface architecture and increasing electrical conductivity of the material. Doping involves the intentional incorporation of foreign atoms (heteroatoms) into the surface or crystal lattice of a nanomaterial. This modification can synergistically enhance catalytic activity and charge transfer kinetics, while also tuning important characteristics such as electrical conductivity, density and distribution of active sites and energy barriers associated with electrochemical reactions. Furthermore, it provides a powerful strategy for engineering nanomaterials with tailored physicochemical properties suitable for advanced sensing applications.

In this work, we report the development of a novel electrochemical sensor based on a La-doped Dy_2O_3 and multi-walled carbon nanotube (MWCNT) composite for the sensitive and selective detection of N-methyl-p-aminophenol sulfate (Metol, MTL), a representative aromatic pollutant of environmental and toxicological relevance. The La-Dy_2O_3/MWCNT nanocomposite was synthesized via a hydrothermal method and characterized using SEM-EDS and XRPD (**Scheme 1**).



Scheme 1. Schematic diagram of the preparation of working electrode for voltammetric detection of MTL

Electrochemical evaluation using cyclic voltammetry (CV), square wave voltammetry (SWV) and electrochemical impedance spectroscopy (EIS) confirmed the superior electrocatalytic performance of the composite-modified glassy carbon electrode (GCE), attributed to the synergistic effects between La^{3+}-doping and the conductive MWCNT network.

The sensor exhibited a wide linear response range (0.03–220 µM), a low detection limit of 0.45 µM, and high sensitivity (0.387 µA μM^{-1} cm^{-2}). Kinetic analyses indicated a diffusion-controlled and proton-coupled electron transfer mechanism, with optimized sensing achieved at pH 7.0. The sensor demonstrated excellent reproducibility (RSD = 3.06%), repeatability (RSD = 3.35%), and stability over 15 days (**Fig. 1**). Importantly, it showed strong anti-interference capability and high recovery rates in complex matrices, including tap water, river water, urine and human serum, without requiring pretreatment or sophisticated instrumentation.

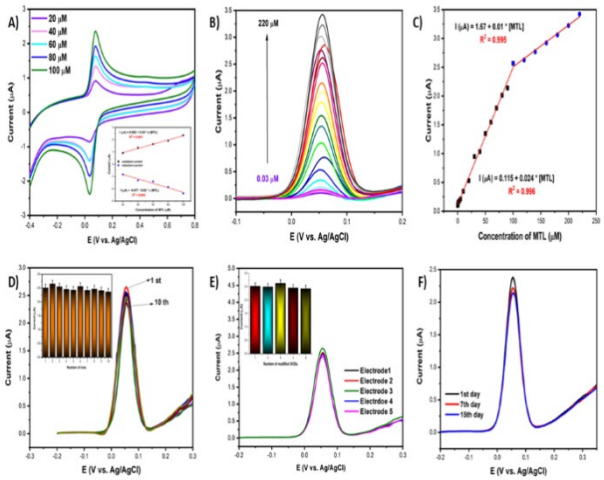


Fig. 1. A) CVs recorded at the GCE/La-Dy_2O_3/MWCNT electrode in BRBS, pH 7.0 containing increasing concentrations of MTL (20–100 µM) at a scan rate of 50 mV s^{-1},

along with the corresponding calibration curve showing the relationship between peak current and MTL concentration; B) SWV responses obtained for MTL concentrations ranging from 0.03 to 220 μM at the GCE/La-Dy_2O_3/MWCNT sensor in BRBS (pH 7.0); (C) Linear calibration plot of peak current (μA) as a function of MTL concentration (μM); D) Evaluation of the reproducibility of the GCE/La-Dy_2O_3/MWCNT sensor; E) Reproducibility assessment of GCE/La-Dy_2O_3/MWCNT sensors; F) Stability study of the modified electrode monitored over a 15-day period, indicating consistent electrochemical performance

Acknowledgements

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References

1. Mhlongo, et al., *Frontiers in Toxicology*, **5**, 1269601 (2024).
2. Duane, et al., *Ecotoxicology and Environmental Safety*, **157**, 441–56 (2018).
3. Aravind Kumar, et al., *Science of The Total Environment*, **831**, 154808 (2022).
4. Sun, et al., *Sensors and Actuators B: Chemical*, **136**, 419–24 (2009).
5. Andreozzi, et al., *Water Research*, **34**, 463–72 (2000).
6. Andreozzi, et al., *Water Research*, **34**, 4419–29 (2000).

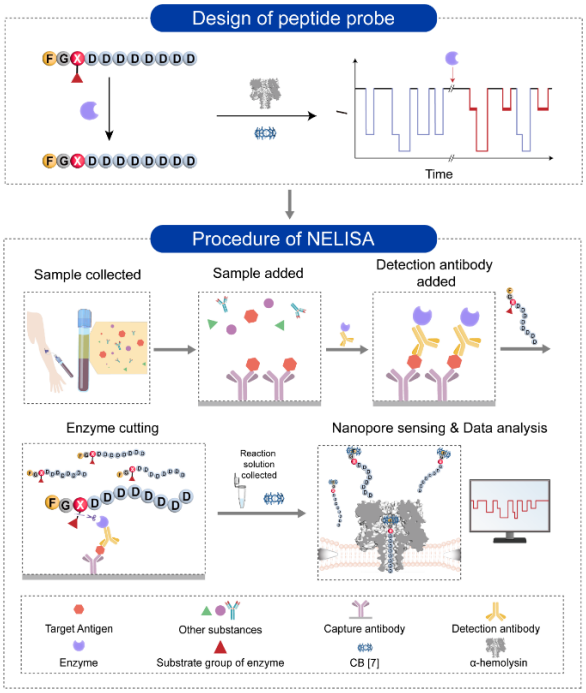
Nanopore-based enzyme-linked immunosorbent assay

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Cancer early diagnosis is important for the prognosis of patients. It can significantly reduce the mortality rate. Compared with radiological and invasive diagnostics, body fluid cancer biomarker detection, which is less harmful to the organism, is more suitable for earlier diagnosis. Serum cancer marker detection has been used as a support for diagnosis and treatment in clinical practice since the middle of last century. The enzyme-linked immunosorbent assay (ELISA) is the most widely used method. However, traditional ELISA's signal output relies on colorimetry, resulting in sensitivity and multiplexed detection throughput cannot meet the requirements for early cancer detection. Although the recent technologies developments have improved the test effect of traditional ELISA to some degrees, it is still difficult to meet the requirements of ultra-early diagnosis of diseases. In this study, we have developed a nanopore-based enzyme-linked immunosorbent assay for cancer biomarker detection. We designed and synthesized peptide probe $FGXD_8$⊂CB[7], which contains different enzyme response groups, as an enzyme substrate instead of a chromogenic substrate to perform the enzymatic reaction after the formation of the immune complex for enzyme-linked immunoassays. The reaction products were then subjected to translocation experiments by wild-type α-hemolysin. Finally, the quantitative detection of biomarker concentrations in the samples was achieved by statistically analyzing the frequency of the current signals of the $FGXD_8$⊂CB[7]. This method combines the advantages of ELISA and nanopore sensing technology to develop a marker multiplex detection assay with high sensitivity, low detection limit (3-4 orders of magnitude lower than conventional methods), and high immunity to interference. It provides a new technical tool for point-of-care testing (POCT) based on body fluid biomarker detection, which allows for efficient and reliable simultaneous detection of multiple markers in small-dose samples.



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References

1. Yakun Yi, Peng Song, Ziyi Li, Jinzhou Ju, Guixiang Sun, Qianyuan Ren, Ke Zhou, Lei Liu* and Hai-Chen Wu*, *Nat. Nanotechol.* (2025) https://doi.org/10.1038/s41565-025-01918-z.

Biofuel Cell-Based Self-Powered Biosensors

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Biofuel Cell Self-Powered Biosensing (BFC-SPB) is a critical cutting-edge field in electrochemical analysis, holding significant research value for advancing life sciences, environmental sciences, energy catalysis, and related disciplines. BFC-SPB achieves sensing by modulating the electrode interface structure and electron transfer through target analytes, thereby altering the battery's output signals. Consequently, precise regulation and design of electrode interface structures, investigation of electron transfer behaviors at electrochemical interfaces, and elucidation of electron transport mechanisms are pivotal for constructing highly sensitive and selective BFC-SPB platforms. A novel strategy for organic conjugated molecule-mediated transmembrane electron transfer has been developed to enable self-powered biosensing. Cationic organic conjugated molecules can directly insert into cell membranes, allowing electrons to travel along the conjugated molecular chains to membrane proteins. This approach effectively reduces energy loss during transmembrane electron transfer and enhances electron transport efficiency. The heterojunction photosensitive layer interface structure further promotes efficient electron separation, strengthening the driving force for transmembrane electron transfer. The proposed molecular membrane-embedding mechanism for enhancing microbial extracellular electron transfer lays a foundation for interface electron regulation in BFC-SPB systems. A bio-conjugate-mediated signal transduction method has been established for self-powered sensing. By leveraging highly specific DNA bio-conjugates to regulate interface structures and electron transfer rates, the competitive recognition mechanism between DNA bio-conjugates and targets has been clarified. Based on the differential effects of single/double-stranded functional nucleic acids on electron transport and signal transduction in bio-conjugates, a stimulus-responsive BFC-SPB platform was constructed. This innovation provides a simple, rapid, highly sensitive, and selective sensing method for antibiotic residue detection.

Acknowledgements

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Cooling-free sampling of exhaled breath for respiratory diagnostics

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Exhaled breath aerosol (BA) is a promising target for diagnostic purposes due to its diverse content. It includes both volatile and nonvolatile substances that can serve as a potential markers of different body conditions [1]. In contrast to bronchioscopy and bronchoalveolar lavage and biopsy, BA is collected noninvasively with minimal disturbances for a person. Common way of breath aerosol collection employs cooling (EcoScreen, RTube, TurboDECCS and others) which tends to dilute the sample with condensed water vapor being the major componens of the exhale.

Recently we reported on cooling-free condenser that requires no energy supply and no pretreatment and creates turbulent flows for enhanced aerosol condensation [2]. Compared to cooling, the device provides at least one order of magnitude more concentrated sample. The condenser was applied to volunteers with post-COVID-19 syndrome and with cystic fibrosis. Compared to healthy people, groups of interest have shown substantial difference in marker levels (hydrogen peroxide and conductivity).

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References

1. M. Maniscalco, C. Candia, S. Fuschillo, P. Ambrosino, D. Paris, A. Motta, *J. Breath Res.* **18**, 045001 (2024)
2. E. A. Andreev, V. A. Shavokshina, V. N. Nikitina, D. D. Pozdnyakova, I. A. Baranova, A. G. Chuchalin, A. A. Karyakin, *Talanta* **290**, 127792 (2025)

Multiplexed Nano-Flexible Electrochemical Biosensors for Point-of-Care Biomedical Applications

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The rapid advancement of nanotechnology has catalyzed the emergence of innovative nanomaterials for point-of-care (POC) diagnostics, addressing the increasing demand for sensitive, specific, and rapid pathogen detection in the post-pandemic biomedical landscape[1,2]. Among these, carbon-based nanostructures, quantum dots, metallic nanothin film, and DNA-based materials have shown remarkable potential due to their unique physicochemical properties, including high surface-to-volume ratios, tunable optical properties, and excellent electrical conductivity[3]. These properties enhance biosensor performance by amplifying biorecognition signals and enabling efficient transduction mechanisms. Besides, a low-cost, flexible electrochemical biosensing platform was also developed using plasma-sputtered metallic nano-thin films (~20 nm) on PET substrates[4]. These metal nano-thin-film electrodes were rapidly functionalized with specific biomolecules produced via recombinant or solid-state synthesis, forming stable self-assembled monolayers (SAMs) within 20–30 minutes without crosslinkers, streamlining fabrication while maintaining bioactivity. Furthermore, the resulting biosensor platform was integrated with DNA-based recognition elements and electrochemical impedance spectroscopy (EIS) for highly sensitive and selective detection of bacterial or viral pathogens. The platform demonstrated excellent performance in identifying *Escherichia coli* O157:H7, *Salmonella* spp., *Vibrio orientalis*, SARS-CoV-2 and Enterovirus, with rapid detection times and low limits of detection[4,5]. Additionally, a multiplexed version of the platform was developed using distinct DNA probes immobilized on discrete electrode zones, enabling simultaneous detection of multiple pathogens in a single assay. This flexible, multiplexed biosensing system represents a promising tool for POC diagnostics in clinical, environmental, and food safety applications.

It combines the advantages of nanomaterial-enabled signal amplification, scalable electrode fabrication, and label-free electrochemical detection, paving the way for next-generation biosensing technologies.

Acknowledgements

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References

1. S. Mudiandy, et.al., Sensors & Diagnostics, **1**,1209 (2022)
2. S. Muniandy, et.al., Crit Rev Anal Chem, **49**, 510-533 (2019)
3. X.J.K. Ng, et.al., Clinica Chimata Acta, **570**, 120191 (2025)
4. H.S. Chou, et.al., Journal of Electroanalytical Chemistry, **967**, 118479 (2024)
5. L.V. Kiew, et.al., Biosens Bioelectron, **183**, 113213 (2021)

Enhanced luminol/H_2O_2 chemiluminescence sensor based on peroxidase-mimic activity of lattice-confined Ru single-atom anchored on ZIF-derived Co_9S_8 hollow polyhedron

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Abstract

Nanomaterials as co-reaction accelerators have been extensively employed to promote H_2O_2 into reactive oxygen species to enhance the chemiluminescence (CL) efficiency of luminol.[1-2] Metal single atoms are currently attracting more attention due to their atomic dispersions of active sites, strong metal-support interactions, and maximized atom-utilization efficiency. They offer the capability of modulating the coordination environment, tailoring surface activity, and improving selectivity for catalytic reactions.[3-5] Confined Ru single metal atoms on transition metal sulfides have been applied as catalytic nanomaterial in oxygen reduction reaction, oxygen evolution reaction and CO_2 reduction reactions which regarded as potential alternative to Pt electrocatalysis.[4, 6-7] Herein, we report lattice-confined Ru single atoms on Co_9S_8 hollow polyhedrons (Ru_{SA}-Co_9S_8) for sensitive and selective CL dopamine sensing. Zeolitic imidazolate framework (ZIF-67) based Ru_{SA}-Co_9S_8 hollow polyhedrons were synthesized following coprecipitation and thermal annealing methods. The as-synthesized Ru_{SA}-Co_9S_8 demonstrated peroxidase-like activity and significantly enhanced the luminol/H_2O_2 CL. Moreover, dopamine demonstrated a strong quenching effect on CL emission intensities of the luminol/H_2O_2/Ru_{SA}-Co_9S_8 system. Based on this, a new method for dopamine detection was developed.

Acknowledgements

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References

1. Ouyang, H. *et al. Chemistry* **2020,** *26* (34), 7583-7588.
2. Huang, X. *et al. Mikrochim Acta* **2024,** *191* (2), 111.

3. Ma, T. *et al. Small Methods* **2024**, *8*(12), 202400530.
4. Liu, X. *et al. Nano Res* **2023,** *16* (5), 6701-6709.
5. Li, F. *et al. Anal Chem* **2023,** *95* (43), 16021-16028.
6. Chen, Y. X. *et al. Chem Commun* **2024,** *60* (55), 7069-7072.
7. Li, Z. *et al. Small* **2022,** *18* (19), 2201092.

Novel catalyst layer design with in-situ constructed cross-linked porous network towards high-performance PEMWE

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Engineering catalyst layer structure is of significant importance to improve the performance and durability of proton exchange membrane water electrolysis, yet rare efficient design strategies has been reported. This work developed an in-situ pore making approach to constructing cross-linked porous catalyst layer, which significantly improves catalyst active site utilization compared to conventional catalyst layer. The electrochemical activity area of the porous catalyst layer MEA (52.22 cm^2 $mgIr^{-1}$) is 2.10 times higher than that of the conventional catalyst layer MEA (24.90 cm^2 $mgIr^{-1}$), which indicates that more active sites exposed during pore making process, leading to the higher utilization efficiency of the electrocatalyst. As a result, the porous catalyst layer exhibited a high current density of 3.8 A cm^{-2} at 1.9 V, which is exceeding the U.S. Department of Energy (DOE) 2025 target (3 A cm^{-2}@1.9 V), and showed superior durability with no significant degradation after 1600 hours of operation at a constant load of 2 A cm^{-2}. Scanning electron microscope analysis confirmed the structural integrity of the porous catalyst layer, while cracks formed in the conventional catalyst layer during testing. These results highlight the benefits of the porous structure in improving mass transport, stability, and overall performance in PEMWE applications.

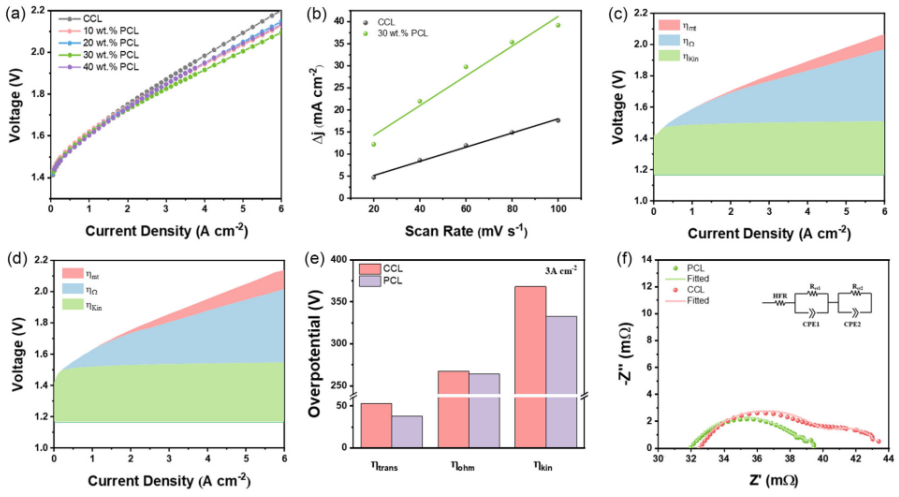


Fig.1 Electrochemical characterization of MEAs prepared with varying structures and conditions. a) Steady state polarization curves at 80 °C for MEAs prepared with varying NH_4HCO_3 additions. b) Bilayer capacitance comparison between the PCL-MEA and CCL-MEA. c,d) Contributions of different overpotential components to the polarization curves of PCL-MEA and CCL-MEA at specific current densities. e) The contribution of polarization overpotential, ohmic overpotential, and mass-transfer overpotential of PCL-MEA and CCL-MEA at 3 A cm_2. f) EIS spectra of PCL-MEA and CCL-MEA under low reactant supply condition at 2 A cm^{-2}.

Acknowledgements

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Tissue Papers Derived Scalable One-Pot Fabrication of Carbon-Nanofiber Supported Noble-Metal-Free Nanocrystals for Hydrogen Production

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The most promising environmentally friendly method for producing green hydrogen is thought to be electrocatalytic hydrogen evolution reactions (HER), but its high cost (⩾ USD/kg) is a great barrier in the commercialization process [1]. The high cost of HER is mainly due to the necessity to use noble metal catalysts, so using non-noble catalysts is the most effective solution to improve efficiency while reducing the cost of HER [2, 3]. This study presents the simple, green, and one-pot fabrication of porous carbon fibers derived from tissue papers in situ encapsulated MnM (M=Co, Cu, Ni, and Fe) nanocrystals for HER. The method included directly impregnating tissue papers in a water solution containing binary metal precursors and then drying and carbonization at 550 °C under an inert atmosphere. Tissue papers act as a carbon source and reducing agent for metal slats with the help of built-in functional groups of cellulose like ether and hydroxyl groups [4]. The as-made materials had an ultra-long fiber structure and confined MnM nanocrystals with an average diameter of (10-14 nm) and an average loading of 2.87 wt.% besides a high yield of several grams (Figure 1). The electrocatalytic HER activity and durability of thus formed MnM/C were benchmarked compared with Mn/C and commercial Pt/C catalyst. The activity followed the trend of MnCo/C> MnNi/C>MnFe/C> MnCu/C> Mn/C (Figure 2a). The overpotential (η_{10}) at 10 mA/cm^2 and onset potential (E_{Onset}) of MnCo/C were about 250 mV and 200 mV, respectively which were significantly lower than other electrocatalysts (Figure 2b). The obtained data herein may endow the large-scale synthesis of carbon fiber materials supported metal nanocrystals as affordable electrocatalysts on a wide scale for real-world green hydrogen production.

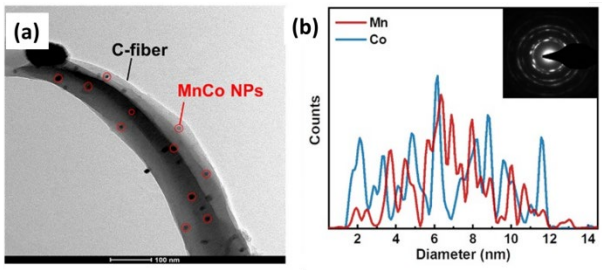


Fig.1 (a) TEM image and (b) EDX scan line profil of MnCo/C nanofiber. The inset in (b) is the SAED for MnCo/C fiber.

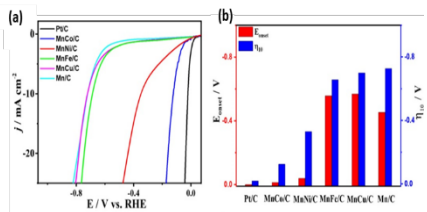


Fig.2 (a) LSV at 2 mV/s in 0.5 M H_2SO_4 and (b) overptenatial TEM image onset potentail of MnM/C relative to Pt/C.

Acknowledgements

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References

1. K. Eid, K.I. Ozoemena, R.S., Coord. Chem. Rev., 523, 216238 (2025).
2. B. Salah, A. Abdelgawad, Q. Lu, A.K. Ipadeola, R. Luque, K. Eid, Green Chem., 25 6032-6040 (2023).
3. A. Abdelgawad, B. Salah, Q. Lu, A.M. Abdullah, M. Chitt, A. Ghanem, R.S. Al-Hajri, K. Eid, J. Electroanal. Chem., 938, 117426 (2023).
4. B. Salah, A. Abdelgawad, J.K. El-Demellawi, Q. Lu, Z. Xia, A.M. Abdullah, K. Eid, ACS Appl. Mater. Interfaces, 16, 18768-18781 (2024).

Reactivity of Anodically-Generated Stilbene Cation Radicals

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A systematic study was undertaken to determine the influence of ortho'-substituted nucleophilic (OH, NH_2, CH_2OH, CH_2NHR, COOH) groups on the reactivity of anodically generated 4-methoxy- and 3,4-dimethoxystilbene cation radicals. The products obtained were mainly stilbenoid dimers such as bisbenzofuras/bisindoles, bisbenzopyrans, bisisoquinolines, tetrahydrofurans, and dehydrotetralines. Mechanistic ratolnalization for the formation of the various products is presented and discussed.

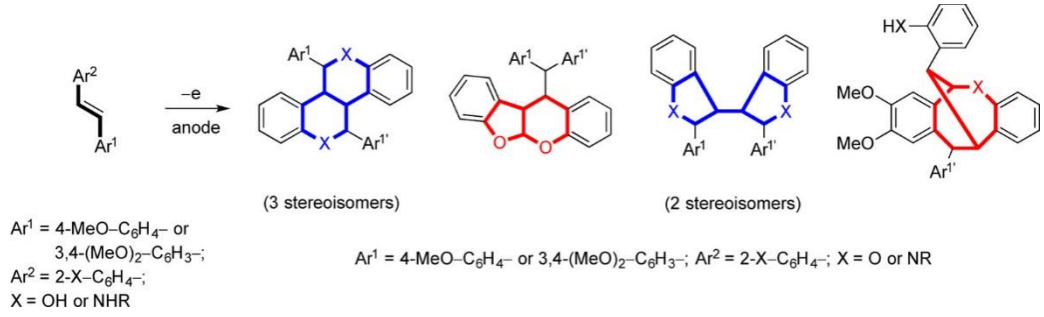


Fig.1 Anodic oxidation of 4-methoxy- and 3,4-dimethoxystilbene with ortho'-substituted nucleophilic groups (OH, NH_2, and NHR) leads to the bisbenzofurans/bisindoles, fused bisbenzopyrans/ bisquinolines, or oxocine/azocine derivatives.

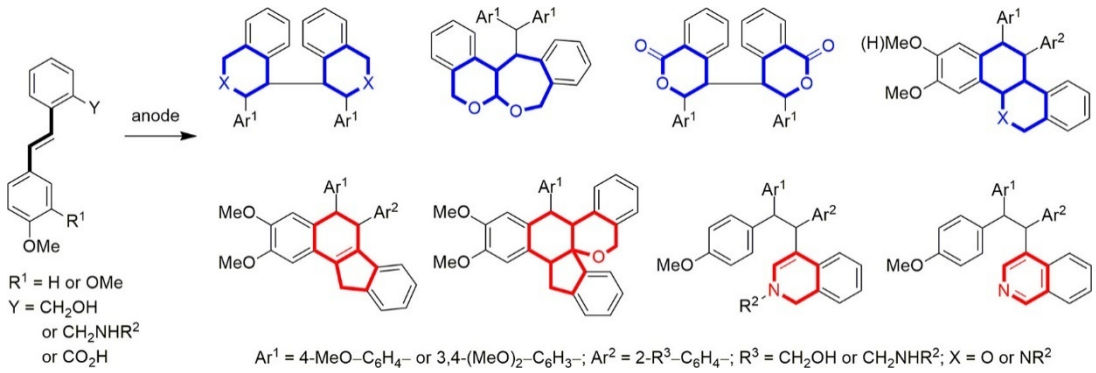


Fig.2 Anodic oxidation of 4-methoxy- and 3,4-dimethoxystilbene with ortho'-substituted nucleophilic groups (CH_2OH, CH_2NHR, and COOH) leads to the bisbenzopyrans/ bisisoquinolines or bis-δ-lactones derivatives.

Acknowledgements

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References

1. *J. Org. Chem.* **82**, 12, 6172-6191 (2017)
2. *J. Org. Chem.* **83**, 24, 15087–15100 (2018)

Biomimetic coacervates for cellular targeting and intervention

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The biomimetic assembly of coacervates may provide a new strategy for the development of efficient biological tools. We have recently been engaged in the research of dynamic assembly of coacervates and the consequent intervention of cell migration. First, a hybrid chain reaction triggered by miRNA-21 and K+ in human breast cancer MCF-7 cells was used to generate G-quadruplex DNA to assemble monophasic coacervates. This strategy allows the specific response by miRNA-21 with a linear range of 10 pM~10 μM. By targeting mitochondria, the coacervates significantly inhibit ATP production and regulates cell migration [1]. Furthermore, the photodynamic core-shell multiphase coacervates were assembled with nucleic acids and somatostatin (SST), a cyclopeptide to target the SST receptor on the surface of mouse breast cancer 4T1 cells. The system may produce $^1O_2$ to induce apoptosis and inhibit cell migration [2]. Our current work further uses tannic acid shell to fabricate core-shell multiphase coacervates, to regulate cellular death modes. These works have a positive impact on the understanding of the assembly of coacervates.

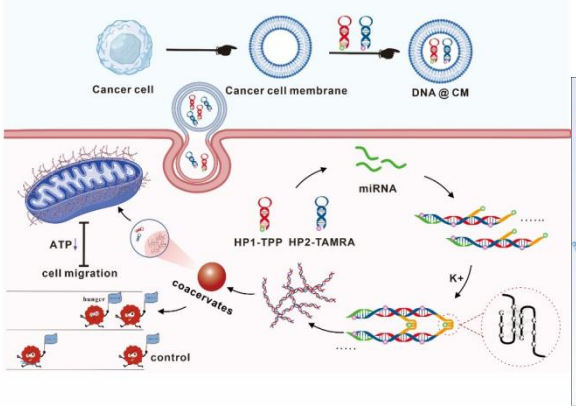


Fig.1 Monophasic coacervates for inhibition of ATP production and regulates cell migration.

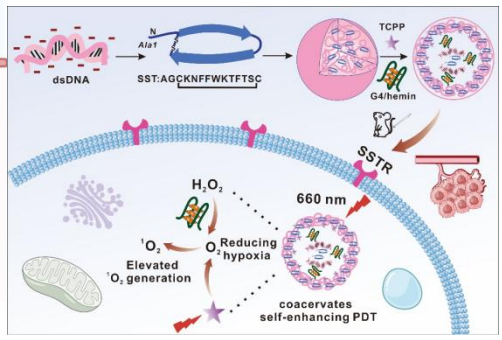


Fig.2 The formation of core-shell coacervates as photodynamic biomimetic organelles.

Acknowledgements

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References

1. W. Y. Sun, J. J. Yin, L. Liu, Z. C. Wu, Y. H. Wang, T. F. Liu, H. J. Xiong, X. H. Liu, X. M. Wang, and H. Jiang, *Anal. Chem.*, **95**, 14101-14110 (2023)
2. W. Y. Sun, H. J. Xiong, J. J. Yin, W. Y. Yao, X. H. Liu, L. Liu, X. M. Wang, and H. Jiang, *Adv. Healthc. Mater.*, **14**, 2403561 (2025)

Microplastic Pollution in Coastal Waters and Sediments of East Africa: Impacts on Fish Intestinal Health, Growth, and Reproduction

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Abstract

The pervasive presence of microplastics in marine ecosystems presents an emerging threat to environmental and biological integrity, particularly in rapidly urbanizing coastal zones (GESAMP, 2015; Khan et al., 2020). This study quantified microplastic contamination in coastal waters and sediments of Dar es Salaam, Zanzibar, and Mombasa, while assessing their biological effects on fish intestinal health, growth, and reproduction. Using a combination of field sampling and laboratory analyses, 2,429 microplastic particles were identified in surface waters, with abundances ranging from 0 to 6.31 particles m^{-3} (mean 0.41 ± 0.9 m^{-3}). Predominant microplastics included fragments (63%) and films (26%), with white polypropylene microplastics being most common. Sediment samples showed average concentrations of 110 ± 12 particles kg^{-1} (dry weight), increasing with distance from shore and dominated by fibers (97%).

Biological assessments revealed that 48% of sampled *Lethrinus harak* individuals had ingested microplastics, primarily fibers, implicating textile-derived sources. Controlled exposure studies on *Oreochromis urolepis* juveniles revealed significant histopathological damage to intestinal tissues following chronic microplastic ingestion, although partial recovery was observed post-depuration. Despite this tissue damage, no significant changes were detected in short-term growth metrics. Trophic transfer experiments confirmed microplastic accumulation from *Artemia salina* to fish, while co-exposure with benzo[a]pyrene did not indicate significant pollutant transfer via microplastics.

These findings highlight the widespread distribution and biological effects of microplastics in East African coastal systems, emphasizing the need for robust analytical approaches and long-term ecotoxicological assessments (Obbard et al., 2014; Khan et al., 2020). The study underscores the role of microplastics as emerging contaminants with potential to disrupt marine food webs, and calls for enhanced monitoring strategies integrating chemical, biological, and ecological endpoints.

Keywords: Microplastics, Coastal Pollution, Fish Health, East Africa, Analytical Chemistry, Histopathology, Marine Ecosystems

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References

1. F. R. Khan, K. Syberg, Y. Shashoua, F. Biginagwa, and M. Khan, (2020). Microplastics in Inland African Waters: A Call to Action. *Environmental Pollution, 267*, 115107. https://doi.org/10.1016/j.envpol.2020.115107
2. GESAMP. (2015). *Sources, fate and effects of microplastics in the marine environment: a global assessment* (Kershaw, P. J., ed.). GESAMP Reports and Studies No. 90. https://www.gesamp.org/publications/microplastics-in-the-marine-environment

Studying Stress Response Process of Cell during Electrical Stimulation Through Spectra Techniques

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Electrical stimulation (ES) is treated as a promising physical means for the diagnosis and treatment of diseases, which can regulate cell proliferation, differentiation and cell death. Thus, it is widely used in the biomedical field. Recently, we found that electrical stimulation can controllable and rapidly trigger cancer cell pyroptosis.We find that the ES-induced cancer-cell pyroptosis is through the activated caspase-3 (pathway) cleavage of gasdermin E (GSDME) to form a N-terminal fragment (GSDME-N), and observe nuclear shrinkage, reduction of the number of nucleoli and expression level of nucleolin depressing during pyroptosis. Simultaneously, the endoplasmic reticulum stress was examined during cell pyroptosis based on fluorescent imaging and Surface-enhanced Raman spectroscopy. The results demonstrated that expression levels of calcium ions, calreticulin and calcium adhesin subtypes were obviously changed. Interestingly, weak electrical stimulation could effectively inhibit the migration of cancer cells. Importantly, we found that the number of exosomes released by cancer cells was significantly higher than that of normal cells, and the miRNA content released by cancer cells was significantly higher than that of normal cells. These studies provide reliable methods and potential clinical application value for the diagnosis and treatment of electrical stimulation cancer and monitoring the changes of key factors in the process of diagnosis and treatment.

Acknowledgements

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References

1. G. H. Qi, T. F. Yu, J. M. Li, Z. R. Guo, K. S. Ma, Y. D. Jin, "EWF BUFS 2023, 35, 2208414.
2. J. Kong, Y. Zhang, X.K. Ju, B. Wang, X. K. Diao, J. Li, G. H. Qi, Y. D. Jin, FOBM$I FN 2024, 96, 13438.
3. J. Kong, X. K. Ju, G. H. Qi, J. F. Wang, X. K. Diao, B. Wang, C. Y. Zhang, J. Li, Y. D. Jin, "OBMF $I FN 2024, 96, 926.
4. C. Y. Zhang, G. H. Qi,* J. Kong, X. K. Diao, X. K. Ju, J. F. Wang, S. J. Dong, Y. D. Jin, "OBMF $I FN 2023, 95,17716.

Single Nanoparticle Impact Electroanalytical Chemistry

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Single-particle collision electrochemistry is an innovative and rapidly developing electroanalytical technique that allows for the investigation of individual nanoparticle behaviors at the single-entity level. In this approach, nanoparticles suspended in an electrolyte undergo Brownian motion and intermittently collide with the surface of an ultramicroelectrode. These collisions trigger electrochemical reactions that can be detected and analyzed in real time. By monitoring these transient signals, researchers can obtain critical insights into the intrinsic properties of single nanoparticles, such as their size, catalytic activity, composition, and surface chemistry. The technique offers exceptionally high temporal resolution and throughput, making it possible to observe dynamic processes and reaction mechanisms under nanoscale confinement with great precision.

A key distinction between single-particle collision electrochemistry and conventional particle-modified electrodes lies in the mode of mass transport and reaction. In the former, reactant molecules are transported through highly efficient spherical diffusion during the brief moments when a nanoparticle collides with the electrode, leading to a significant enhancement in mass transfer rates. Moreover, unlike fixed electrodes where reactions occur continuously over extended periods, single-particle collisions represent discrete, short-lived events. This intermittent reaction pattern enables the study of time-resolved kinetics and mechanistic pathways that would otherwise be obscured in bulk or ensemble measurements.

This report aims to provide a detailed analysis of complex electrochemical reaction mechanisms using the framework of single-particle collision electrochemistry. By focusing on individual reaction events, it is possible to deconvolute overlapping processes and better understand heterogeneous electrochemical behavior at the nanoscale. The insights gained from this technique have profound implications for the design of advanced sensors, catalysts, and energy conversion systems.

References

1. Zerong Liang, Wei Xu, Jian Li*, Chuhong Lin*, Wenmin Zhang, Wensheng Liu, Xing-Hua Xia, Yi-Ge Zhou*, *Nano Lett.*, **2023**, **23(23):**10871.
2. Wei Xu, Jia-Jia Zheng, Yu-An Li, Xingfa Gao*, Xiaobo Ji, Yi-Ge Zhou*, *Angew. Chem. Int. Ed.*, **2023**, **62**: e202306185.
3. Rui Zhong, Xiaoyu Wang, Qianqian Tao, Jianhua Zhang, Chuhong Lin*, Hui Wei*, Yi-Ge Zhou*, *Angew. Chem. Int. Ed.*, **2022**, **61**: e202207270.
4. Wenmin Zhang, Jian Li, Xing-Hua Xia, Yi-Ge Zhou*, *Angew. Chem. Int. Ed.*, **2022**, **61**: e202115819.

Fully Integrated Wearable Sweat Sensors

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Fully integrated bioelectronic devices represent a significant leap forward in the realm of bioelectronics, offering a remarkable advantage that sets them apart from conventional counterparts. These devices are engineered to achieve complete and seamless operational functionality without the need for any additional accessories or external devices. This self - contained nature not only simplifies the overall system but also enhances its portability, reliability, and ease of use. Consequently, it has positioned them as one of the most highly coveted and ultimate goals in the contemporary design and construction landscape of bioelectronic devices, attracting substantial attention and research investment from both academia and industry. In the diverse array of bioelectronic applications, wearable sweat biosensors have emerged as a game - changing innovation. They possess a unique and invaluable capability: the ability to non - invasively and continuously track chemical biomarkers present in sweat. These biomarkers, such as electrolytes, metabolites, and hormones, are closely intertwined with an individual's health status and can offer crucial insights for health assessment and disease diagnosis. Unlike traditional invasive methods that may cause discomfort or pose infection risks, wearable sweat biosensors provide a less intrusive and more user - friendly approach to gathering vital health - related information. To propel this field to new heights, we've embarked on an ambitious journey of integrating the concept of full integration with wearable sweat - sensing technology. Through relentless research, innovative design, and rigorous testing, we've successfully developed several types of fully integrated wearable sweat sensors. These cutting - edge sensors are capable of in - situ, real - time, and dynamic monitoring of biomarkers in sweat. Whether it's for athletes looking to optimize their performance, patients with chronic conditions requiring continuous health monitoring, or individuals interested in general wellness tracking, these sensors hold immense potential to revolutionize healthcare and sports physiology monitoring, paving the way for a more personalized and proactive approach to health management [1-5].



Fig. 1 Overview of the design framework and application scenarios of multimodal wearable sweat sensors. The schematic highlights the integration of chemical, thermal, and mechanical sensing mechanisms within wearable platforms, enabling real-time, non-invasive monitoring of diverse physiological parameters [5].

Acknowledgements

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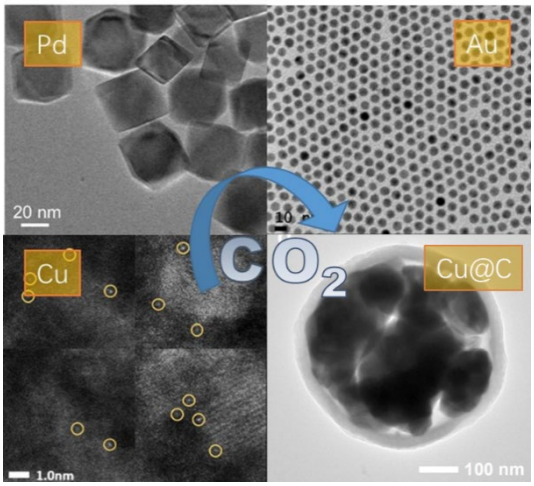
References

1. Ma. C-B, Shang. X, Sun. M, Bo. X, Bai. J, Du. Y, Zhou. M, *ACS Sensors*, **10**, 2388-2408 (2025)
2. Bi, Y., Sun, M., Wang, J., Zhu, Z., Bai, J., Emran, M. Y., Kotb, A., Bo, X., Zhou, M., Anal. Chem., **95**, 6690-6699 (2023)
3. Pei, X., Sun, M., Wang, J., Bai, J., Bo, X., Zhou, M., Small, **18**, 2205061 (2022)
4. Ma, C.-B., Shang, X., Zhu, Z., Zheng, L., Sun, M., Cao, M., Bai, J., Du, Y., Zhou, M., TrAC Trends in Analytical Chemistry, **179**, 117889 (2024)
5. Zheng, L., Cao, M., Du, Y., Liu, Q., Emran, M. Y., Kotb, A., Sun, M., Ma, C.-B., Zhou, M., Nanoscale, **16**(1), 44-60 (2024)

Fune-Tuned Nanomaterials for Electrochemical CO_2 Conversion

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Climate change and air pollution are two critical environmental issues that often intersect, posing severe threats to ecosystems, human health, and global economies. The relentless and ever-increasing worldwide consumption of fossil fuels has not only accelerated the depletion of these finite natural resources but also triggered an alarming overproduction of greenhouse gases, particularly carbon dioxide (CO_2). As the burning of coal, oil, and natural gas continues to fuel industrial growth, transportation, and energy generation, the atmosphere becomes increasingly saturated with CO_2, contributing significantly to the warming of the planet[1]. Electrochemical methods are suitable for CO2 reduction reactions (CO_2RR) due to mild reaction conditions and tunable reduction products[2]. However, large overpotentials, low faradaic efficiency, and poor selectivity hinder the advances of the CO_2RR3,4. Advanced synthesis strategies and detailed characterizations have been applied to fully understand the relations between catalysts and CO_2RR products. This paper presents the strategies to rational design metal-based high-performance catalysts for reducing CO_2 to targeted products, including size effects, facet effects, single-atom active site engineering, and confinement engineering[5,6,7,8]. We highlight the importance of controlling the physical and chemical environment of catalysts, such as their shape, composition, and electronic properties, to tailor their activity for specific chemical reactions.



Reference:

1. Zhu W, Michalsky R, Metin Ö, Lv H, Guo S, Wright CJ, et al. Monodisperse Au Nanoparticles

for Selective Electrocatalytic Reduction of CO_2 to CO. +PVSOBMPGUF PGN FSJDBO $IFNJDBM 4PDJFUZ–2013;135(45):16833-6.
2. Song R-B, Zhu W, Fu J, Chen Y, Liu L, Zhang J-R, et al. Electrode Materials Engineering in Electrocatalytic CO_2 Reduction: Energy Input and Conversion Efficiency. "EWBODFE PG BUFSJBMT 2020;32(27):1903796
3. Liu J, Cai Y, Song R, Ding S, Lyu Z, Chang Y-C, et al. Recent progress on single-atom catalysts for CO_2 electroreduction. . BUFSJBMT5PEBZ–2021.
4. Zhu W, Tackett BM, Chen JG, Jiao F. Bimetallic Electrocatalysts for CO_2 Reduction. 5PQJDT JO $VSSFOU$IFNJTUSZ 2018;376(6):41.
5. Zhu W, Kattel S, Jiao F, Chen JG. Shape-Controlled CO_2 Electrochemical Reduction on Nanosized Pd Hydride Cubes and Octahedra. JE WBOD FE &OFSHZ PG BUFSJBMT 2019;9(9):1802840.
6. Cai Y, Fu J, Zhou Y, Chang Y-C, Min Q, Zhu J-J, et al. Insights on forming N,O-coordinated Cu single-atom catalysts for electrochemical reduction CO_2 to methane. / BUVSF $PNNVOJDBUJPOT–2021;12(1):586.
7. Zhu W, Fu J, Liu J, Chen Y, Li X, Huang K, et al. Tuning single atom-nanoparticle ratios of Ni-based catalysts for synthesis gas production from CO_2. "QQMJFE $BUBMZTJT #–BOWJSPONFOUBM– 2020;264:118502
8 Cai Y, Yang R, Fu J, Li Z, Lin Y*, Zhu W*. Self-pressurizing nanoscale capsule catalysts for CO_2 electroreduction to acetate or propanol. / BUVSF #ZOU FTJT 2024, *3*, 891-902.

Nanopore electrochemical decoding of single polymers for molecular information storage

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Sequence-defined polymers have become increasingly attractive alternatives due to the potential of high storage density. To fulfil the goal of polymer data storage, suitable methods should be developed to accurately decode the information-containing polymers. Nanopore technology is an emerging single-molecule electrochemical analysis method that uses the ionic current changes during single molecule translocation to characterize the composition, sequence and structure of analytes[1]. As one of the most competitive single-molecule sensing and sequencing techniques, nanopore approaches are expected to read both natural and synthetic polymers with single monomeric resolution[2]. This work presents nanopore decoding of a model polymer composed by natural nucleotides and unnatural monomers[3]. Similar to conventional DNA data storage, four main steps are necessary for the information writing-reading process based on unnatural polymers, which ranges from data encoding, polymer synthesis, and polymer sequencing (readout) to data decoding[4]. In a typical nanopore decoding process, a nanopore filled with electrolytes captures and transports individual analytes continuously one by one under an electric field, producing analyte-dependent ionic current blockade features for single-polymer analysis and sequencing. A DNA storage

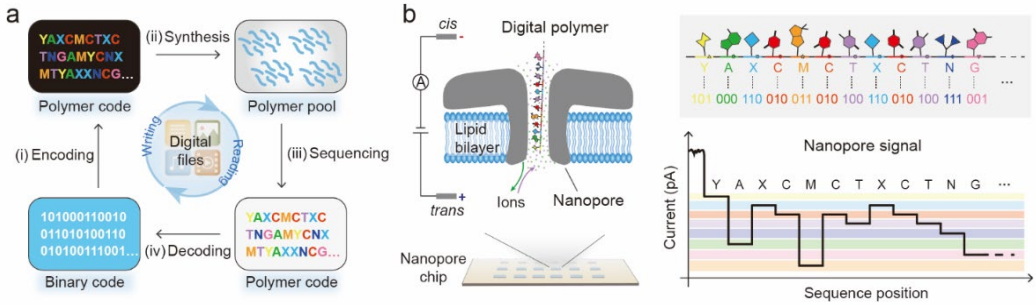


Fig.1 (a) The writing-reading process of polymer data storage. (b) Schematic diagram of polymer sensing and decoding by a nanopore.

and encryption system was developed, which uses five positionally isomeric photoresponsive DNAs to write encrypted messages, with decryption facilitated by aerolysin nanopore. This system employs light irradition conditions as secret keys, apparently reducing redundancy as no need of additional noncoding strands to to encrypt information. The readout time is shorten from a few hours to less than 10 minutes, benefiting from the simplified sample processing. This work offers fresh insights to balance storage density, security and efficiency, facilitating advanced multilevel steganography systems towards secure molecular information storage and transmission.

Acknowledgements

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References

1. Z. Hu, M. Huo, Y. Ying, Y. Long, *Angew. Chem. Int. Ed.*, 133, 14862 (2021).
2. Y. Ying, Z. Hu, S. Zhang, Y. Qing, A. Fragasso, G. Maglia, A. Meller, H. Bayley, C. Dekker, Y. Long, *Nat. Nanotechnol.* **42**, 1136 (2022**)**.
3. Z. Hu, Y. Liu, K. Xin, R. Yu, L. Zhang, Y. Ying, *Chem. Eur. J.* **29**, e202203919 (2023).
4. J. Wang, Z. Hu, Y. Ying, Y. Long, *Biophys. J.* **123**, 147a (2024.)

0 QFSBOEP Raman Insights into Pressure-Dependent Mechanisms of CO_2 Electroreduction

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Electrochemical CO_2 reduction (CO_2R) represents a pivotal strategy for mitigating anthropogenic carbon emissions and enabling a circular carbon economy by converting CO_2 into value-added chemicals using renewable electricity. Despite its promise, conventional CO_2R systems predominantly rely on pure, ambient-pressure CO_2 sources—conditions that diverge from real-world industrial emissions (e.g., flue gases or pressurized process streams) and impose substantial energy penalties for gas conditioning. Direct utilization of high-pressure CO_2 (HP-CO_2) offers a compelling alternative, obviating energy-intensive depressurization steps while exploiting elevated pressure to enhance mass transfer, increase reactant concentration, and improve overall system efficiency. Although several studies have reported that pressure can markedly influence catalytic performance, the underlying mechanisms remain poorly understood due to the complexity of high-pressure systems and the challenges associated with *operando* characterization.

In this work, we systematically investigate the electrocatalytic valorization of HP-CO_2 in two complementary reactor configurations—gas-phase membrane electrode assemblies (MEA) and liquid-phase aqueous cells—to elucidate pressure-mediated mechanistic insights and advance scalable CO_2R technologies [1,2]. In the gas-phase MEA system, we designed a high-pressure electrolyzer employing alloyed Cu catalysts, achieving exceptional ethylene selectivity and elevated current densities under pressure. *Operando* high-pressure Raman spectroscopy revealed that pressurized CO_2 enriches the cathode–membrane interfacial CO_2 coverage, stabilizes *CO intermediates, and promotes C–C coupling, while concurrently suppressing bicarbonate precipitation by localizing its formation at the catalyst–membrane interface to facilitate rapid anion migration. Conversely, in the liquid-phase flow cell, dissolution of HP-CO_2 in aqueous electrolytes was found to drastically shift product distribution on Cu catalysts from hydrocarbons toward formate. Custom-built *operando* Raman spectroscopy—optimized for high-pressure aqueous environments—quantitatively probed the cathodic microenvironment, demonstrating that elevated CO_2 pressure increases surface CO_2 coverage, reduces proton availability, and stabilizes *OCHO intermediates, collectively favoring formate production. Therefore, by harnessing HP-CO_2—either in gas-phase MEA or in dissolved form in aqueous cells—this study demonstrates substantial enhancements in CO_2R performance and selectivity. Tailored *operando* Raman spectroscopy bridges macroscopic performance metrics with microscopic reaction pathways, elucidating pressure-driven mechanisms at catalyst/electrolyte interfaces and providing a rational foundation for designing next-generation, efficient CO_2 electroreduction systems.

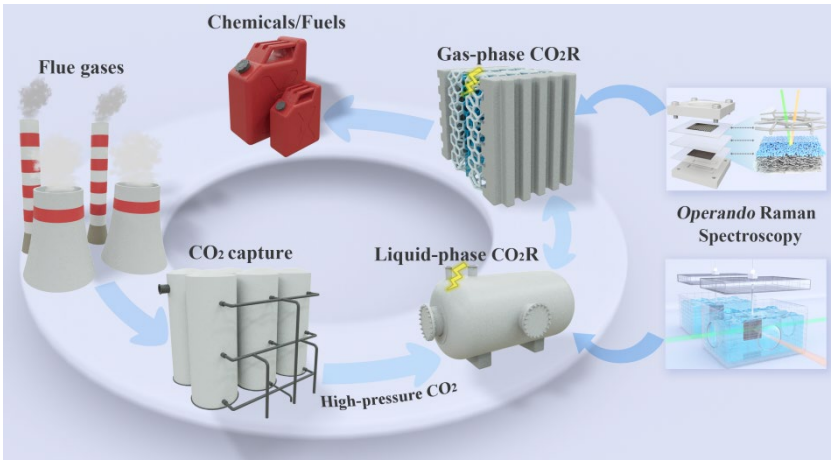


Fig.1 Schematic of the proposed CO_2 value chain and customized *operando* Raman spectroscopy.

References

1. L. Huang, G. Gao, C. Yang, X. Y. Li, R. K. Miao, *et al*. *Nat. Commun*., **14**, 2958 (2023)
2. L. Huang, G. Gao, J. W. Zhao, X. Lu, *et al*. *Research Square*, https://doi.org/10.21203/rs.3.rs-4339066/v1 (2024)

Electrochemiluminescence imaging for dynamic process on micro-interface reactions

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Electrochemiluminescence (ECL) microscopy is a combination of optical microscopy and ECL analytical methods. Therefore, ECL microscopy possesses various advantages, including low optical background, high spatiotemporal resolution, and simple configuration. Electrochemical imaging can obtain the local physicochemical dynamic information of electrode interface. At present, there are still scientific problems in the monitoring of electrochemical interface, such as weak detection signal, electrode interface passivation, and unknown reaction sites. These hindered the analysis of electrode interface dynamic reactions. To solve the above problems, we innovates the instrument hardware through engineering and technical means, develops co-focal coaxial electrochemiluminescence imaging and carries out research in three aspects: new technology, new mechanism and new route:[1, 2] First, establishing a single-cell highly sensitive recognition and detection technology based on laser in-situ pyrolysis electrode;[3] Second, developing self-regulated high-steady-state electrolysis system to reveal the kinetics of protein crown formation and the mechanism of particle-protein interaction;[4] Third, proposing the space-time transformation strategy of biomolecular in situ enhanced luminescence to clarify exogenous molecular transport pathways inside cells.[5] These research works provide analytical tools for electrochemical microscopic detection and evaluation of high performance interface. In addition, the tunable ECL microscopy pave a new avenue to study single entities and provide more insights into ECL mechanisms.

References

1. Xing, Zejing; Gou, Xiaodan; Yang, Ruixin; Wang, Yihan; Tang, Wenjing; Jiang, Li-Ping; Zhu, Wenlei; Chen, Zixuan; Xu, Qin; Zhu, Jun-Jie; Ma, Cheng, Pre-Label-Free Three-Dimensional Imaging of Cellular Bottom Topography with a Charge-Lock Electrochemiluminescence Microscope. *Nano. Lett.* **2025,** *25* (18), 7507-7516.

2. Ma, Cheng; Gou, Xiaodan; Xing, Zejing; Wang, Min-Xuan; Zhu, Wenlei; Xu, Qin; Jiang, Dechen; Zhu, Jun-Jie, Reversibly Tuning Electrochemiluminescence with Stimulated Emission Route for Single-Cell Imaging. *Research* **2023,** *6*, 0257.

3. Gou, Xiaodan; Xing, Zejing; Zhang, Zhichen; Jin, Rong; Xu, Qin; Sojic, Neso; Zhu, Jun-Jie; Ma, Cheng, Designable Electrochemiluminescence Patterning for Renewable and Enhanced Bioimaging. *Angewandte Chemie-International Edition* **2024**, e202410825.

4. Xing, Zejing; Gou, Xiaodan; Jiang, Li-Ping; Zhu, Jun-Jie; Ma, Cheng, An In Situ Investigation of the Protein Corona Formation Kinetics of Single Nanomedicine Carriers by Self-Regulated Electrochemiluminescence Microscopy. *Angew. Chem. Int. Ed.* **2023,** *62* (39), e202308950.

5. Ma, Cheng; Wu, Shaojun; Zhou, Yang; Wei, Hui-Fang; Zhang, Jianrong; Chen, Zixuan; Zhu, Jun-Jie; Lin, Yuehe; Zhu, Wenlei, Bio-Coreactant-Enhanced Electrochemiluminescence Microscopy of Intracellular Structure and Transport. *Angew. Chem. Int. Ed.* **2021,** *60* (9), 4907-4914.

Ultra-stable transducer for oxidase-based biosensors

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Continuous monitoring is of great importance for medical diagnostics. Minimally invasive implantable glucose biosensors have been developed for diabetes monitoring [1]. Non-invasive diagnostics is even more attractive because it is avoiding injuries and infections. Still, there are only two glucose biosensing principles for continuous monitoring: hydrogen peroxide oxidation on platinum electrodes (used in all clinical analyzers and implantable devices from Dexcom and Medtronic) and osmium complexes for low-potential oxidation of glucose (used in minimally invasive monitors from Abbott). However, due to much higher sensitivity towards reductants the false-positive signals in blood can reach 100%. Low-potential glucose oxidation is based on glucose dehydrogenase, which has broader selectivity than glucose oxidase. In 1994, Prussian Blue (PB) was introduced as a selective electrocatalyst for H_2O_2 low-potencial reduction in applications to oxidase-based biosensors. As compared to platinum, Prussian Blue is 1000 times more active providing similarly improved sensitivity and 1000 times more selective allowing H_2O_2 detection by its reduction in the presence of oxigen [2]. The only disadvantage of Prussian Blue is its solubilization by hydroxyl ion – a product of H_2O_2 reduction. The most versatile stabilizers seem to be isostructured hexacyanoferrates (HCF) of iron triade-mates (Co and Ni) [3]. Herewith we report on simultaneous interfacial deposition of iron and nickel hexacyanoferrates resulting in H_2O_2 transducer displaying operational stability peculiar to thick NiHCF film, but with activity close to pure Prussian Blue. Reliable calibration-free H_2O_2 monitoring with the resulting composite PB-NiHCF electrode is up to 100 times longer than in case of pure PB and up to 5 times – than with the electrodes stabilized through layer-by-layer assembly. The corresponding biosensor is completely stable during 3 days of continuous glucose monitoring (5 mM). The reported ultra-stable and highly sensitive transducer would provide reliable continuous monitoring of low-molecular weight metabolites in a variety of biological liquids.

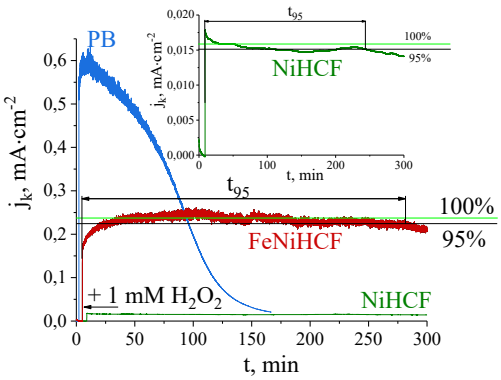


Fig.1 Stability of PB, PB-NiHCF and NiHCF modified electrodes under 1 mM of H_2O_2 in batch mode upon stirring; 0.00 V (vs. Ag|AgCl), 0.05 M phosphate, pH 6.0 with 0.1 M KCl

Acknowledgements

The financial support of Russian Science Foundation through grant № 24-13-00049 (https://rscf.ru/project/24-13-00049/) is greatly acknowledged.

References

1. T. Bobrowski and W. Schuhmann, *Curr. Opin. Electrochem.*, **10**, 112-119 (2018)
2. A.A. Karyakin, *Curr. Opin. Electrochem.,* **5**, 92-98 (2017)
3. N.A. Sitnikova, A.V. Mokrushina and A.A. Karyakin, *Electrochim. Acta*, **122**, 173-179 (2014)

In Vivo Sensors for the Detection of Plant Metabolites

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Plants produce a wide array of metabolites, such as sugars, amino acids, and phytohormones, which are indispensable for their growth, development, and environmental adaptation, thereby supporting normal physiological functions [1,2]. With the rapid development of precision agriculture, there is an increasing demand for technologies capable of in vivo and real-time detection of plant metabolites. Electrochemical sensors have demonstrated considerable potential due to their sensitivity and adaptability in this field [3,4]. In this study, we designed and fabricated electrochemical sensors adapted to the specific morphologies of different plant tissues to achieve in vivo metabolite detection of metabolites. A stainless-steel wire microelectrode sensor was developed for monitoring auxin levels in the stems of soybean seedlings. A screen-printed electrode-based glutamate sensor was constructed to assess glutamate content variations in tomatoes at different ripening stages. Additionally, a flexible laser-induced graphene electrode (LIG/PDMS) was prepared for in vivo and in situ detection of quercetin within strawberry leaves. This work offers a novel platform for in vivo plant metabolite analysis, offering promising applications in precision agriculture.
Keywords: plants; metabolic information; in vivo detection; sensors

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References

1. Yan, S.; Zhan, M.; Liu, Z.; Zhang, X. *Biochimie*, **228**, 8-14 (2025)
2. Tian, H.; Lyu, R.; Yi, P. *Journal of Experimental Botany*, **75**, 3778-3796 (2024)
3. Lin, Y.; Yang, L.; Ma, Y.; Ye, J. Microchemical Journal,**188**, 108505 (2023)
4. Zhang, Y.; Li, M.; Li, H. *Talanta*, **283**, 127114 (2025)

Enhanced Corrosion Inhibition of AA7075-T6 via Synergistic Action of Cerium Salts and Sodium Sulphate

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Aluminium alloy AA7075-T6 is often used in the transportation sector, particularly in the aerospace industry, due to its favourable mechanical properties. However, its practical application is significantly limited by high susceptibility to corrosion in chloride-containing environments. This limitation mainly concerns intermetallic particles exhibiting electrochemical potential differences relative to the aluminium matrix.

Traditionally, chromate-based treatments have been employed as effective corrosion inhibitors. Their use is restricted in many countries due to their well-known toxicity.[1] As alternative solutions, rare-earth salts such as cerium acetate $Ce(OAc)_3$,[2, 3] have demonstrated promising corrosion inhibition. In addition, the presence of SO_4^{2-} decreases the pH required for precipitation of Ce hydroxide and ions are incorporated in the insoluble cerium-based protective layer, Figure 1.[2, 3]

This study aimed to characterise the conversion layer formed during immersion in Cl^- containing solution with the addition of $Ce(OAc)_3$ and Na_2SO_4, emphasising the underlying corrosion inhibition mechanism. The composition and thickness of the resulting coatings were characterised using surface analytical techniques such as scanning electron microscopy coupled with energy-dispersive X-ray spectroscopy (SEM/EDS) and X-ray photoelectron spectroscopy (XPS). Corrosion resistance was evaluated through electrochemical methods, specifically potentiodynamic polarisation and electrochemical impedance spectroscopy (EIS).

The results confirmed that the synergistic action of cerium and sulphate ions enhanced corrosion inhibition due to forming a thin film on the aluminium alloy, Figure 2, that inhibits the corrosion process even after longer exposure to corrosive environments.

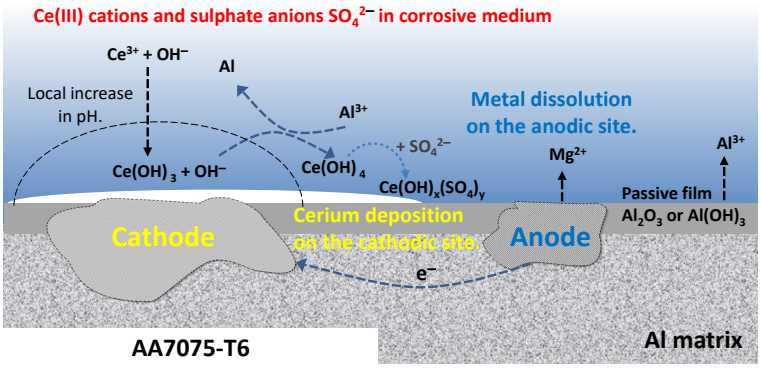


Fig. 1. Proposed mechanism of cerium film formation on AA7075-T6 during immersion.

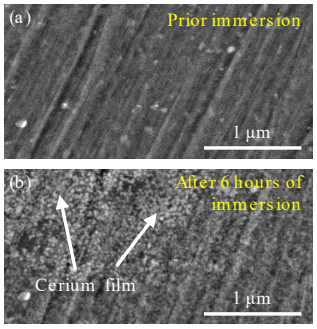


Fig. 2. SEM images of surface appearance of 7075-T6 (a) prior and (b) after 6 hours of immersion in $Ce(OAc)_3$ + SO_4^{2-}solution.

Acknowledgements

The financial support from the Slovenian Research and Innovation Agency (ARIS) research core funding
No. P1-0134 and P2-0393.

References

1. ECHA European Chemicals Agency, Chromium VI compounds, Conditions of restrictions, https://echa.europa.eu.
2. P. Rodič and I. Milošev, *Corros. Sci.*, **149,** 108–122 (2019).P. Rodič, I. Milošev, M. Lekka, F. Andreatta, L. Fedrizzi, *Electroch. Acta* **308**, 337–349 (2019).

Electrochemical investigation of the corrosion inhibition efficiency of choline-based ionic liquids in protecting mild steel structures

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Corrosion of mild steel structures leads to significant economic loss and safety concerns. This research investigated the corrosion inhibition efficiency of Choline-based ionic liquids, a green and biodegradable compounds, as a potential alternative to conventional inhibitors. Electrochemical techniques including Electrochemical Impedance Spectroscopy (EIS), Potentiodynamic Polarization (PDP), Open Circuit Potential (OCP), and Linear Polarization Resistance (LPR), were utilized to evaluate the inhibitor's performance in neutral, basic and acidic media. The results demonstrated that Choline-based ionic liquids effectively reduces corrosion rates by forming a protective film on the mild steel surface in different environments. These findings suggest that Choline-based ionic liquids could be promising eco-friendly solutions for protecting mild steel structures in various industrial applications, contributing to a more sustainable and environmentally conscious approach to corrosion management.

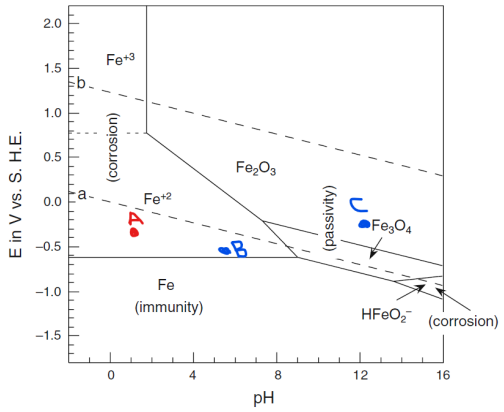


Fig.1 The Pourbaix diagram for iron (~ mild steel) at 25°C **[1]**

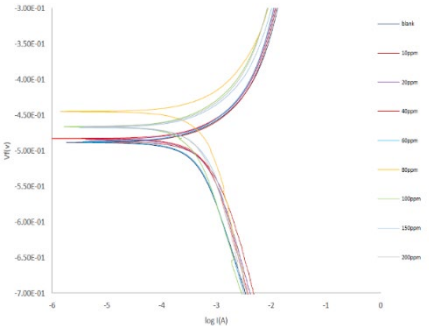


Fig.2 *the PDP curves for mild steel in HCl with varying concentrations of choline glutamate ionic liquid.*

Acknowledgements

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References

1. Pourbaix, M., (1966). Atlas of Electrochemical Equilibria in Aqueous Solution, Pergamon, New York, USA.

Scalable Synthesis of Hierarchal Porous Carbon Nanotubes Encapsulated Metal Nanocrystals with a Strong Metal-Carbon Interaction for High Performance Supercapacitors

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The innovation of cutting-edge electrode materials derived from biomass wastes possesses several benefits, including inducing renewable resources, earth-abundant, inferior price, ease of access, and eco-friendly nature, as well as contributing to waste management[1, 2]. In addition to outstanding specific surface area and built-in functional groups that provide accessible active sites for the adsorption-desorption process between the carbon-electrode and the electrolyte, they introduce pseudocapacitance reactions and enhance the specific capacitance[3]. Also, inherent interconnected multimodal porosity (i.e., macropores >50 nm, mesopores (2–50 nm), and micropores <2 nm) act as ion transport channels and sites for electrolyte storage. Biomass-based engineered hierarchical porous carbons are deemed cost-effective and sustainable materials for supercapacitors, ascribed to their tunable merits, high conductivity, and stability [4]. However, their multiple preparation steps and low capacitance are great barriers[5]. These issues were defeated herein via the rational design of hierarchal porous carbon nanotubes (p-CNTs) enriched with metal nanocrystals (M/p-CNTs) (M=Cu, Co, W, Bi, and Mn) via impregnation of coconut silks in metal precursors solution and pyrolysis under nitrogen (Figure 1). All materials had porous nanotubes strcutre supported metal nanocrsyatls with size of nealry (5±2 nm) and metal laoding of 8-9.5 wt.% as shon in the SEM, TEM, EDX mapping analysis (Figure 1a-o). This approach is green, one-pot, and without activation step or hazard chemicals and endowed the formation of nanotubes with a strong-metal carbon interaction, built-in metal electron-deficient, great electrochemical active surface area (39.5 m^2/g), and interconnected tri-modal porosity, which accelerate charge mobility and bridge the paths for ions transport. These advantages promoted the performance of supercapacitors significantly in the order of Cu/p-CNTs> Co/p-CNTs> Bi/p-CNTs> Mo/p-CNTs> W/p-CNTs, and it was tuned by the intermolecular electron transfer between metals and p-CNTs (Figure 2a-f). The optimum specific capacitance of 150.83 F/g at 0.5 A/g, energy density of 7.54 Wh/kg, and power density of 150 W/kg at 0.5 A/g were achived on Cu/p-CNTs, which was amongst highest reported active supercapacitors[6]. These findings may allow simple and sustainable synthesis of active materials from biomass for energy storage devices.

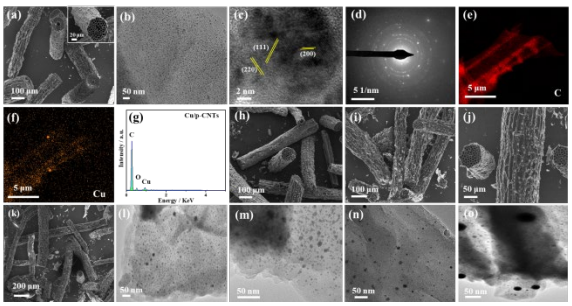


Fig.1 (a) SEM, (b) TEM, (c) HRTEM image, (d) SAED, (e-f) elemental mapping, and (g) EDX of Cu/p-CNTs catalyst. (h-k) SEM images, (i-o) TEM images, of Co/p-CNTs, Bi/p-CNTs, Mo/p-CNTs, and W/p-CNTs, respectively.

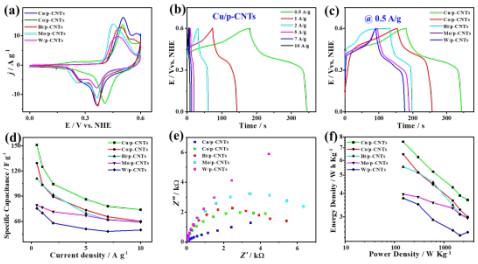


Fig. 2 (a) CV curves recorded at scan rates at 50 mV s^{-1} of SSC device, (b) GCD curves at different current densities of SSC, of Cu/p-CNTs. (c) GCD curves @ 0.5 A, (d) Nyquist plots, (e) Current density vs specific capacitance plot, and (f) Ragone plots related to energy density and power density of the M/p-CNTs //M/p-CNTs SSC device.

Acknowledgements

The authors thank Shaanxi Union Research Center of University and Enterprise for Health Food Ingredient and Walnut Industry, Shangluo, Shaanxi, China for supporting this work.

References

1. P. Manasa, S. Sambasivam and F. Ran, *J. Energy Storage*, **54,**105290 (2022)
2. J. Feng, Q. Zhu, Q. Le, W. Zhu, B. Song, Z. Zhang and J. C.-H. Lam, *Renew. Sust. Energ.*, **211**, 115178 (2025).
3. N. Chalmpes, I. Tantis, A. W. Alsmaeil, B. S. Aldakkan, A. Dimitrakou, M. A. Karakassides, C. E. Salmas and E. P. Giannelis, *Energy & Fuels*, **39**, 1305-1315 (2025).
4. Y. Yardım, İ. Genel and C. Saka, *Int. J. Hydrogen Energy*, **99**, 383-393 (2025).
5. U. Menon, B. K. Dubey and A. Kumar, *Biomass and Bioenergy*, **198**, 107844 (2025).
6. X. Zhu, Y. Zeng, X. Zhao, D. Liu, W. Lei and S. Lu, *EcoEnergy*, e70000 (2025).

Determination of Environmental Polylactic Acid Microplastic Residues by Indirect Method using Single-Atom Nickel Composite Electrode

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[♯]These authors contribute equally to this work

Agricultural mulch films are widely utilized in agricultural production[1-2], yet it was lack of the regulation. Due to the application of polylactic acid(PLA) film covering in agricultural production, the residue and accumulation of microplastics (MPs) in soil ecosystems have caused serious white pollution[3-4]. In this research, single-atom nickel doped nitrogen on carbon nanosheets(Ni-N-C) was used to combine with gold and palladium nanoparticles (AuPdNPs) to achieve highly sensitive detection of lactic acid. Through its oxidation by the single-atom metal, it exhibits linearity within the concentration range of 50 μmol·L^{-1} to 50 mmol·L^{-1} lactate acid, with a detection limit as low as 10 μmol·L^{-1}. This is the first instance of utilizing electrochemical method to indirectly determine the depolymerized polylactic acid in order to obtain PLA content in enviroment. This research demonstrates significant applicability in real environments. This study novelly employs a single-atom nickel catalyst composite electrode to stably and effectively detect microplastic monomers, indirectly determining the content of microplastics.

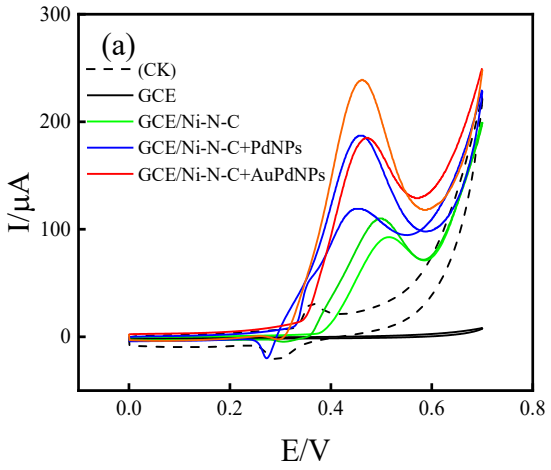


Fig.1 CV curves for various modified electrodes in a 0.16 mol·L^{-1} LA solution, at a scan rate of 20 mV/s, in 1.0 mol·L^{-1} KOH

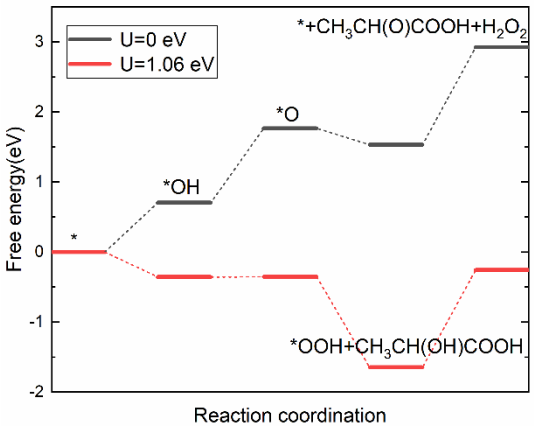


Fig.2 Free energy diagram for the lactic acid oxidation reaction on NiN_4@graphene at U = 0 V (black line) and U = 1.06 V (red line).

Acknowledgements

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References

1. J. Zhou, A. Shuai, T. Liu, S. Lin, L. Li, H. Liang, Y. He, Y. Xin, Q. He, C. Liu, Frontiers of Environmental Science & Engineering, 18 (2024). http://dx.doi.org/10.1007/s11783-024-1917-z
2. A.D. Vethaak, J. Legler, 371 (2021) 672-674. http://dx.doi.org/doi:10.1126/science.abe5041
3. L. Pang, Q. Lin, S. Zhao, H. Zheng, C. Li, J. Zhang, C. Sun, L. Chen, F. Li, Frontiers of Environmental Science & Engineering, 17 (2023). http://dx.doi.org/10.1007/s11783-023-1694-0
4. J. Hu, Z. Xie, J. Zuo, Frontiers of Environmental Science & Engineering, 18 (2024). http://dx.doi.org/10.1007/s11783-024-1813-6
5.Z. Wang, X. Wang, C. Hu, T. Ge, L. Wang, J. Xing, X. He, Y. Zhao,Agriculture, 14 (2024) 554.

Effects of Mechanical Microenvironment on Cell Characteristics Investigated by Scanning Electrochemical Microscopy

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The mechanical microenvironments in human body have been proven to be associated with the occurrence and development of various diseases, such as cancer, neurological disorders, microbial infections, etc. Constructions of cellular mechanical microenvironment models to simulate diseases in vitro, development of single-cell analysis techniques, and in-situ studies of influences of mechanical microenvironments on cell characteristics can provide new references for exploring disease pathology. Scanning electrochemical microscopy (SECM) and scanning ion conductive microscopy (SICM) are two kinds of electrochemical principle-based advanced scanning probe microscopy techniques that utilize micro/nanoelectrodes or nanopipettes to record faradaic or ionic currents of species in solution. These two techniques offer noninvasive measurements with high temporal and spatial resolutions, making them ideal for dynamically tracking various cellular processes and species at the single-cell level. In our work, we constructed mechanical microenvironment models to simulate the different stages of liver cancer and Alzheimer's disease and the host cells in which the biofilm is located. We then used SECM and SICM to in situ characterize the ferroptosis process, activation and metabolism related respiratory activity, released ROS, membrane permeability, migration behavior, etc. of liver cancer cells, microglia, and biofilm under different matrix stiffness. The results confirmed the influence of mechanical microenvironment on ferroptosis in liver cancer, early activation of microglia, and bacterial resistance, providing single-cell in situ characterization references for studying the mechanisms of mechanical microenvironment related diseases.

References

1. Y. X. Zhao, Z. y. Ye, Y. L. Liu, J. J. Zhang, S. Kuermanbayi, Y. Zhou, H. Guo, F. Xu, F. Li*, *Anal. Chem.*, **96**, 1102 (**2024**).
2. Y. L. Liu, J. J. Zhang, Y. B. Li, Y. X. Zhao, S. Kuermanbayi, J. Zhuang, H. Zhang, F. Xu*, F. Li*, *Chem. Sci.*, **15**, 171 (2024).
3. Y. Zhou, X. Zhou, J. J. Zhang, Y. X. Zhao, Z. Y. Ye, F. Xu, F. Li*, *Anal. Chem.*, **97**, 5517 (2025).

Multi-resolved Imaging of Electrochemical Interfaces

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Mott-Schottky junctions are considered an ongoing focus in electrocatalysis due to their unique ability to modulate charge distribution, thereby improving the performance of electrocatalysts. However, resolving the interfacial reaction mechanism with high spatiotemporal and chemical resolution in situ remains challenging. Herein, a time-synchronized multimode optical imaging platform is developed, realizing multi-perspective visualization of a model Mott-Schottky (MS) electrocatalytic system. The unique interfacial electrooxidation dynamics of the individual silver nanowires (AgNWs) on ITO substrate (AgNWs@ITO) MS junction and associated electrocatalytic oxygen evolution reaction (OER) pathways are revealed. The MS effect has been proven to regulate the reaction mechanisms by redistributing interfacial charges, leading to the unique reaction pathway. The unveiled modulating effect of the Mott–Schottky nanostructure on the electrochemical reaction pathway shows the potential and importance of the multi-resolved imaging approach in analyzing fundamental mechanisms of heterogeneous catalysis.

Epitaxy Orientation and Kinetics Diagnosis for Zinc Electrodeposition

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Zinc has emerged as a great anode material for high-performance batteries due to its high capacity, intrinsic safety, and cost-effectiveness. However, the electrochemical stability and reversibility of zinc anodes depend critically on the electrodeposition process, whose mechanistic details—particularly crystal growth pathways—remain unclear. To address this, we developed a scanning electrochemical microscopy (SECM)-based method to dynamically resolve epitaxial growth processes and quantitatively analyze surface activity. Using a highly oriented pyrolytic graphite (HOPG) substrate with exceptional lattice-matching properties, we observed unique zinc deposition modes, including helical growth, stacking, and extrusion. Early-stage epitaxial deposition favored the formation of multi-layered stacked structures with intermittent rotations, while three-dimensional bulk structures dominated in later stages. Site-dependent kinetic activity, correlated with deposition morphology, revealed distinct evolutionary pathways between initial and advanced growth phases. SECM results demonstrated that electron transfer activity at the crystal center was orders of magnitude higher than at the edges, a phenomenon linked to the gradient distribution of lattice defects induced by rotational stacking. This study establishes the structure-activity relationship model connecting zinc epitaxial growth patterns with spatially resolved electrochemical activity.

Apart from static epitaxial Zn growth, we further evaluated the Zn deposition mechanism on flexible graphene substrate under external strain. We found the lattice-matching graphene guided oriented zinc epitaxial growth, while an in situ strain system revealed strain-dependent deposition behavior: static bending induced dense (101) zinc stacking, with reversible recovery to (002) orientation upon strain release through stress redistribution. Quantitative analysis further established a mechano-electrochemical coupling model for strain-induced failure, advancing flexible battery design principles. By providing in situ insights into interfacial kinetics and strain-dependent behavior, our work offers a comprehensive foundation for suppressing dendrite formation and enhancing the reversibility of both rigid and flexible metal battery systems.

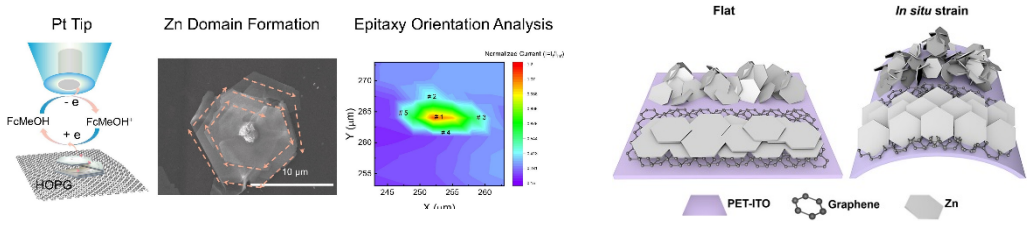


Fig.1 Schematic diagram of SECM analysis on epitaxial Zn electrodeposition process on

Fig.2 Schematic illustration of strain-modulated Zn electrodeposition on flexible graphene

Acknowledgements

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References

1. J. Zhao, Y. Yang*, Z. Liu*, J. Hui* et al, *ACS Nano* ' ' ', *19, 736*.
2. Z. Meng, J. Hui* et al, *ACS Appl. Mater. Interfaces* **2025**, *17* (12), 18307–18318.
3. J. Zhao, J. Hui* et al, *Small Methods* ' ' ';*2300731*.

A Thermosensitive α-Amino Acid Hydrogel Layer Deposited on an Electrode Surface: Actuator and Sensor Performance

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Hydrogels are cross-linked polymer networks that swell in aqueous or physiological fluids. One of most interesting property of these materials is the ability to undergo volume phase transition. This phenomenon is related to the transition of hydrogels from the swollen state to the shrunken state and vice versa. The transition can occur in response to changes in temperature, pH, or electric signal. The modification of electrodes surface with a hydrogel layer gives them new functionalities.

We would like to present the electrodes modified stimuli responsive hydrogel layer based on the acrylic derivative of an α-amino acid and N-isopropylacrylamide. The electroactive, electrosensitive, and thermosensitive gel layer was obtained through a two-step process. The first step includes synthesis and electrodeposition of p(NIPA-ArOr) using electrochemically induced free-radical polymerization. In the second step, the formed layer was modified with copper ions (p(NIPA-ArOr-Cu^{2+})), which formed complexes with the α-amino acid groups. The resulting material was characterized as an actuator, where thickness changes were controlled by an electric signal, and as an electrochemical sensor for hydrogen peroxide detection. Thickness modulation triggered by an electric stimulus was monitored using QCM-D, revealing temperature-dependent reversible changes. Moreover, the p(NIPA-ArOr-Cu^{2+})-modified glassy carbon electrode demonstrated high performance as a prospective electrochemical hydrogen peroxide sensor.

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Nanoelectrochemical Insight into the Single Polymersomes Activation for Drug Delivery

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In recent years, stimuli-responsive polymersome (Plys) delivery systems have emerged as a promising strategy for enhancing drug delivery efficiency. Elucidating the molecular mechanisms underlying polymersome activation is crucial for the rational design of intelligent nanocarriers in nanomedicine. Despite their advantages, such as cost-effectiveness and high drug encapsulation efficiency, these nanosystems often face challenges including low structural stability, high polydispersity, and limited surface functionalization capabilities [1]. Therefore, there is a pressing need for advanced characterization techniques capable of resolving heterogeneity among individual Plys and accurately tracking their dynamic activation behaviors in real time. Here, we present a single entity electrochemical approach based on collision electrochemistry (Fig.1a), offering sub-millisecond temporal resolution and single-particle spatial resolution, to monitor activation kinetics of individual Plys (Fig. 1b) in situ [2-4]. We developed a nanoscale biomimetic system that simulates the motion of Plys in vivo. Upon random Brownian motion, individual Plys collide with a platinum ultramicroelectrode (UME)/electrolyte interface, triggering non-equilibrium electron transfer that leads to their electrochemical activation. Through high-throughput statistical analysis of non-equilibrium current–time (i–t) transients (Fig. 1c), we uncovered a previously unreported electrochemical activation mechanism that is closely associated with the oxygen reduction reaction (ORR). This study demonstrates an effective electrochemical strategy for elucidating the structure–function relationship of Plys, thereby facilitating drug development and contributing to the advancement of next-generation precision therapeutics.

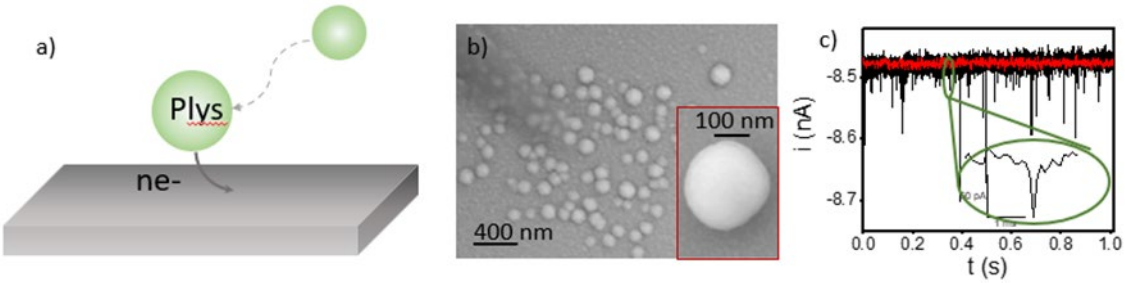


Fig.1 a) Schematic illustration of the configuration of single polymersomes activation based on single entity collision electrochemistry; b) Scanning electron microscopy image of of polymersomes; (c) The first-second current vs. time transient, obtained using a Pt UME in a 10mM KCl solution containing the polymersomes, compared to a transient recorded without the polymersomes (red).

References

1. A. Guinart, M, Korpidou, B. L. Feringa, et al., *P. Natl. Acad. Sci. USA.*, **120**, e2301279120 (2023).
2. X. Xu, D. Valavanis, P. Ciocci, S. Confedrat, F. Marcuccio, J.-F. Lemineur, P. Actis, F. Kanoufi,

P.R. Unwin, *Anal. Chem.,* **95**, 319 (2023).
3. S.-M. Lu, K. J. Vannoy, J. E. Dick, Y.-T. Long, *J. Am. Chem. Soc.,* **145**, 25043 (2023).
4. S.-M. Lu, J.-M. Noël, J.-F. Lemineur, *Curr. Opin. Electrochem.,* **45**, 101518 (2024).

Quantitative Study of the Stability of Colloidal Metallic Nanoparticles at an Atomic Level

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Understanding and controlling electrochemical interfaces at atomic and molecular levels have transformed electrochemistry into a science with clearly defined fundamental principles, leading to significant impact on various electrochemical systems and devices. Although the principles guiding the activity of electrochemical reactions are quite well established, the driving forces that control stability are still poorly understood. Here, we achieve in situ monitoring of the early stages of Pt, Pd, and Ni dissolution using the operando attenuated total reflectance surface enhanced infrared absorption spectroscopy (ATR-SEIRAS). Our unique operando ATR-SEIRAS method provides femtogram sensitivity levels that, in combination with other techniques, provide otherwise inaccessible information about the dissolution of colloidal metallic nanoparticles with different shapes in acidic environments, and thus deliver a more sensitive approach to understanding the structure-stability relationships of colloidal metallic nanocatalysts at an atomic level.

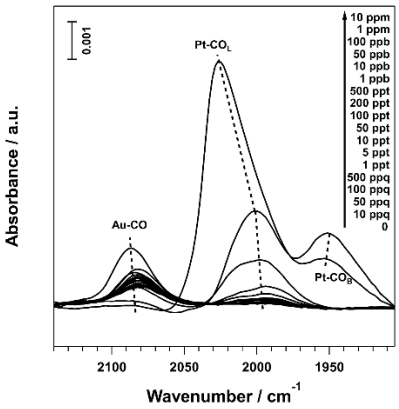


Fig.1 Quantification of Pt dissolution with a detection limit of 10 ppq.

Acknowledgements

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References

1. P. P. Lopes, et al., *ACS Catal.*, **6**, 2536 (2016).
2. A. A. Topalov, et al., *Angew. Chem. Int. Ed.*, **51**, 12613 (2012).

Insights into the interfacial processes in Li-S batteries *WJUI JO TJUV/ PQFSBOEP* methods

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With the continuous development of new energy electrochemical systems, the study of electrochemical reaction processes and dynamic evolution of their complex multiphase interfaces has rapidly become a research frontier for many research disciplines. The development of multidimensional *in situ/ operando* techniques is the key for the deep understanding of complex and multiphase interfacial reaction processes. Important insights into the interfacial processes in Li-S batteries were provided based on the advanced characterization techniques including environmental electrochemical atomic force microscopy, confocal Raman imaging, and X-ray imaging.The *in situ/ operando* techniques enable *in situ* characterization and probing of interfacial electrochemical processes in batteries and their dynamic evolution under realistic operating conditions. With the help of *in situ/ operando* techniques, we reveal the multi-scale chemical composition and structural evolution of electrode-electrolyte interfaces during electrochemical processes, gaining profound insights into battery interfacial processes and failure reasons, thereby providing scientific support for advancing the understanding of interfacial electrochemistry and the development of battery systems. In addition, correlation models between interfacial processes and battery performance will be established to enable performance evaluation and prediction. These outcomes will provide critical guidance for the rational design of advanced battery materials and interfaces, accelerating the development of next-generation energy storage technologies and novel methods and devices.

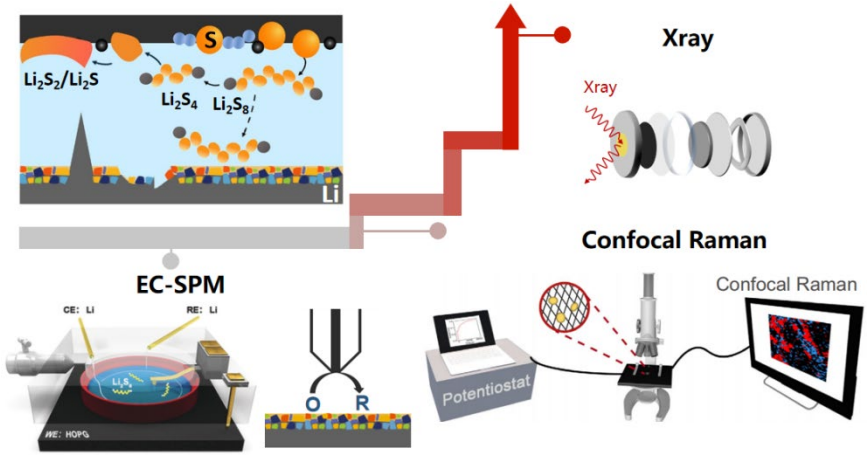


Fig.1 *In situ/ operando* techniques provide insight into Li-S redox reactions.

Acknowledgements

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References

1. W. Xu, S. Lang, K. Wang, R. Zeng, H. Li, X. Feng, M. R. Krumov, S. Bak, C. J. Pollock, J. Yeo, Y. Du, H. D. Abruña, *Sci. Adv.* **9**, eadi5108 (2023).
2. S. Lang, M. R. Colletta, M. R. Krumov, J. Seok, L. F. Kourkoutis, R. Wen, H. D. Abruña, *Proc. Natl. Acad. Sci.* **120**, e2220419120 (2023).
3. S. Lang, S. Yu, X. Feng, M. Krumov, H. D. Abruña, *Nat. Comm.* **13**, 4811 (2022).

Understanding and Controlling Electrolyte-Induced Interfacial Side Reactions in Lithium Metal Batteries

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The electrode-electrolyte interface plays a pivotal role in mediating fundamental electrochemical processes and is central to determining the performance, stability, and lifespan of energy storage systems. Among the various interfacial phenomena, electrolyte decomposition constitutes a major parasitic reaction that compromises interfacial integrity and overall electrochemical efficiency. In this work, we focus on high-energy-density lithium metal batteries (LMBs) and conduct comprehensive multi-scale characterizations to elucidate the interfacial decomposition kinetics of electrolytes and their underlying physicochemical mechanisms. Our investigation reveals that both the micro-coordination environment and the molecular configuration of solvent species are key determinants of electrolyte stability.

We report, for the first time, that the incorporation of anions into the primary solvation sheath of Li^+ effectively attenuates the cation-induced polarization of solvent molecules. This modulation reduces their electron affinity, thereby mitigating reductive decomposition at the anode surface.[1] This approach suppresses the formation of organic-rich decomposition products in the solid electrolyte interphase (SEI), resulting in a thinner, more inorganic, and more stable SEI architecture.

In parallel, we demonstrate that structural tailoring of ether-based solvents provides an effective strategy to simultaneously enhance both the reductive and oxidative stability of the electrolyte. Specifically, elongating the terminal alkyl chains of ethylene glycol ethers-from methyl to butyl-significantly suppresses solvent decomposition at both the Li metal anode and the high-voltage cathode interface.[2] This strategy not only reduces the accumulation of organic degradation products in the SEI and cathode electrolyte interphase (CEI), but also promotes the preferential formation of robust, inorganic-rich interphases through enhanced anion-derived decomposition. As a result, LMBs incorporating such electrolytes exhibit substantially improved cycling stability, particularly at an elevated temperature of 60 °C.

Furthermore, we propose a solvent-engineering paradigm to regulate cathode surface reactivity in the charged state, thereby further influencing electrolyte decomposition kinetics. By extending the carbon chain length of ether solvents, the covalency of Ni-O bonds in high-Ni layered oxide cathodes is reduced, which in turn mitigates interfacial parasitic reactions at high potentials.[3] This leads to suppression of electrochemically inactive NiO rock-salt phase formation, reduced gas evolution, and decreased CEI thickness. Notably, these findings are corroborated across both ether- and ester-based electrolyte systems, affirming the broad applicability of the design principles proposed

herein.[4]

In conclusion, this work offers a mechanistic framework for understanding the origin of interfacial side reactions and provides molecular-level design strategies for the development of safe, high-performance electrolytes tailored for LMBs.

Acknowledgements

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References

1. Z. Wang, Y. Wang, B. Li, J.C. Bouwer, K. Davey, J. Lu & Z. Guo. *Angew. Chem. Int. Ed.*, **61**, e202206682 (2022).
2. Z. Wang, C. Chen, D. Wang, Y. Zhu, & B. Zhang. *Angew. Chem. Int. Ed.*, **62**, e202303950 (2023)
3. Z. Wang, X. Che, D. Wang, Y. Wang, X. He, Y. Zhu, & B. Zhang. *Angew. Chem. Int. Ed.*, **63**, e202404109 (2024)
4. X. He, R. Xu, & Z. Wang. *J. Phys. Chem. C.*, **129**, 15, 7165-7173 (2025).

Potentiometric Sensor with High Sensitivity for Peroxidase

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Natural enzymes with enhanced catalytic activity and selectivity have long been studied by tuning the microenvironment around the active site, but how to modulate the active-site electric field in a simple fashion remains challenging. In this presentation, we will demonstrate that microdroplets as a simple yet versatile reactor can enhance the electric field at the active site of an enzyme. By using horseradish peroxidase as a model, improved selectivity in microdroplet-mediated enzyme catalysis can be obtained [1]. More importantly, the enzyme activity mediated by microdroplets can be greatly enhanced for potentiometric measurements. A potentiometric sensor for rapid, direct, and in-field analysis of soil enzyme activity is proposed, in which soil particle separation and soil enzyme extraction can be achieved within a single device [2].

Acknowledgements

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References

1. Y.H. Li, J.W. Ding, W. Qin, *J. Am. Chem. Soc.*, **146,** 24389-2439 (2024).
2. Y.H. Li, J.W. Ding, W. Qin, *Anal. Chem.*, 97, 11, 5938-5942 (2025).

Nanopore Approach for Single-Molecule Temporal Omics

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A dynamic and coordinated network of biomolecules supports various functions, activities, and the overall stability of living systems at the cellular, tissue, and organ levels. Therefore, simultaneously characterizing the temporal changes of key molecules in complex biological processes could contribute to revealing the molecular regulatory mechanisms underlying physiological and pathological processes. Given the challenges of diversity of the molecule with their subtle differences, and short half-lives in biological processes, we established a real-time multi-species monitoring approach at the single-molecule level based on nanopore On one hand, by revisiting the sensing mechanism of nanopores, we overcame the limitation of current detection methods that are restricted to target sequences, achieving sequence-independent, precise recognition of individual functional groups, such as tyrosine sulfation post-translational modifications on peptides[1]. On the other hand, by developing a novel electroosmotic capture strategy and a rapid multi-species quantification method, we enhanced the time resolution of nanopore real-time monitoring, thereby establishing a nanopore-based single-molecule temporal omics[2]. Taking the renin-angiotensin system (RAS) as a model, we achieved the real-time monitoring of the sequential transformation of angiotensin (Ang) peptides with single-amino-acid difference under enzymatic mediation by ACE and ACE2, with a quantitative interval of 30 seconds. This study revealed a molecular crosstalk effect within RAS: ACE2 selectively inhibits ACE-mediated digestion of Ang I [3]. Furthermore, we evaluated the influence of SARS-CoV-2 on RAS and found that SARS-CoV-2 and its variants significantly inhibit ACE2 activity, thereby disrupting the RAS crosstalk effect and increasing the production and accumulation of Ang II, which is associated with fibrosis and pro-inflammatory effects, by 3 to 4 times, providing insights for effective intervention in COVID-19.

Acknowledgements

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References

1. H. Niu, M.-Y. Li, Y. Gao, J.-G. Li, J. Jiang, Y.-L. Ying and Y.-T. Long, *Nat. Chem. Biol.*, **21**, 716-726 (2025) ;
2. M.-Y. Li, J. Jiang, J.-G. Li, H. Niu, Y.-L. Ying and Y.-T. Long, *Nat. Methods*, **22**, 241-253 (2025) ;
3. J. Jiang, M.-Y. Li, X.-Y. Wu, Y.-L. Ying, H.-X. Han and Y.-T. Long, *Nat. Chem.*, **15**, 578-586 (2023).

Flexible Wearable Electronic Sensors for Proactive Health Management

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With the deepening of national digital transformation and the "Healthy China" initiative, non-invasive wearable sensing technologies are emerging as a research frontier in the field of health management. Ultra-sensitive wearable sweat analysis platforms that integrate flexible electronics, microfluidics, and electrochemical analysis enable real-time and continuous monitoring of physiological and metabolic signals, offering new opportunities for early disease screening, personalized diagnosis, and proactive health management. Sweat, as a biofluid rich in diverse biomarkers, reflects key physiological parameters such as metabolic status and hormone levels. Its non-invasive and continuously accessible nature makes it especially valuable for the digital and intelligent management of women's health. For instance, fluctuations in female hormone levels are closely associated with fertility, menstrual disorders, and menopause, and are critical for monitoring, intervention, and therapeutic evaluation in conditions such as infertility, polycystic ovary syndrome (PCOS), and menopausal transition [1, 2]. This report focuses on the precise detection of ultra-low concentration biomarkers in sweat, introducing the development of high-performance sweat sensing platforms from the perspectives of molecular recognition mechanisms, microfluidic chip design, and wearable system integration. It systematically reviews recent advances in sensor sensitivity, selectivity, and stability, and highlights strategies to address challenges such as signal interference, miniaturization, and long-term wearability. Furthermore, it explores the promising applications of these platforms in the digital and intelligent management of women's health, particularly in scenarios requiring continuous, real-time hormone monitoring for reproductive health tracking, menstrual cycle analysis, early diagnosis of endocrine disorders, and personalized intervention.

References

1. C. Ye, M. Q. Wang, J. H. Min, et al. *Nat. Nanotechnol.*, **19**, 330-337 (2024).
2. M. Q. Wang, C. Ye, et al. *Nat. Mater.* **24**, 589–598 (2025)

Core-sheath braided yarn wearable bioelectronics for sweat capture and multimodal sensing

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World Health Organisation statistics show that Noncommunicable diseases (NCDs) related deaths account for 71% of global deaths. Early screening and dynamic monitoring have become important directions in the development of modern medicine.[1] Breathable and comfortable sensing textiles capable of detecting multiple biomarkers in human sweat offer a promising approach for comprehensive health monitoring in daily life.[2,3] However, current wearable flexible electrochemical textiles face limitations in multi-biomarker integration and often require large surface areas and excessive sweat volumes to activate the sensors.[4,5]

Herein, we report a highly integrated sweat sensor based on a multifunctional core-sheath sensor, which integrates multiple electrodes in a three-dimensional spatially isolated manner in a single yarn through an improved braiding process. By leveraging the synergistic effects of the wetting gradient and yarn microstructure, sensor constructs a microfluidics transport system, which can directly and spontaneously transport fluids to enable the continuous transport of sweat in a pre-programmed path, significantly shortening the sweat transmission distance and enabling rapid detection(<5s). The spiral cross-braiding structure enhances its stability and provides stable sensing performance even under various dynamic deformation conditions, achieving both detection and wearer comfort. This work provides new ideas for the large-scale production of low-cost, wearable, and multifunctional sensor yarns.

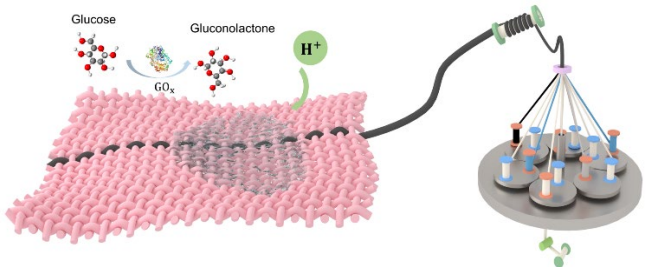


Fig.1 Schematic illustration of the wearable fabric by weaving the core-sheath sensor for multi-biomarkers analysis.

Acknowledgements

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References

1. J. Kim, A. S. Campbell, B. E.-F. de Ávila and J. Wang, *Nat. Biotechnol.*, **37**, 389-406 (2019).

2. A. Zhang, L. Zhou, Q. Liang, X. Wang, X. Hu, K. Jia, H. Chu, Y. Luo, L. Qiu, H. Peng and S. He, *Sci. China Mater.*, **67**, 251-260 (2024).
3. L. Wang, J. Lu, Q. Li, L. Li, E. He, Y. Jiao, T. Ye and Y. Zhang, *Adv. Funct. Mater.*, **32**, 2200922 (2022).
4. L. Wang, L. Wang, Y. Zhang, J. Pan, S. Li, X. Sun, B. Zhang and H. Peng, *Adv. Funct. Mater.*, **28**, 1804456 (2018).
5. X. He, C. Fan, T. Xu and X. Zhang, *Nano Lett.*, **21**, 8880-8887 (2021).

Interface Regulation for Photoelectrochemical Analysis

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Abstract: Photoelectrochemical (PEC) sensing is a highly sensitive analytical technique that combines photoexcitation and electrochemical detection. PEC sensing exhibits great potential in food safety, environmental monitoring, and biomedical applications due to its unique advantages over traditional analytical methods. PEC analysis utilizes the biorecognition between components and target molecules under illumination to cause changes in photoelectric current detection signals, thereby achieving quantitative analysis of the analyte. However, the performance of PEC sensing is limited by difficulties in carrier separation, slow interface reaction kinetics, and interference from biometric recognition units on signal transmission. The key to achieving highly sensitive PEC analysis lies in the construction of a high-response photoelectrode. At this time, interface engineering provides effective strategies to overcome these challenges by regulating interface structure, optimizing catalytic activity, and creating novel sensing interfaces. Optimizing the interfacial properties among semiconductors/catalysts/electrolytes can establish new charge transfer channels, expand the charge diffusion length, enhance the electrochemical reaction driving force, and ultimately improve the electrode photoelectric current response. Currently, research on interfacial properties is still in its early stages, and combining interfacial regulation with biorecognition is expected to achieve multiple amplification of PEC signals. Therefore, fine-tuning and in-depth analysis of the interfacial properties of PEC systems will provide broad prospects for further exploration of its applications in biosensing.

Keywords: photoelectrochemical biosensing; interface regulation; charge separation; signal amplification

References

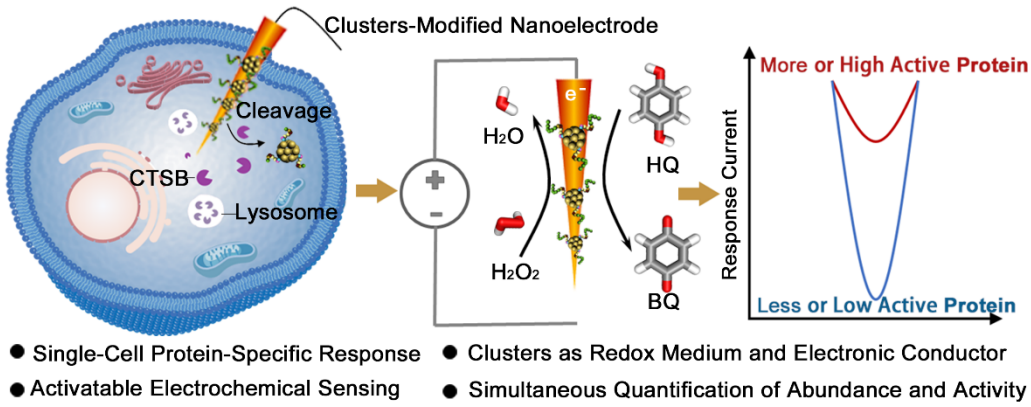
1. Liu, M.; Yang, W.; Xiao, R.; Qin, Y.; Tan, R.; Chen, Y.; Gu, W.; **Hu, L.**;* Lin, Y.; Zhu, C.* *Angew. Chem. Int. Ed.* **2024**, *63*, e202407481.
2. Xiao, R.; Yu, H.; Liu, M.; Xu, W.; Qin, Y.; Tan, R.; Chen, Y.; Wen, J.; Peng, X.; Gu, W.;* Zhu, C.; **Hu, L.**;* *Adv. Funct. Mater.* **2023**, *33*, 2304915.
3. Qin, Y.; Wen, J.; Zheng, L.; Yan, H.; Jiao, L.; Wang, X.; Cai, X.; Wu, Y.; Chen, G.; Chen, L.; **Hu, L.**;* Gu, W.;* Zhu, C.* *Nano Lett.* **2021**, *21*, 1879-1887.
4. Qin, Y.; Wen, J.; Wang, X.; Jiao, L.; Wei, X.; Wang, H.; Li, J.; Liu, M.; Zheng, L.; **Hu, L.**;* Gu, W.;* Zhu, C.* *ACS Nano* 2022, *16*, 2997-3007.

Monitoring Abundance and Activity of Electrochemically Inactive Protein in a Single Cell by an Atomically Precise Metal Cluster Based Electrochemical Sensor

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The analysis of tumor metastasis-associated proteins is of vital importance for monitoring tumor evolution and evaluating therapeutic outcomes of protein-targeted drugs. However, electrochemically analyzing both the abundance and activity of these electrochemically inactive proteins in single living cells remains an unresolved challenge. Here, we develop an electrochemical sensor composed of a nanoelectrode

functionalized by atomically precise metal clusters with excellent electrocatalytic activity. It enables highly selective detection of electrochemically inactive proteins associated with tumor metastasis. Via this sensor, we demonstrate the relation between cathepsin B abundance and metastatic features of tumor cells. The inherent heterogeneous protein expression among individual cells is confirmed by a quantitative manner. Additionally, this methodology allows for the assessment of cathepsin B activity in response to the antimetastatic drug exposure at a single-cell level. It deepens our understanding of cathepsin B's role in tumor metastasis and provides potential for precise evaluation of cathepsin B-targeted drugs. [1]



Acknowledgements

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References

1. Y. Han, X. Gao and L. Gao, *ACS Nano*, **19**, 20765-20778 (2025).

Single-entity resolution nanosensor reveals interfacial redox activity of stress granules

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The spontaneous electrochemical activities of biomolecular condensates represent a new fundamental functioning mechanism in biochemistry and cell biology. However, our understanding of the underlying molecular mechanism and the interfacial field-dependent chemical activities remain limited. This is due to the lack of technology to probe such activities in real time and at a single-condensate level. Stress granules (SGs) are membrane-less organelles that form in cytoplasm to adapt to cell stress, which are found to encapsulate reactive oxygen species (ROS) in our lab. Here we design and implement a collision-based electrochemical nanosensor that enables probing the spontaneous redox activities of SGs at a single-condensate level in live cells. We show that ex-vivo separated SGs drive the spontaneous redox reactions depending on their own interfacial po-tentials and the constituents of the solution system. Surprisingly, we found that water molecules, rather than solvated oxy-gen (the main source of ROS produced by a conventional enzyme reaction in cells), is the main chemical origin of the redox activity of SGs. Finally, we demonstrate the application of this electrochemical nanosensor in real-time probing the genera-tion of hydrogen peroxide from SGs in mammalian cells and show that the electrochemical environment of the cells can reg-ulate the redox activity of SGs. This work uncovers the mechanisms encoding the non-enzymatic redox activities of SGs and demonstrates a key fundamental technological capability that can be highly useful in exploring the intracellular electroactive pathways of macroscale assemblies.

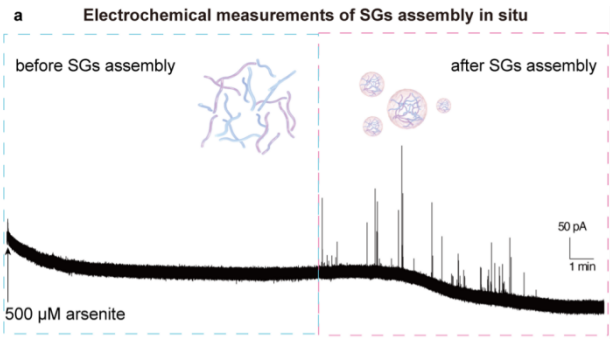


Fig 1. Scheme showing the nanosensor for intracellular quantitative measurement of the ROS in SGs.

Fig 2. A typical amperometry trace obtained by a nanosensor in a U2OS cell stressed by 500 μM arsenite to trigger the generation of SGs *in-situ*.

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References

1. Y. Dai, C. E. Chamberlayne, M. S. Messina, C. J. Chang, R. N. Zare, L. You, *Chem* **9** (6), 1594-1609 (2023).
2. H. Gu, C. Gu, N. Locker, A. G. Ewing, *Angew. Chem. Int. Ed.* **63** (16), e202400422 (2024).
3. K. Hu, E. Relton, N. Locker, N. T. N. Phan, A. G. Ewing, *Angew. Chem. Int. Ed.* **60** (28), 15302-15306 (2021).

Real-Time Nanoscale Tracking of Single-Particle Anisotropy in Photoelectrochemistry

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This study introduces operando collision electrochemistry as a novel technique to investigate the anisotropy of single silver nanoprisms (Ag NPs) in photoelectrochemical processes at the nanoscale. By monitoring transient current responses during collisions of Ag NPs with a gold ultramicroelectrode (UME), we are able to directly observe direction-dependent mass transfer and electron transfer behaviors that are intrinsically linked to the morphological anisotropy of the Ag NPs. Statistical analysis of the collision frequency and current amplitude data reveals bimodal distributions, indicating the presence of heterogeneous diffusion coefficients and electron tunneling kinetics across different crystal facets. Furthermore, plasmonic excitation via laser irradiation is found to modulate these dynamics, with the 648 nm laser wavelength exhibiting the most pronounced effects due to its wavelength-dependent photothermal expansion of the polyvinylpyrrolidone (PVP) layer covering the Ag NPs. Finite-Difference Time-Domain (FDTD) simulations are employed to corroborate the observed electric field enhancements and provide insights into the underlying mechanisms. Comparisons with isotropic Ag nanospheres (NSs) highlight the unique role of anisotropy in influencing interfacial processes. This approach not only enhances our understanding of the fundamental kinetics and mass transfer dynamics at the sub-nanoparticle level in real-time but also holds promise for advancing high-throughput screening of nanomaterials with superior performance.

Reference

(1) Lu, S.; Wang, H.; Chen, M.; Xie, B.; Long, Y. Unlocking Single Particle Anisotropy in Real-Time for Photoelectrochemistry Processes at the Nanoscale. *Angew Chem Int Ed* **2024**, *63* (32), e202404170.

Anion Modulated Reductive Proton-Coupled Electron Transfer

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Proton-coupled electron transfer (PCET) reactions are fundamental importance in a wide range of biological and chemical processes of natural and artificial systems[1], among which electrochemical PCET are intimately associated with energy and/or matter transformation and storage[2]. It is well recoganzied that electrolyte components have significant impact on PCET process[3]. However, the scientific attentain is mainly focused on the considerable influence of cations, the understating of anion effect is very limited at current stage, especially in reduction reactions. Takding advantage of in situ attenuated total reflection surface-enhanced infrared absorption (ATR-SEIRA) spectroelectrochemistry, we explored and elucidated the mechanisms of anion effect in model reduction reaction, demonstrating the dual effect of anion on thermodynamic and kinetic properties of electrochemical PCET. Our work underscores the significance of anion effect at both kinetic and thermodynamic aspect in PCET reduction processes, not only deepens the understanding of anion effect, but also broadens the scope of electrolyte engineering in electrocatalysis.

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References

1. R., Tyburski, T. Liu, S. D. Glover, L. Hammarström, *J. Am. Chem. Soc.*, **143**, 560-576 (2021)
2. R. E. Warburton, A. V. Soudackov, S. Hammes-Schiffer, *Chem. Rev.*, **122**, 10599-10650 (2022).
3. C. Chen, H. Jin, P. Wang, X. Sun, M. Jaroniec, Y. Zheng, S. Z. Qiao, *Chem. Soc. Rev.*, **53**, 2022-2055 (2024).

Investigating enhanced ethanol selectivity on Ag-Based catalysts for CO_2 electroreduction by operando EC-SERS

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Electrochemical CO_2 reduction powered by renewable electricity is a promising avenue for chemical energy storage and Carbon Neutrality. However, it is still difficult to achieve CO_2 conversion to C_{2+} products such as ethanol with high selectivity by electroreduction, while investigating the mechanisms is even difficult. Herein, we investigate the enhanced ethanol selectivity on the sulfurized Au core Ag shell nanoparticles (Au@Ag-S NPs) for CO_2 electroreduction by operando electrochemical surface-enhanced Raman spectroscopy (EC-SERS). We achieve a high ethanol Faradaic efficiency (FE) of 60% at a high potential of −0.75 V vs. RHE on Au@Ag-S NPs for CO_2 electroreduction. The electron transfer from Au core to Ag shell at the Au@Ag-S NPs interface is proved by X-ray photoelectron spectroscopy (XPS), which facilitates the CO_2 electroreduction to ethanol. Operando EC-SERS provides direct spectral evidence of the *CO intermediates stably adsorbed at the surface of Au@Ag-S NPs, which facilitates subsequent C-C coupling and the formation of ethanol. By analyzing Stark slope and relative Raman intensity of K^+-H_2O of interface water with potential decreasing, it is proved that sulfurization can inhibit hydrogen evolution reaction (HER), and therefore facilitate the CO-CO coupling and ethanol formation. Density functional theory (DFT) calculations find that the energy barrier of CO-CO coupling is smaller after the Au@Ag NPs are sulfurized, making ethanol formation easier on the Au@Ag-S interface. This study provides an efficient way to rationally design catalysts with high selectivity for catalysis.

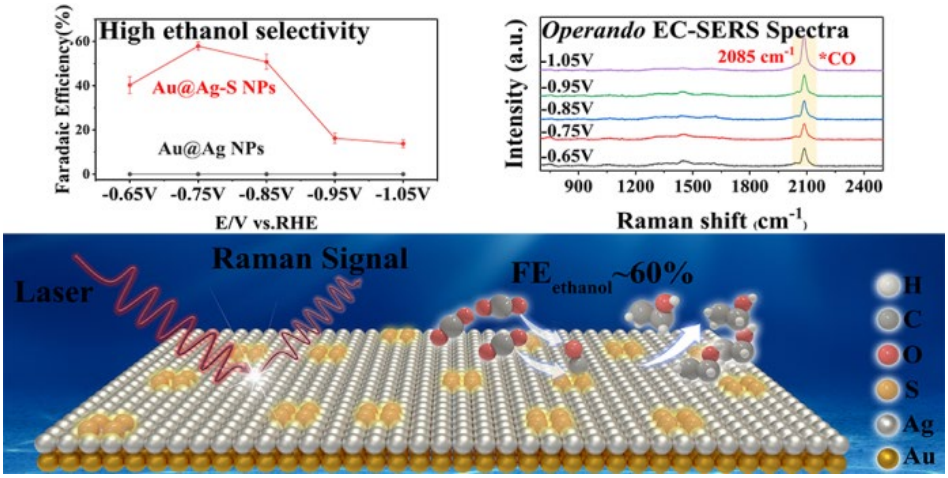


Fig.1 Ethanol FE on different Au@Ag-S NPs samples with different Ag/Au ratios. Operando EC-SERS spectra of CO2 electroreduction on the surfaces of Au@Ag-S NPs. DFT-based optimal energy evolution models for CO2 reduction to ethanol on the surface of the Au@Ag NPs and Au@Ag-S NPs with Ag/Au ratio of 1.42.

Acknowledgements

This work was supported by grants from the National Natural Science Foundation of China (22174165).

References

1. Liu, Q.; Zhang, X.-G.; Du, Z.-Y.; Zou, C.-J.; Chen, H.-Y.; Zhao, Y.; Dong, J.-C.; Fang, P.-P.*; Li, J.-F.*, *Sci. China-Chem.* **66**, 259-265 (2023).
2. Wang, Q.-Y.; Li, Y.-H.; Zhao, Y.; Chen, Y.-Y.; Geng, B.-J.; Ye, R.-K.; Liu, Q.; Liu, X.-Q.; Tong, Y.-X.; Zhang, Y.-J.; Cheng, J.; Fang, P.-P.*; Hu, J.-Q.*; Li, J.-F.*; Tian, Z.-Q., *CCS Chem.* 4, 3319-3328 (2022).

Application of Chemometrics in Nanosensing Measurement

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The measurement of complex nanosensing systems has emerged as a frontier in modern analytical chemistry. Chemometrics, acting as the bridge connecting chemistry, mathematics, statistics, and computer science, is a discipline dedicated to applying mathematical and statistical methodologies. By leveraging computer technology, it streamlines chemical measurement processes and extracts the maximum amount of valuable chemical information from measurement data. Nevertheless, the application of chemometrics in analyzing complex nanosensing systems remains in its infancy, calling for significant advancements. This report will present selected research outcomes from our group. These studies integrate chemometric approaches with different analytical techniques, focusing on complex nanosensing systems constructed from noble metal nanoparticles, molybdenum disulfide, carbon dots, nanoclusters, and other materials. The specific work is as follows: (1) A ratiometric electrochemical sensor for the detection of clenbuterol was developed using a Nafion/Berlin green/multi-walled carbon nanotubes-modified glassy carbon electrode. Chemometric methods were applied to conduct baseline calibration, peak position correction, and peak deconvolution on the electrochemical signals. This enhances the accuracy of clenbuterol detection. (2) An adenosine-protected gold nanocluster receptor with specific recognition ability for riboflavin was synthesized through an aqueous heating method. This receptor was used to construct a highly sensitive and selective luminescent sensor for the detection of riboflavin in mouse brain microdialysates. Abstract factor analysis and multivariate curve resolution-alternating least squares (MCR-ALS) were employed to study the interaction between adenosine-protected gold nanocluster and riboflavin. These analyses offer insights into the spectral and concentration changes, thus laying a solid foundation for a more detailed explanation of the sensing mechanism. (3) Different carbon quantum dots and fluorescent copper clusters were synthesized by using various bases and nucleosides as precursors or protective agents. By combining fluorescence spectroscopy with supervised and unsupervised chemometric pattern recognition methods, discriminative sensing among different bases and nucleosides was achieved. (4) Molybdenum disulfide quantum dots and nanosheets were synthesized via a hydrothermal method for the fluorescent detection of 2,4,6-trinitrophenol and the colorimetric detection of ferrous ions, respectively. A multi-wavelength Stern-Volmer equation method was proposed to investigate the quenching mechanisms. Multivariate curve resolution-alternating least squares (MCR-ALS) was used to clarify the reaction mechanisms involved in the sensing detection. Additionally, "second-order advantage" algorithms such as parallel factor analysis (PARAFAC) enabled fluorescence detection in the presence of unknown backgrounds. (5) UV-visible absorption spectroscopy, combined with MCR-ALS, was employed to comprehensively study the interactions between human serum albumin and gold or silver nanoparticles. Thermodynamic, kinetic, and structural information about these interactions was obtained, and a sensitive sensor for the detection of human serum

albumin was developed. It is hoped that these research achievements will deepen the cross-disciplinary research between chemometrics and nanosensing.

Acknowledgements

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References

1. C. Zeng, Y. X. Mu, W. X. Cao, Q. F. Zhuang and Y. Wang, *Anal. Chem.*, **95(2)**, 1671-1679 (2023)
2. W. F. Fan, L. H. Guo, Y. Qu, Q. F. Zhuang and Y. Wang, *J. Hazard. Mater.*, **468**, 133795 (2023)
3. Y. Wang, T. X. Chen, Q. F. Zhuang and Y. N. Ni, *ACS Appl. Mater. Interface*, **9(37)**, 32135-32141 (2017)
4. Q. F. Zhuang, W. Cao, Y. N. Ni and Y. Wang, *Talanta*, **185**, 491-498 (2018)
5. Y. Wang, J. Hu, Q. F. Zhuang and Y. N. Ni, *Biosens. Bioelectron.*, **80**, 111-117 (2016)
6. J. Hu, Q. F. Zhuang, Y. Wang and Y. N. Ni, *Analyst*, **141(5)**, 1822-1829 (2016)
7. Y. Wang and Y. N. Ni, *Analyst*, **119(2)**, 416-424 (2014)
8. Y. Wang and Y. N. Ni, *Talanta*, **119**, 320-330 (2014)
9. Y. Wang and Y. N. Ni, *Anal. Chem.*, **86(15)**, 7463-7470 (2014)

Disordered hyperuniform two-dimensional materials

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Disordered hyperuniformity [1] is a recently discovered novel state of many-body systems that possesses vanishing normalized infinite-wavelength density fluctuations and a hidden long-range order similar to a perfect crystal, and yet is statistically isotropic with no Bragg peaks like a liquid or glass. The exotic structural features of disordered hyperuniform systems appear to endow such systems with desirable optical, transport, and mechanical properties that cannot be achieved in either ordinary disordered or perfectly crystalline states. In this talk I present a series of research [2-5] on disordered hyperuniform atomic-scale two-dimensional (2D) materials. In particular, we discover a hyperuniformity-preserving topological transformation in two-dimensional networks that involves continuous introduction of Stone-Wales (SW) defects, and the resulting networks capture the salient structural feactures of amorphous 2D materials such as graphene and silica. Interestingly, we find that when adding disorder in a hyperuniform manner, certain 2D materials exhibit a semiconductor-to-metal or insulator-to-metal transition, which is in contrast to the conventional wisdom that disorder generally diminishes electronic transport. Our results strengthen our understanding of the structure-property relationships in amorphous materials, and have important implications for a range of applications, including quantum computing.

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References

6. S. Torquato, *Phys. Rep.*, **745**, 1-95 (2018)
7. D. Chen, Y. Zheng, L. Liu, G. Zhang, M. Chen, Y. Jiao, and H. Zhuang, *Proc. Natl. Acad. Sci. U. S. A.*, **118**, e2016862118 (2021)
8. Y. Zheng, L. Liu, H. Nan, Z.-X. Shen, G. Zhang, D. Chen, L. He, W. Xu, M. Chen, Y. Jiao, and H. Zhuang, *Sci. Adv.*, **6**, eaba0826 (2020)
9. D. Chen, H. Zhuang, M. Chen, P. Y. Huang, V. Vlcek, and Y. Jiao, *Appl. Phys. Rev.*, **10**, 021310 (2023)
10. Y. Zheng, D. Chen, L. Liu, Y. Liu, M. Chen, H. Zhuang, and Y. Jiao, *Phys. Rev. B*, **103**, 245413 (2021)

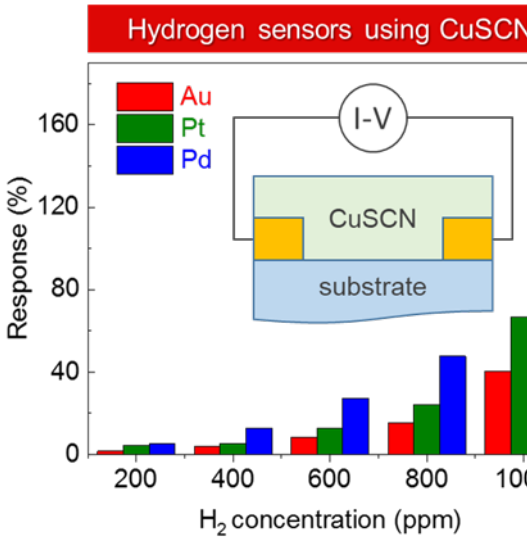
Low power conductometric Gas sensors based on p-type Semiconductors

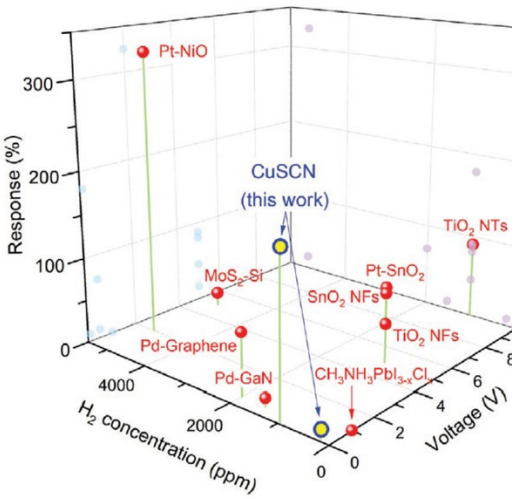
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Metal oxides have been used widely as the gas sensing element in solid-state devices due to their sensitivity toward various atmospheric elements. However, the often high working temperature combined with the high power consumption that is required to operate such sensors represent two major technical and scientific challenges. For the past 50 years a broad range of metal oxides (e.g., SnO2, ZnO, In2O3, Cu2O, CuO, NiO, TiO2) [1] have been studied for the detection of toxic and hazardous gases such as O3, NOx, CO, CO2, VOCs, CH4, H2. [2–3] Among them, various metal oxides semiconductors, such as n-type SnO2, ZnO, TiO2, and p-type CuO, NiO, have been reported to be sensitive, yet only a handful of these sensors were shown to operate at room temperature reversibly while consuming low power. In this talk I will give an overview of my research on low power conductometric gas sensors based on ultrathin p-type semiconductors (such as metal thyocyanates, cobalt vanadates etc).





References (see example below)

1. E. Gagaoudakis, V. Kampitakis, M. Moschogiannaki, A. Sfakianou, T. Anthopoulos, L. Tsetseris, G. Kiriakidis, G. Deligeorgis, F. Iacovella, V. Binas, Sensors and Actuators A: Physical, 338 (2022) 113462.
2. V. Kabitakis, E. Gagaoudakis, M. Moschogiannaki, G. Kiriakidis, A. Seitkhan, Y. Firdaus, H. Faber, E. Yengel, K. Loganathan, G. Deligeorgis, L. Tsetseris, T. D. Anthopoulos, V. Binas, Advanced Functional Materials, 32 (2021)2102635.
3. E. Petromichelaki, E. Gagaoudakis, K. Moschovis, L. Tsetseris, T. D. Anthopoulos, G. Kiriakidis and V. Binas, Nanoscale Adv., (2019), 1, 2009

Precise Synthesis of Discrete Chiral Nanomaterials for Circularly Polarized Photocatalysis and Chiral Sensors

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Conventionally, the emerged chiral nanomaterials via self-assembly of metal nanoparticles (NPs) with amino acids, DNA, DNA origami, proteins and polymers, have been attracted by their complex functionalities and excellent chiroptical activities. Stability and duration of assembled chiral nanomaterials still remain a great challenge for their applications [1-4]. In this presentation, we have conducted a series of synthetic methodologies for the precise synthesis of chiral nanomaterials with tunable, excellent and stable chiroptical response, for instance, chiral Au NRs, chiral magnetic NPs and chiral hybrid nanomaterials [5-7]. The chirality origin of chiral nanomaterials is due to the synergistic effect of chiral molecules and twisted surface. In addition, we have investigated the chiral nanomaterials-based circularly polarized photocatalysis, in the fields of dye degradation, nanozyme, and others. Based on this phenomenon and mechanism, chiral nanomaterials were selected as potential promising materials for utilizing light energy [8-10].

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References

1. G. C. Zheng; J. J. He; V. Kuma; S. L. Wang; I. Pastoriza-Santos; J. Perez-Juste; L. M. Liz-Marzan; K. Y. Wong. *Chem. Soc. Rev.* 50, 3738-3754 (2021)
2. J. Chen, X. Chen, R.-I. Murakami, H. Li, X. Yu, W. Feng, Y. Yang, P. Wang, G.C. Zheng, Z. Tang, X. Wu. *Advanced Materials*, 2410676 (2024)
3. S. Wang, X. Liu, S. Mourdikoudis, J. Chen, W. Fu, Z. Sofer, Y. Zhang, S. Zhang, G.C. Zheng. *ACS Nano,* 16, 19789–19809 (2022)
4. Y. Zhao, J. Xie, Y. Tian, S. Mourdikoudis, N. Fiuza-Maneiro, Y. Du, L. Polavarapu, G.C. Zheng *Advanced Science*, 2305797 (2024).
5. G.C. Zheng; S. Jiao; W. Zhang; S. Wang; Q. Zhang; L. Gu; W. Ye; J. Li; X. Ren; Z. Zhang; K.Y. Wong, *Nano Research*, 15, 6574–6581 (2022)
6. X. Liu, Y. Du, S. Wang, Y. Huang, Y. Tian, D. García-Lojo, I. Pérez-Juste, J. Pérez-Juste, I. Pastoriza-Santos, and G.C. Zheng. *Small*, 19 (26), 2205187 (2023)
7. X. Liu, Y.L. Du, S. Mourdikoudis, G.C. Zheng, K.-Y. Wong *Advanced Optical Materials*, 11 (18), 2202859 (2023)
8. W. Fu, J. Chen, S. Zhang, G.C. Zheng, Y. Zhang. *Journal of Materials Chemistry C*, 12, 9139-9145 (2024)
9. X. Pan, H. Li, X. Chen, S. Wang, S. Mourdikoudis, T. Luo, K.-Y. Wong, G.C. Zheng *Advanced Optical Materials*, DOI: 10.1002/adom.202403422 (2025)
10. X. Chen, S. Wang, X. Zhang, S. Mourdikoudis, C. Song, L. S. Lun, J. Xie, W.L. Wong, J. Perez-Juste, I. Pastoriza-Santos, K.-Y. Wong, G.C. Zheng *Nano Research*, DOI: 10.26599/NR.2025.94907307 (2025)

Electrochemical Chiral Recognition Based on Helical Chiral Gold Nanoparticles

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Chiral surfaces have found widespread application in many significant enantioselective chemical processes such as enantioselective heterogeneous catalysis, enantiospecific sensing, and chiral separation. Metal surfaces with intrinsic chirality, featuring with their superior stability and exceptional surface properties, have been envisioned as an ideal candidate for developing enantioselective surface chemistry and understanding the fundamental origin of surface enantioselectivity. To fully implement their advantageous properties, development of reliable methods for the preparation of metal surfaces with intrinsic homochirality is highly desired. To date, chiral metal surfaces with homochirality are mainly obtained from physical methods, including cleaving single crystals of metals, homochiral heteroepitaxial growth, and impression of chiral surface orientations. Despite their capability of preparation of homochiral surfaces, these approaches generally suffer with issues of unscalable production and low surface areas, which have substantially hampered the fundamental and technological development of enantioselective surface chemistry. In this respect, developing scale-up synthetic methods for metal nanoparticles with homochiral facets is of paramount importance, which is listed as a key challenge in the field of enantioselective surface chemistry in a recent perspective.

Herein, we propose a novel approach involving the formation of chiral (hkl) facets through the rotation of regular (hhk) facets and design a rational synthesis strategy termed "facet presetting–chiral rotation" to fabricate chiral gold nanoparticles with well-defined chiral facets. During nanoparticle growth, the introduction of L-/D-cysteine disrupts mirror symmetry, inducing counterclockwise or clockwise rotation of structural units and enabling the synthesis of high-Miller-index chiral facets, specifically $\{12\bar{5}8\}^R$ and $\{8\ \bar{5}\ 12\}^S$. Notably, these intrinsic chiral single-crystal facets exhibit efficient enantioselective recognition for L-/D-tryptophan. This study overcomes the limitations of traditional single-chiral-facet construction methods, such as low specific surface area, and offers new insights for enantioselective recognition, chiral heterogeneous catalysis, and the rational design of chiral nanofunctional materials.

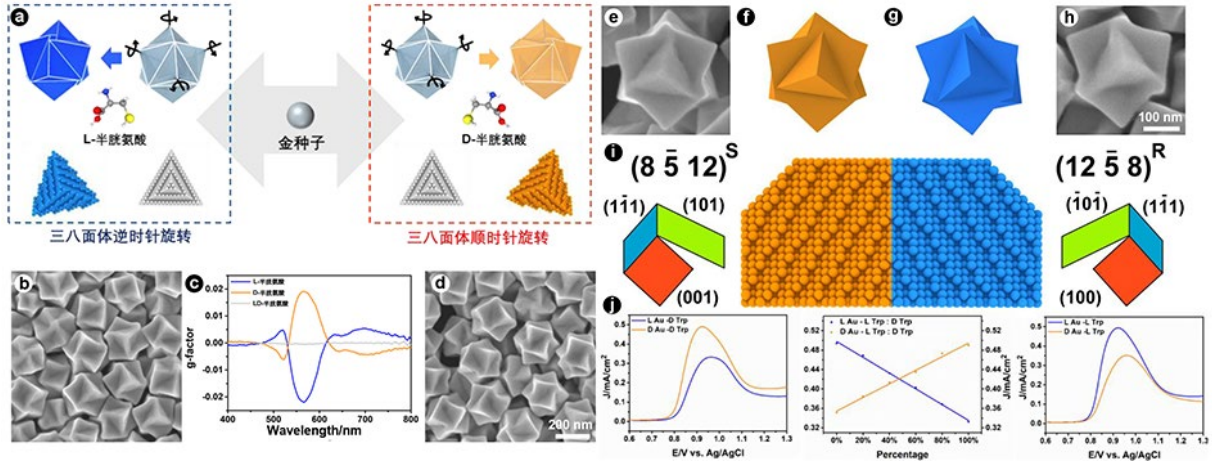


Fig.1 (a) Scheme of synthesis of gold nanocrystals with homochiral facets. (b-i) gold nanocrystals with $\{1\bar{2}58\}^{R}$ and $\{\bar{8}512\}^{S}$ facets, (j) Differential pulse voltammograms (DPV) curves of L-tryptophan at L- and D- chiral homochiral facets-modified electrodes.

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References

1. F. X. Wu, Y. Tian, X. X. Luan, X. L. Lv, F. H. Li, G. B. Xu, W. X. Niu*, *Nano Letters*, **22**, 2915-2922 (2022)
2. F. X. Wu, F. H. Li, Y. Tian, X. L. Lv, X. X. Luan, G. B. Xu, W. X. Niu *, *Nano Letters*, **23**, 8233-8240 (2023)

A Single-Electrode System for ZIF-67 Enhanced Luminol Electrochemiluminescence Detection of AQP4 Antibody

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Currently, cell-based assays are widely recognized as the most reliable method for detecting aquaporin-4 (AQP4) antibodies in the diagnosis of neuromyelitis optica spectrum disorder (NMOSD) [1], due to their high specificity and sensitivity [2]. However, access is limited as detection requires complex procedures in specialized laboratories. Therefore, expanding access through simple, cost-effective multiplex detection is crucial for improving diagnosis and treatment. In this study, a single-electrode electrochemical system (SEES)-based electrochemiluminescence (ECL) immunosensor was developed, with cobalt-based metal-organic frameworks (ZIF-67) incorporated to enhance the efficiency of ECL in the luminol system. A screen-printed carbon ink electrode was covered with a multiple circular-hole plastic sticker to make numerous independent ECL cells that are appropriate for multiplex analysis. In the ZIF-67 enhanced luminol/H_2O_2 system, ECL reactions occurred at both edges of each cell, driven by a local potential difference generated by the applied voltage and the electrode's inherent resistance, which created a linear potential gradient along the electrode surface. In order to validate the developed immunosensor, its linearity, accuracy, dilutability, precision, sensitivity, and selectivity were assessed. It had a linear range from 1 to 100 ng/mL and a detection limit of 0.3 ng/mL. Furthermore, an effective implementation was demonstrated by the detection of AQP4 antibodies in the serum samples of seropositive NMOSD patients. The efficiency of the immunosensor is significantly enhanced due to its reliance on a single electrode and ability to perform multiplex analysis, which contribute to its simplicity, speed, and cost-effectiveness. The integration of these features establishes the immunosensor as a promising tool for better disease diagnosis and treatment, which will help its widespread adoption, especially in regions with limited resources.

Acknowledgements

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of International Science Organizations.

References

1. P. Waters, M. Reindl, A. Saiz, *et al*., *J. Neurol. Neurosurg. Psychiatry,* **87**, 1005-1015 (2016).
2. S. Prasad and J. Chen, *Semin. Neurol.,* **39**, 718-731 (2019).

Applications of transition metal nanomaterials in the fast degradations and detections of antibiotics

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Antibiotics are one of the greatest inventions of the 20th century, which have greatly extended human life. They are necessities in hospital, clinic, family, school, farm, and the other public occasions.[1] Yet only a fraction of the antibiotics taken by humans or animals are digested, the most is released into the aquatic environment (i. e. river, soil). The accumulated antibiotics and their metabolites not only cause serious bio-toxicity, but also lead to the formations of antibiotic-resistant genes and bacteria. Thus, the efficient decompostions and detections of antibiotics are important issues.[2, 3] Herein, we develop new electrode materials and new single atom doped electrocatalysts to decompose metronidazole (MNZ) and chloramphenicol (CAP) and detect levofloxacin (LFX), as showin in Fig. 1A-C. First, transition metal phosphide electrode is applied as the catalyst and promote the decompositions of both MNZ and CAP, which are removed in 1 and 2 h in high-amount Cl^-. Apparent first-order reaction rate constant, k_{obs} are 0.117 and 0.048 min^{-1} for MNZ and CAP at pH 3.0, respectively (Fig. 1D-G). Small molecules, such as acetonitrile (P6, m/z=42), acetic acid (P5, m/z =61), and imidazol (P3, m/z =83) are present after decompositions of MNZ. For CAP, (2-hydroxy-2-(4-nitrophenyl)acetic acid (P1, m/z =195) and p-nitrobenzoic acid (P2, m/z=165) are remained in 2 h. The minerization efficiencies are above 20%. Second, single atoms doped MoS_2 are developed and mimick peroxidase. Through the inhibition effects of LFX to the nanozyme, 1.0–250 μM LFX are detected selectively (limit of detection, 0.5 μM). This study is significate to remove and detect the antibiotics in sophisticated environment efficient and economically.

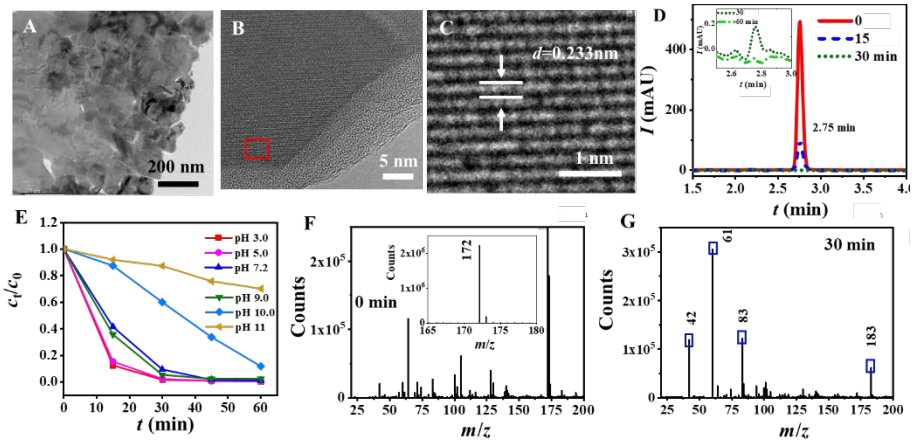


Fig.1 (A-C) TEM characterizations of transition metal phosphide electrode marterials. (D-G) Degradation kinetics and mass spectra analysis of MNZ.

Acknowledgements

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References

1. M. Rafiq, M. Mateen, *et al*., J. Environ. Chem. Eng., **11,** 111608 (2023).
2. Y. Zhe, A. Wang, *et al*, Water Res., **274**, 123122 (2025).
3. L. Zhang, J. Han, *et al*, Nanoscale Adv., **5**, 2804-2812 (2023).

Electrocatalytic glucose oxidation by AuNi bimetallic aerogel to promote diabetic wound healing

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The high glucose concentration microenvironment of diabetic wound poses significant challenges to wound healing, and lowering the glucose concentration is of great importance for the wound treatment. Herein, we constructed the three-dimensional AuNi bimetallic aerogel, which exhibited excellent electrocatalytic activity for the oxidation of glucose compared to Au or Ni aerogels, enabling continuous and sensitive detection as well as catalytic oxidation of glucose. In situ characterization and theoretical calculations revealed that the superior glucose oxidase reaction (GOR) performance of the AuNi bimetallic aerogel was attributed to the synergistic catalytic effect between gold and nickel, and the enhanced adsorption of glucose on the surface. Because of the excellent electrocatalytic property of AuNi bimetallic aerogel, it is later employed as the electrode material on for glucose consumption to promote the diabetic wound healing. After electrocatalytic GOR treatment, the wound healing process was significantly accelerated in diabetic wound of mice, compared to it of the untreated diabetic wound. Therefore, the deleption of glucose by electrooxidation is suggested to lower the glucose oxidation in diabetic wound, and showed its feasilibity for wound treatment. Thus, this electrocatalytic glucose consumption method by AuNi bimetallic aerogel provides a new strategy for the treatment of chronic diabetic wounds.

References

1. X. Jiang, R. Du, R. Hübner, Y. Hu, A. Eychmüller, *Matter*, **4**, 54-94 (2021).
2. M. Shi, Z. Du, Y. Qi, W. Li, H. Hu, X. Lin, S. Wang, Z. Tang, M. Zhou, *Theranostics*, **12**, 2658 (2022).
3. Q. Shen, J. Chen, T. Wang, Y. Yang, C. Huang, W. Zhang, G. Tian, N. Cheng, S. Kai, *J.Colloid Interf. Sci.*, **695**, 137753 (2025).
4. C. Wang, L. Wang, V. Nallathambi, Y. Liu, J. Kresse, R. Hübner, S. Reichenberger, B. Gault, J. Zhan, A. Eychmüller, B. Cai, *Adv. Mater.*, **36**, 2405200 (2024).
5. Q. Fang, J. Wen, H. Wang, X. Wei, L. Jiao, X. Luo, M. Sha, Y. Qin, M. Liu, L. Zheng, W. Gu, H. Zhong, L. Hu, C. Zhu, *Nano Energy*, **131**, 110217 (2024).

Ni-Co Layered Double Hydroxide Nanocages Mediated Reactive Oxygen Species Generation for Ultra-Sensitive Chemiluminescent Detection of Dopamine

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Chemiluminescence (CL) is vital for accurate dopamine detection. A CL has excellent profiles, including high sensitivity, low cost, low detection limit (LOD), simple operation, rapid, wide calibration range, and safety [1, 2]. But, the low quantum efficiency, poor sensitivity, and selectivity of the binary luminol/H_2O_2 system in the presence of some metal ions and biologically active molecules have dramatically restricted the feasibility of classical CL for analytical applications [3]. To overcome this barrier, efficient catalysts or reaction accelerators are often introduced to activate the coreactant, thereby enhancing ROS generation and significantly amplifying the CL signal [4]. Herein, nickel-cobalt layered double hydroxides hollow nanocages (Ni-Co LDHs) with peroxidase catalytic activities are well synthesized with zeolitic imidazolate framework-67 (ZIF-67) nanocrystals serving as the self-sacrificing templates. The metal active sites found on the host layer of Ni-Co LDHs and the low redox potential of Co^{3+}/Co^{2+} embark on good affinity towards H_2O_2. Decomposing H_2O_2 generates significant amounts of ROS, which enhance the CL response by an impressive factor of 952 times. Dopamine remarkably quenches the produced CL of luminol/H_2O_2/Ni-Co LDHs. Based on the concentration-dependent quenching of the intense luminol/H_2O_2/Ni-Co LDHs signal, we established a sensitive and selective CL method for detecting dopamine in the linear range of 5-1000 nM, achieving a low limit of detection of 1.51 nM. The developed method's practical efficacy was verified by determining dopamine in human serum. This study proves that Ni-Co LDHs embrace great prospects in analytical method development.

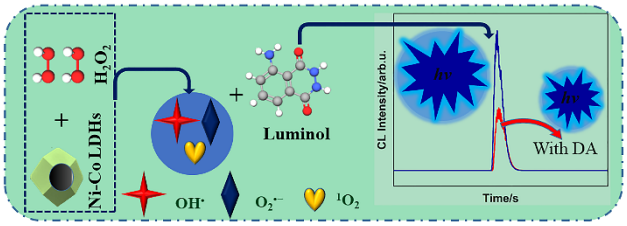


Fig.1 Detection of DA based on luminol/H_2O_2/Ni-Co LDHs CL

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References

1. H. Xing, C. Peng, Y. Xue, Y. Fan, J. Li, Wang, E., *Anal. Chem.*, **92**,10108-10113 (2020)
2. Y. Ma, Y. Zhao, X. Xu, S. Ding, Y. Li, *Talanta*, **235**, 122798 (2021)
3. N. Yang, H. Song, X. Wan, X. Fan, Y. Su, Y. Lv, *Analyst*, **140,** 2656-2663 (2015)
4. A. Qileng, S. Chen, H. Liang, M. Chen, H. Lei, W. Liu, Y. Liu, *Biosen. Bioelectron.* **234**, 115338 (2023)

Oxidation of 4-Aminophenylboronic Acid with Artesunate Accelerated by Ethanol for Artesunate Detection

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Malaria, primarily caused by *Plasmodium falciparum* [1], remains a critical global health concern [2], with artesunate widely administered for its potent and rapid antimalarial activity [3]. However, the growing threat of artesunate resistance necessitates the development of fast, accurate, and accessible detection methods. While conventional techniques such as high-performance liquid chromatography (HPLC) and fluorimetry provide high sensitivity, they often require sophisticated instrumentation and time-consuming procedures [4]. In contrast, current electrochemical detection methods may suffer from high oxidation potentials or involve complex electrode fabrication [5, 6]. This study presents a new, simple, and highly sensitive electrochemical strategy for the rapid detection of artesunate, achieving a response within 2 minutes. The method is based on the selective oxidation of 4-aminophenylboronic acid in the presence of ethanol, where artesunate is converted into electroactive 4-aminophenol, generating a distinct signal at approximately 0.083 V. The presence of ethanol significantly accelerates reaction rate and reduces analysis time from more than one hour to 2 minutes because of solvent effect. The system demonstrated a wide linear range (0.5–135 μM), a low detection limit of 0.12 μM, and excellent recovery in pharmaceutical formulations (98.70–103.59%). This rapid, cost-effective method holds strong potential for routine quality control and on-site artesunate detection in pharmaceutical and clinical settings.

Acknowledgements

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References

1. G. Figueroa-Miranda , S. Chen, M. Neis, L. Zhou, Y. Zhang, Y. Lo, J. A. Tanner, A. Kreidenweiss, A. Offenhäusser, and D. Mayer, "Multi-target electrochemical malaria aptasensor on flexible multielectrode arrays for detection in malaria parasite blood samples," *[illegible]*, **349, 130812 (2021).**
2. **World Health Organization,** *[illegible]*, **Geneva, Switzerland, 30–31 October (2019).**
3. T. E. Chiwunze, V. N. Palakollu, A. A. S. Gill, F. Kayamba, N. B. Thapliyal, and R. Karpoormath,

"A highly dispersed multi-walled carbon nanotubes and poly (methyl orange) based electrochemical sensor for the determination of an anti-malarial drug: Amodiaquine," *. BUFS-#D-8CH-$*, **97, 285–292 (2019).**

4. L. Mamede, G. W. Rangel, L. M. Shinyuy, N. Boussif, M.-F. Herent, B. Govaerts, O. Jansen, A. Ledoux, P. De Tullio, and J. Quetin-Leclercq, "Metabolite profiling of Artemisia afra and Artemisia annua extracts reveals divergent effects on Plasmodium falciparum," *1/ ZUPN FEJDOF*, **136, 156361 (2025).**
5. F. Ansah, F. Krampa, J. K. Donkor, C. Owusu-Appiah, S. Ashitei, V. E. Kornu, R. K. Danku, J. D. Chirawurah, G. A. Awandare, and Y. Aniweh, "Ultrasensitive electrochemical genosensors for species-specific diagnosis of malaria," *&MDLSPD1 JN-#DUB*, **429, 140988 (2022).**
6. A. Chen and S. Chatterjee, "Nanomaterials based electrochemical sensors for biomedical applications," *$/ FN-#PD-3FW/-*, **42, 5425–5438 (2013).**

Introduction of Journal Advanced Sensor and Energy Materials

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Multi-Principal-Element Nanoalloy Electrocatalysts: A Dual-Strategy Electrochemical Synthesis and Performance Investigation

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The accelerating depletion of fossil fuels and the intermittency of renewables have intensified the quest for robust, low/no-noble-metal catalysts that can drive both halves of the water-splitting reaction. We here advanced two complementary "bottom-up" and "top-down" electrochemical routes that allows for the preparation of multi-principal-element alloy (MEA) nanomaterials, which deliver exceptional hydrogen evolution reaction (HER) and oxygen evolution reaction (OER) activities with long-term stability. First, ultrasound-assisted pulsed electrodeposition (UPED), a 'bottom-up' approach, is employed to deposit IrPtMnFeCu, etc., MEA nanoparticles onto nano-carbon under ambient conditions. The resulting single-phase solid-solution catalyst exhibits superior hydrogen-evolution activity and durability in acidic media compared with commercial Pt/C. In the second, a cathodic-corrosion "top-down" route is developed for FeCoNiCrMn MEA in NaOH, yielding carbon-supported high-entropy oxide nanosheets and subsequent alloy-oxide heterostructures after controlled annealing. These materials deliver outstanding oxygen-evolution performance and long-term stability in both alkaline freshwater and natural seawater. This work highlights electrochemical synthesis as a versatile platform for preparation of high-performance MEA nano-electrocatalysts.

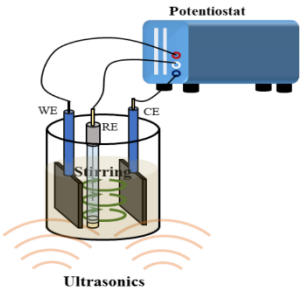


Fig.1 A schemetic illustration of UPED

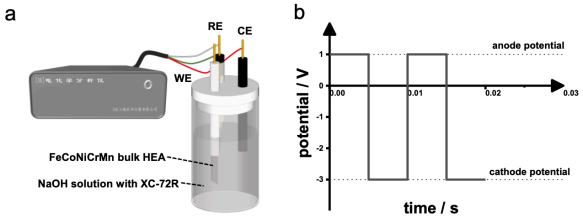


Fig.2 A schemetic illustration of cathodic corrosion

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References

1. C. Yao, P. Zhang, M. Liu, et al. *Electrochim. Acta*, **53**, 8359-8365 (2008)

2. M. Glasscott, A. Pendergast, S. Goines, et al. *Nat. Commun*, **10**, 2650 (2019)
3. P. Rodriguez, F. Tichelaar, M. Koper, et al. *J. Am. Chem. Soc.*, 133, 17626-9 (2011)

The Interface Challenges of Solid State battery

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With long-term expertise in lithiumion batteries, our team has recentlyconducted systematic and innovative research on critical challenges in solid-statelithium batteries, yielding significant breakthroughs[1]. Regarding cathode interface structural stability mechanisms, we discovered that the curvature of transition metal layers governs the structural stability of layered oxide cathodes in all-solid-state lithium batteries under high-voltage[2]. We proposed a novel cathode modification strategy featuring synergistic doping/coating through mesoscale elemental segregation in nanoscale oxide coatings[3], and pioneered a ternary composite cathode layer ("layered oxide cathode/polymer/solid electrolyte") to resolve interfacial contact failure[4]. For anode interface engineering, interfacial voids and cracks in lithium metal anodes were suppressed by pre-engineering artificial SEI films on solid electrolyte surfaces, enabling long-cycle stability in all-solid-state Li metal batteries. Furthermore, we developed novel ion-conductive polymer binders that, combined with dry-/wet-processing techniques, enabled the fabrication of ultrathin solid electrolyte membranes exhibiting high ionic conductivity and flexibility, along with stress-compatible integrated cathodes with high areal loading. These binders facilitate the formation of mechanically robust and ionically conductive solid electrolyte interphase (SEI) and cathode electrolyte interphase (CEI) at electrode interfaces, achieving interfacial stabilization. Through integrated isostatic pressing and lamination processes, we ultimately realized commercially viable sulfide-based all-solid-state pouch cells with High Energy Density[5].

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References

1. R. Shao and W. Yang, *Adv. Energy Mater,* 2023, 13, 2203703
2. R. Shao, L. Zhang and W. Yang, *Journal of Energy Chemistry,*2025.02.031
3. S.Sun and W.Yang, *Advanced Function Materials*, 2022, 32, 2201528
4. R. Shao and W. Yang, *Small*, 2024, 2310547
5. N.Ahmad, R.Shao and W.Yang, *Journal of Energy Chemistry,*2025, 102,377-385

Electrochemical biosensors utilizing aptamers that are enhanced with MXenes nanoscale catalyst layers; our team outputs

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The utilization of biomarkers represents a significant and advancing approach for comprehending various cancers [1]. They fulfill numerous roles in domains such as analytical epidemiology, randomized clinical trials, screening, diagnosis, and risk assessment. Biomarkers facilitate the monitoring of changes in tissue components or bodily fluids, providing crucial tools for the accurate classification of diseases and their associated risk factors. Additionally, they offer valuable insights into the fundamental mechanisms of diseases, thereby deepening our understanding in this field. Detectable signals present in biological samples such as blood, urine, or tissue enable diverse applications, including disease screening, diagnosis, characterization, and monitoring.

MXenes, a novel category of two-dimensional (2D) metallic materials, have attracted considerable interest due to their distinctive properties. Their high electrical conductivity, large surface area, and ease of modification make MXenes particularly suitable for sensor fabrication, especially in electrochemical biosensors [2]. This presentation will explore aptamer-based biosensors enhanced with MXenes, along with an examination of relevant research in this area.

References

1. S. Naylor, *Expert Rev. Mol. Diagn.,* **3(5):** 525-529 (2003)
2. N. Zare, H. Karimi-Maleh, Z. Zhang, Z. L. Fu, J. Rouhi, N.Zhong, Y. Wen, M. Ghalkhani, *Carbon Lett.* 35: 1691–1700 (2025)

Analysis of Aging Mechanical Characteristics of Polyolefin Samples Based on Nano-mechanics and AFM

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UV aging is a common environmental factor that significantly impacts the performance and lifespan of many materials. This study employs a 340 nm UV light source to replace the conventional UVA-340 fluorescent UV lamp in UV accelerated aging experiments. Two technical configurations—side and bottom illumination—were applied to irradiate the detection area of atomic force microscopy (AFM) sample regions. Morphological characterization tests on standard gratings demonstrated that the UV light sources caused no interference with the imaging resolution or detection accuracy of the AFM. Subsequent evaluations of polyethylene film samples before and after UV aging revealed consistent results in surface structure morphology and mechanical properties, confirming the applicability of the AFM-based in-situ UV aging detection method developed in this work. The proposed technique provides a robust platform for investigating correlations between UV aging mechanisms and structural changes in materials.

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References

1. Wang X, Zhang X, Wu X H, et al. *Polymer Materials Science & Engineering*, **35**, 160-166 (2019)
2. Cai Y, Gao F X, Zhang Y M, et al., *Journal of Functional Polymers*, **33**, 70-77 (2020)

Preparation of Lithium-rich Lithium Vanadium Phosphate Materials and Modification of Magnesium Ion Doping

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Lithium vanadium phosphate is considered as a very potential lithium ion battery cathode material with high specific capacity and high voltage window. We try to use the lithium ion surplus strategy and the magnesium ion dopant to improve the electrochemical properties of the materials. The experimental results show that by adjusting the lithium source to a molar ratio of 3.15, the maximum discharge ratio capacity of the surplus lithium material is larger than that of original ratio material, and in several ratios of lithium surplus material, the best discharge specific capacity and cycle stability were demonstrated. After the molar ratio of lithium source is 3.2, the specific discharge capacity of the first circle decreased, and after the 200 cycles, the residual capacity also decreased, indicating that the excessive lithium surplus causes impurities in the material and leads to the performance decline.

The material is further modified by magnesium ion doping. By introducing metal ions to produce lattice defects in the material structure, to improve the electronic conductivity of the material, and then improve its cycle stability and ratio performance. Magnesium ion-doped materials exhibit cyclic stability under high-current discharge.

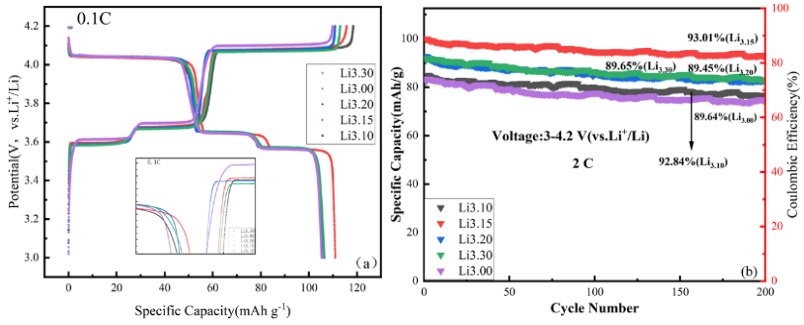


Fig.1 (a) is the 0.1 C charge-discharge curve of materials with different lithium-ion contents, and (b) is the 200 cycles of charge-discharge cycles of materials with different lithium-ion contents at 2 C current

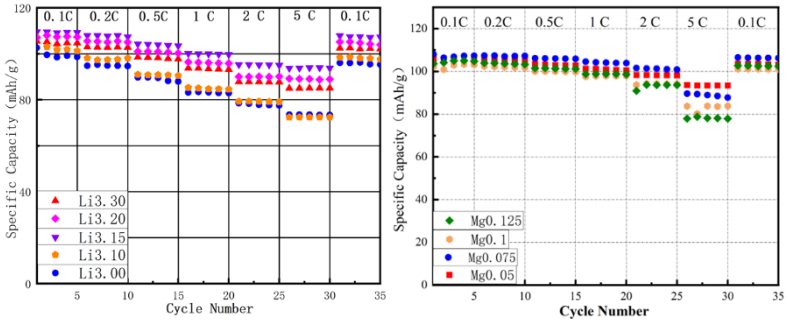


Fig.2 (a) is the Undoped rate performance, and (b) is the Rate performance after doping

Efficient and simple synthesis of B_2O_3-Al_2O_3 nanocomposites assisted by deep eutectic solvent for production of 5-hydroxymethylfurfural from glucose

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The catalytic conversion of glucose to high value-added platform chemical 5-hydroxymethylfurfural (HMF) is a promising biorefinery process, and alumina-boria catalysts are considered to be green and mild solid acid catalysts for this catalytic reaction. Here, compared to the common synthesis methods with complicated steps, we reported a simple and efficient strategy to prepare B_2O_3-Al_2O_3 nanocomposites by calcining cost-effective glucose-urea deep eutectic solvent (DES) solution containing the precursors. The prepared B_2O_3-Al_2O_3 nanocomposites exhibited an open three-dimensional skeleton and two-dimensional thin lamellar substructure, endowing them with abundant mesoporous sturctures and a high specific surface area (228.27 m^2/g). The introduction of boron changed the ratios of different aluminum species (Al^{IV}, Al^{V}, Al^{VI}) and borate species (BO_3, BO_4), thus further affecting the acidity and the types of acid sites of the materials. The prepared B_2O_3-Al_2O_3 bifunctional acid catalysts possessing abundant Lewis acid sites and adjustable Brønsted acid sites showed complete glucose conversion and 55.38% of HMF yield under the optimum conditions. Besides, the material also showed promising stability and reusability during 5 cycles. Our study proposed a concise method to synthesize alumina-boria solid acid catalysts assisted by glucose-urea DES. We hope to extend the application and prospect of this efficient and simple synthesis strategy.

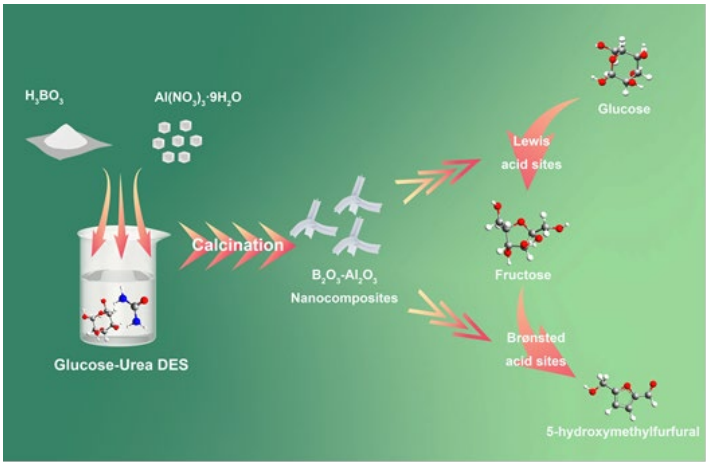


Fig.1 Schematic diagram of one-step synthesis of B_2O_3-$Al_2O_3$with deep eutectic solvent and catalytic conversion of glucose to HMF

Acknowledgements

This work was financially supported by the Science and Technology Development Plan Project of Jilin Province (20240602122RC), National Natural Science Foundation of China (Nos.22074137, 22274149 and 22274146).

References

1. K. Rong, J. Wei, L. Huang, Y. Fang, S. Dong, Nano Reseasrch, 18, 94907060 (2025).

High-Valence Mn MOF Inspired by Laccase Mediators Enables Versatile Nature-Mimicking Catalysis

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In nature, active Mn^{3+} –ligand complexes produced by laccase catalyzed oxidation can act as the low-molecular mass, diffusible redox mediators to oxidize the phenolic substrates overcoming the limitations of natural enzymes. Learning from the metal–ligand coordination of natural functional units, high-valence Mn metal–organic framework (Mn MOF) is constructed to simulate the catalysis in natural mediator system. Benefiting from the characteristics of nanoscale size, rich metal coordination unsaturated sites, and mixed valence state dominated by Mn(III), Nano Mn(III)-TP exhibits superior laccase-mimicking activity, whose V_{max} (maximal reaction rate) is much higher than that of natural laccase. Referring to natural systems, relevant free radical experiments prove that the material induces the production of active oxygen species with the assistance of carboxylic acid, and active oxygen species further oxidize phenolic substrates. Based on its robust performances, the primary oxidative degradation of an emerging pollutant triclosan (TCS) is creatively applied, an important antiasthmatic medicine terbutaline sulfate (TBT) detection, and the synthesis of non-toxic and black near-natural dyes for dyeing. By simulating the essential mediators of natural enzymatic catalysis, an Mn MOF-based material that demonstrates multiple novel applications is successfully developed, which introduces a new reliable strategy for achieving versatile nature-mimicking catalysis.

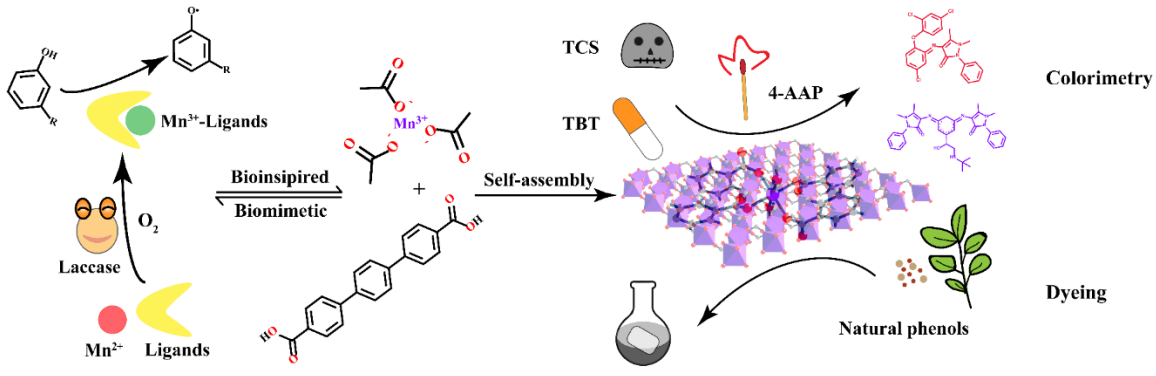


Fig.1 Bioinspired high-valence Mn MOF enables versatile nature-mimicking catalysis

Acknowledgements

This work was financially supported by the Science and Technology Development Plan Project of Jilin Province (SKL202302032), China, and the National Natural Science Foundation of China (Nos. 22274149 and 22074137).

References

1. L. Xu, J. Nan, S. Han, Z. Yu, S. Wu, Y. Fang and S. Dong, *Small*, 2024, **20**, 2405293.

Revealing the heterogeneous catalytic kinetics of PtRu nanocatalysts at single particle level

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Decades of extensive research efforts by scientists in the field of catalysis and nanomaterials have led to a large number of excellent bimetallic nanocatalysts. These precisely engineered hybrid nanomaterials, constructed through controlled integration of dual metallic elements at the atomic scale, demonstrate exceptional catalytic performance in electrocatalytic processes. Comparison of the structural features and catalytic performance of bimetallic nanocatalysts will help to develop the unified understanding of the structure-reaction relationships. [1] Due to the intrinsic heterogeneity of nanocatalysis, many underlying catalytic details on nanocatalysts are hidden in ensemble-averaged measurements. [2] Single-molecule fluorescence technique was utilized to reveal the difference in catalytic kinetics among PtRu bimetallic nanocatalysts, Pt and Ru monometallic nanocatalysts at single particle level. The results show that bimetallic nanocatalysts have higher apparent rate constant and desorption rate constants relative to monometallic, which leads to their higher catalytic activity. At single particle level, the bimetallic nanocatalysts have a wider distribution of apparent rate constants, suggesting that the bimetallic nanocatalysts have higher activity heterogeneity relative to monometallic nanocatalysts. By investigating the relationship between the reaction rate and the rate of dynamic activity fluctuations, spontaneous surface restructuring and reaction-induced surface restructuring of nanoparticles were found. The surface of bimetallic nanoparticles restructuring faster, which made the bimetallic nanocatalysts more active. These findings provide new insights into the design of highly active bimetallic nanocatalysts.

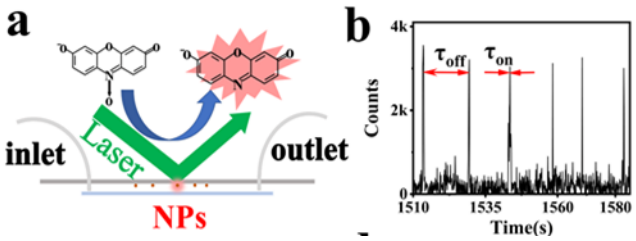


Fig.1 a) The experimental setup of fluorescent catalytic reactions b) A segment of the fluorescence turnover trajectory

Acknowledgements

This work was supported by the National Natural Science Foundation of China (21925205, 22072145, 22372155, and 22102172).

References

1. M. Zhao, W. J. Li, M. W. Yang, Z. H. Zhao, R. Ye, X. W. Mao, P. Padgett, P. Chen, Nat. Catal. 2024, 7, 912-920.
2 . Y. Xiao, Z. C. Guo, J. Cao, P. Song, B. Yang, W. L. Xu, Proc. Natl. Acad. Sci. U. S. A. 2024, 121, 1

Cell Wall Binding Strategies Based on Cu_3SbS_3 Nanoparticles for Selective Bacterial Elimination and Promotion of Infected Wound Healing

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Utilizing nanomaterials as substitutes for antibiotics is regarded as a promising strategy in combating antibiotic resistance. However, the main challenge is that nanomaterials may attack both bacterial and mammalian cells indiscriminately, limiting their practical application. In this study, Cu_3SbS_3 nanoparticles (NPs) capable of generating reactive oxygen species (ROS) were found to selectively adsorb and kill bacteria without causing significant damage to mammalian cells. This selectivity is attributed to the interaction between the oxygen in the bacterial cell wall's N-acetylmuramic acid and the copper in the NPs, combined with the short diffusion distance of ROS in the surrounding medium. The antibacterial mechanism of Cu_3SbS_3 NPs was identified as follows: these NPs catalyze the generation of O_2^-, which is subsequently converted by superoxide dismutase into H_2O_2. Then, the NPs further catalyze H_2O_2 to produce •OH and $^1O_2$. These ROS species launch an in situ attack on bacteria, depleting bacterial glutathione and disrupting the bacterial antioxidant defense system. Notably, Cu_3SbS_3 NPs have been demonstrated to effectively prevent biofilm formation. In experiments, they promoted the healing of MRSA-infected wounds. Importantly, the design of bacterial cell wall-binding nano-antibacterial agents can be widely expanded through diverse approaches.

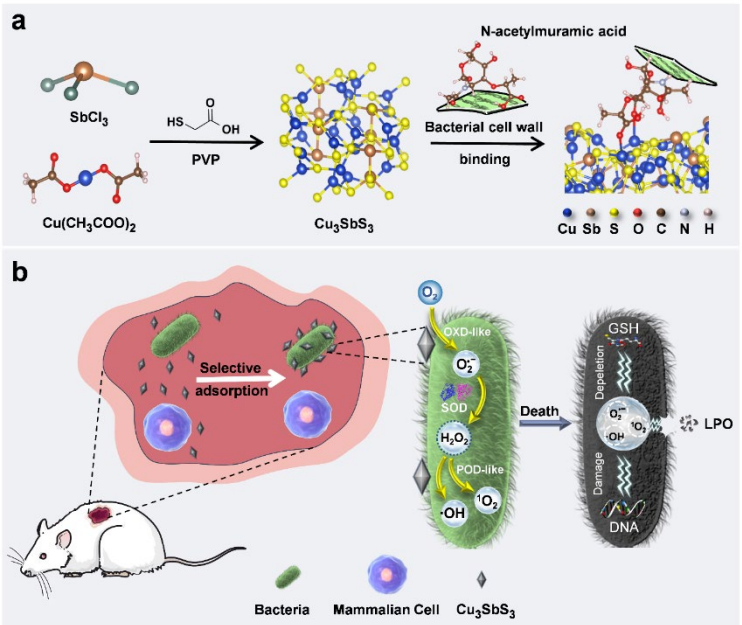


Fig.1 Schematic diagram describing the cell wall-binding strategies of Cu_3SbS_3 NPs for killing bacteria. (a) Preparation of Cu_3SbS_3 NPs for cell wall binding. (b) Mechanism for selectively killing bacteria: Cu_3SbS_3 NPs bind to the bacterial surface exploiting the distinctive cell wall structure of bacteria and catalyze the

formation of $O_2^{\bullet-}$ for initial damage to bacteria. The bacteria employ their inherent antioxidant defense catalyzed by SOD to convert $O_2^{\bullet-}$ into H_2O_2, and subsequently, which is aptly catalyzed by Cu_3SbS_3 NPs to generate active •OH and $^1O_2$. This triggers a cascade of synergistic effects, including GSH depletion, DNA damage, and lipid peroxidation, ultimately resulting in bacterial demise.

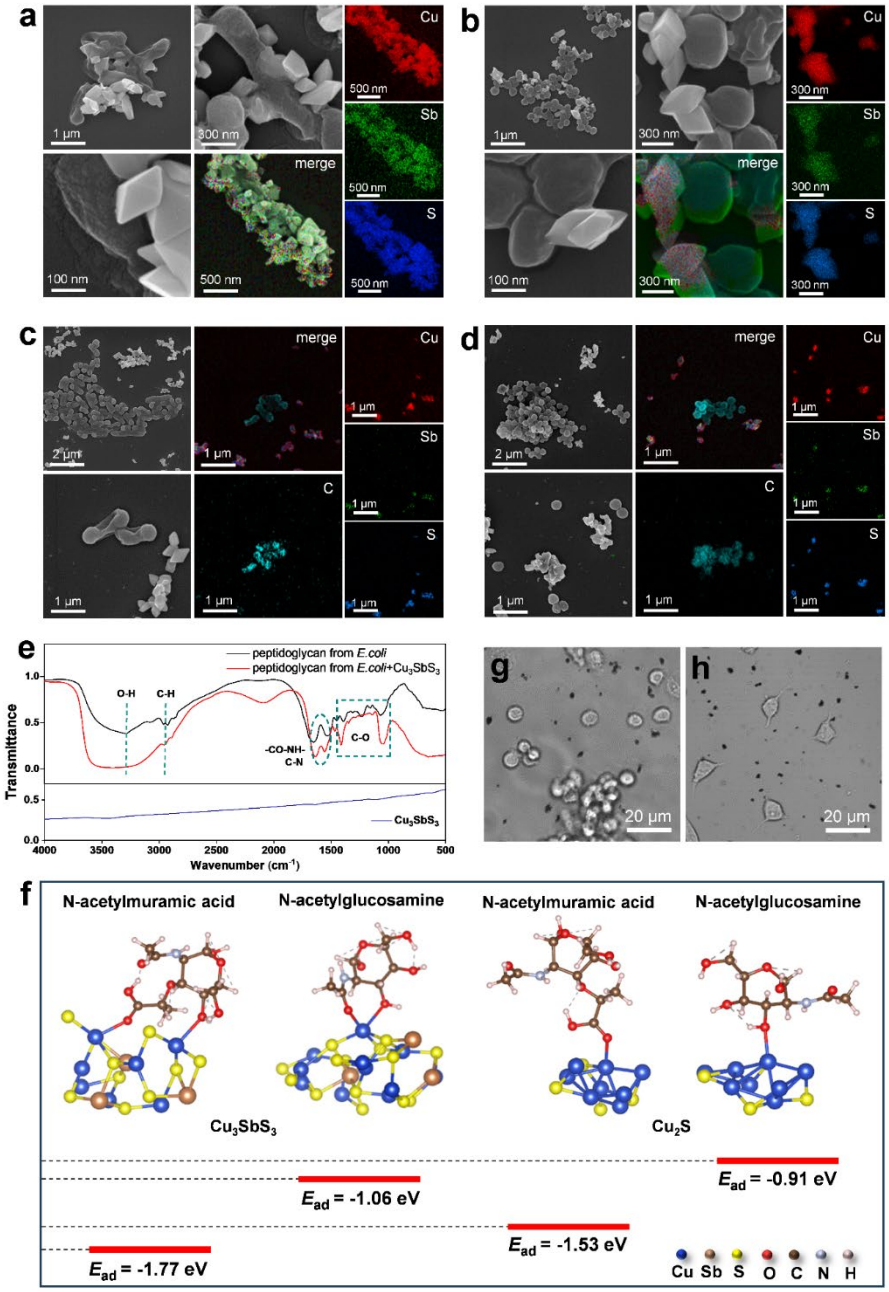


Fig.2 Selective action of Cu_3SbS_3 NPs to bacteria. Cu_3SbS_3 NPs treated (a) normal *E. coli*, (b) normal MRSA, (c) *E. coli* with removed cell walls, (d) MRSA with removed cell walls. (e) FT-IR spectra of Cu_3SbS_3 NPs and the peptidoglycan from *E. coli* cell walls (4000-500 cm^{-1}). (f) DFT calculations. In these plots, most atoms in the unit cell of the NPs were omitted to clearly show the binding sites, and the complete plots were available in the supplementary information. Distribution of Cu_3SbS_3 NPs after interaction with (g) suspended cells, (h) adherent cells.

Acknowledgements

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References

1. Chernousova S and Epple M, *Angew. Chem. Int. Ed.*, **52**, 1636-1653 (2013).
2. Chen L C, Kung S K, Chen H H, et al. *Carbohydr. Polym.*, **82**, 913-919 (2010).
3. Lee I, Kim J, Kwak R, et al. *Adv. Funct. Mater.*, **33**, 2213650 (2023).
4. Jenkins J, Mantell J, Neal C, et al. *Nat. Commun.*, **11**, 1626 (2020).

Palladium single-atom assembly for highly efficient synthesis of hydrogen peroxide

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Hydrogen peroxide (H_2O_2) is widely used in chemical synthesis, paper bleaching, wastewater treatment, etc. At present, most of the H_2O_2 that we used depends on the conventional anthraquinone oxidation process, leading to environmental pollution and energy waste. Compared with the commercial anthraquinone process, the in situ production of H_2O_2has attracted extensive research interest in recent years due to its safety and environmental friendliness1,2. Recently, some researchers have focused on the enzymatic reactions of living organisms. Flavin-containing oxidoreductases3, including glucose oxidase, alcohol oxidase and formate oxidase (FOD), can catalyze the production of H2O2 under mild conditions without energy input. In this work, inspired by the electron transfer path of natural formate oxidase (FOD), we show that palladium single-atom assembly (Pda) can catalyze H_2O_2 production in the presence of formic acid. Enzyme kinetic tests, electrochemical tests and DFT calculations confirmed that Pda can effectively catalyze the dehydrogenation of formic acid and the subsequent reduction of oxygen to $H_2O_2$with high selectivity, achieving a H_2O_2 production rate of 22.86 mol gPd-1h-1. Compared with isolated palladium single atoms (Pdi) and palladium nanoparticles (Pdp), the high activity and selectivity make Pda have high FOD-like activity for the rapid synthesis of H_2O_2under mild conditions.

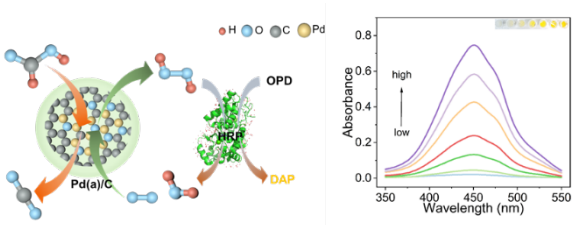


Fig.1 Characterization of catalysts.

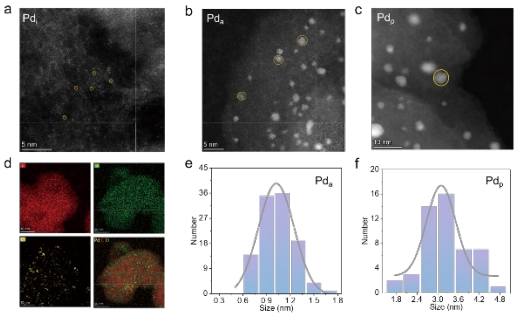


Fig.2 Synthesis and detection of hydrogen peroxide.

Acknowledgements

This work was financially supported by the National Natural Science Foundation of China (Nos. 22074137 and 22274146)

References

1. Wei Z, Deng B, Chen P, Zhao T, Zhao S. Chem Eng J 428, 131112 (2022)
2. Chen S, et al. J Am Chem Soc 144, 14505-14516 (2022)
3. Romero E, Castellanos JRG, Gadda G, Fraaije MW, Mattevi A. Chem Rev 118, 1742-1769 (2018)

Polymerizable Quaternary Ammonium Salt-Based Deep Eutectic Gels for Epidermal Sensing Electrodes

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Epidermal sensing electrodes represent a critical component in the development of smart healthcare, yet current commercial hydrogel materials face challenges such as inadequate skin compatibility, electrode detachment, and signal distortion in sweat-rich environments. To address these issues, this study developed a novel polymerizable quaternary ammonium salt-based deep eutectic gel (DES gel) system. The gel was synthesized by first preparing a deep eutectic solvent (DES) from diallyldimethylammonium chloride (DMDAAC) and urea, followed by UV-induced free radical polymerization. The resulting DES gel exhibits outstanding properties, including high transparency (94%), excellent environmental stability (resistance to drying and freezing), extreme elasticity (strain >2400%), as well as conductivity, self-healing capability, and recyclability. Owing to these unique characteristics, the gel demonstrates superior skin compatibility and sweat-resistant performance, enabling its direct application as an epidermal sensing electrode for monitoring various physiological signals such as body motion and electrocardiogram (ECG). This technology not only provides new insights into the design and application of DES gels but also offers a viable solution to the limitations of existing commercial epidermal sensing materials. The findings hold significant promise for advancing next-generation epidermal electrode materials and accelerating progress in smart healthcare technologies.

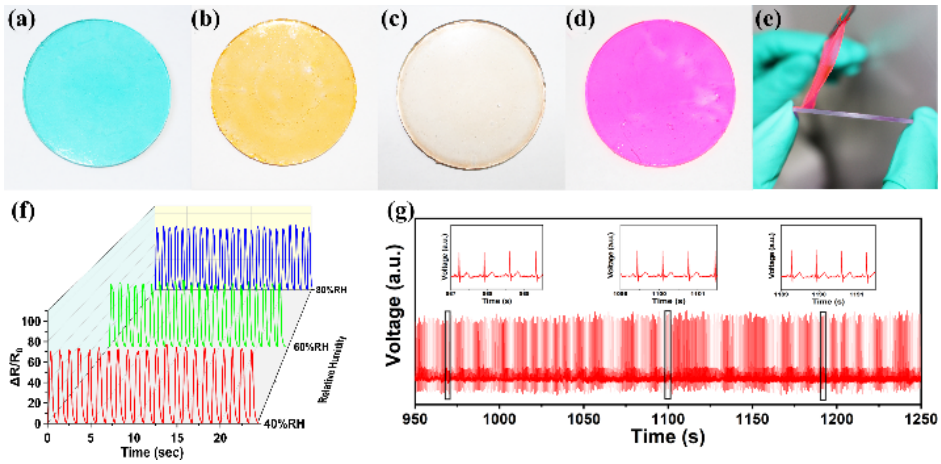


Fig. 1 (a–e) Photographs of DMDAAC-urea deep eutectic gel (DES gel) dissolving different dyes, including water-soluble dyes: (a) malachite green, (b) orange II, (c) alizarin red, and (d) rhodamine B, as well as (e) oil-soluble dye oil red O. (f) Relative resistance change ($\Delta R/R_0$) of the DMDAAC-urea DES gel electrode under varying humidity levels. (g) ECG signals collected by the polymerizable quaternary ammonium salt-based DES gel sensing electrode in human trials.

Acknowledgements

This work was financially supported by the Science and Technology Development Plan Project of Jilin Province (20240602122RC), National Natural Science Foundation of China (Nos.22074137, 22274149 and 22274146).

References

1. Chang, S.; Rong, K,*; Wang, Y.; Yu, Z.; Zhai, J.; Tian, H.; Fang, Y.*; Dong, S.*; *Chem. Eng. J.* 2024, 499

Accurate Molecular Sensing based on a Modular and Customizable Cas12a-Assisted Nanopore Operational Nexus (CANON)

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Solid-state nanopore technology has garnered significant attention in the field of biosensing due to its single-molecule detection capabilities. However, its resolution for small-molecule targets remains limited, and the design of molecular probes is often complex. Existing approaches frequently rely on chemical modifications or single-mode signal outputs, thereby constraining the flexibility and applicability of multiplexed target detection. Although the CRISPR/Cas system demonstrates high specificity in molecular recognition, its integration with nanopore systems is often hindered by the susceptibility of the "signal-OFF" mode to interference, which compromises the signal-to-noise ratio.

In this study, we propose a modular and customizable CRISPR/Cas-assisted nanopore operational network (CANON). This platform leverages the trans-cleavage activity of CRISPR/Cas12a to degrade a blocking strand (RI), thereby releasing an initiator (I) that triggers downstream DNA self-assembly reactions (Fig. 1)—such as the hybridization chain reaction (HCR), G-quadruplex-based HCR (G-HCR), and the double-stranded polymer strategy (DPS). These reactions convert a variety of input targets—including double-stranded DNA, RNA, microRNA (miRNA), and Pb^{2+}—into structurally distinct, large DNA probes, which are subsequently detected with high resolution through nanopore current signatures. CANON is composed of four functional modules: upstream target recognition, Cas-mediated cleavage, downstream DNA assembly, and nanopore signal readout, collectively supporting simultaneous multi-target detection.

The CANON system achieves detection sensitivities of 1 copy/μL for FluA genes (Fig. 2), 1 nM for miRNA (e.g., let-7d, Fig. 3A), and 100 nM for Pb^{2+} (Fig. 3B), with strong anti-interference capabilities, including resistance to coexisting heavy metals or non-target nucleic acids. By alternating between HCR and G-HCR, the system enables concurrent discrimination of FluA and FluB, exhibiting distinct current amplitude reductions (HCR: 100 pA vs. G-HCR: 600 pA) and temporal signal distributions (0–2.5 ms vs. 0–25 ms),

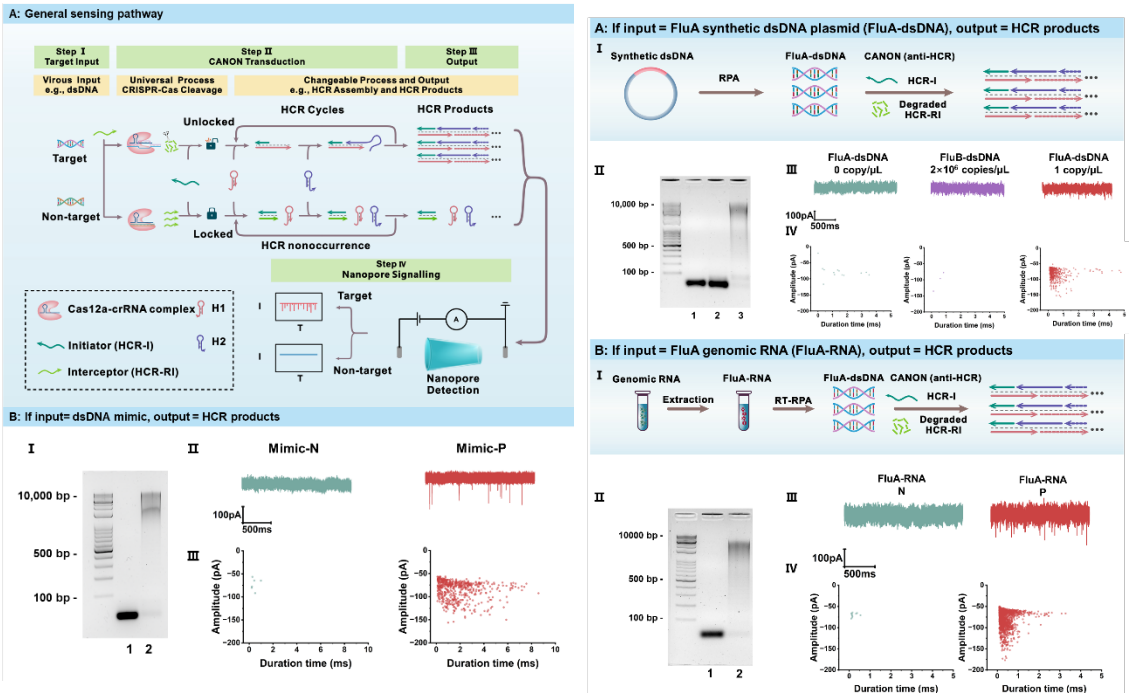


Fig. 1. Scheme of CANON and nanopore measurements of using dsDNA mimic as a test model.

shown in Fig. 4. The incorporation of DNA nanostructures, such as tetrahedral tags, further enhances signal specificity.

Through its modular architecture, the CANON platform seamlessly integrates the CRISPR/Cas system with DNA self-assembly techniques, effectively overcoming key limitations of conventional nanopore sensing. It offers high sensitivity, superior resolution, and robust multi-analyte detection, without requiring intricate probe design. Its compatibility with a "signal-ON" detection mode provides a versatile solution for clinical diagnostics, environmental monitoring, and related applications. Future developments may further expand the platform's utility by diversifying the types of CRISPR enzymes and DNA assembly strategies employed.

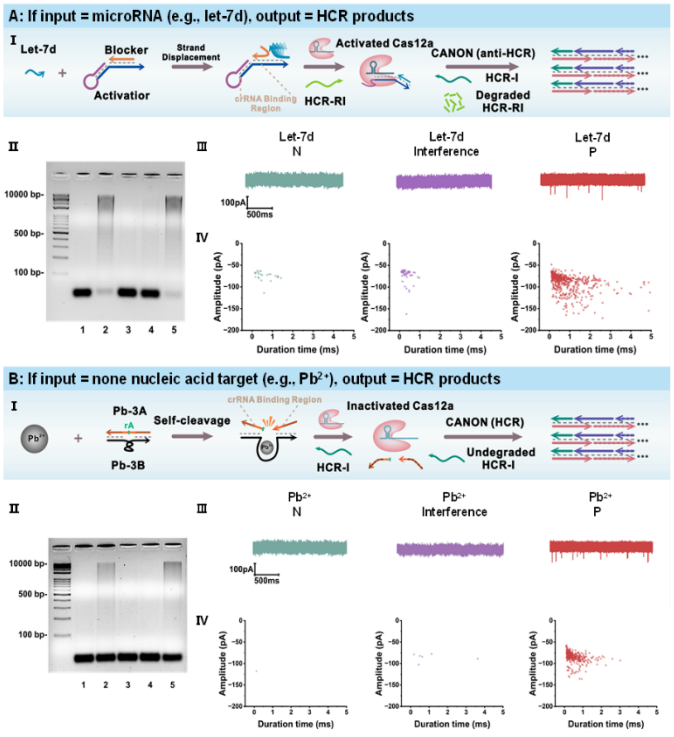


Fig. 3. Illustration of CANON to detect miRNA (i.e., let-7d) and small molecules (i.e., Pb^{2+}).

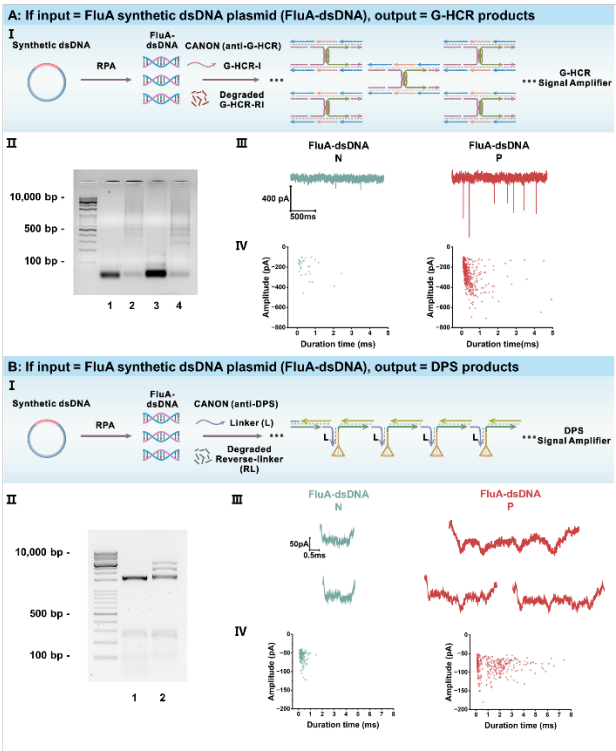


Fig. 4. Illustration of CANON to detect target (i.e., FluA-dsDNA as model) with replaced downstream outputs such as (A) G-HCR and (B) duplex polymerization strategy (DPS) to achieve more output modalities and improved differentiation effects.

Acknowledgements

We sincerely appreciate Professor Meng Liu in Dalian University of Technology for the useful direction in handing the DNAzyme. This work was supported by the Science and Technology Development Plan Project of Jilin Province (SKL202402017, SKL202302030), Natural Science Foundation of China (22474135, 22074136), The Jilin Province Science Fund for Distinguished Young Scholars (20240101005JJ) and Major Project of Changchun State Key Laboratory (23GZZ03).

References

1. H. N. Wang, R. J. Zhao, B. Zhang, Y. Xiao, C. M. Yu, Y. S. Wang, C. X. Yu, Y. D. Tang, Y. R. Li, B. Y. Lu, B. L. Li*, "CHFX-$1 FN-ROUBE", 2025, 64, e202423473.

Design and synthesis of lithium ionophores based on heterocyclic crown ethers

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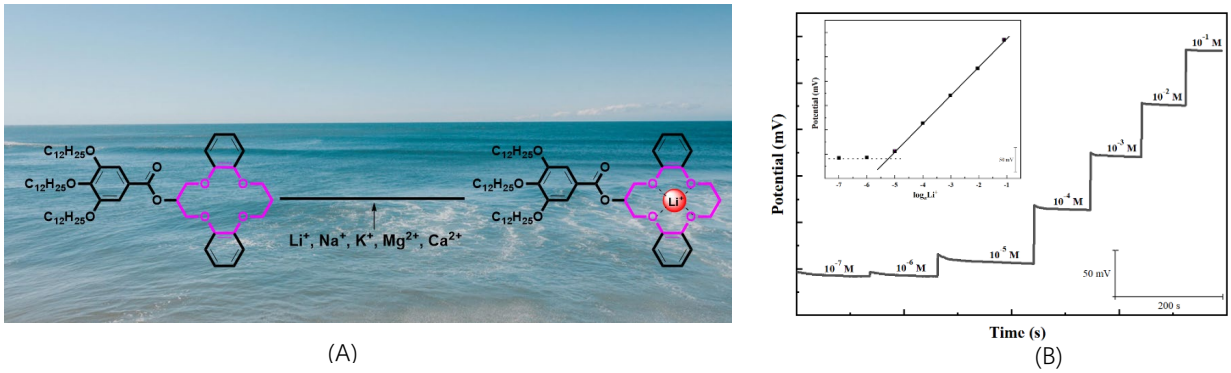
CAS Key Laboratory of Coastal Environmental Processes and Ecological Remediation, Yantai Institute of Coastal Zone Research (YIC), Chinese Academy of Sciences (CAS), Shandong Key Laboratory of Coastal Environmental Processes, YICCAS, Yantai, Shandong, 264003, PR China

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At present, lithium batteries have become the core of clean energy development, and their future market prospects are very broad [1]. At the same time, lithium pollution in the ocean will also become a hot topic of global concern. Therefore, it is urgent to design ionophores with high selectivity for Li^+, especially over Na^+ and K^+ [2]. Crown ethers are well-known ion carriers for certain metal ions, and their selectivities can be controlled by adjusting the number of coordination sites and cavity size [3].

According to previous work reports, the 12-14 membered CE ring (cavity size: 1.2-1.8 Å) is the most selective for Li^+, with an ion diameter of approximately 1.4 Å, and the most favorable coordination numbers for Li^+ are expected to be 4, 5 and 6 [4]. On this basis, we designed and synthesized compound 7,8,16,17-tetrahydro-6H,15*H*-dibenzo [*b,i*] [1,4,8,11] tetraoxacyclotetradecin-7-yl 3,4,5-tris(dodecyloxy)benzoate as a Li ionophore. Under the optimized conditions, the proposed Li^+-ISE exhibits a Nernstian response in the activity range from $10^{-5.0}$ - $10^{-1.0}$ M with a slope of -58.39 ± 0.02 mV/dec and a detection limit of $10^{-5.3}$ M. Additionally, the selectivity of the Li^+-selective membrane was estimated by the separated solution method, and the logarithms of the selectivity coefficients toward Ca^{2+}, Mg^{2+}, Na^+ and K^+ are −2.76, −3.02, −1.30 and −1.00, respectively.



(A) (B)

Fig.1 (A) Crown ether derivative as lithium-ion ionophore and the recognition strategy. (B) Dynamic responses of the Li^+-ISE and its corresponding calibration curve.

Acknowledgements

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References

1. P. W. Fritz, T. Ashirov and A. Coskun, *Chem*., **10**, 2207–2219 (2024)
2. H. Gohil, S. Chatterjee, S. Yadav, E. Suresh and *A. R.* Paital, *Inorg. Chem*., **58**, 7209−7219 (2019)
3. G. W. Gokel, W. M. Leevy and M. E. Weber, *Chem. Soc. Rev*., **104**, 2723–2750 (2004)
4. U. Olsher, R. M. Izatt, J. S. Bradshaw and N. K. Dalley, *Chem.Rev*., **91**, 137–164 (1991)

Research on the online monitoring system for Food freshness detection

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Food spoilage is a crucial food safety issue that threatens human health and restricts economic development [1]. Exploring reliable and effective strategies for real-time monitoring of food freshness is of great significance. The total volatile basic nitrogens (total VBNs) including ammonia and biogenic amines, produced through the action of microorganisms during food storage, are considered important markers for monitoring food freshness[2-3]. Conventional analytical methods for detecting VBNs mainly include electronic nose or tongue, instrumental techniques, and capillary electrophoresis, although with high accuracy, the operation of these methods is time-consuming, complex, and destructive, which cannot meet the demands of in-situ and real-time monitoring for food freshness throughout the supply chain.We have developed a miniaturized online monitoring system for VBNs based on molecular imprinting, laying a solid research foundation for real-time monitoring of food freshness. The system uses a QCM chip sensitive membrane with molecular imprinting polymers as the recognition unit, and polymerizes the molecular imprinting recognition membrane as the recognition unit on the surface of the QCM chip through an electrochemical polymerization method. The system contains a high-precision QCM sensing module, which achieves automatic matching and precise measurement of the quartz crystal resonant frequency within a wide frequency range through the deep integration of embedded software and hardware circuits. In addition, the system innovatively designs an integrated miniaturized QCM detection device with functions such as gas filtration, temperature control, duct turbulence, and APP operation, and sets a high-concentration warning function, triggering an alarm when the threshold is exceeded.

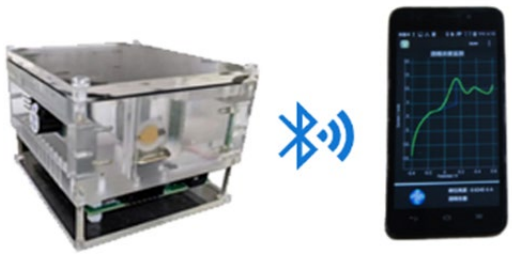


Fig.1 The scheme of online monitoring system for etomidate based on QCM

Acknowledgements

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References

1. H. He, D.-W. Sun, Z. Wu, H. Pu, Q. Wei, *Trends in Food Science & Technology*, **119,** 243-256 (2022).
2. Johnson Esua, J.H. Cheng, D.-W. Sun,*Ultrasonic Sonochemistry*, **76** (2021).
3. W. Zhang, D.-W. Sun, J. Ma, J. Cheng, Z. Wang, B.Z. *Tang, Analytica Chimica Acta*, **1221** (15) (2022).

Revealing the regulation of interfacial water structure on interfacial molecular recognition by surface-enhanced infrared absorption spectroscopy

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The interaction between proteins and metal ions in aqueous solutions is a crucial aspect of physiological activities and is significantly influenced by the unique physicochemical properties of water. [1][2] This study constructs a model system simulating the heterogeneous surface of proteins and achieves precise control of the coordination ability of the model system through accurate molecular introduction strategies. [3][4] In order to investigate the interactions between complex protein interfaces and metal ions, we designed a model system with carboxyl groups at the terminal ends. By introducing new functional groups, we modulated the deprotonation degree of the terminal groups and the interfacial water network, thereby regulating the weak interactions between the interface and Ni^{2+}. [5] Based on this, the interaction mechanism between Ni^{2+} and the model system, as well as key factors influencing this interaction, including electrostatic interactions, hydrogen bond competition, and the hindrance effect of water molecules, were thoroughly investigated through a series of detection methods including SEIRA spectroscopy, XPS, and QCM-D. Contrary to common perception, electrostatic interaction is not the dominant factor in ionic coordination within the model system. The interfacial water structure becomes the key determinant of nickel ion coordination, followed by the hydrogen bonds between terminal groups, further highlighting the central role of water structure in this process.

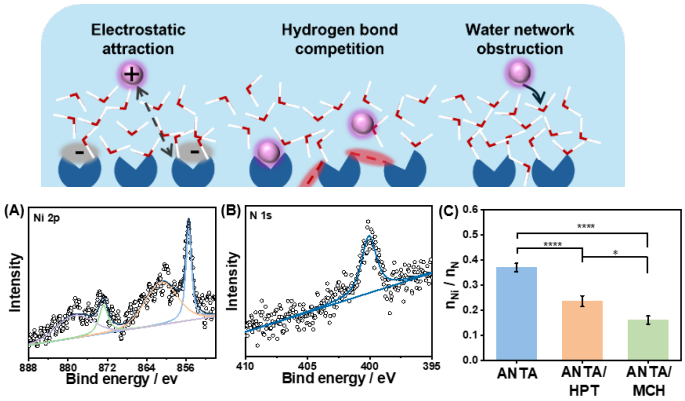


Fig.2 XPS (A) Ni 2p and (B) N 1s spectra for ANTA. Empty symbols refer to the XPS spectrum. Lines represent the result of fitting the XPS spectrum. (C) The n_{Ni} / n_N was calculated based on the XPS results to indicate the relative content of

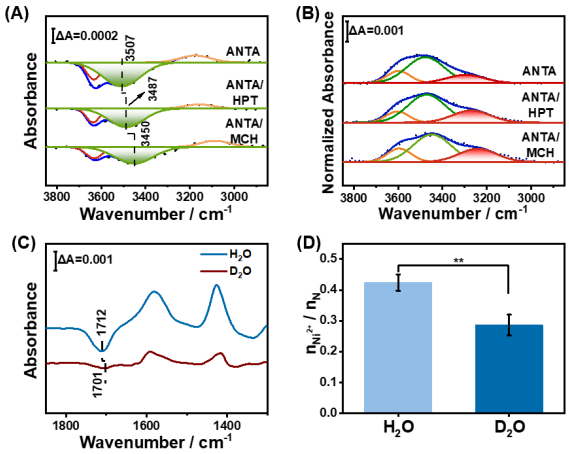


Fig.3 Monitoring of interfacial water structure and the impeding effect of water networks on Ni^{2+}

Acknowledgements

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References

1. Dong, J.; Davis, A. P., Molecular Recognition Mediated by Hydrogen Bonding in Aqueous Media. Angewandte Chemie International Edition **2021,** 60 (15), 8035-8048.
2. Chen, S.; Itoh, Y.; Masuda, T.; Shimizu, S.; Zhao, J.; Ma, J.; Nakamura, S.; Okuro, K.; Noguchi, H.; Uosaki, K.; Aida, T., Subnanoscale hydrophobic modulation of salt bridges in aqueous media. Science **2015,** 348 (6234), 555-559.
3. Chavan, V.; Agarwal, C.; Shinde, R. N., Phosphate barrier on pore-filled cation-exchange membrane for blocking complexing ions in presence of non-complexing ions. Applied Surface Science **2018,** 443, 535-543.
4. Tschiggerl, H.; Breitwieser, A.; de Roo, G.; Verwoerd, T.; Schäffer, C.; Sleytr, U. B., Exploitation of the S-layer self-assembly system for site directed immobilization of enzymes demonstrated for an extremophilic laminarinase from Pyrococcus furiosus. Journal of Biotechnology **2008,** 133 (3), 403-411.
5. Ataka, K.; Giess, F.; Knoll, W.; Naumann, R.; Haber-Pohlmeier, S.; Richter, B.; Heberle, J., Oriented Attachment and Membrane Reconstitution of His-Tagged Cytochrome c Oxidase to a Gold Electrode: In Situ Monitoring by Surface-Enhanced Infrared Absorption Spectroscopy. Journal of the American Chemical Society **2004,** 126 (49), 16199-16206.

Unveiling Cation-Specific Modulation of Multiplex-Coupled Structured Water in Electric Double Layer

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A fundamental understanding of complicated solvation environments at the electrode-electrolyte interface is imperative for electrochemical reactions kinetics and mechanism. Although electrolyte composition exerts a profound impact on catalytic activity, the multiple coupling mechanistic role of cations[1–3] and multiplex-coupled interfacial structured water[4] is poorly understood. Combining ATR-SEIRAS and molecular simulations, we design a deep eutectic electrolyte ($M(ClO_4)_x$/succinonitrile/water, M= Na, Li, Mg) to probe cation-specific modulation of multiplex-coupled structured water on reaction dynamics. Succinonitrile spatially confines water while acting as an *in situ* interfacial electric field reporter, revealing the dominant role of first-layer water inverse dipoles on interfacial electric field, which can be regulated through adjusting the collective orientation of first-layer water by different cations. Water content modulation disentangles short-range ion-water interaction from long-range water networks in hydrogen evolution reaction. This study develops an integrated approach combining functionalized solvent design, in-situ dynamic characterization, and multiscale simulations to precisely control water molecular structures and reaction dynamics at solid-liquid interfaces. By challenging classical Gouy-Chapman-Stern theory, this work highlights the dominant role of interfacial water dipole on interfacial electric field and establishes a hydration-structure-activity framework for electrolyte design, particularly in nanoconfined or high-ionic-strength environments, advancing electrocatalytic interface optimization for energy technologies.

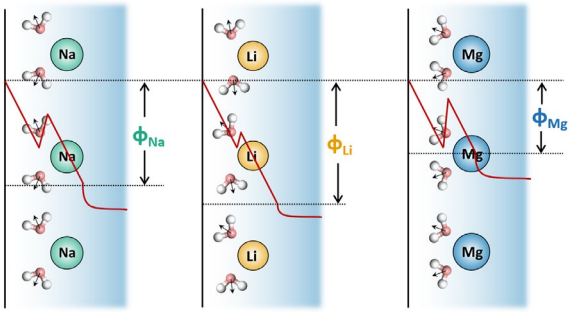


Fig.1 Schematic diagram of interfacial water collective dipole orientation on interfacial electric field.

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(2022YFE0113000), National Science Fund for Distinguished Young Scholars (22025406).

References

1. Q. Wu, Z. J. Xu, *Angew Chem Int Ed.*, e202505022 (2025**)**.
2. H. Khani, A. R. Puente Santiago, T. He, *Angew Chem Int Ed.*, **62**, e202306103 (2023).
3. J. Noh, H. Kim, H. Park, D. Y. Chung, *ACS Catal.*, 7780–7791 (2025).
4. G. Gonella, E. H. G. Backus, Y. Nagata, D. J. Bonthuis, P. Loche, A. Schlaich, R. R. Netz, A. Kühnle, I. T. McCrum, M. T. M. Koper, M. Wolf, B. Winter, G. Meijer, R. K. Campen, M. Bonn, *Nat Rev Chem.*, **5**, 466–485 (2021).

Construction of QDs Modified Nanopipette for In-situ Monitor of Intracellular Reactive Oxygen Species Levels

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Reactive oxygen species (ROS) are crucial signaling molecules involved in controlling various cell functions. Differences in ROS levels between cells indicate their distinct physiological states. Real-time monitoring of ROS enables the study of individual cell responses and heterogeneity within cell populations. Photoelectrochemical (PEC) techniques using semiconductor nanomaterials offer high sensitivity and selectivity for detecting low concentrations of ROS. However, traditional PEC methods rely on large ITO or glassy carbon electrodes, which limit the detection of ROS inside cells or within organelles. In this work, we used quartz nanopipettes as carriers and attached g-C_3N_4 quantum dots (QDs) to the tips of the nanopipettes to construct a wireless PEC sensor for ROS detection. Fluorescence microscopy and TEM confirmed that the g-C_3N_4 QDs were successfully anchored at the tip of nanopipette. This wireless nanopore sensor reduces spatial constraints and interacts more effectively with cells, improving the sensitivity and spatial resolution of intracellular ROS measurements. Under light exposure, electron-hole separation in the QDs guides ions to move in specific directions, resulting in a light-responsive ionic current. The presence of ROS alters the ion migration pathway, decreasing the amplitude of this ionic current. The experimental results demonstrated a direct, linear relationship between ROS concentration and photocurrent response. Consequently, by monitoring ion currents in real time, this method enables highly sensitive and in situ measurement of intracellular ROS levels directly and accurately.

Reprogramming and electrochemical monitoring of tumor cells into cancer stem cells based on dipeptide self-assembled hydrogel platform

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Cancer stem cells (CSCs), inherently resistant to chemotherapy and radiotherapy, are key drivers of tumor recurrence and metastasis. Current *in vitro* CSC enrichment models, which rely on isolation from solid tumors and suspension culture sphere-formation, often suffer from time-consuming and low efficiency. Here, we introduce a self-assembled dipeptide hydrogel, N-fluorenylmethoxycarbonyl diphenylalanine (Fmoc-FF), which exhibits the bio-inspired nature, and the 3D interwoven characteristic serves as a 3D cell culture matrix, under physiologically relevant mild stiffness (~10 kPa) that is significantly lower than that of previously matrix materials, enables highly efficient reprogramming of breast, cervical, and lung cancer cells into CSCs. In addition, we developed a 3D electrochemical sensor based on carbon foam (CF), which could be integrated with Fmoc-FF hydrogels due to their high inclusiveness for the 3D culture induction and non-destructive, in situ monitoring of cells for the first time. Specifically, Au nanoparticles (Au NPs) electrodeposited on CF (Au NPs/CF) conferred the prominent electrochemical sensing performance. Then, Fmoc-FF hydrogel with tumor cells seeded in was filled into the interspace of the 3D Au NPs/CF sensor to establish an integrated platform (Tumor cells/Fmoc-FF hydrogel/Au NPs/CF), which allowed the successful non-destructive monitoring of the dynamics of stemness-associated biomarker Aldehyde dehydrogenase 1 (ALDH1) released from tumor cells during reprogramming. With increasing days of induction, the electrochemical signal of ALDH1 gradually increased, indicating elevated levels of ALDH1 enzymes released from CSCs. This electrochemical integrated platform demonstrated excellent electrical conductivity, electrochemical performance, and cellular biocompatibility, proposing a sensing strategy that shows great versatility in monitoring multiple biomarkers. This study highlights the robust induction of stemness by Fmoc-FF hydrogels and provides a promising strategy to enhance *in vitro* reprogramming efficiency and expand the number of CSCs.

Acknowledgements

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References

1. J. Suzuka, T. Ueno, M. Frauenlob, H. Mano and J. P. Gong et al., *Nat. Biomed. Eng.,* **5**, 914-

925 (2021)
2. PE. Saw, Q. Liu, P. P. Wong and E. Song. *Cell Stem Cell,* **31**, 1101-1112 (2024).
3. C. F. Pereira, et al. *Science* **386**, eadn9083 (2024)

Electrochemical Profiling of Intracellular Ferrous Ions via a Modified Glass Nanopore

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Iron plays a vital role in numerous physiological processes, with ferrous ions (Fe^{2+}) acting as key regulators of redox homeostasis and ferroptosis[1]. Disruption of iron metabolism leads to Fe^{2+} accumulation, triggering Fenton reactions and oxidative stress[2]. Fe^{2+} detection in cells primarily relies on fluorescent probes[3]. However, fluorescence-based methods are often affected by cellular autofluorescence, photobleaching, and phototoxicity, which limit their long-term and stable monitoring capabilities[4]. Therefore, there is a pressing need to develop a more convenient and accurate Fe^{2+} detection technique. In recent years, Glass capillary-based nanopores (G-nanopores) have gained increasing attention for small molecule detection due to their nanoscale size, ease of fabrication, and ability to be inserted into cells with negligible damage[5].

Here, a functionalized G-nanopore was developed for direct insertion into HepG2 cells to achieve real-time, label-free detection of intracellular Fe^{2+} (Fig.1). The G-nanopore internal surface was functionalized with Fe^{2+}-selective ligands to ensure specificity. Firstly, the borosilicate capillary was treated with piranha solution to hydroxylate the surface, generating abundant Si-OH groups for further functionalization. Surface activation was performed by immersing the capillary in piranha solution (3:1 H_2SO_4:H_2O_2) for 1 hour at room temperature. Then, dry the nanopipette with nitrogen gas and store it in ethanol. Secondly, 3-Aminopropyltriethoxysilane (APTES) solution (5% v/v in isopropanol) was injected to react with the silicon hydroxyl groups of the inner surface for 30 min at room temperature. After several times rinses with isopropanol, the nanopipette was dried at 60 °C for 30 min. Thirdly, the 4-FL (in MES) was activated using coupling reagents EDC/NHS at room temperature for 30 min, and subsequently filled into the nanopipette, following by placing overnight at 4 °C. The functionalized G-nanopore can obtain Fe^{2+} content with negligible damage, and the electrochemical signal showed high sensitivity and selectivity against interfering species. To precisely position the probe and obtain electrochemical imaging of cells, we integrated scanning ion conductance microscopy (SICM) with the G-nanopore system. This approach provides high spatial resolution and real-time monitoring. In the future, this method offers a promising platform for studying metal ion dynamics and pollutant-induced cellular responses at the single-cell level.

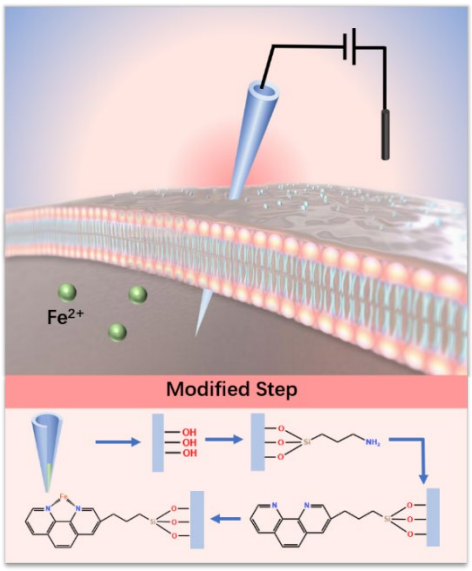


Fig.1 Schematic illustration of modified G-nanopore for single-cell Fe^{2+} detection.

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References

1. Scott J. Dixon, and Kathryn M. Lemberg, et al. *Cell*, **149,** 1060-1072 (2012)
2. B. R. Stockwell, and J. P. F. Angeli, et al. *Cell*, **171**, 273-285 (2017)
3. R. Tian, and T. Guo, et al. *Sens. Actuators, B.*, **393**, 134288 (2023)
4. P. Hu, and Y. Wang, et al. *Anal. Chem.*, **94**, 14273-14279 (2022)
5. X. Guan, and H. Li, et al. *ACS Sens.*, **8**, 427-442 (2023)

On-demand Catalytic Platform for Glycerol Upgrade and Utilization Using Photo-bioelectro-heterogenous Coupling Systems

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As the race towards carbon neutrality intensifies, utilizing biomass as an energy source presents a strategically significant opportunity for boosting the global share of renewable energy. However, surplus byproducts generated during bioenergy production, typically glycerol as a 10 wt% byproduct within biodiesel manufacturing, seriously undermine the credibility of bioenergy policies. Here, we established an on-demand catalytic platform for the upgrade and utilization of glycerol via phot-bioelectro-heterogeneous coupling catalysis. The theoretical descriptors, specifically the highest occupied molecular orbital energy levels and dual local softness values, and systematic experimental validation were combined to demonstrate the reaction activity of glycerol and its upgraded products on $BiVO_4$ photoanodes. We confirmed that glyceric acid was the optimal biofuel candidate which could be produced through mono-hydroxyl oxidation of glycerol. Coupling the preferential upgrading of glycerol to glyceric acid by night and its reuse as biofuel by day, a hybrid bio-photoelectrochemical system could deliver an open-circuit voltage of 0.89 ± 0.02 V and a maximum power density of 0.41 ± 0.03 mW cm^{-2} with stable diurnal operation for over 10 days. This successful model construction provides valuable insights into the strategic integration of multiple energy sources and the exploration of coupling-catalytic platforms, charting new territory for the next-generation sustainable energy systems.

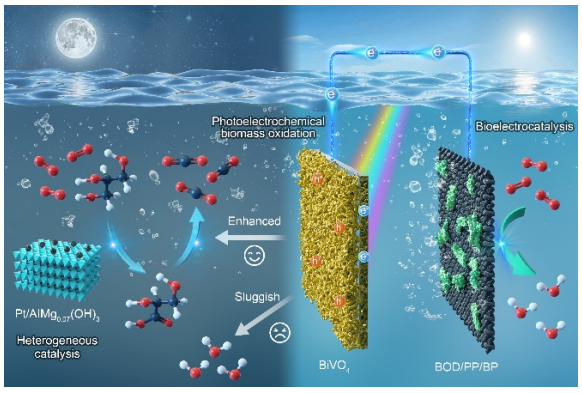


Fig.1 Schematic representation of hybrid BPEC system with diurnal operation based on photo-bioelectro-heterogeneous Coupling Catalysis

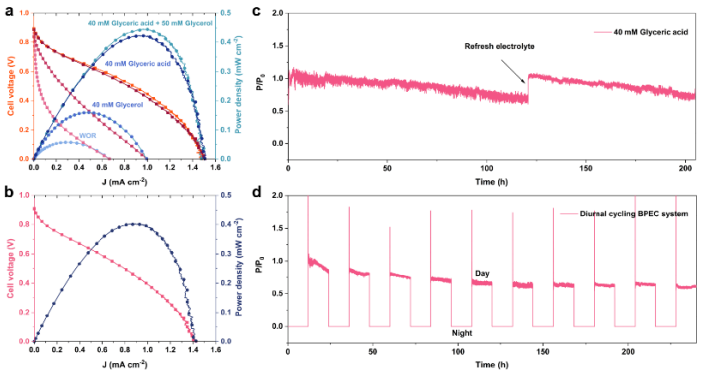


Fig.2 (a) Comparison of polarization curves and power densities of the BPEC cells in the absence and presence of glycerol, glyceric acid, and mixed fuel. (b) Polarization curves and power density curves of the BPEC cells utilizing the fuel solution obtained from heterogeneous catalysis. (c) Normalized chronoamperometry curve of the BPEC cell with 40 mM glyceric acid as photoanodic fuel at 0.4 V. (d) Diurnal cycling stability of hybrid BPEC systems.

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References

1. S. Hao, H. Zhang, X. Sun, J. Chen, J. Zhai and S. Dong, *Appl. Catal. B Environ.*, **343**, 123481-123489 (2024)
2. Z. Wang, Y. Guo, M. Liu, X. Liu, H. Zhang, W. Jiang, P. Wang, Z. Zheng, Y. Liu, H. Cheng, Y. Dai, Z. Wang and B. Huang, *Adv. Mater.*, **34**, 2201594-2201603 (2022)
3. Z. An, Z. Zhang, Z. Huang, H. Han, B. Song, J. Zhang, Q. Ping, Y. Zhu, H. Song, B. Wang, L. Zheng and J. He, *Nat. Commun.*, **13**, 5467-5479 (2022)

A NiFe-LDH/$BiVO_4$-BOD photocatalytic fuel cell for bias-free and selective 5-hydroxymethylfurfural oxidation to 2,5-furandicarboxylic acid

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The efficient conversion of renewable biomass into value-added products with low energy consumption, environmental friendliness and cost-effectiveness is essential for sustainable development, but remains a significant challenge.[1-3] In this work, we put forward a two-chamber photocatalytic fuel cell (PFC) consisting of a NiFe-LDH/$BiVO_4$/FTO photoanode and a BOD/TCPP/BP/ITO biocathode, which allows for the simultaneous accomplishment of energy conversion and bias-free production of 2,5-furandicarboxylic acid (FDCA). At the photoanode, the 2,2,6,6-tetramethylpiperidine-1-oxyl (TEMPO) oxidation takes place at the potential higher than 0.38 V, and subsequently, due to the redox reaction with 5-hydroxymethylfurfural (HMF), TEMPO is regenerated while HMF is oxidized. On the biocathodic side, the bilirubin oxidase (BOD) is utilized to catalyze the oxygen reduction reaction (ORR) under neutral conditions, and the onset potential of 1.1 V is high enough to force the electron to flow from the photoanode to it. The results show that HMF can be effectively and selectively oxidized to FDCA, with the production yield and the Faradaic efficiency of approximately 100%. The PFC also possesses good durability after six cycles (30 h) of FDCA production (retaining 90.8% of its initial value). Therefore, the proposed PFC offers a promising solution to the challenges associated with the conversion of renewable biomass.

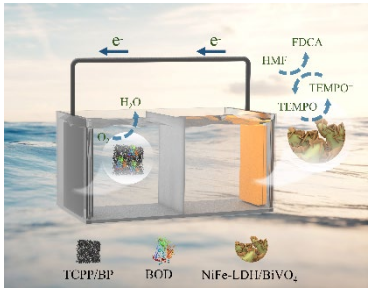


Fig.1 Working principle of the PFC.

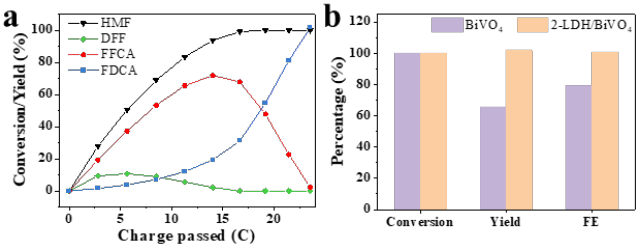


Fig.2 (a) The concentration changes of HMF and organic products in the anodic chamber of the PFC. (b) The final results of TEMPO-mediated photoelectrochemical HMF oxidation.value.

Acknowledgements

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References

1. O. Ali Qamar, F. Jamil, M. Hussain, A.a.H. Al-Muhtaseb, A. Inayat, A. Waris, et al., *Chemical Engineering Journal*, **454**, 140240(2023).
2. J.A. Okolie, E.I. Epelle, M.E. Tabat, U. Orivri, A.N. Amenaghawon, P.U. Okoye, et al., *Process Safety and Environmental Protection*, **159**, 323-44(2022).
3. N. Ibrahim, S.K. Kamarudin, L.J. Minggu, *Journal of Power Sources*, **259**, 33-42(2014).

Hyperelastic Eutectogel with Reversible Biaxial Strain for Strain Sensors and Health Monitoring

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Traditional hydrogel is susceptive to freezing below zero, dehydration, performance swelling-induced deformation, and suffers from mechanical damage in extremely mechanical environments, which result in the loss of wet-soft peculiarities (e.g., flexibility, structure integrity, transparency), greatly limiting their applications.[1] Therefore, reducing the freezing point, improving the dehydration/solution resistance, and designing mechanical adaptability are effective strategies to endow hydrogels with the extreme environmental adaptability. As new generation of environmentally friendly solvents, deep eutectic solvents (DESs) usually are composed of hydrogen bond donors (HBDs) and hydrogen bond acceptors (HBAs), which interact via hydrogen bond interactions to form the eutectic mixtures with melting points lower than those of the individual components. In this work, we prepared eutectogels by one-step photopolymerization in DES/H2O binary solvent without any chemical crosslinking agent. Numerous hydrogen bonds in the system provide a supramolecular network structure for eutectogel, making it difficult to achieve molecular motion and reorientation of free water available in the eutectogel system, making it difficult for water to nucleate. The gel exhibited high transparency (~95%), biaxial tension (>8100% areal strain) and self-healing ability in a wide temperature range (-40~60°C). Furthermore, these gels demonstrate high sensitivity for monitoring joint movements and health monitoring, show casing their potential for wearable strain sensors and monitoring physiological signals.

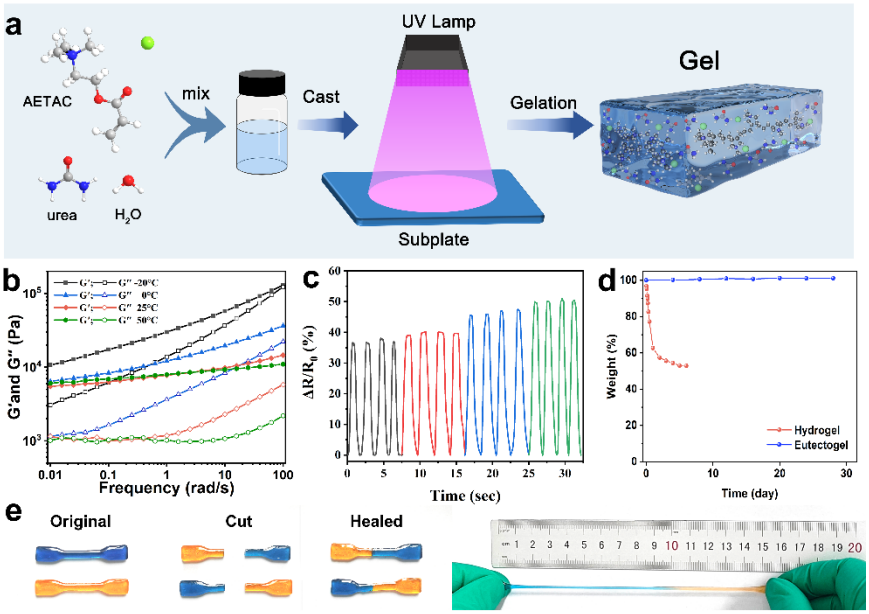


Fig.1 (a) Schematic Diagram of PAETAC Eutectogel Synthesis; (b) Storage modulus (G') and loss modulus (G") of the PAETAC gel in different frequencies and at different temperatures; (c) Electric response ($\Delta R/R_0$)

on the stretching movement of PAETAC eutectogel; (d) Evolution of mass with the time of the PAETAC eutectogel and hydrogel at room temperature; (e) Photographs of the cutting, healing and stretching processes of color-labeled eutectogels.

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References

1. K. Lei, M. Chen, et al. Adv. Funct. Mater., **33**.41: 2303511 (2023).

A robust Au-C≡C anchoring group greatly improves the signal stability of electrochemical aptamer-based sensors for in-vivo measurements

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The development of medical devices that enables continuous, in-vivo monitoring are emerging technologies capable of tracking specific target substances in a real-time fashion, thus providing great opportunities for clinical use. For instance, the variations between individuals in pharmacokinetics can profoundly affect the drug efficacy during treatment[1]. The in-vivo measurement of drug molecules employing an implantable sensor can achieve pharmacokinetics in real-time, continous manner, which will revolutionize the conventional drug dose particularly for those with narrow therapeutical windows and thus achieve personalized medicine[2-5]. Nevertheless, there is a significant gap between the unmet requirement and the current few biomedical devices for in-vivo measurement, including oxygen[6], glucose[7], lactate[8,9], which typically relies on the specific reaction of the target molecules and their enzymes and thus hard to be generalizable. Therefore, there is an urgent need to develop a general detection platform capable of detecting a variety of targets.

E-AB sensors are promising candidates to fill this role. They utilize aptamers as recognition probes, which reserve several merits including low cost, high stability, and ease of chemical modification[10,11]. E-AB sensors utilize the conformational changes of such aptamers upon the recogniton of target analytes, thereby generating easily measurable electrochemical signals. Unlike oxygel and glucose meters, they rely on the specific binding between aptamer and target rather than the chemical reactivity of the analyte itself. They also require no preprocessing steps and no exogenous reagents to support in vivo measurements[12,13]. So far, E-AB sensors involve Au-S bond as most commonly-used anchoring group to attach DNA aptamers onto the electrode surface, which tends to detach from the electrode surface during continuous testing in complex biological systems. Recent studies have shown that thiol ligands can be replaced by biological thiols in complex physiological environments. Additionally, Tian and his team demonstrated that gold-alkyne bonds have higher binding energy compared to gold-thiol bonds, providing the sensors with enhanced stability and electrochemical performance[14-16].

To address the stability issues encountered by probes when immobilized on electrode surfaces, we have developed a class of alkyne-anchored probe molecules, (including DNA

and SAMs). Here in this study, we demonstrated the use of the Au-C≡C anchoring group to greatly improve the stability, achieving 92% signal stability upto 72 hours (> 6000 scans). Given this, we achieved the real-time monitoring of drug pharmacokinetics directly in vivo in the living rats (**Fig. 1**).

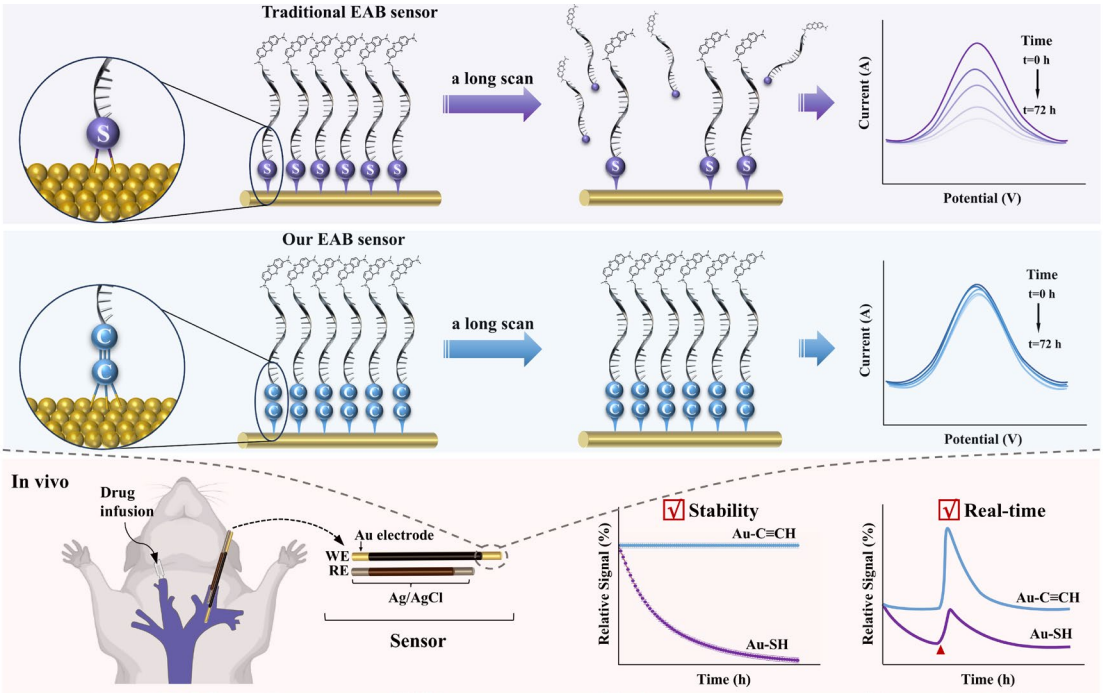


Fig.1 Aptamers are anchored to the electrode surface through alkyne-based anchoring to form Au-C≡CH based E-AB sensors, which exhibits superior stability compared to sensors utilizing Au-S bonds.

Acknowledgements

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References:

1. J.W. Seo, K.Y. Fu, et al. *Sci. Adv.*, **8**, eabk2901 (2022)
2. J. Das, S. Gomis, et al. *Nat. Chem.*, **13**, 428-434 (2021)
3. T. Zhou, H. Yuk, et al. *Nat. Mater.*, **22**, 895-902 (2023)
4. P. Dauphin-Ducharme, K. Yang, et al. *ACS Sens.*, **4**, 2832-2837 (2019)
5. R.S. Gaster, D.A. Hall, et al. *Nat. Med.*, **15**, 1327-U1130 (2009)
6. H. Ren, M.A. Coughlin, et al. *Anal. Chem.*, **87**, 8067-8072 (2015)
7. H. Yoon, X. Xuan, et al. *Biosens Bioelectron*, **117**, 267-275 (2018)
8. O.M. Schuvailo, O.O. Soldatkin, et al. *Anal. Chim. Acta.*, **573**, 110-116 (2006)
9. E. Fernandes, A. Ledo, et al. *Molecules*, **27**, 514-530 (2022)
10. T. Hermann & D.J. Patel. *Science*, **287**, 820-825 (2000)
11. A. Porchetta, A. Vallée-Bélisle, et al. *J. Am. Chem. Soc.*, **134**, 20601-20604 (2012)
12. B.R. Baker, R.Y. Lai, et al. *J. Am. Chem. Soc.*, **128**, 3138-3139 (2006)
13. N. Arroyo-Currás, J. Somerson, et al. *Proc. Natl. Acad. Sci. U.S.A*, **114**, 645-650 (2017)

14. C.P. Zhang, Z.C. Liu, et al. *Angew. Chem. Int. Ed.*, **59**, 20499-20507 (2020)
15. R.P. Weston, Y.F. Chen, et al. *J. Phys. Chem. C*, **126**, 9673-9682 (2022)
16. T. Zaba, A. Noworolska, et al. *J. Am. Chem. Soc.*, **136**, 11918-11921 (2014)

Investigation Multivalent Binding of Lectin-Glycofullerene via Label-Free Glass Nanopipettes

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The interaction between lectins and carbohydrates plays a crucial role in numerous physiological processes, such as fertilization, pathogen infection (e.g., viruses and bacteria), and immune recognition of tumor cells[1-5]. However, the affinity of monovalent interaction occurring between them is relatively weak[6, 7]. In nature, this affinity is typically enhanced through multivalent interactions involving multiple ligands and receptors[4, 8-10]. The investigation of multivalent interactions between lectins and carbohydrate polymers enables to achieve a more comprehensive understanding of cellular signaling processes and explore strategies to inhibit pathogenic infections. Nevertheless, the current detection methods for multivalent binding, including isothermal titration calorimetry (ITC)[3], surface plasmon resonance (SPR)[8], and nuclear magnetic resonance (NMR)[11, 12], are predominantly based on statistical interpretations of ensemble-averaged data. They fundamentally lack the capacity to resolve molecular-scale interaction parameters. This critical limitation manifests as an inability to discriminate specific binding conformations or elucidate the spatial arrangements underlying multivalent complexes, thereby omitting essential mechanistic insights into the dynamic structural transitions during binding events.

In recent years, glass nanopipette has emerged as an advanced platform for the applications of single-molecule analysis, due to its unique advantages including ease of fabrication, facile modification, tunable pore size, and the capability for single-molecule detection[13]. To achieve single molecule analysis, such platform typically operates by detecting target-induced ionic current changes, i.e., resistive pulse signals (RPS) from molecular translocations[14]. This mechanism measures the transient current or voltage modulations arising from time-varying resistance during particle translocation through a confined nanopipette. Building on this, glass nanopipette has achieved great progress in gene sequencing[15, 16] and protein detection[14, 17-19], single-cell analysis[20, 21], especially in the field of single molecule detection[17, 22, 23]. The application of glass nanopipettes in the monitoring multivalent recognition processes yet remains to be explored[24].

Herein in this study, we employed the nanopipette-based electroanalytical platform to study the multivalent binding of glycan molecules and lectin. Specifically, we employed

two spherical glycofullerene molecules, containing 12 mannoses (**C_{60}-12Man**) or 120 mannoses (**C_{60}-120Man**), and Concanavalin A (ConA) as lectin. The two glycofullerene derivatives exhibit differential binding affinities toward the lectin, thereby enabling systematic investigation of intermolecular interaction. We have investigated the feeding ratios dependence of the glycofullerene and lectin protein (**Fig. 1**). Using statistical analysis of the resulting signals, we can obtain the information of the products' composition. The variation in the peak current value suggests the structural transition from glycofullerene-centered to protein-centered complexes. Notably, the maximum blocking current was observed when the binding sites ratio of ConA to two kinds of glycofullerenes reached 10:3, corresponding to the formation of a glycofullerene-centered structure encompassing four ConA lectins. In summary, our study holds significant implications for future investigations into the mechanisms of multivalent binding.

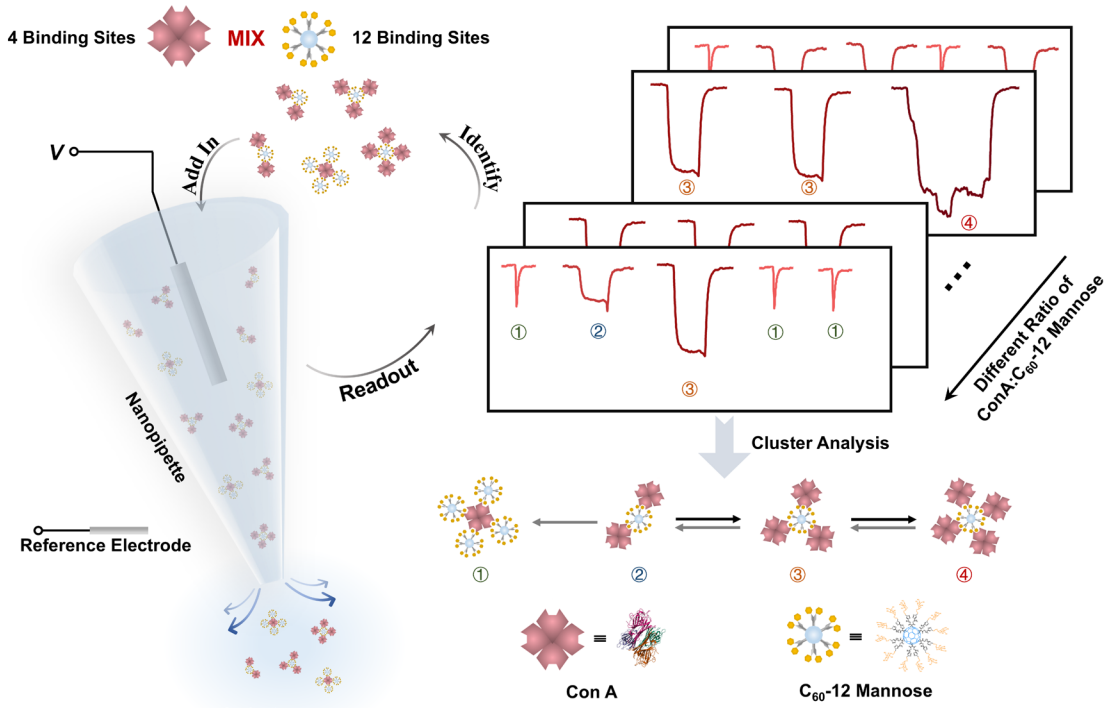


Fig.1 Scheme of ConA lectin-glycofullerene multivalent binding detection employed nanopipettes.

Acknowledgements

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References:

1. S. Cecioni, A. Imberty, et al., *Chem. Rev.,* **115**, 525-561 (2015)

2. H. Y. Jin, D. W. Li, et al., *ACS Appl. Mater. Interfaces*, **7**, 12249-12253 (2015)
3. M. Sánchez-Navarro, A. Muñoz, et al., *Chem.-Eur. J.*, **17**, 766-769 (2011)
4. V. Kumar,W. B. Turnbull, *Chem. Soc. Rev.*, **52**, 1273-1287 (2023)
5. A. Singh, J. C. Arango, et al., *J. Am. Chem. Soc.*, **145**, 1668-1677 (2023)
6. Y. C. Lee,R. T. Lee, *Acc. Chem. Res.*, **28**, 321-327 (1995)
7. S. S. Li, N. X. Wang, et al., *Nat. Chem.*, **15**, 33-42 (2023)
8. I. Papp, J. Dernedde, et al., *Chembiochem*, **12**, 1075-1083 (2011)
9. J. I. Quintana, U. Atxabal, et al., *Chem. Soc. Rev.*, **52**, 1591-1613 (2023)
10. M. Martínez-Bailén, J. Rojo, et al., *Chem. Soc. Rev.*, **52**, 536-572 (2023)
11. A. Silva-Díaz, J. Ramírez-Cárdenas, et al., *J. Am. Chem. Soc.*, **145**, 26009-26015 (2023)
12. G. Nestor, T. Anderson, et al., *J. Am. Chem. Soc.*, **139**, 6210-6216 (2017)
13. R. J. Yu, Y. L. Ying, et al., *Angew. Chem. Int. Ed.*, **58**, 3706-3714 (2019)
14. X. Zhang, D. Luo, et al., *ACS Nano*, **16**, 15108-15114 (2022)
15. L. R. Guo, X. L. Xing, et al., *ACS Nano*, **18**, 26382-26390 (2024)
16. X. L. Xing, Z. C. He, et al., *Anal. Chem.*, **94**, 9851-9855 (2022)
17. K. L. Chen, R. J. Yu, et al., *Angew. Chem. Int. Ed*, **63**, e202406677- e202406681 (2024)
18. R. Ren, S. L. Cai, et al., *Nat. Commun.*, **14**, 7362-7377 (2023)
19. Y. X. Liu, X. Y. Wang, et al., *ACS Nano*, **17**, 22999-23009 (2023)
20. Y. F. Ruan, H. Y. Wang, et al., *Anal. Chem.*, **93**, 1200-1208 (2021)
21. R. R. Pan, M. C. Xu, et al., *P. Natl. Acad. Sci. USA*, **115**, 4087-4092 (2018)
22. L. R. Guo, Y. D. Han, et al., *Nano Lett.*, **24**, 5639-5646 (2024)
23. R. Ren, M. Z. Sun, et al., *Adv. Mater.*, **33**, e2103067- e2103075 (2021)
24. H. Ma, Y. Y. Wang, et al., *J. Am. Chem. Soc.*, **146**, 28014-28022 (2024)

Harnessing Hydrogen Spillover: Biomimetic Dual-Site Platinum-Gold Catalyst Mimicking NAD+-Reducing Hydrogenase

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The hydrogen spillover phenomenon in heterogeneous catalysis shares similarities with the proton-coupled electron transfer (PCET) mechanism observed in natural enzymes. Drawing inspiration from these mechanisms, biomimetic dual-site platinum-gold (PtAu) catalyst was theoretical designed as a model to mimic the function of soluble NAD^+-reducing hydrogenases (SH). This model catalyst facilitates efficient hydrogen oxidation and NAD^+ reduction, offering potential applications in both bioelectrocatalysis and biosynthetic systems. In the design, Pt and Au simulated the NiFe and FMN active sites of SH, respectively, with hydrogen spillover serving as an alternative to the PCET mechanism. Experimental results and theoretical calculations revealed the individual contribution and synergistic interactions between Pt and Au, where Pt sites dissociated H_2 to produce active hydrogen which spontaneously spilled to neighboring Au sites for adsorbed NAD^+ hydrogenation. In biocatalysis, PtAu catalyst exhibited superior NAD^+ conversion efficiency and selectivity toward 1,4-NADH compared to previously reported Pt-based catalysts. In electrocatalysis, coupling PtAu anode with bilirubin oxidase (BOD) biocathode, a H_2/O_2 enzymatic biofuel cell was constructed, achieving a maximum power output exceeding 2.0 mW cm^{-2} while maintaining excellent operational stability. This mechanism-inspired strategy provided valuable insights into the understanding and design of catalysts, thereby offering greater potential for applications in replacing natural enzymatic catalysis.

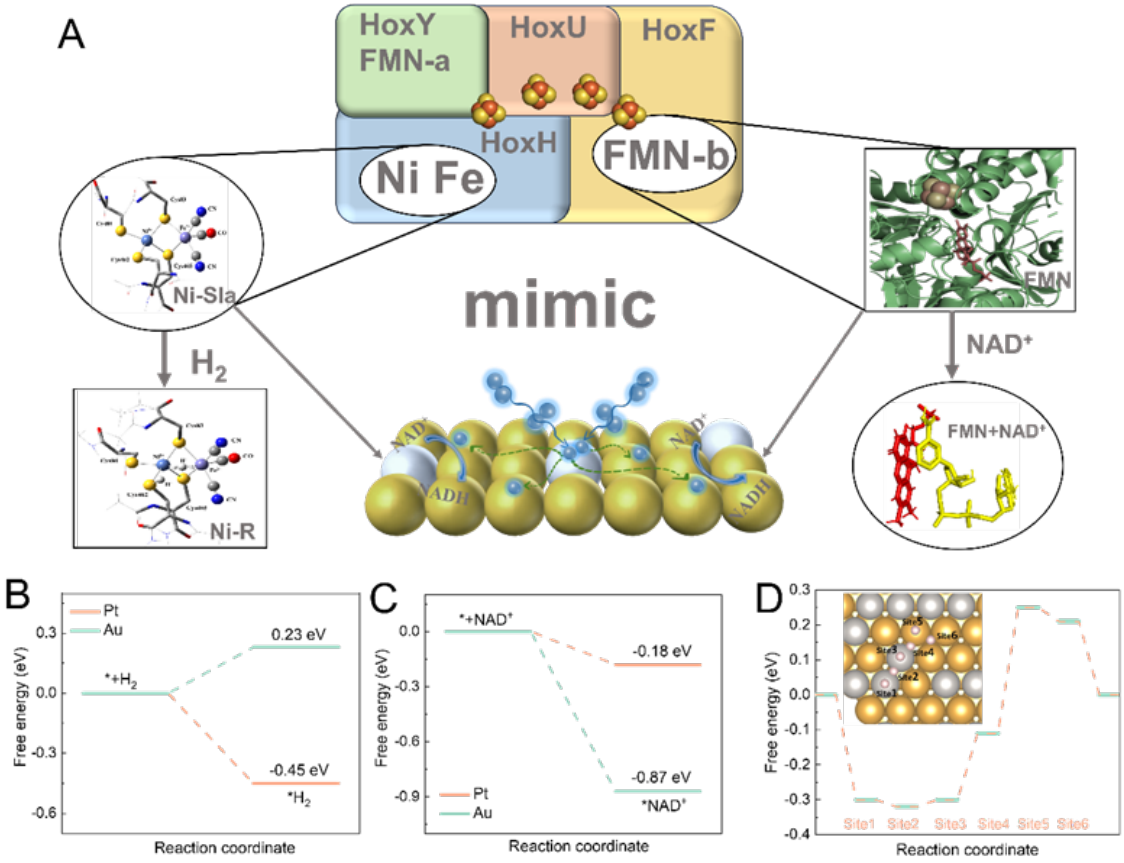


Fig. 1. (A) Configurations of the structure of SH, molecular docking between SH and H_2 or NAD^+, and the design of PtAu catalyst. (B, C) Free energy profiles of H_2 (B) and NAD^+ (C) adsorption on Pt or Au, the * indicates the adsorption site. (D) Free energy change of H_{act} at different sites on PtAu and labeled H_{act} spillover path (site 1 → site 2 → site 3 → site 4 → site 5 → site 6).

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An enzyme-free and signal-amplified DNA electrochemical detection strategy

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DNA, as an important biomarker, plays a crucial role in medical diagnosis and environmental monitoring. Traditional DNA electrochemical sensors based on exonuclease-assisted signal amplification strategies demonstrate advantages of high sensitivity and low detection limits. However, due to heavy reliance on natural nucleases, there are problems such as high cost and poor stability. In this work, we utilized the highly active artificial nuclease 1MIA-Zr developed in previous research replacing natural nucleases to design an enzyme-free and signal-amplified DNA electrochemical detection strategy [1]. The large molecular weight and substantial negative charges of dsDNA caused the electrochemically active terminal bases to move away from the electrode surface, resulting in weak current signals. While dsDNA is hydrolyzed by 1MIA-Zr, the long-chain dsDNA can be broken into short-chain DNA fragments and free bases [2]. This process exposed large terminal bases near the electrode surface making an enhanced electrical signal, thereby achieving amplification of the electrochemical response for dsDNA detection. Based on this strategy, we have achieved a 10.9-fold enhancement in detection of dsDNA. This approach paves a new avenue for constructing novel DNA electrochemical sensors with high sensitivity, high stability, and low cost, providing a new light for the synergistic application of artificial nuclease and electrochemistry.

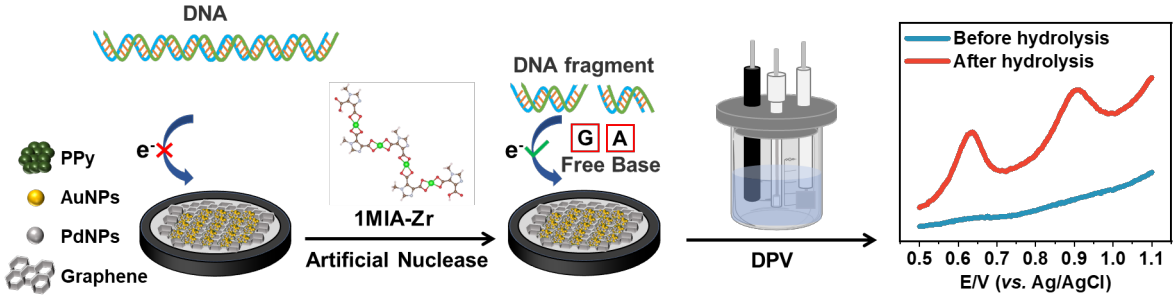


Fig.1 Schematic illustration of an enzyme-free and signal-amplified DNA electrochemical detection strategy.

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References

1. Z. Yu, L. Yang, H. Liu, T. Li, J. Chen, L. Liu and S. Dong, *Anal. Chem.*, **97**(10), 5546-5553 (2025)
2. P. Lei, Y. Zhou, B. Li, Y. Liu, C. Dong, and S. Shuang, *ACS Appl. Nano Mater.*, **5**(1), 1635-1643 (2022)

Bias-free Glucose/O_2 Bio-photoelectrochemical System for Multi-energy Conversion and Phenolic Pollutant Degradation

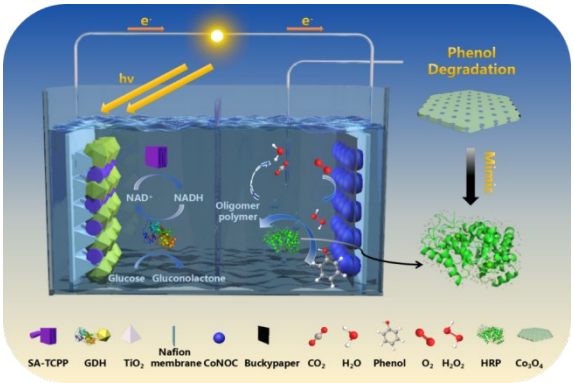
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Developing a multi-functional green energy device that propels sustainable energy development and concurrently purifies environmental pollutants offers an irresistibly compelling vision for a cleaner future. Herein, we reported a bias-free glucose/O_2 bio-photoelectrochemical system (BPECS) for both energy conversion and phenolic pollutants degradation. Coupling a glucose dehydrogenase (GDH) modified self-assembled meso-tetrakis(4-carboxyphenyl)-porphyrin (SA-TCPP)-sensitized TiO_2 biophotoanode for glucose oxidation and nitrogen/oxygen doped cobalt single-atom catalyst (CoNOC) cathode for two-electron oxygen reduction, both solar and biochemical energies were converted into electric power in BPECS with a maximum power density of 296.98 μW cm^{-2} (0.49 V). Working in synergy with horseradish peroxidase (HRP) biocatalysis, the cathode-generated H_2O_2, a by-product, is effectively redeployed for degrading phenol, attaining an impressive degradation efficiency of approximately 100% within 60 minutes. Additionally, aiming to scale up this ingenious BPECS approach, peroxidase-mimicking Co_3O_4 nanozyme were engineered as a substitute for natural HRP. Remarkably, these nanozyme demonstrated a comparable degradation efficiency, achieving the same result in 90 minutes. In this work, our bias-free glucose/O_2 BPECS model provide a meaningful research model for scalable and cost-effective multi-energy conversion. Simultaneously, the successful establishment of this degradation system marks a significant step forward in integrating renewable energy harvesting with environmental remediation, but also opens new avenues for the versatile application of nanozymes.



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References

1. S. Fan, B. Liang, X. Xiao, L. Bai, X. Tang, E. Lojou, S. Cos-nier, A. Liu, J. Am. Chem. Soc., 142, 3222-3230 (2020).
2. C. Tang, L. Chen, H.J. Li, L.Q. Li, Y. Jiao, Y. Zheng, H.L. Xu, K. Davey, S.Z. Qiao, J. Am. Chem. Soc., 143, 7819-7827 (2021).
3. W. Wu, L. Huang, E. Wang, S. Dong, Chem. Sci., 11, 9741-9756 (2020).

Vacancy engineering of $BiFeO_3$ perovskite for low-barrier electrochemical nitrogen fixation

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Due to its environmental and inherent advantages, the nitrogen reduction reaction (NRR) using electrocatalysts has garnered significant attention. Surface engineering is widely employed to enhance electrocatalytic activity through atomic defects. In this study, we have developed an effective approach to promote N_2 activation by introducing oxygen vacancies into $BiFeO_3$ perovskite. During N_2 electroreduction, $BiFeO_3$ with oxygen vacancies (denoted as V_O-$BiFeO_3$) exhibits a high NH_3 yield rate (89.3 μg h^{-1} mg_{cat}^{-1}) and a high Faradaic efficiency (FE) (13.5%) at -0.40 V vs. RHE. Density functional theory (DFT) calculations indicate that the introduction of oxygen vacancies results in an enhanced binding capacity for nitrogen immobilization and a significant decrease in the energy barrier for the rate-determining step of NRR. Furthermore, the analysis of the thermodynamic limiting potentials for N_2 reduction and H_2 evolution demonstrates a higher selectivity for N_2 electroreduction over V_O-$BiFeO_3$ compared to pristine $BiFeO_3$.

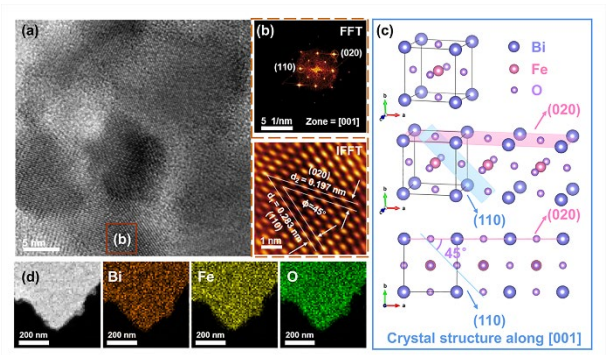


Fig.1 (a) HRTEM image of V_O-$BiFeO_3$. (b) Corresponding FFT and IFFT patterns from (a). (c) Crystal structure diagrams of V_O-$BiFeO_3$, which crystallizes in the rhombohedral space group R3m (166), with lattice parameters of a = b = c = 3.952 Å, and α = β = γ = 89.6°. (d) Elemental mapping analysis of V_O-$BiFeO_3$ based on EDX.

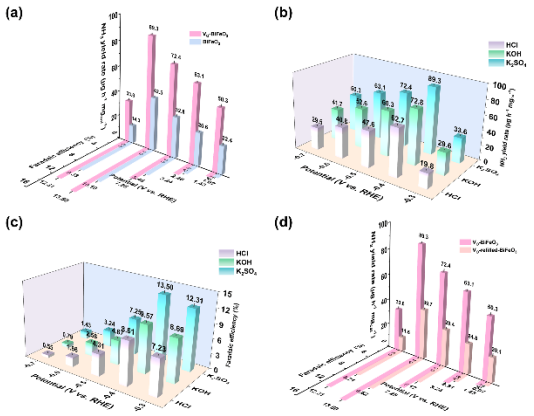


Fig.2 (a) NH_3 yield rates and FEs of pristine $BiFeO_3$ and V_O-$BiFeO_3$ at corresponding potentials in 0.1 M K_2SO_4 solution. (b) NH_3 yield rates and (c) FEs of V_O-$BiFeO_3$ after electrocatalysis at corresponding potentials in 0.1 M HCl, 0.1 M KOH, and 0.1 M K_2SO_4 solution, respectively. (d) NH_3 yield rates and FEs of V_O-refilled-$BiFeO_3$ and V_O-$BiFeO_3$ at corresponding potentials in 0.1 M K_2SO_4 solution.

Acknowledgements

This work was financially supported by the National Natural Science Foundation of China (Nos. 22074137 and 22274146).

References

1. Nan, J.; Fang, Y.; Rong, K.; Liu, Y.; Dong, S, *Appl. Catal., B* 2024, [illegible], 124328.

Constructing Enzymatic Biofuel Cells With Formic Acid Oxidase-like Pd-Pt Alloy Immobilized on Carbon Dot-Functionalized Graphene Oxide

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Formic acid (FA), a primary product derived from biomass carbohydrates, has emerged as a promising sustainable fuel for clean energy systems due to its high energy density, ease of storage, and compatibility with direct formic acid fuel cells (DFAFCs). However, the large-scale deployment of formic acid-based energy technologies is severely hindered by catalyst poisoning resulting from CO intermediates generated during the incomplete oxidation of FA. CO adsorption on conventional Pt-based catalysts irreversibly blocks active sites, leading to rapid performance degradation.[1] Inspired by the natural enzymatic catalysis of formic acid for selective deep oxidation, we designed a Pd-Pt alloy nanozyme catalyst.[2] We innovatively employed carbon dots decorated graphene oxide aerogels as a carrier to disperse and anchor nanoparticles. The designed carrier features a large specific surface area, facile mass transport, and abundant defect sites, effectively suppressing the aggregation of active centers. By coupling the nanozyme with an enzymatic biocathode, we constructed a nanozyme-enhanced enzymatic biofuel cell. The system achieved an open-circuit potential of 1.03 ± 0.01 V and a maximum power density of 0.71 ± 0.01 mW cm^{-2}, demonstrating exceptional electrochemical performance. This work establishes a novel pathway for optimizing the performance of enzymatic biofuel cells through the strategic integration of nanozymes.

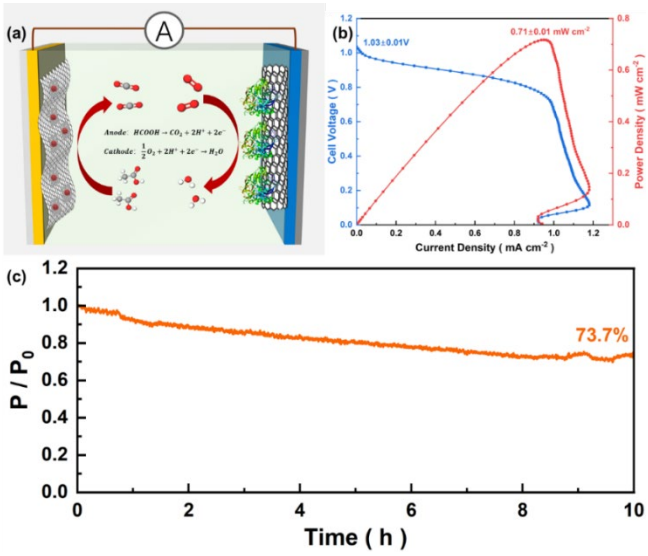


Fig.1 (a) Working principle of the membrane-less FA/O_2 EBFC composed of the Nanozymes-based anode and biocathode. (b) Polarization curves and power densities of FA/O_2 EBFC. (c) Normalized i-t curve of FA/O_2 EBFC at a cell voltage of 0.4 V.

Acknowledgements

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References

1. X. T. Chen, L. P. Granda-Marulanda, I. T. McCrum and M. T. M. Koper, *Nature Communications*, 2022, **13**.
2. J. X. Chen, Q. Ma, M. H. Li, D. Y. Chao, L. Huang, W. W. Wu, Y. X. Fang and S. J. Dong, *Nature Communications*, 2021, **12**.

Single-Cell Amperometry Reveals Paracrine-Mediated Vesicle Secretion in Chromaffin Cells.

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Paracrine signaling, a central mechanism of intercellular communication, plays a critical role in the dynamic regulation of the neuroendocrine system. However, direct evidence of paracrine-mediated signal transmission between individual cells remains limited. In this study, we integrated single-cell amperometry (SCA) with calcium imaging to investigate vesicle secretion dynamics in bovine chromaffin cells in response to electrical stimulation of neighboring cells. The "stimulus-response" transcellular signaling events were captured at the single-cell resolution for the first time. Experiments confirmed that electrical stimulation of a single cell can trigger paracrine signaling by releasing catecholamines and directly induce synchronous exocytosis in adjacent unstimulated cells. This effect is completely blocked by catecholamine receptor antagonists, suggesting that the signaling is strictly receptor-mediated. Furthermore, we discovered that excessive stimulation can trigger a threshold-dependent programmed death of neighboring cells, revealing that cell damage signals can propagate via the paracrine network. This study provides direct evidence of neuroendocrine cell-to-cell communication at the single-cell level and highlights the dual role of catecholamine-mediated paracrine signaling in coordinating both physiological secretion and the pathological spread of cell stress. It establishes a new paradigm for dissecting the spatiotemporal dynamics of complex neuroendocrine networks.

Acknowledgements

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References

1. Chen Zhang and Zhuan Zhou, *Nat Neurosci.*, **5**, 425-430(2002)
2. Skylar S. Wright et al., *Cell*, **188**, 280 - 291(2025)
3. K. Hu et al., *J. Am. Chem. Soc,* **145**, 11499-11503(2023)

Multiple detection based on Repeating Sequences-Duplex Polymerization Strategy, a kind of “Self-tag” strategy

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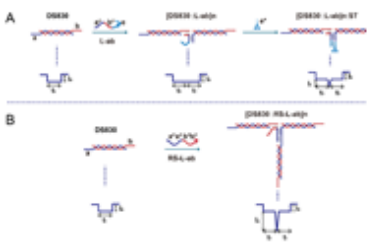
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Nanopore analysis is one of the most promising single-molecule technologies, offering advantages such as high throughput, label-free operation, and ultrahigh sensitivity[1,2]. For multiplex detection, the Duplex Polymerization Strategy (DPS) strategy serves as an effective signal amplification and conversion approach. However, it faces challenges including low ligation efficiency, difficulty in distinguishing products with multiple lengths, high costs and complex synthesis steps for generating secondary peaks. To address these issues, we developed an enhanced strategy termed Repeating Sequences-Duplex Polymerization Strategy (RS-DPS). The strategy increases the number of structural domains in the linkers, providing more binding sites to improve ligation efficiency. The framework generates secondary peaks by self-labeling, instead of traditional “tag-on” step utilizing nanostructures such as DNA tetrahedrons, reducing costs and simplifying experimental procedure. Additionally, RS-DPS offers advantages such as universality, modularity, and editability. Using APOE genotyping as a proof of concept, we employed two methods to achieve multiplex detection of two duplex substrate (DS) types. To enhance specificity and distinction, we implemented the RS-DPS strategy, under which two DS types can generate target-specific DS polymers. DS polymers can be distinguished through nanopore signal scatter plots and single-molecule signal features (I_1/I_0) as a complement. Finally, to meet multiplexing requirements, we used a single linker to simultaneously detect two DS types. By ligating two types of DS, distinct DS polymers are formed depending on their different coexistence situations, enabling multiplex detection of the two DS types through nanopore signal scatter plots and single-molecule I_1/I_0 signals.

Fig.1



Acknowledgements

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References

1. E. Neher and B. Sakmann, *Nature,* **260**, 799-802 (1976)
2. Y.L. Ying and Y.T. Long, *Nat. Nanotechnol,* **17**,1136-1146 (2022).

Gold Nanoparticles Functionalized M_3(Hexaiminotriphenylene)$_2$ (M = Co, Fe, Ni) MOFs Boost Cathodic Electrochemiluminescence of Luminol in Neutral Solution

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The cathodic electrochemiluminescence (ECL) of the classical luminol/H_2O_2 system is great challenging due to the difficulty in direct electrochemical oxidation of luminol and the low reactive oxygen species (ROS) generation efficiency of H_2O_2 at the negative potential. In this work, we observed significantly boosted cathodic ECL of luminol/H_2O_2 in neutral solution by using gold nanoparticles-modified $M_3(HITP)_2$ (M = Co, Fe, Ni; HITP = 2,3,6,7,10,11-hexaiminotriphenylene) MOFs as coreaction accelerator. Mechanistic studies revealed that $M_3(HITP)_2$ could electrocatalytically decompose H_2O_2 into massive •OH and $•O_2^-$ at the negative potential, and the catalytic performance was greatly enhanced after electrodeposition of gold nanoparticles (depAu) on MOFs due to the change of electronic structure in MN_4 active sites. In situ pH measurements using rotating ring-disk electrode technique further certified the synergistic catalytic effect of $M_3(HITP)_2$ and AuNPs in water splitting, creating an alkaline microenvironment near the electrode surface for luminol cathodic ECL in neutral bulk solution. Therefore, $M_3(HITP)_2$-depAu as an efficient coreaction accelerator was reported for the first time to enhance H_2O_2 electroreduction and hydrogen evolution reaction (HER), thus achieving about 4250 times enhancement in cathodic ECL of luminol/H_2O_2 system under neutral condition. Based on the established luminol/H_2O_2/$M_3(HITP)_2$-depAu ternary ECL system, a label-free ECL immunosensor was constructed for ultra-sensitive detection of amyloid-β(1-42) protein ($Aβ_{42}$), a biomarker of Alzheimer's disease (AD), and satisfactory analytical performance was achieved.

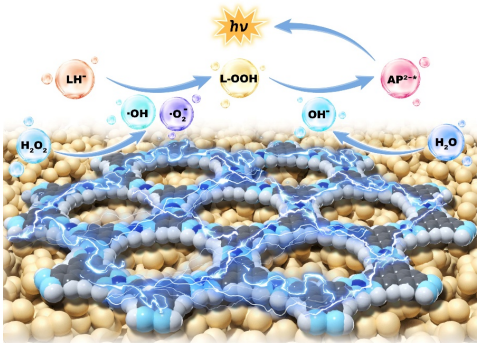


Fig.1 Mechanistic illustration of luminol/H_2O_2/$Co_3(HITP)_2$-depAu cathodic ECL system.

Acknowledgements

This work was supported by the National Natural Science Foundation of China (22034006 and 22393930), the National Key Research and Development Program of China (2022YFF0710000).

References

1. T. Chen and M. Dincă, *J. Am. Chem. Soc.*, **142**, 12367-412373 (2020)
2. W. Xu and C. Zhu, *Angew. Chem. Int. Ed.*, **62**, e202304625 (2023)

Direct electron transfer of horseradish peroxidase at a novel laser-induced graphene biochip for amperometric detection of H_2O_2

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Hydrogen peroxides (H_2O_2) is a simple but important chemical that not only frequently used in pharmaceutical and food manufacturing applications but also widely found in living organisms. For example, H_2O_2 has been used as the major adulterants in dairy industry. On the other hand, H_2O_2 is also an important metabolic intermediate and plays an essential role as a signal molecule in various biological process including immune cell activation, apoptosis, cell differentiation and tissue growth. Various detection methods including electrochemical sensors and biosensors have been reported in the past decades, a simple and sensitive device for rapid H_2O_2 detection is still desired. Direct electron transfer of horseradish peroxidase has been reported at several nanomaterials-based electrodes and has been utilized for H_2O_2 detection [1-4]. The porous structures of such nanomaterials-functionalized electrodes are proposed to be essential to the direct electron transfer of horseradish peroxidase [5]. The preparation as well as the modification of such nanomaterials onto a suitable electrode, however, is somewhat complicated. Herein, we reported a novel laser-induced graphene electrode, which was produced at polyimide surface by a simple laser scribing process and with three-dimensional porous structures, therefore, is very suitable for direct electron transfer of horseradish peroxidase. As a result, an integrated laser-induced graphene electrochemical biochip was developed for direct electron transfer of horseradish peroxidase and finally, for amperometric detection of H_2O_2.

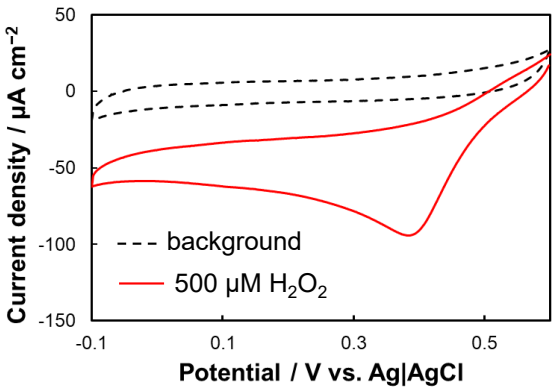


Fig.1 Cyclic voltammograms of horseradish peroxidase functionalized laser-induced graphene chips in the absence (broken line) and presences (solid line) of 500 µM H_2O_2

Acknowledgements

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References

1. H. Xia, Y. Kitazumi, O. Shira, and K. Kano, *Anal. Sci.*, **33**, 839-844 (2017).
2. H. Xia, Y. Kitazumi, O. Shirai, H. Ohta., S. Kurihara, and K. Kano, *J. Electroanal. Chem.*, **804**, 128-132 (2017).
3. H. Kawai, Y. Kitazumi, O. Shira, and K. Kano, *J. Electroanal. Chem.*, **841**, 73-78 (2019)
4. H. Xia, H. Tang, B. Zhou, Y. Li, X. Zhang, Z. Shi, L. Deng, R. Song, L. Li, Z. Zhang, and J. Zhou, *Sens. Actuators B- Chem.* **312**, 127962 (2020)
5. Y. Kitazumi, O. Shirai, and K. Kano, in *Novel Catalyst Materials for Bioelectrochemical Systems: Fundamentals and Applications,* **1342**, 147-163 (2020).

Real-time discriminative detection of bimodal neurotransmitter release by multichannel nanoelectrode arrays

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Vesicle exocytosis is a fundamental physiological process of neurotransmission. Conventional theory suggests that neurotransmitters can only be released through fusion of vesicles with cell membranes in neurons and neuroendocrine cells. However, we found for the first time that exosome-mediated neurotransmitter release coexists with the classical vesicular pathway in the same cell, suggesting that these two mechanisms may dynamically interact with each other in the spatiotemporal dimension. To unravel the molecular regulatory mechanisms behind the synergistic/competitive relationship between these two mechanisms, it is crucial to achieve simultaneous identification and dynamic monitoring of bimodal release events at the single-cell level. To address the technical limitation that conventional microelectrodes are unable to distinguish between these two exocytosis mechanisms, this study innovatively developed a multi-channel open carbon nanotube detection system: when exosomes pass through the electrode orifice, the diffusion of the added electroactive tracer molecules is transiently blocked, generating a downward impedance pulse, which is followed by the rupture of the exosomes and release of neurotransmitters, generating an upward oxidative peak, while vesicles fused with the cell membrane fusion with the cell membrane produces only one oxidation peak. The multi-channel array design extends the coverage of the assay while maintaining the resolution of the bimodal signal, greatly improving event capture efficiency.

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References

1. Chem.Rev.2008, 108, 2585–2621
2. J. Am. Chem. Soc, 2020, 142(40), 16910-16914.
3. Angew. Chem. Int. Ed. 2022, 61
4. J. Am. Chem. Soc, 2019, 141(50), 19555-19559.
5. J. Am. Chem. Soc. 2023, 145(21), 11499−11503

Electrochemiluminescence Biosensor Based on Duplex-Specific Nuclease and Dual-output Toehold-mediated Strand Displacement Cascade Amplification Strategy for Sensitive Detection of MicroRNA-499

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The timely and accurate diagnosis of acute myocardial infarction (AMI) is of great significance to reduce mortality and morbidity associated with the condition. Herein, we developed an electrochemiluminescence biosensor for the detection of the potential AMI biomarker microRNA-499 (miRNA-499), which was based on duplex-specific nuclease (DSN)-assisted target recycling [1] and dual-output toehold-mediated strand displacement (TMSD) [2]. Firstly, miRNA-499 was converted into a large amount of single-stranded DNA through the DSN-assisted target recycling, which was further incubated with the DNA triple-stranded complex (S) to implement TMSD cycles. Thus, the $Ru(bpy)_3^{2+}$-labeled signal strands were released and captured by the capture probe on the electrode surface, resulting in an intense ECL signal. Owing to the prominent cascade signal amplification, the constructed biosensor displayed a good linear response to miRNA-499 within the range of 100 aM-100 pM with a detection limit of 69.99 aM. Furthermore, it demonstrated superior selectivity, stability, and reproducibility. In addition, the biosensor was successfully applied to detect miRNA-499 in real human serum samples, demonstrating its potential in nucleic acid detection in the early diagnosis of diseases.

Acknowledgements

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References

1. L. Zhu; M. Zhang; J. Ye; M. Yan; Q. Zhu; J. Huang; and X. Yang, *Anal. Chem.*, **92**, 8614-8622 (2020)
2. Y. Zhang; G. Xu; G. Lian; F. Luo; Q. Xie; Z. Lin; and G. Chen, *Biosens. Bioelectron.*, **147**, 111789 (2020)

Electrochemiluminescence studies of Au_{25} NCs with near-infrared fluorescence emission and its application in sensitive detection of $A\beta_{42}$ protein

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Gold nanoclusters (Au NCs) have garnered significant attention in optoelectronic materials research due to their atomically precise structures and high quantum efficiency. While conventional Au NCs typically exhibit strong fluorescence emission in the visible light region, studies on the electrochemiluminescence (ECL) of Au NCs without fluorescence in the visible light region remain notably scarce. In this study, Au_{25}(p-MBA)$_{18}$ (p-MBA = 4-mercaptobenzoic acid), characterized by NIR fluorescence, was innovatively employed as an ECL emitter to construct a co-reactant-enhanced ECL system utilizing potassium persulfate ($K_2S_2O_8$). Experimental results revealed that although this cluster displayed no visible-range fluorescence emission at room temperature, it effectively reduced the activation energy for the conversion of $S_2O_8^{2-}$ to sulfate radicals ($SO_4^{\bullet-}$), thereby accelerating redox reaction kinetics and generating intense, stable ECL signals at 650 nm. A novel signal amplification strategy involving pre-reduction was successfully developed, achieving breakthrough improvements in ECL signal enhancement. Leveraging the exceptional biocompatibility of Au NCs, the study further integrated a β-amyloid protein ($A\beta_{42}$)-platinum nanoparticle (Pt NPs) complex into the ECL system to construct a label-free electrochemiluminescence immunoassay (If-ECLIA) sensor. This sensor demonstrated highly specific detection of $A\beta_{42}$ through a linear correlation between ECL intensity and analyte concentration, exhibiting an ultrabroad dynamic range and an ultralow detection limit under optimized conditions. Validation using human serum samples showed excellent recovery rates and reproducibility, confirming its strong potential for early Alzheimer's disease diagnosis.

Acknowledgements

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References

1. Luo, X. X.; Kong, J.; Xiao, H.; Sang, D. M.; He, K.; Zhou, M.; Liu, J. B., *Angew. Chem. Int. Ed.*, **63** (2024)
2. Jia, H.; Zhang, N.; Kuang, X.; Ren, X.; Wu, D.; Ma, H.; Wei, Q.; Ju, H., *Analytical Chemistry,* **96**, 11044-11051 (2024)

Electrochemical Biosensing Platform Based on MOF Carrier Signal Probes and CRISPR/Cas12a Cleavage for Sensitive Detection of MicroRNAs

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In this work, we constructed an electrochemical sensing platform based on a zirconium-based metal-organic backbone with CRISPR-Cas12a trans-cleavage activity was constructed for the ultrasensitive detection of let-7a. Specifically, the sensing platform used UiO-66-NH_2 as a porous carrier, methylene blue as a signaling molecule, and single-stranded DNA (ssDNA) encapsulated with MB-loaded UiO-66-NH_2 to construct a signaling probe, which was captured and immobilized on the electrode surface by the capture probe[1]; when the target is present, let-7a forms a DNA-RNA heterodimeric duplex with complementary DNA strands, which triggered the specificity of double-stranded specific nuclease (DSN) specific cleavage, releasing let-7a into the enzyme-assisted target cycle amplification process; the remaining DNA strand acted as an activating strand to activate the trans-cleavage activity of the CRISPR-Cas12a system, which non-specifically cleaved the ssDNA on the surface of the probe, and the signaling molecule MB was released from the well, and the electrochemical signal was reduced[2]. Under the optimal conditions, the constructed sensing platform showed a good linear relationship between the current value and the logarithm of the target concentration within 10 fM ~ 10 nM, and the detection limit was as low as 2.67 fM. The synergistic integration of MOF-mediated signal amplification, DSN-assisted target recycling, and CRISPR-Cas12a collateral cleavage endowed the platform with high specificity, sensitivity, and anti-interference capability, establishing a robust methodology for trace miRNA analysis in complex biological matrices.

Acknowledgements

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References

1. T. Bao, R. Fu, ACS Appl. Mater., **12**, 2087-2094 (2019)
2. Y. Dai, R. A. Somoza, *Angew. Chem. Int. Ed.*, **58**, 17399-17405 (2019)

Integrated sweat sensors based on hydrogen-bonded organic skeletons are used to detect vascular spasm markers

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Abstract: The diagnosis of vasospasm usually requires methods such as transcranial Doppler and angiography in hospitals. Portable sensors can non-invasively and simply detect sweat for diagnosis and prevention. Here, we have developed an electrochemical sensor to detect tyrosine, lactic acid and Mg^{2+} in sweat. These substances are all sweat markers of vasoconstriction and dilation. We use (carboxylated carbon nanotubes) cMWCNTs modified electrodes to promote electron transfer, which can sensitively detect biomarkers at low concentrations. The detection of lactic acid and tyrosine is accomplished through enzymatic catalytic reactions. We encapsulate the enzymes using HOF-101, a hydrogen-bonded organic framework material, so as to be able to output long-term stable signals. Magnesium ion detection is accomplished through the specific recognition of ion carriers. This process leads to the generation of potential differences. Different concentrations of magnesium ions result in different potential differences, thereby enabling the detection of magnesium ions. The prepared sensor has good stability within 20 days. Meanwhile, the detection of these three substances in the real sweat of the volunteers under different environments (including exercise, tyrosine intake, magnesium tablet intake, and drug regulation) verified that this sensor has certain practical application effects. Therefore, this sensor is expected to achieve non-invasive health monitoring of vascular dilation, thereby enabling the diagnosis and prevention of vascular spasm.

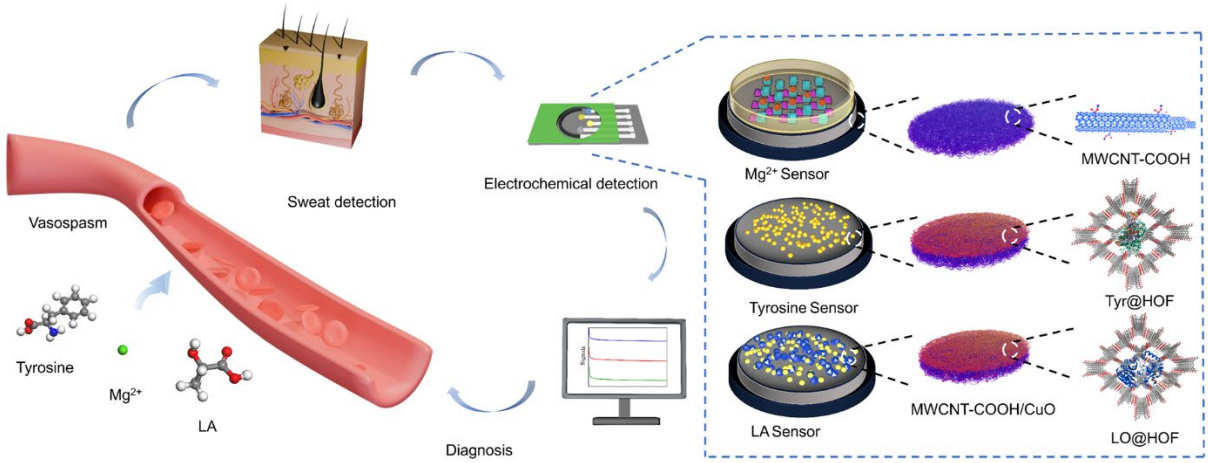


Fig.1 Schematic diagram of vasospasm biomarker sensor.

Construction of gel nerve electrode based on semi covalent crosslinker and its application in the treatment of Parkinson's disease

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Parkinson's disease (PD) is a neurodegenerative disease caused by the loss of dopamine neurons in the substantia nigra, leading to a decrease in dopamine levels in the brain and resulting in motor symptoms such as bradykinesia, resting tremors, and postural balance disorders. At present, China has the highest number of PD patients, and exploring effective PD treatment methods is closely related to the well-being of the people. Due to multiple factors such as drug tolerance and side effects, the symptoms of late stage PD patients cannot be effectively controlled by drugs. The application research of deep brain electrical stimulation is developing rapidly, and the regulation of target neuron activity in awake animals through optogenetic methods can achieve higher sensitivity and stronger specific regulation, which has more development prospects. Photoelectrodes suitable for deep brain stimulation need to have low modulus, high transparency, high conductivity and other properties, and hydrogels can become excellent brain computer interface materials by adding conductive fillers. Here we design a three arm cross-linking agent based on the host guest pairing of β-cyclodextrin (β-CD) and adamantane (Ad). While ensuring the low modulus and high transparency of polyacrylamide hydrogel, polyethylene glycol chain is introduced to improve the conductivity of PEDOT: PSS.

High-valent Transition Metal Enable Selective Detection of Neurotransmitters in Complex Tumor Model

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Glioma is one of highly aggressive brain malignancy characterized by high morbidity and mortality rates. Neurotransmitters in the brain are closely related to the occurrence of tumors[1]. However, the investigation of neurotransmitters in glioma is constrained due to the complex tumor microenvironment[2].

Thus, a high-selective CoCx@C catalyst with superior dopamine (DA) oxidation kinetics was constructed to achieve specific detection of DA. The carbon coordination endowed CoCx@C with good stability and biocompatibility. Electrochemical characterization confirmed that CoCx@C was able to selectively detect DA (Figure 1). Thus, we applied CoCx@C to develop a DA sensing platform to detect the DA level in glioma mouse model. It is found that glioma progression is accompanied by a 4.17-fold reduction in DA levels and aberrant neuronal discharges (Figure 2). The potential correlation between neurotransmitter dynamics and electrophysiological alterations may provide novel pathophysiological mechanisms underlying brain disorders, advancing both diagnostic and therapeutic development.

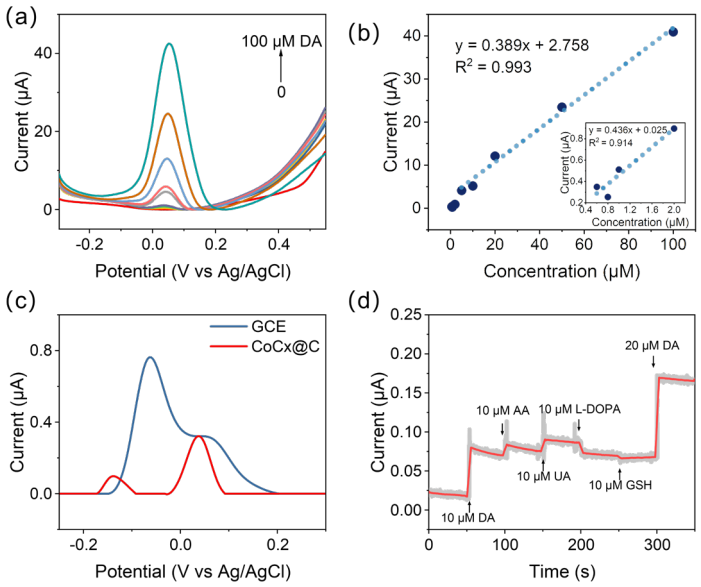


Fig.1 (a) Differential Pulse Voltammetry (DPV) curves obtained at CoCx@C in aCSF containing different concentrations of DA. (b) The corresponding calibration plots of current versus DA concentrations in aCSF. Inset: the magnified plot at low concentrations. (c) DPV curves obtained at CoCx@C and GCE in aCSF containing 100μM AA and 1 μM DA. (d) Amperometric response recorded at CoCx@C toward continuous

additions of DA, Ascorbic acid (AA), Levodopa (L-DOPA), Uric acid (UA), DA in aCSF containing 10 μM AA.

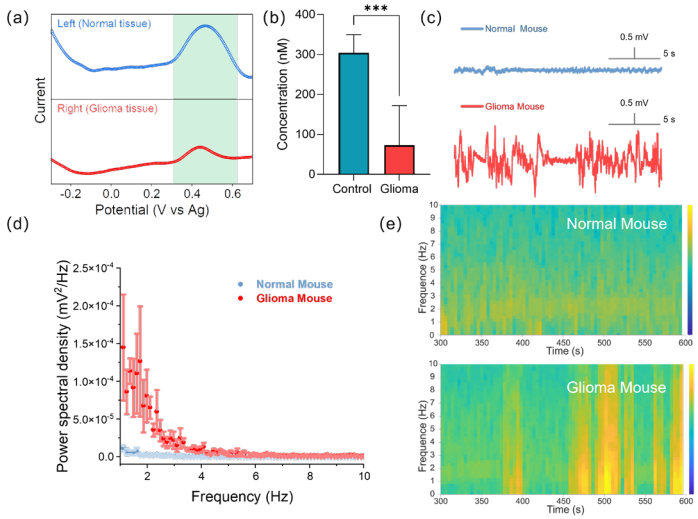


Fig.2 (a) Differential Normal Pulse Voltammetry (DNPV) curves obtained at glioma tissue (right striatum) and normal tissue (left tissue) in the same mouse with CoCx@C-coated carbon fiber microelectrode. (b) Statistics of the DA concentration in the striatum of the normal mouse brain and glioma mouse brain. (c) Electroencephalogram (EEG) traces from control and glioma tumours mouse. (d) Power spectrum density of the striatum recorded in normal and glioma mice. (e) Power spectrograms recorded from the striatum in normal and glioma mice.

Acknowledgements

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References

1. J. Meyer and K. Yu. *Nat Commun*, **15**, 4503 (2024).
2. G. Zeng and J. Mao. *Adv Sci*, **11**, e2406683 (2024).

A dopamine-accelerated polymerization method for aromatic ring compounds and its applications in ion concentration sensing and pH sensing

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The research and development of soil pH sensors is the key to ensuring national food security. China's policies emphasize intelligent agriculture and soil monitoring to address the acidification of cultivated land (30% of cultivated land in the south has a pH value less than 5) and the reduction in production caused by the salinization of 1.5 billion mu of land, ensuring a grain output of 1.3 trillion jin. Precise pH regulation can reduce the abuse of chemical fertilizers by three times globally, supporting the "dual carbon" goals. The traditional aromatic compounds are difficult to polymerize, with strict polymerization conditions, long polymerization time and high cost. The existing ion and pH sensors have problems such as high preparation cost, instability and narrow detection range. Therefore We have developed a low-cost and rapid polymerization method for aromatic compounds, promoting the low-cost and rapid preparation of stable ions and pH sensors.

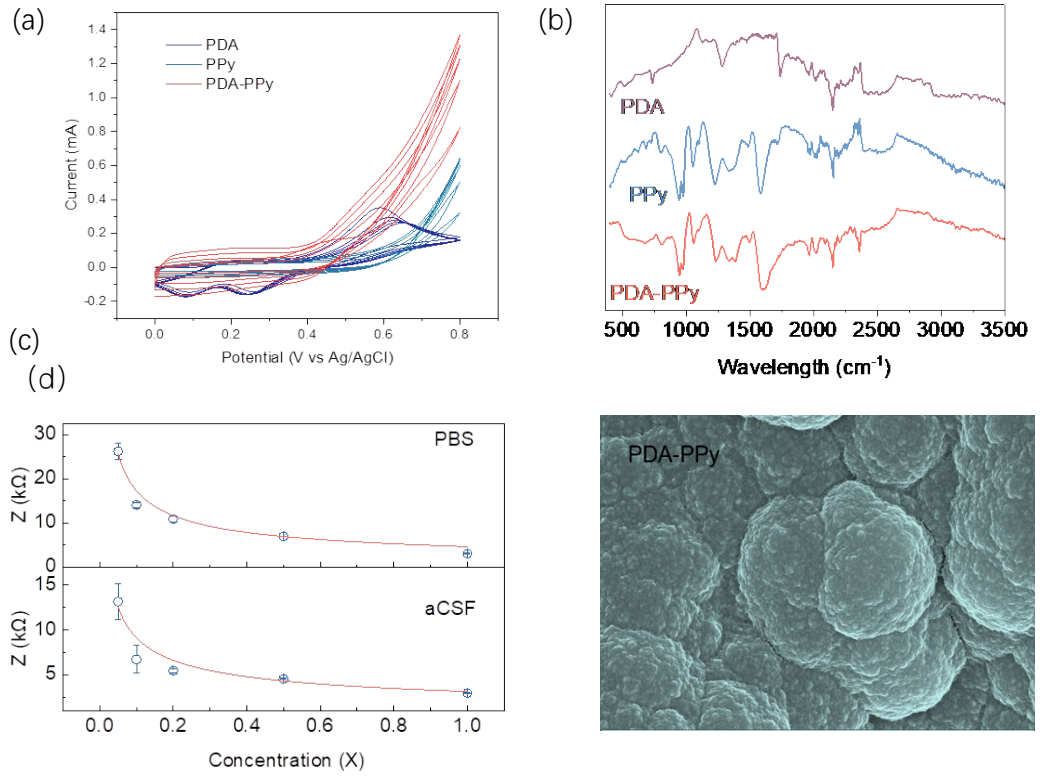


Fig.1 (a) Cyclic Voltammetry of PDA、PPy、PDA-PPy. (b) Fourier Transform infrared spectroscopy(FT-IR) of PDA、PPy、PDA-PPy. (c) Ion intensity sensor diagram of PBS、aCSF. (d) Infrared scanning electron microscope image of PDA-PPy

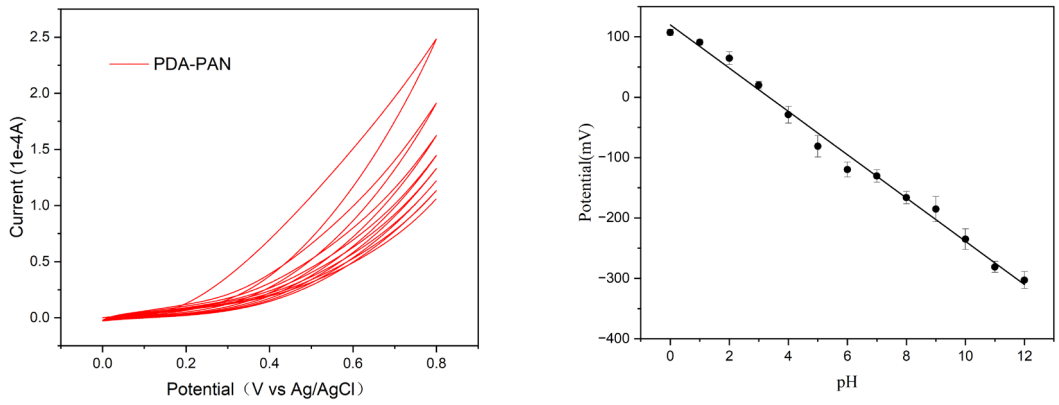


Fig.2 (a) Cyclic Voltammetry of PDA-PAN. (b) The corresponding calibration plots of the sensor detects the standard curve with pH ranging from 0 to 12

References

1．P. Coatsworth and Y. Cotur. Adv Sci, 10, 6315 (2024).
2. H.-H. Tsai and W. Schmidt. Nat Commun, 10(2021)

Aurophilic-Driven Hierarchical Assembly of Au Nanoclusters into ECL Luminophor Superstructures for Ultrasensitive Biosensing

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Electrochemiluminescence (ECL) has emerged as a powerful analytical technique due to its remarkable advantages, including near-zero background noise, high sensitivity, and excellent spatiotemporal controllability. These superior characteristics make ECL particularly suitable for clinical diagnostics and precision bioanalysis. In this study, we developed an innovative strategy to dramatically enhance ECL performance through oriented ordered interface self-assembly (OOISA) of Au_{10} nanoclusters (NCs) into highly ordered fibrous superstructures ($Au_{10\text{-}Fiber}$). The hierarchical assembly process, driven by synergistic aurophilic interactions and π-π stacking, transforms discrete NCs into extended nanowire architectures, resulting in unprecedented ECL enhancement. Comprehensive characterization reveals the assembled $Au_{10\text{-}Fiber}$ exhibits a remarkable 164% relative ECL quantum yield compared to the benchmark $Ru(bpy)_3^{2+}$/TEA system, surpassing other reported metal NCs.

The exceptional ECL performance stems from three key structural advantages: (1) significantly increased local electron density through Au(I)-rich staple motifs, (2) highly efficient charge transport enabled by the π-conjugated system, and (3) effective suppression of non-radiative decay via ligand rigidification in the ordered superstructure. To demonstrate practical applications, we engineered a label-free ECL immunosensor for ultrasensitive detection of Alzheimer's disease biomarkers $A\beta_{1\text{-}42}$, achieving an exceptionally low detection limit of 3.33 fg/mL. This breakthrough sensitivity, combined with the technique's inherent advantages in specificity and stability, establishes OOISA for the next-generation diagnostic technologies. The fundamental insights into structure-ECL relationships gained from this study provide a foundation for developing advanced luminescent nanomaterials with tailored properties, opening new possibilities for biomedical research and clinical applications.

Acknowledgements

This work is supported by the National Natural Science Foundation of China (Nos. 22034006, and 21721003).

References

1. Ouyang, X. and Wu, Y. *Angew. Chem. Int. Ed.*, **62**, e202300893 (2023)
2. Sun, Q, and Ning, Z. *Angew. Chem. Int. Ed.*, **62**, e20232053 (20223)

Electronic Modulation of Frustrated Lewis Pairs in Boron-Doped Cobalt Oxide Nanosheets for Enhanced Oxidase-like Catalysis and Biosensing

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The optimization of substrate-binding sites plays a pivotal role in designing enzyme-mimetic catalysts for small molecule activation. This work demonstrates the successful construction of frustrated Lewis pairs (FLPs) through boron-doped cobalt oxide (CoO_x) nanosheets ($CoBO_x$) with abundant oxygen vacancies (O_v). Experimental and theoretical analyses reveal that O_v not only modulates the valence state and coordination environment of active sites but also elongates the Lewis pair (M-O) distance. In the synthesized $CoBO_x$, Co and O atoms adjacent to O_v serve as Lewis acid (LA) and Lewis base (LB) sites, respectively. The electron-deficient LA sites facilitate efficient O_2 adsorption and dissociation, while the electron-rich LB sites shorten reaction distances by attracting positively charged TMB substrates, synergistically enhancing the oxidase-like (OXD) activity and reaction kinetics. Density functional theory (DFT) calculations confirm that FLPs significantly increase the electron density at Co sites, accelerating electron transfer rates, stabilizing reaction intermediates, and reducing the energy barrier of the rate-determining step. As a proof-of-concept application in colorimetric biosensing, the FLPs-engineered $CoBO_x$ exhibits high sensitivity and selectivity for dopamine (DA) detection. This work highlights the substantial potential of FLPs in activating small molecules and provides a novel strategy for designing advanced enzyme-inspired catalytic materials through electronic and structural regulation.

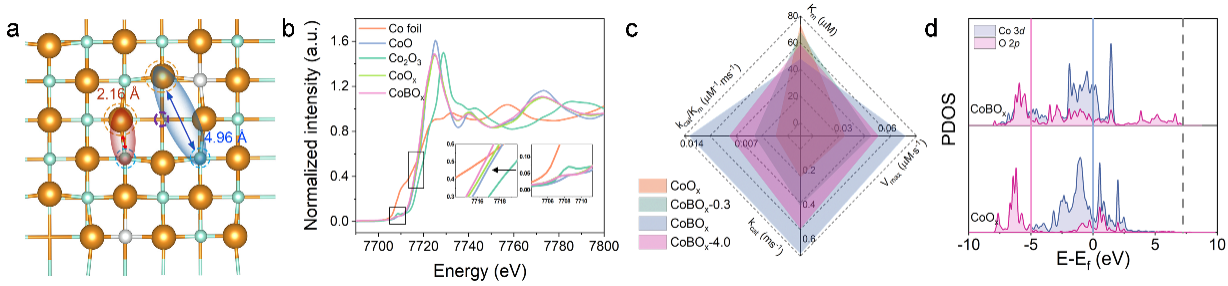


Fig.1 (a) The surface structure features of $CoBO_x$. (b) Normalized Co K-edge XANES spectra of $CoBO_x$, CoO_x and the corresponding reference samples. (c) Comparison of kinetics for various nanozymes. (d) PDOS of Co 3*d* and O 2*p* orbitals on $CoBO_x$ and CoO_x.

Acknowledgements

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(2022YFF0710000) and the Jilin talent Development Foundation (E41S2001).

References

1. J. Wu, X. Wang, Q. Wang, Z. Lou, S. Li, Y. Zhu, L. Qin and H. Wei, *Chem. Soc. Rev.*, **48**, 1004-1076 (2019).
2. G. C. Welch, R. R. S. Juan, J. D. Masuda and D. W. Stephan, *Science*, **314**, 1124-1126 (2006).
3. M. Zhou, H. Wang, R. Liu, Z. Liu, X. Xiao, W. Li, C. Gao, Z. Lu, Z. Jiang, W. Shi and Y. Xiong, *Angew. Chem., Int. Ed.*, **63**, e202407468 (2024).

Atom-pair engineering of single-atom nanozyme for boosting activity for antioxidant nutrition quality evaluation in food

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Single-atom nanozymes have garnered significant attention due to their exceptional atomic utilization efficiency and catalytic kinetics closely resembling natural enzymes. However, the non-polar coordination environment in single-atom nanozymes with typical M-N_4 configurations exhibits symmetrical electron distribution, resulting in low substrate affinity and catalytic efficiency that remains far below expectations. Introducing an additional metal atom adjacent to the central metal site represents an effective strategy to enhance catalytic activity. This approach leverages the synergistic chemical interactions between dual metallic sites to regulate electronic structures, thereby achieving synergistic catalytic activity and improved substrate adsorption capacity. In this work, we report a Fe/Ce dual single-atom nanozyme (Fe/Ce-SNC) synthesized using a ZIF-8 framework. The engineered Fe/Ce-SNC demonstrates significantly enhanced peroxidase-like (POD) activity by modulating the d-band center of Fe sites to strengthen substrate adsorption. Remarkably, it exhibits 3.0-fold and 15.55-fold catalytic efficiency improvements compared to single-site Fe-SNC and Ce-SNC counterparts, respectively, which substantiates that Fe-Ce diatomic engineering constitutes a rational and effective strategy for enhancing the peroxidase-mimicking activity of metallic single-atom nanozymes. As a proof of concept application, a multifunctional colorimetric sensor array was constructed for rapid and sensitive detection of five antioxidants based on the different catalytic activity of Fe-SNC, Ce-SNC and FeCe-SNC.

Acknowledgements

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References

1. L. Li and L. Wang, Nat. Commun., 15, 8720-8734 (2024)
2. S. Wei and Y. Li, Nat. Commun., 15, 6888-6900 (2024)

Cu/Fe Bimetallic Nanospheres for Enhancing the Sensitivity of Lateral Flow Immunoassay

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The lateral flow immunochromatographic strips prepared by the traditional colloidal gold method are often limited by their low sensitivity when detecting samples with low concentrations [1]. Currently, methods such as the colorimetry, fluorescence, photothermal and Raman method have become the mainstream strategies for improving the sensitivity of lateral flow immunochromatographic analysis [2, 3]. Among them, the colorimetric method is widely used because the signal enhancement can be read out with the naked eye [4].

In this study, $Cu_xFe_{3-x}O_4$ nanospheres composed of Cu and Fe were designed through a one-step hydrothermal method. Moreover, the composition of these $Cu_xFe_{3-x}O_4$ nanospheres was precisely regulated and functionally modified, thus enabling the acquisition of a novel nanomaterial with excellent catalytic activity. The modified $Cu_xFe_{3-x}O_4$ nanospheres are coupled with the Deoxynivalenol (DON) antibody, replacing the traditional colloidal gold, to construct a lateral flow immunochromatographic detection platform for the highly sensitive detection of DON. Meanwhile, in the presence of the

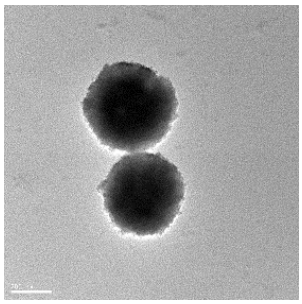


Fig.1 TEM image of $Cu_xFe_{3-x}O_4$ nanospheer

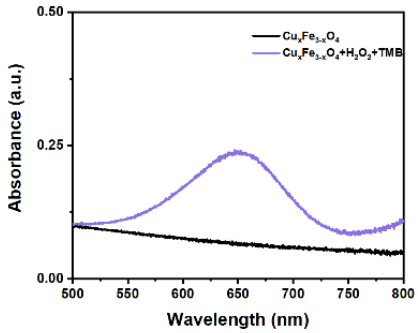


Fig.2 UV-vis absorption spectra of $Cu_xFe_{3-x}O_4$ and $Cu_xFe_{3-x}O_4$ +H_2O_2+TMB

AEC and H2O2 substrates, this platform can further catalyze the signal amplification of the C and T lines, significantly reducing the detection limit of DON and demonstrating excellent detection sensitivity. Finally, we expect that this study will provide new ideas and potential applications for food safety detection technologies.

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References

1. J. Wang, C. Jiang, J. Jin, L. Huang, W. Yu, B. Su, and J. Hu, *Angew. Chem. Int. Ed.*, 60, 13042–13049 (2021)
2. X. Tang, J. Chen, M. Zhang, J. Sun, and X. Yang, *Sci. China. Chem.*, **66**, 1860-1868 (2023)
3. Q. Zhao, Y. Wang, M. Zhang, D. Wu, J. Sun, and X. Yang, *Biosens. Bioelectron.*, **214**, 114504 (2022)
4. D. Wu, Q. Zhao, Y. Wang, B. Zhang, X. Tang, J. Talap, J. Sun, and X. Yang, *Anal Chem.*, **96**, 15682–15691 (2024)

Switchable Cas12a Inhibition via 3'-Extending-Lock Activator and Integrated Microfluidic Electrochemical Circuitry for miRNA Detection

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As one of the most influential an promising members of the Cas (CRISPR-associated proteins) family, Cas12a is an excellent genome-engineering tool that can induce the double-stranded DNA (dsDNA) or single-stranded DNA (ssDNA) break under the guidance of a single CRISPR RNA (crRNA).[1] Moreover, Cas12a can also indiscriminately cleave ssDNA surrounding the target with an extremely high turnover rate (~1250 turnovers per second) upon the formation of the Cas12a/crRNA/target DNA ternary complex, exhibiting a unique target-activated trans-cleavage ability, which constitutes a natural signal amplifier for fabricating diverse biosensors.

Engineering the guide RNA structures has been considered as one of the most efficient ways to tune the activity of the CRISPR/Cas system. For example, modifying photo-labile groups on the crRNA or using an oligonucleotide-containing photocleavable linker to hybridize with the crRNA for the blockade of crRNA/dsDNA hybridization, which is then activated by the controllable photolysis to release the native crRNA, resulting in the recognition and cleavage function of the CRISPR/Cas12a system.[2] Inhibiting the activity of the Cas12a system by extending the 5'-end or 3'-end of the crRNA to block the pseudoknot structure and then switched on the crRNA by a trigger molecule to activate the crRNA, relying on the intrinsic RNA-processing activity of Cas12a.[3] However, these methods require a long crRNA sequence or modification of crRNA, which is complex and costly. Therefor a simpler and more universal biosensing strategy is urgently needed, which could rapidly reinstate the function of the CRISPR/Cas12a system upon exposure to a specific stimulus without requiring complex and stringent crRNA structure regulation, skilled and professional chemical modification, as well as site optimization.

Here, we present a simple and robust CRISPR/Cas12a switch via extending the 3'-end of the ssDNA activator to lock the crRNA spacer/repeat joint region, and sequence-specific DNA were used as keys to unlock by strand displacement restore CRISPR/Cas12a activity. Based on this, we proposed a method called KUCA (the Key machine Unlocked Cas12a Activity) for miRNA detection, the 3WJ probe recognizes target miRNA and releases DNAzyme (key machine), which cleaves HP (precursor of key) to generate keys, Cas12a activity was restored. Finally, a miRNA detection platform is established by further combining KUCA and integrated microfluidic electrochemical circuitry.

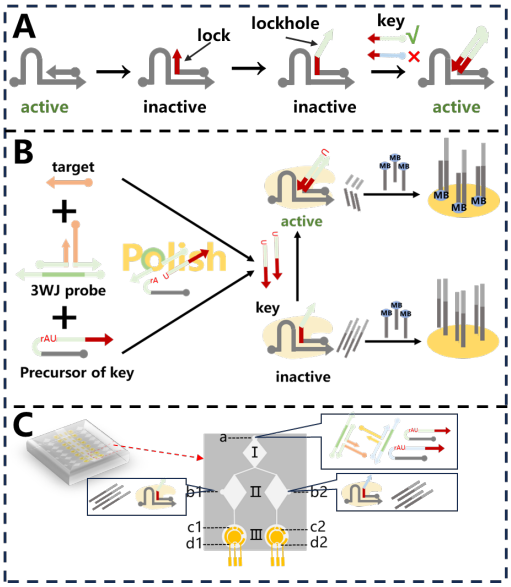


Fig.1 Schematic illustration of the KUCA strategy for miRNA detection. (A) Switchable inhibition of Cas12a activity via 3'-extended lock on the activator strand. (B) Activation of Cas12a by the KUCA (Key-Unlocked Cas12a Activity) system in response to target miRNA, enabling signal generation through DNAzyme-mediated strand displacement. (C) Integration of the KUCA system into a microfluidic electrochemical platform for sensitive and portable miRNA detection.

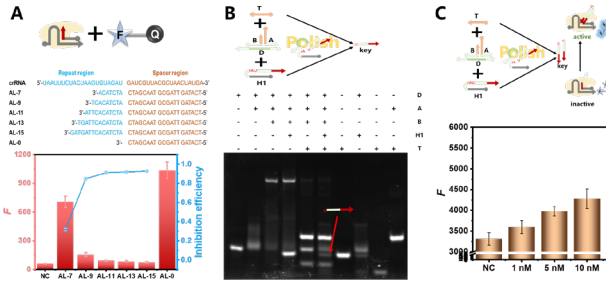


Fig.2 Feasibility verification of the KUCA system. (A) Optimization of the length of the 3'-extending-lock on the activator strand for efficient Cas12a inhibition. (B) PAGE analysis verifying the sequential release of DNAzyme and the generation of the unlocking key (H1) triggered by the target miRNA. (C) Fluorescence response of the KUCA system to varying concentrations of target miRNA mimic, demonstrating target-dependent signal activation.

Acknowledgements

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References

1. Guo, L. Y.; Bian, J.; Davis, A. E.; Liu, P. T.; Kempton, H. R.; Zhang, X. W.; Chemparathy, A.; Gu, B. K.; Lin, X. Q.; Rane, D. A.; Xu, X. S.; Jamiolkowski, R. M.; Hu, Y.; Wang, S.; Qi, L. S. *Nat Cell Biol* **2022**, *24* (4), 590-+.
2. Sun, Y. J.; Chen, W. D.; Liu, J.; Li, J. J.; Zhang, Y.; Cai, W. Q.; Liu, L.; Tang, X. J.; Hou, J.; Wang, M.; Cheng, L. *Angew Chem Int Edit* **2023**, *62* (5).
3. Creutzburg, S.; Wu, W. Y.; Mohanraju, P.; Swartjes, T.; Alkan, F.; Gorodkin, J.; Staals, R. H. J.; van der Oost, J. *Nucleic Acids Res* **2020**, *48* (6), 3228-3243.

Synthesis of Cu_2S-C-$CoMn_2O_4$ Composites for Electrochemical Sarcosine Detection

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Prostate cancer is the third most common cancer in the world, of which 125,000 new cases are expected to occur in China in 2022, and the incidence and mortality rates are increasing significantly. Sarcosine is a marker for prostate cancer and can be used for early diagnosis of prostate cancer, which has received much attention in recent years.

In this work, Cu_2O cubes were first synthesized by electroless deposition, and then sulfurized and etched using Na_2S and $Na_2S_2O_3$. Subsequently, dopamine was wrapped around its surface and a carbon layer was formed by calcination. Finally, $CoMn_2O_4$ nanosheets were formed on the surface of the carbon layer of the composite by oil bath-calcination to obtain the final composite, Cu_2S-C-$CoMn_2O_4$. The carbon layer formed was able to enhance the electrical conductivity of the material, giving it more excellent electrochemical properties. The introduction of the carbon layer can also provide attachment sites for the $CoMn_2O_4$ nanosheets formed on its outer surface, further expanding the specific surface area of the material. When applied to electrochemical sarcosine detection, it showed a wide linear range (0.4-400 μM), a low detection limit (0.17 μM, S/N = 3), and good repeatability and reproducibility. In addition, the application of Cu_2S-C-$CoMn_2O_4$ in real samples was explored, and the material was found to have excellent detection ability for sarcosine in simulated urine, suggesting that it has a promising prospect for application.

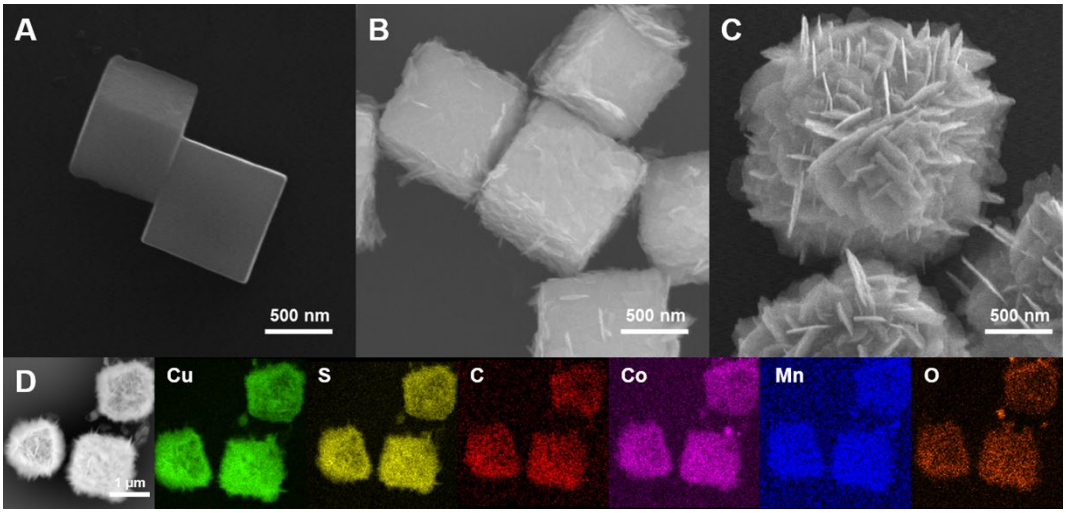


Fig.1 SEM images of (A) Cu_2O cubes, (B) Cu_2S-C cubes, (C) Cu_2S-C-$CoMn_2O_4$ composite. (D) EDS elemental mapping images of Cu, S, C, Co, Mn and O of the synthesized Cu_2S-C-$CoMn_2O_4$.

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61971274 and 62171268).

References

1. K. Chen, S. Wang, C. He, H. Zhu, H. Zhao, D. Guo, Z. Chen, J. Shen, P. Li, A. Liu, C. Li, F. Wu, W. Tang, ACS Appl. Nano Mater., 6169, 2 (2019).
2. L. Zhao, J. Yang, M. Gong, K. Li, J. Gu, J. Am. Chem. Soc., 15145, 143 (2021).

Self-Directed Assembly Drives Spatial Confinement Polymerization for Controlled Capsule Engineering

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Facile and template-free synthesis of polyphenol-based polymer capsules is highly desired but remains challenging, owing to rapid oxidization of polyphenols and the corresponding uncontrolled assembly. Here, inspired by the natural structure and spontaneous assembly of cell membrane, we for the first time report a one-pot spatial confinement polymerization strategy based on the self-directed assembly of the "smart" lipid-like phenylboronate-dopamine derivatives (pDA). Both the experimental results and theoretical calculations demonstrate that these amphiphilic pDA molecules can spontaneously assemble into metastable vesicles, providing a spatially confined pre-capsules framework for the later cross-linking polymerization. Strikingly, the ingeniously designed hydrophobic phenylboronate ends not only block the catechol groups from rapid oxidization, but also take off / dissociate / decompose under the polymerization trigger-H_2O_2, thus enabling a controllable stimuli-responsive polymerization. Particularly, the uniform macroporous cavities with tunable sizes and sufficient cross-linking degree account for acoustic cavitation enhancement, providing a biocompatible sonosensitizer-free therapy platform. The general strategy paves the way toward the template-free synthesis of polyphenol-based capsules and may enlighten chemists to achieve intracellular synthesis of hollow polydopamine.

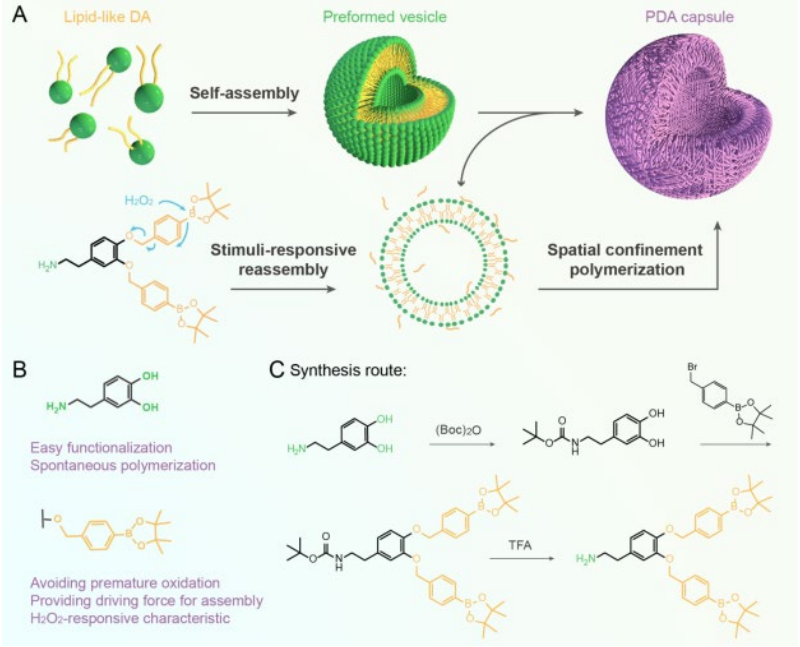


Fig.1 The spatial confinement polymerization strategy based on the self-directed assembly of the "smart" pDA to synthesize PDA capsules.

Acknowledgements

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References

1. Yuzhu Wang , *Nano Today*, **57**, 102405 (2024)

Accurate and Rapid Detection of Respiratory Pathogen Nucleic Acid

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Early and sensitive detection of respiratory pathogens enables targeted treatment, facilitating personalized therapy. The most commonly used method for detecting respiratory pathogens is microbial culture, which is both time-consuming and requires a high level of expertise and controlled environments. Next-generation sequencing (NGS) is another commonly used method in clinical practice, capable of characterizing whole-genome sequence information with high efficiency. But the high costs and lengthy processing times associated with NGS limit its ability to meet clinical testing needs and reduce its practicality for routine use. As a result, non-sequencing methods appear to be an alternative solution with high accuracy and efficiency. Polymerase chain reaction (PCR)-based detection methods are essential techniques in this field. However, PCR assays may generate false-positive signal beyond 35 Ct (Cycle threhold), particularly when detecting samples with low-abundance targets, resulting in ambiguous results that compromise the accuracy and reliability required for clinical diagnostics. In order to decrease the dependence on strict temperature control, advanced equipment, and specialized data analysis, and to further facilitate low-cost or point-of-care detection (POCT), isothermal amplification techniques that can amplify nucleic acid targets at constant temperature have attracted increasing attention. However, in the absence of thermocycling, as utilized in PCR, most isothermal amplification reactions face two significant challenges: 1) a heightened tendency to produce non-specific or wrong amplification products, and 2) a lack of sequence-specific signal probes. These limitations often lead to frequent false-positive or false-negative results, thereby compromising the accuracy of target quantification. It is thus even more difficult to distinguish the mutations, especially SNVs. To address the above issues, our approach combined isothermal amplification techniques with nucleic acid circuits, which were known as specific, efficient method for the detection of nucleic acid targets. This strategy not only realized simultaneous detection of both conserved genomic regions and drug-resistant mutations in pathogens within a single reaction, but also achieved the detection of multiple pathogens in one tube.

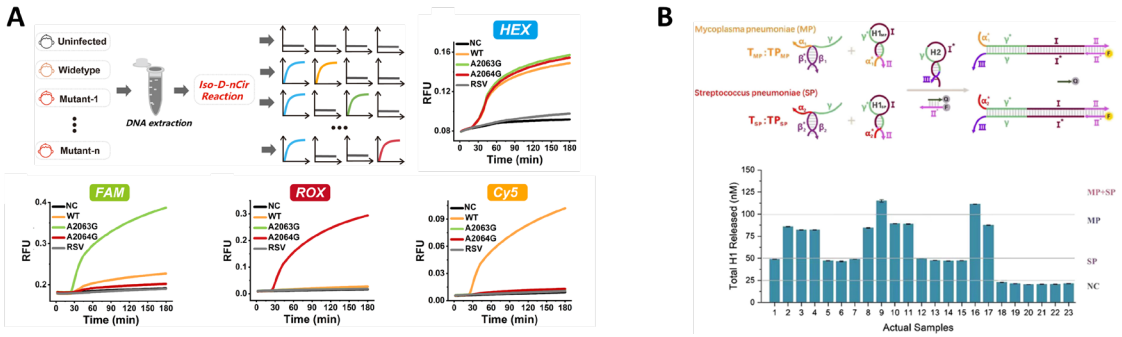


Fig.1 (A) A dual-position nucleic acid coding strategy for one-pot recognition of a pathogen and multiple drug-resistant mutations. (B) Multiplex detection of clinical pathogen nucleic acids via a three-way junction structure-based nucleic acid circuit.

Acknowledgements

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References

1. C. Yu, B. Lu, Y. Tang, W. Zhuang, et al. *CHEM. ENG. J.,* **512,** 162464 (2025)
2. C. Yu, R. Zhao, Y. Tang, S. Zhou, et al. *Advanced Agrochem.,* **2,** 291-296 (2023)
3. C. Yu, S. Zhou, X. Zhao, Y. Tang, et al. *Anal. Bioanal. Chem.,* **415,** 2173-2183 (2023)

Adaptive deep learning enhanced magneto-potentiometric sensing of antibiotics in coastal seawater

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This study presents a novel magneto-controlled potentiometric assay for qualitative and quantitative detection of target molecules utilizing non-equilibrium measurement techniques.[1,2] The potentiometric responses of negatively charged aptamers, serving as both receptors and reporters, are dynamically controlled and modulated through application of a magnetic field. Functionalized DNA probes were utilized to modify magnetic beads, enabling selective capture of target molecules. A novel potentiometric sensing interface was designed to construct a magnetically controlled potentiometric sensor, achieving ultra-sensitive, label-free detection with remarkable precision. The aptasensing system was equipped with an online adaptive deep-learning model to regulate databases and improve predictive performance. Using antibiotics as a model analyte, the system demonstrated exceptional sensitivity and selectivity. This method significantly reduced detection limits compared to conventional magneto-potentiometric approaches. Adaptive learning algorithm demonstrates superior performance through implementation of transfer learning techniques, whereby pre-trained models are fine-tuned with domain-specific data, resulting in 87.3% reduction in false positives compared to conventional statistical approaches. Additionally, the system employs Bayesian optimization for hyperparameter tuning, facilitating autonomous calibration under varying environmental conditions. The coupling of magneto-potentiometric aptasensing with powerful adaptive learning algorithms provides an effective tool for resolving various antibiotics in a selective and quantitative manner, demonstrates significant potential for deployment in various analytical scenarios requiring rapid, sensitive detection of molecular targets in complex media.

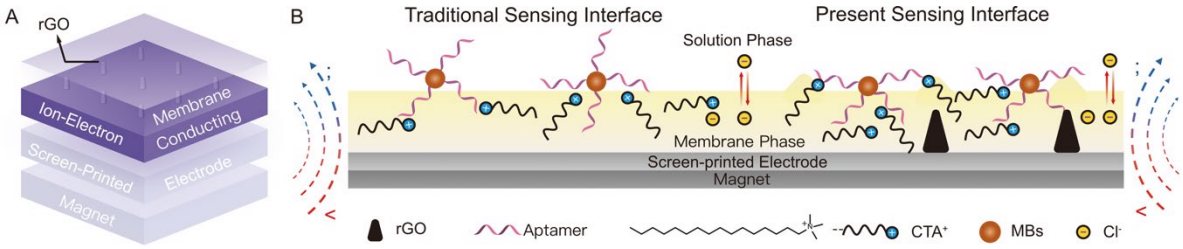


Figure 1 Schematic diagrams of (A) magneto-controlled potentiometric sensors; and (B) the sensing mechanism.

Acknowledgements

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References

1. **J. Mou**, J. Ding, W. Qin, *Angew. Chem. Int. Ed.*, **62**, e202210513. (2023)
2. **J. Mou**, J. Ding, W. Qin, *Chem. Eur. J.*, **29**, e202302647. (2023)

Metal Hydrogel-Driven Acupuncture for Integrated in Situ Electrochemical Cancer Theranostics

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Cancer theranostics represents an emerging field in precision medicine that integrates diagnostic and therapeutic modalities to enable spatiotemporally controlled interventions with real-time efficacy monitoring, garnering significant scientific interest. This study pioneers an electrochemical platform synergizing hydrogen (H_2) therapy with reactive oxygen species (ROS)-responsive sensing, addressing critical challenges in targeted H_2 delivery control and delayed therapeutic assessment inherent to conventional approaches. Mechanistically, PtCu hydrogel-mediated H_2 electrochemotherapy triggers apoptosis via mitochondrial dysfunction and oxidative stress, positioning ROS as critical biomarkers for treatment evaluation. We engineered a PtCu hydrogel-based acupuncture needles demonstrating dual functionalities in situ: voltage-regulated electrocatalytic H_2 generation for precise therapy, and meanwhile sensitive ROS monitoring through current response in the tumor microenvironment (TME). Specifically, leveraging the synergistic effects of a three-dimensional porous architecture and bimetallic electronic optimization, the hydrogel exhibits exceptional HER efficiency and ultra-high ROS detection sensitivity. This bifunctional electrocatalyst was successfully integrated with medical acupuncture needles, with therapeutic and diagnostic performance validated through in vitro cellular assays and in vivo murine models (i.e., current response signal of ROS associated with apoptosis was detected within 300 seconds via H_2 therapy). Our work establishes a new electrochemical system for closed-loop cancer theranostics by combining the imbalance of REDOX levels caused by in-situ controlled H_2 delivery with digitalized real-time apoptotic feedback, advancing the development of intelligent platforms for personalized oncology management.

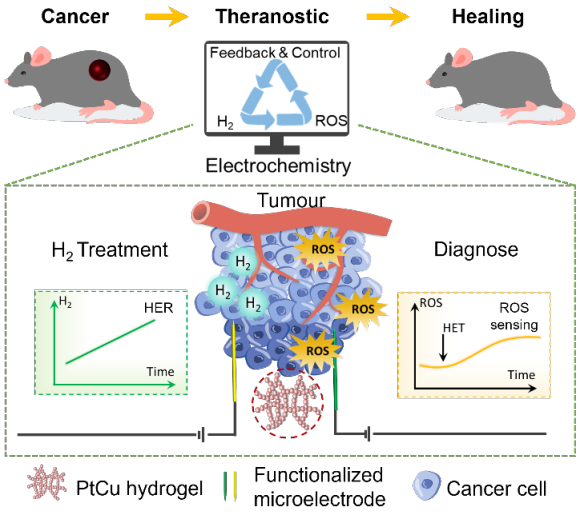


Fig.1 Schematic illustration of electrochemical theranostic platform for cancer.

Acknowledgements

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References

1. G. Qi, K. Ma and et al., *Adv. Mater.*, **35**, 2208414 (2023)
2. S. Zhang, H. Qin and et al., *Angew. Chem. Int. Ed.*, e202300083 (2023)
3. N. Yang, S. Sun and et al., *Adv. Mater.*, **37**, 2414929 (2025)
4. P. Siboro, A. Sharma and et al., *ACS Nano*, **18**, 2485−2499 (2024)

Multi-functional electrochemiluminescence biosensor for efficient capture, elimination, and sensitive monitoring of *4UBQ ZMDPDDVT BVSFVT*

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In this work, we developed a novel strategy for effective bacteria capture, elimination, and detection. Meanwhile, efficient amplification strategies include strand-displacement reaction, DNA walker, and essential oil-synthesized Au:Ag NPs were developed for the sensitive measurement of *S. aureus*. S. aureus could be effectively captured by Fe_3O_4/aptamer:T complex and induced the release of T strand to trigger the SDA reactions. The combination of plenty of SDA produced on the biosensing interface led to the decreased amount of essential oil-synthesized Au:Ag NPs immobilized on the biosensor, resulting in the decreased enhancement effect of Au:Ag NPs on the ECL signal of luminol/H_2O_2 system. The green-synthesized Au:Ag NPs can significantly improving the ECL signal (16.7-fold) while also effectively kill *S. aureus*. Owing to the outstanding features of Au:Ag NPs, this novel biosensor displayed a wide linear range (10^2–10^8 CFU/mL) and a low detection limit (17 CFU/mL) for *S. aureus* measurement. As a result, this multifunctional technique shows great potential for practical applications in the fields of food safety and the environment.

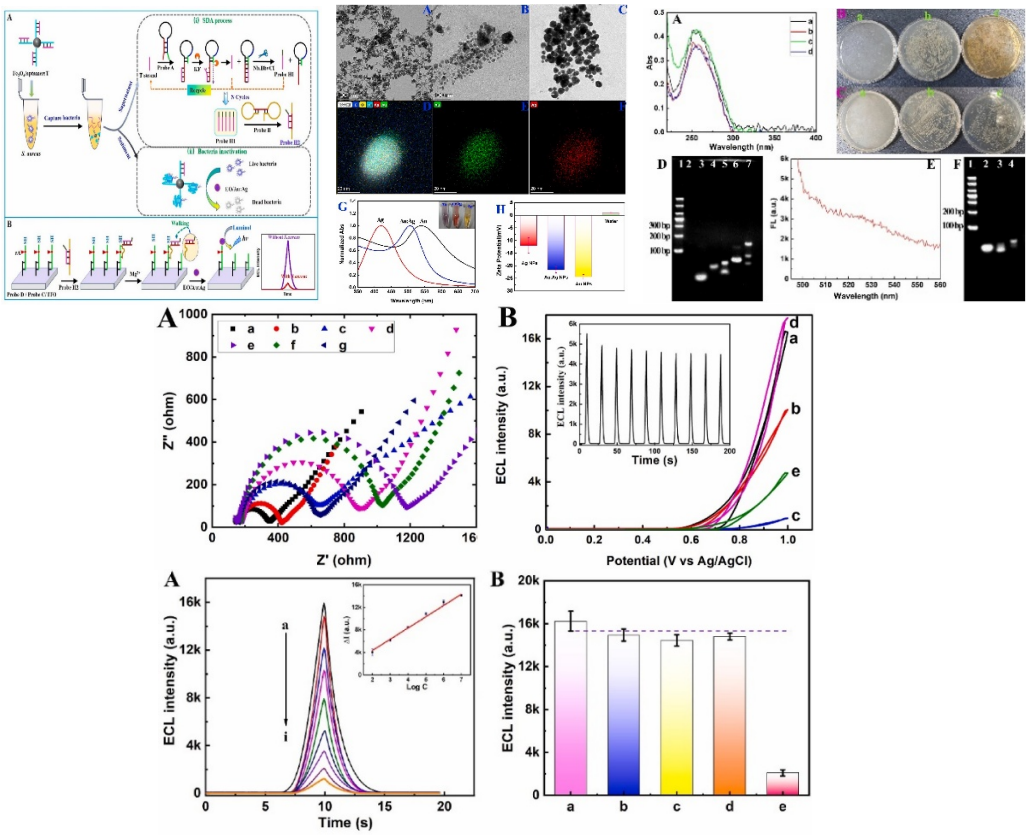


Fig.1 Schematic and some characterization diagram of *S. aureus* based on SDA signal amplification.

Acknowledgements

This work was supported by the Fundamental Research Funds for the Central Universities (YDZX2024017) and the National Natural Science Foundation of China (21675087).

An "on-off" electrochemical immunosensor for the detection of the glycan antigen CA125 by amplification signals using electropositive COFs

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Cancer Antigen 125 (CA125), is a high molecular weight mucinous glycoprotein found on the surface of ovarian cancer cells. Generally, 90 % of women may appear a high concentration of CA125 when they got the cancer; thus, CA125 can act as a marker for ovarian cancer diagnosis and therapeutic evaluation. COFs have been widely used for disease detection due to their structural stability, high loading capacity and biocompatibility. However, the limited variety of electroactive COFs used as signal probes, fewer enriched signaling molecules, weaker electrical signals generated, and higher oxidation or reduction potentials of electroactive substances, a series of side reactions are easily triggered causing serious interference. To solve the above problems, [Fe(CN)6]3/4- as a signal probe and COFs for signal amplification were selected to creating a highly sensitive electrochemical immunosensor for glycan antigen CA125. Firstly, two-dimensional (2D) EP-TD-COF with ultra-high specific surface area was modified on bare GCE, which could covalently bound numerous Ab1 molecules due to the epoxy-rich functional groups. Then, the electropositive AuNPs@2DCOFBTT-DGMH was prepared by the in situ growth of AuNPs, proved an effective platform for loading Ab2 molecules via Au–S bonds. Based on the positively charged AuNPs@COFBTT-DGMH/Ab2 and negatively charged [Fe(CN)6]3/4- of electrostatic interactions, which could significantly enchaned signal for quantitative and sensitive detection of CA125. The constructed immunosensor exhibits excellent stability performance and high sensitivity, enabling ultrasensitive detection of trace glycan antigens. This study provided a new idea for the use of non-electroactive substances for the con- struction of electrochemical immunosensors and provided an effective signal amplification strategy.

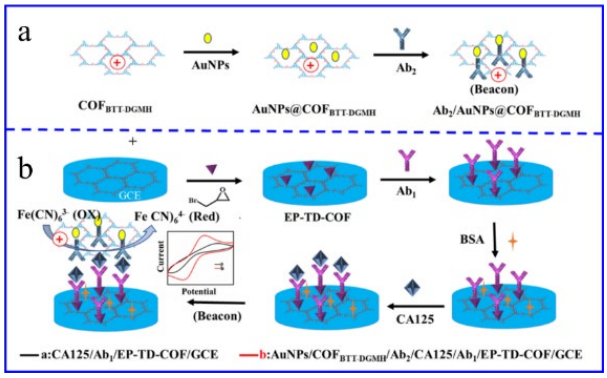


Fig.1 Schematic diagram of the construction and application of immunosensors

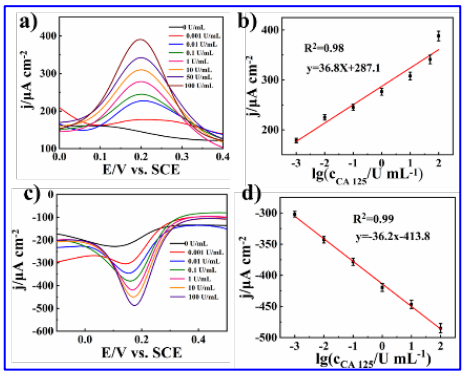


Fig.2 DPV response of oxidized peak current (a) and reduced peak current (c) of AuNPs@$COF_{BTT-DGMH}$/Ab_2/CA125/Ab_1/EP-TD-COF/GCE for detecting different concentrations of CA125 in a 0.1 M KCl solution of 5 mM $[Fe(CN)_6]^{3-/4-}$; oxidized peak current density (b) and reduced peak current density (d) the calibration curve between j and lgC_{CA125}.

Acknowledgements

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References

1. ssatayeva, E. and A. Cucinotta, Talanta, 267, 125198, (2024)
2. M.L. Yola and N. Atar, Microchemical Journal,170, 106643, (2021)
3. G. Zhao and Q. Wei, Analytical Chemistry, 94(29), 10557-10566, (2022)
4. S.R. Torati and C. Kim, Sensors and Actuators B: Chemical, 243, 64-71, (2017)
5. Y. Cai and J. Li, Nanoscale, 16(3). 961-977, (2024)

Pyridine Rings Engineering of Au Aerogels for Wearable Dopamine Biosensing in Extreme Environments

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Wearable biosensors designed for continuous monitoring of biomarkers in body fluids have the potential to significantly advance human health management. Dopamine (DA) levels are intricately linked to the body's mental health, and real-time monitoring of DA concentrations can offer tailored solutions for personalized health management. Conventional analytical methods, such as high-performance liquid chromatography (HPLC), face significant challenges in plateau environments due to the steric limitations of the instruments. Consequently, the incorporation of a wearable sensor with high selectivity and sensitivity for detecting DA has the potential to significantly advance health monitoring methodologies. In this study, we utilize molecular functionalization of the gold (Au) aerogel and systematically regulate the number of pyridine rings (n=4, 2, 0) to achieve highly selective and sensitive detection of DA. Ultimately, we developed a flexible sensing chip (i.e., a sensitivity of 0.487 nA nM^{-1} cm^{-2} and the LOD of 0.4 nM for Au_{H2TPyP} aerogel, n=4) comprising sensitive materialsand successfully realized wearable DA monitoring under the transition from normal to plateau environment by integrating microdialysis techniques with electrochemical methods. This study not only proposes a highly sensitive approach for tracking low-concentration neurotransmitter dynamics but also provides health safeguarding of specialized operational personnel, thereby enhancing operational safety during high-altitude deployments.

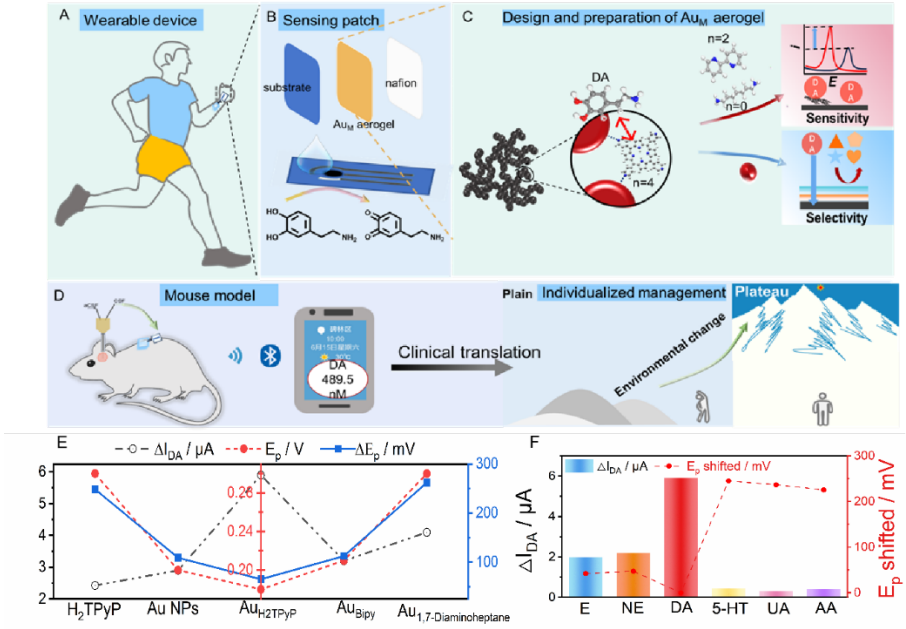


Fig.1 Schematic illustration of Au_M aerogels for wearable device sensing in extreme environments(A-D). (E) Comparison of the DA oxidation response (ΔI_{DA}), E_p and ΔE_p of modified electrodes at the corresponding oxidation peak potential respectively. (F) The current response and E_p shifted potential of different interferences of at Au_{H2TPyP} aerogel at +0.18V.

Acknowledgements

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References

1. S. Shu, W. L. Cheng, *Chem. Rev.*, **124**, 455-553 (2024)
2. J. Min and J. Tu, *Chem. Rev.*, **123**, 5049-5138 (2023)
3. L. Yin and M. Cao, *Nat. Electron.*, **5**, 694-705 (2022)
4. Y. Yang and W. Gao, *Chem. Soc. Rev.*, **48**, 1465-1491 (2019)

A $Ti_3C_2T_x$-Based Electrochemical Biopatch for Photothermal and Electrostimulation Therapy in Diabetic Wound Healing

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This study has developed a $Ti_3C_2T_x$-based electrochemical multifunctional biopatch (M-BioP), offering an innovative electrochemical therapy strategy for diabetic wound healing. By integrating in-body energy harvesting, sensing, and disease treatment, this creates an endogenous electric field near the wound to achieve self-powered electrochemical stimulation therapy. Additionally, the M-BioP has high-efficiency antibacterial properties under near-infrared light assistance.

The M-BioP is primarily composed of $Ti_3C_2T_x$, known for its excellent photothermal conversion and electrochemical properties, which enhance the patch's output and photothermal conversion efficiency. In vitro studies show that the M-BioP promotes fibroblast migration and proliferation and has photothermal antibacterial effects against E. coli, Staphylococcus aureus, and Pseudomonas aeruginosa.

In a diabetic wound model, the M-BioP accelerates healing when used with near-infrared light. It promotes collagen deposition, angiogenesis, and M2 macrophage polarization, optimizing the wound microenvironment and speeding up the healing of diabetic infected wounds. The M-BioP also shows good biocompatibility and blood compatibility, ensuring safe in-body use.

To sum up, $Ti_3C_2T_x$-based M-BioP integrates photothermal and electrochemical stimulation to promote diabetic wound healing. This innovative approach offers valuable new perspectives for the development of wearable medical devices incorporating two-dimensional materials and biopatches. The combination of these two stimulation methods in $Ti_3C_2T_x$-based M-BioP creates a synergistic effect that enhances the healing process of diabetic wounds. The use of two-dimensional materials like $Ti_3C_2T_x$ in wearable medical devices represents a promising direction for future research and application in the field of biomedical engineering.

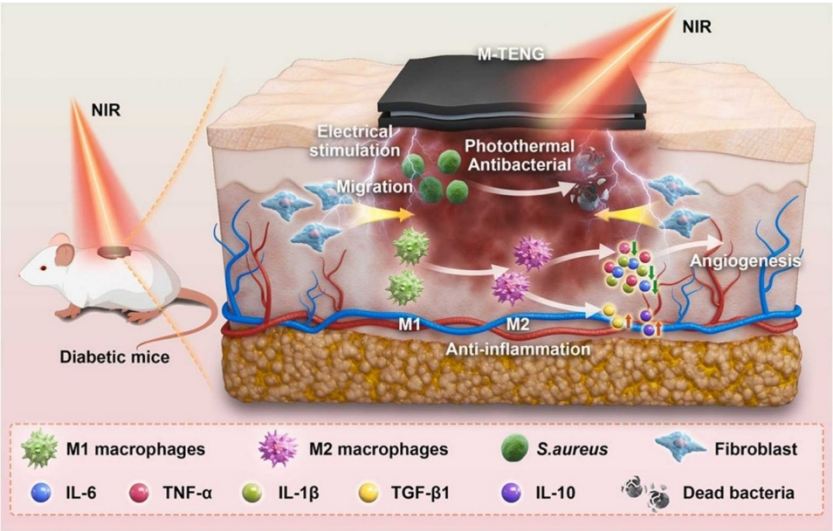


Fig.1 functional schematic diagram

Acknowledgements

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References

1. R. Luo, J.Dai, J. Zhang, Z. Li, *Adv. Healthcare Mater*, **10**, 2100557 (2021).
2. X. Meng, X. Xiao, S. Jeon, D. Kim,, *Adv. Mater,* **35**, 2209054 (2023).
3. R. Luo, Y. Liang, J. Yang, H. Feng, Y. Chen, X. Jaing, Z. Zhang, J.*Adv. Mater*, **35**, 2208395 (2023).

Nanoelectrochemical Monitoring of pH-Regulated ROS/RNS Homeostasis in Macrophages Lysosomes During Phagocytosis

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Macrophages participate in the immune system by recognizing and engulfing foreign bodies inside phagosomes which fuse with lysosomes in their cytoplasm to form mature phagolysosomes. Lysosomes have an acidic interior and generate and release reactive oxygen and reactive nitrogen species (ROS/RNS) to destroy the endocytosed entities.[1-3] It has been previously reported that intra-lysosomal pH plays an essential role in the regulation of ROS/RNS.[4-6] However, the exact regulatory mechanism remains to be elucidated. Taking advantage of the large number of active lysosomes distributed along the phagocytic lumen during frustrated phagocytosis of glass fibers by macrophages[7], the intensity of four primary ROS/RNS released fluxes ($ONOO^-$, H_2O_2, NO and NO_2^-) was monitored with platinum nanoelectrochemical sensors, thereby revealing the important role of intra-lysosomal pH on ROS/RNS fluxes after pharmacological modulations. Acidification (pH<5.0) does not alter the rate of production of ROS/RNS precursors (superoxide ions, $O_2^{\bullet-}$, and parent NO), but promotes $O_2^{\bullet-}$ protonation leading to an increase of H_2O_2 release. In contrast, the initial production of NO, which subsequently increased the release of $ONOO^-$ and NO_2^-, was enhanced by alkalinization (pH>6.0). The resulting increased oxidative stress was associated with massive proinflammatory cytokine release. Taken together, these results provide important information about the impact of lysosomal pH on ROS/RNS regulation.

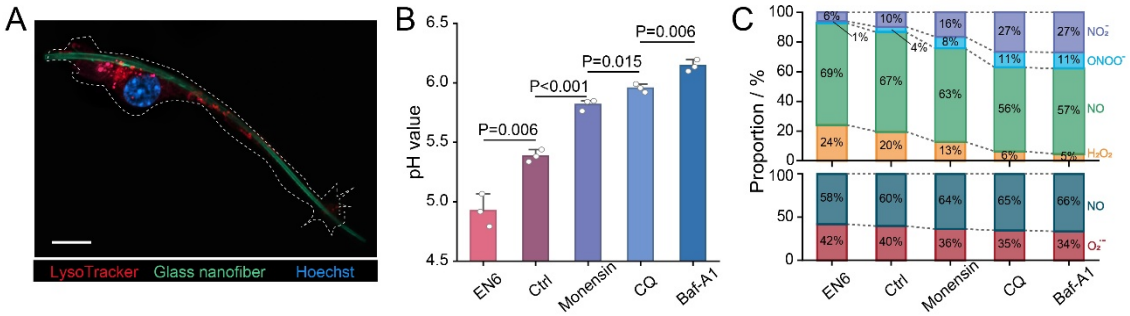


Fig. 1 (A) The confocal micrograph of LysoTracker (red) and Hoechst (blue) staining of a macrophage after frustrated phagocytosis of a FITC-labeled glass nanofiber (green); scale bar, 10 μm. (B) The pH value of macrophage after incubation with or without lysosomal pH regulators; (C) Proportions of the four primary ROS/RNS (NO_2^-, $ONOO^-$, NO, H_2O_2) and their

precursors (NO and $O_2^{\bullet-}$) of macrophage after incubation with or without lysosomal pH regulators.

Acknowledgements
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References

1. Luzio, J. P.; Pryor, P. R.; Bright, N. A. Lysosomes: fusion and function. *Nat. Rev. Mol. Cell Biol.* **2007**, *8* (8), 622-632.
2. Ballabio, A.; Bonifacino, J. S. Lysosomes as dynamic regulators of cell and organismal homeostasis. *Nat. Rev. Mol. Cell Biol.* **2019**, *21* (2), 101-118.
3. Settembre, C.; Perera, R. M. Lysosomes as coordinators of cellular catabolism, metabolic signalling and organ physiology. *Nat. Rev. Mol. Cell Biol.* **2023**, *25* (3), 223-245.
4. Casey, J. R.; Grinstein, S.; Orlowski, J. Sensors and regulators of intracellular pH. *Nat. Rev. Mol. Cell Biol.* **2009**, *11* (1), 50-61.
5. Hajjar, S.; Zhou, X. pH sensing at the intersection of tissue homeostasis and inflammation. *Trends Immunol.* **2023**, *44* (10), 807-825.
6. Bonacina, F.; Zhang, X.; Manel, N.; Yvan-Charvet, L.; Razani, B.; Norata, G. D. Lysosomes in the immunometabolic reprogramming of immune cells in atherosclerosis. *Nat. Rev. Cardiol.* **2024**, *22* (3), 149-164.
7. Qi, Y.-T.; Zhang, F.-L.; Tian, S.-Y.; Wu, H.-Q.; Zhao, Y.; Zhang, X.-W.; Liu, Y.-L.; Fu, P.; Amatore, C.; Huang, W.-H. Nanosensor detection of reactive oxygen and nitrogen species leakage in frustrated phagocytosis of nanofibres. *Nat. Nanotechnol.* **2024**, *19* (4), 524-533.

A Universal Strategy to Prepare Robust Enzyme@Covalent Organic Framework Microcapsules: A New Platform for Biosensing

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Enzyme biosensors, with high specificity and sensitivity, are constrained in biosensing field by the inherent fragility of enzymes. Despite being considered ideal for enzyme protection by in-situ covalent organic frameworks (COFs) immobilization, the harsh conditions often lead to enzyme inactivation. Herein, a universal strategy to prepare robust enzyme@COFs microcapsules, the interfacial assembly of COF spheres forms stable Pickering emulsions, followed by COF regrowth to reinforce the microcapsules. Compared with conventional methods, this approach confines the enzymes in a mild environment, achieving an impressive encapsulation efficiency of 85.9%. Enzymes are protected from inhospitable conditions by the mechanical robustness of microcapsules, which also feature regular pore sizes to enhance substrate transport and exhibit size selectivity. Moreover, the universality of this strategy was verified by the successful construction of enzyme@COFs microcapsules by various COFs spheres or enzymes. The construction of microcapsules can select hydrophobic COFs spheres (water contact angle>90º) with different pore sizes and degrees of functionalization, and they can be pre-modified to meet specific application requirements, the key to the successful construction of enzyme @MC_{COF} vesicles is a WCA > 90°, meaning the COF itself has a certain degree of hydrophobicity. A cascade catalytic system based on enzyme@COFs microcapsules has been successfully emulated, leading to the construction of a novel colorimetric and electrochemical glucose biosensing platform. This study provides new insights into the construction of enzyme microcapsules and their biosensing applications.

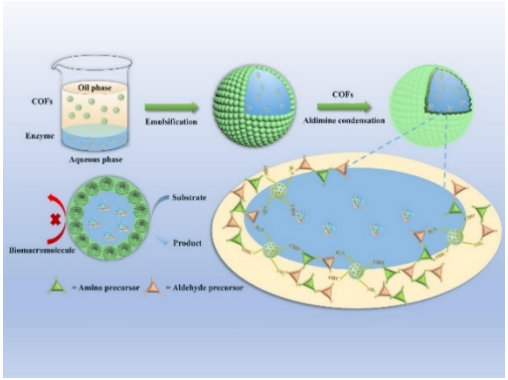


Fig.1 Schematic illustration of the synthesis process of GOx@$MC_{COF\text{-}1}$.

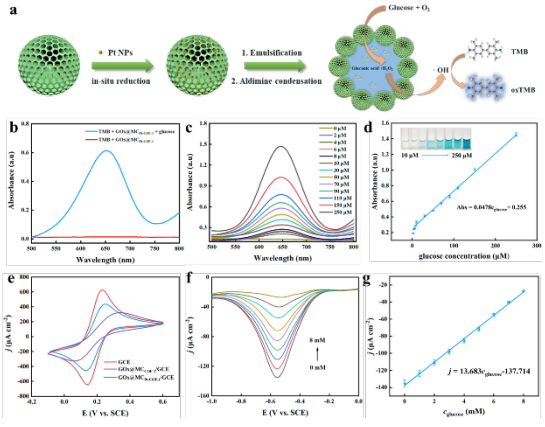


Fig.2 Schematic diagram illustrating the construction and sensing mechanism of GOx@$MC_{Pt\text{-}COF\text{-}1}$ (a). UV-vis absorbance spectra (b-d). Electrochemical tests (e-g).

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Acknowledgements

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References

1. S Kurbanoglu; C Erkmen; B Uslu, Microchemical Journal, 170, 106643, (2021)
2. Y Ye; J Ji; Z Sun; P Shen; X Sun, Trac-Trend Anal Chem, 122, 115718, (2020)
3. W Feng; C Guo; R Xu; Z Yang; H Zhang; L Zhou; H-N Wang; Y Chen; Y-Q Lan, Coordin. Chem. Rev, 515, 215965, (2024)
4. R A Sheldon; S van Pelt, Chem. Soc. Rev, 42 (15), 6223-6235, (2013)

Polymeric membrane nitrate-selective electrode based on a new cyclic thiourea-based ionophore

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Nitrate (NO_3^-) is a critical nutrient in aquatic environments, where appropriate concentrations contribute to maintaining ecological balance [1]. However, high levels of NO_3^- can lead to eutrophication, triggering ecological disasters such as algal blooms. Consequently, real-time and dynamic monitoring of NO_3^- concentrations in aquatic environments is important for ensuring the sustainable development of aquatic ecosystems. Polymeric membrane ion-selective electrodes (ISEs) have been widely used in the fields of biological analysis and environmental detection due to their remarkable advantages such as simple operation, low cost, miniaturization, high reliability and easy on-line analysis [2-7]. It should be noted that the current commercially available and literature-reported ionophores have poor selectivity toward NO_3^-, which could limit the practical applications of the NO_3^--selective electrode. Herein, a series of novel NO_3^- ionophores based on thiourea compounds have been designed in this study, and the interactions of these ionophores with NO_3^- have been systematically investigated using the density functional theory calculations [8]. The ionophore with the highest affinity for NO_3^- (i.e., 1,3,7,9,13,15-hexaazacycloicosane-2,8,14-trithione) has been synthesized and used as the ionophore to construct a NO_3^--selective electrode. The optimized membrane electrode exhibits an improved selectivity toward NO_3^- over a variety of interfering anions as compared to the commercially available NO_3^- ionophore-based electrodes [9]. The present electrode shows a linear response to NO_3^- over a wide range of $10^{-5.5}$ to 10^{-2} mol/L with a Nernstian slope of -58.5 mV/dec and a detection limit of 2.2×10^{-6} mol/L. In addition, the electrode exhibits good reversibility and long-term stability, and has been successfully applied to the direct determination of NO_3^- in natural freshwater samples.

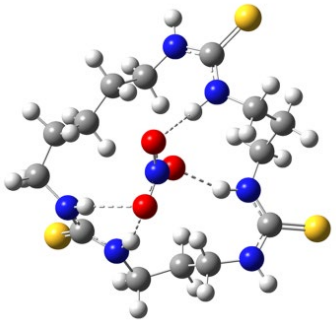


Fig. 1. Optimized structure of the complex between NO_3^- and the new thiourea-based ionophore.

Acknowledgements

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(22176209, U2006208), the National Key Research and Development Program (2024YFE0211700), the Shandong Provincial Natural Science Foundation (ZR2024MB144), the Key Research Development Program of Shandong Province (2022CXPT019), the Key Deployment Project of Centre for Ocean Mega-Research of Science, Chinese Academy of Sciences (COMS2020J06), and the Taishan Scholar Program of Shandong Province (tspd20181215 and tsqn202103132).

References

1. J. Wang, X. Liu, A. Beusen, J. Middelburg, *Environ. Sci. Technol.*, **57**, 19395 (2023)
2. J. Wang, H. Zhou, R. Liang, W. Qin, *Anal. Chem.*, **96**, 9370 (2024)
3. Y. Li, J. Ding, W. Qin, *J. Am. Chem. Soc.*, **146**, 24389 (2024)
4. J. Mou, J. Ding, W. Qin, *Angew. Chem. Int. Ed.*, **135**, e202210513 (2023)
5. E. Lv, Y. Li, J. Ding, W. Qin, *Angew. Chem. Int. Ed.*, **60**, 2609 (2021)
6. R. Liang, J. Ding, S. Gao, W. Qin, *Angew. Chem. Int. Ed.*, **56**, 6833 (2017)
7. J. Ding, B. Li, L. Chen, W. Qin, *Angew. Chem. Int. Ed.*, **55**, 13033 (2016)
8. J. Wang, R. Liang, W. Qin, *Anal. Chim. Acta*, **1298**, 342412 (2024)
9. P. Damala, E. Zdrachek, E. Bakker, *Electroanalysis*, **35**, e202200247 (2023)

Flexible Sensing Platform for Specific Detection of Indole-3-Acetic Acid Based on Hydrogel Electrolyte

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Despite ongoing advancements in the development of electrochemical sensors for detecting indole-3-acetic acid (IAA) in plants, most sensors still face challenges in specificity and stability, especially in real testing environments. This study presents an integrated electrode-electrolyte flexible sensing platform for in situ detection of IAA. MXene nanosheets are used to enhance the conductivity and catalytic activity of laser-induced graphene (LIG)-based electrodes. Dopamine (DA) is used as the functional monomer, with IAA as the template, to prepare a molecularly imprinted polymer (MIP) to construct a selective sensing interface. By integrating the MIP/MXene/LIG sensor with a hydrogel electrolyte, a stable and highly specific system is achieved. The system can detect IAA in the range of 5-200 μM, with a limit of detection (LOD) of 0.137 μM. The mechanical flexibility and excellent water retention properties of the hydrogel ensure long-term stability of the electrolyte environment, enhancing the reliability and accuracy of the sensor for real-time monitoring of plant growth and stress responses. This design provides crucial technical support for smart agriculture, helping to make timely decisions and promoting precision agricultural management.

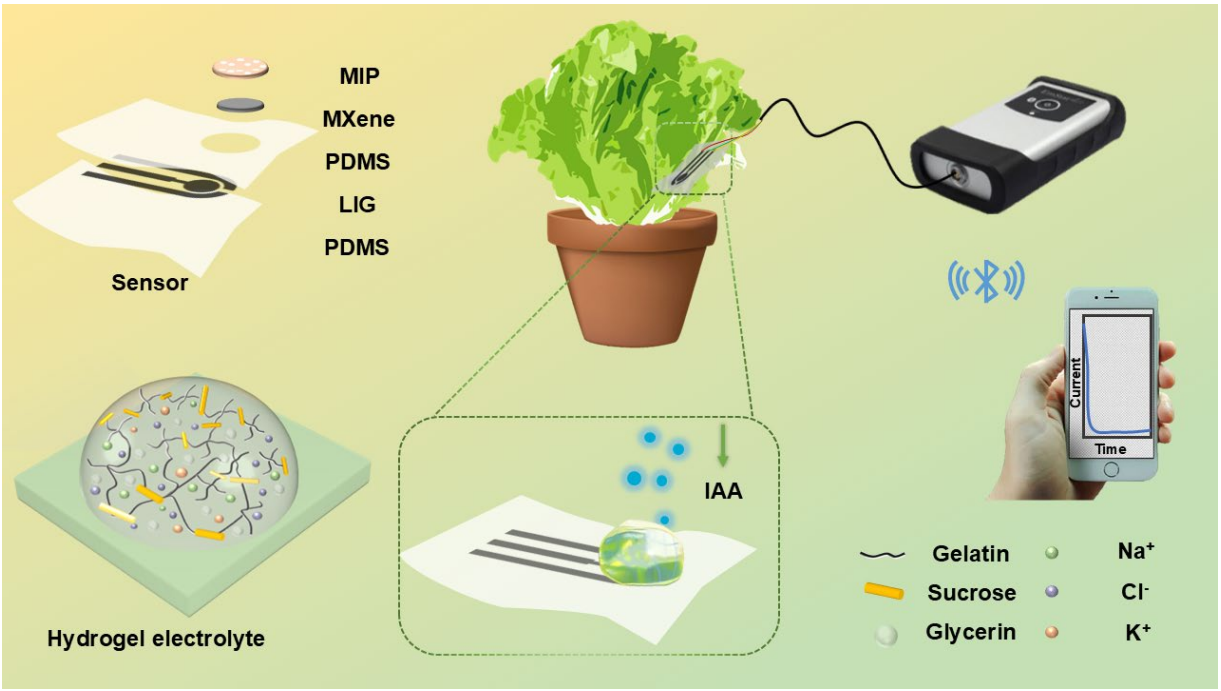


Fig.1 Figure 1. Schematic diagram of the MIP/MXene/LIG flexible sensing platform for IAA detection.

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Foundation (2222007).

References

1. Kim, Y., Seo, Y., Kim, J., *Sens. Actuators, B*, **439**, 137805 (2025)
2. Zhang, Y.; Li, M.; Li, H., *Talanta*, **283**, 127114 (2025)
3. Zhao, F., He, J., Li, X., *Biosens. Bioelectron.*, **170**, 112636 (2020)
4. Lan, L., Le, X., Dong, H., *Biosens. Bioelectron.*, **165**, 112360 (2020)

A Novel Mechanism of DOX-Mediated Superoxide Anion Formation for Multimodal Synergistic Therapy of Tumors

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Doxorubicin (DOX) exerts cytotoxicity by participating in the cytochrome P450 (CYP450) oxidoreductase system to promote superoxide ($O_2^{\bullet-}$) generation. However, the underlying electron transfer mechanism between DOX and CYP450 remains unclear. This study utilizes theoretical calculations to elucidate the electron transfer mechanisms and orbital interactions among DOX, CYP450, and oxygen (O_2). To enhance catalytic efficiency, we introduced a mesoporous polydopamine (mPDA) nanocarrier featuring a π-conjugated system that maintains electron flux to facilitate $O_2^{\bullet-}$ generation. The incorporation of L-arginine (L-Arg) increases DOX loading capacity while simultaneously reacting with H_2O_2 to generate nitric oxide (NO), thereby converting unstable $O_2^{\bullet-}$ into persistent peroxynitrite ($ONOO^-$). DFT calculations confirm that charge redistribution within the PDA nanoparticles significantly promotes the release of $O_2^{\bullet-}$ and NO. The generated $ONOO^-$ upregulates matrix metalloproteinases (MMPs), remodels the extracellular matrix (ECM), and alleviates tumor hypoxia, thereby overcoming its limitation on $O_2^{\bullet-}$ generation. This multimodal strategy promotes the generation and transformation of ROS, establishing a novel paradigm for precise tumor therapy.

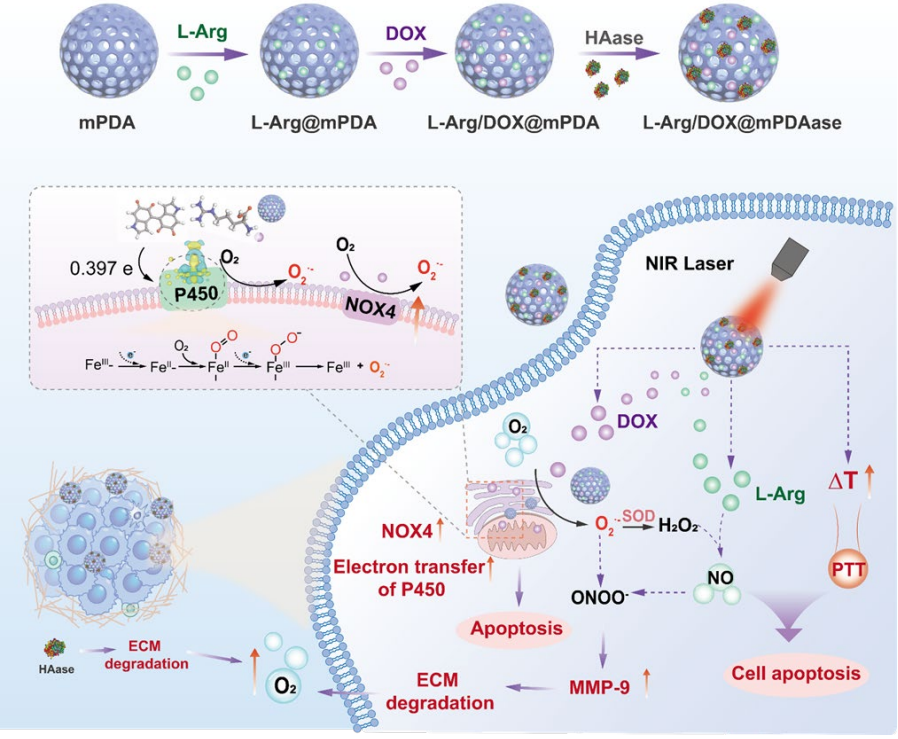


Fig.1 Synthetic procedure and mechanism of action of PADH

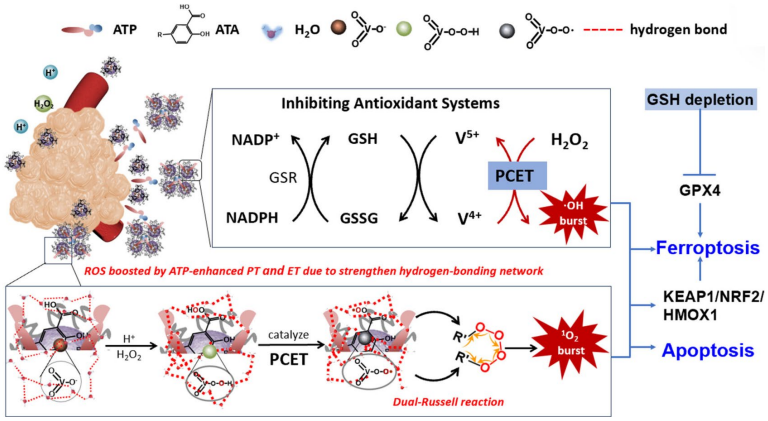
Acknowledgements

This work was supported by the National Key R&D Program of China (No. 2022YFE0113000), National Science Fund for Distinguished Young Scholars (22025406), the National Natural Science Foundation of China (22204162), Science and Technology Innovation Foundation of Jilin Province (20220101065JC).

ATP-Assisted Electron and Proton Transfer Boosting Redox Metabolism-Induced Ferroptosis and Apoptosis for Cancer Therapy

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Ferroptosis, featured by phospholipid peroxidation, represents a programmed cell death pathway distinct from apoptosis, governed by redox homeostasis and metabolic regulation of amino acids, lipids, iron, and mitochondria.[1, 2] To coordinate increased nutrient uptake and bioenergy consumption, cancer cells reprogram their metabolic network,[4, 5] inducing metabolic shifts that create ferroptosis trigger-defense imbalances in various cancers.[6] This offers therapeutic opportunities in malignancies resistant to apoptosis. Compared to the intractability of traditional apoptosis, the vulnerability exposed by cancer cell metabolic reprogramming provides an advantage for ferroptosis treatment. Herein, we developed vanadate and aurintricarboxylic acid coordination nanoparticles (VAP NPs) that synergistically trigger dual cell death pathways. This nanoplatform leveraged dual-Russell mechanisms and Fenton reactions to generate singlet oxygen/hydroxyl radicals in the tumor microenvironment (TME) while depleting glutathione via vanadium redox cycling, thereby silencing glutathione peroxidase 4 and modulating the Kelch-like ECH-associated protein 1 (KEAP1)/nuclear factor erythroid 2-related factor 2 (NRF2)/heme oxygenase 1 (HMOX1) axis. Notably, TME-overexpressed adenosine triphosphate (ATP) acted as a biochemical catalyst, accelerating the transfer of protons and electrons during reactive oxygen species generation to amplify therapeutic efficacy. Therefore, VAP NPs could achieve outstanding efficacy for intrinsically stimulated synergy of ferroptosis and apoptosis in tumor therapy. This study provides reference for revealing the new function of ATP in enhancing the regulation of redox metabolism.



Scheme.1 Therapeutic mechanism of the VAP NPs.

Acknowledgements

This work was supported by the National Key R&D Program of China (2022YFE0113000), the National Science Fund for Distinguished Young Scholars (22025406), the National Natural Science Foundation of China (22204162), and the Science and Technology Innovation Foundation of Jilin Province (20220101065JC).

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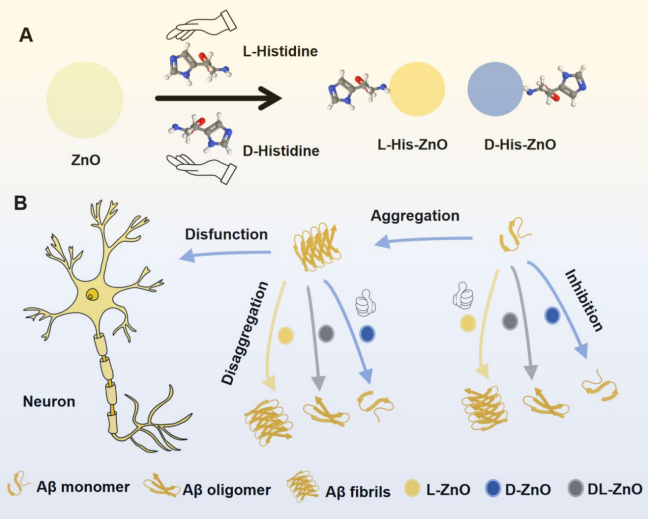
1. B. R. Stockwell, *Cell* **185**, 2401-2421 (2022).
2. B. R. Stockwell, J. P. F. Angeli, H. Bayir, A. I. Bush, M. Conrad, S. J. Dixon, S. Fulda, S. Gascon, S. K. Hatzios, V. E. Kagan, K. Noel, X. Jiang, A. Linkermann, M. E. Murphy, M. Overholtzer, A. Oyagi, G. C. Pagnussat, J. Park, Q. Ran, C. S. Rosenfeld, K. Salnikow, D. Tang, F. M. Torti, S. V. Torti, S. Toyokuni, K. A. Woerpel, D. D. Zhang, *Cell*, **171**, 273-285 (2017).
3. N. N. Pavlova, J. Zhu, C. B. Thompson, *Cell Metab*., **34**, 355-377 (2022).
4. Z. Li, B. W. Ji, P. D. Dixit, K. Tchourine, E. C. Lien, A. M. Hosios, K. L. Abbott, J. C. Rutter, A. M. Westermark, E. F.
   Gorodetsky, L. B. Sullivan, M. G. Vander Heiden, D. Vitkup, *Nat. Metab*. 2022, 4, 711–723.
5. G. Lei, L. Zhuang, B. Gan, *Nat. Rev. Cancer*, **22**, 381-396 (2022).

Chiral ZnO Nanoparticles Inhibition and Disaggregation of Amyloid β Protein Fibrillation

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Alzheimer's disease (AD), one of the most prevalent neurodegenerative disorders, is clinically characterized by memory impairment, disorientation, and cognitive dysfunction[1]. Regarding AD pathogenesis, four predominant hypotheses are widely recognized in the scientific community: the amyloid cascade hypothesis, tau hypothesi, oxidative stress hypothesis, and metal ion hypothesis[2]. The disease's hallmark pathological features include β-amyloid (Aβ) deposition, aberrant tau protein aggregation, oxidative stress responses, and neuroinflammation. Notably, extracellular senile plaques (primarily composed of aggregated Aβ) and intracellular neurofibrillary tangles (NFTs formed by hyperphosphorylated tau proteins) are universally acknowledged as the most definitive pathological markers of AD. Consequently, therapeutic strategies targeting Aβ production, aggregation, and clearance have been regarded as highly promising approaches for AD treatment.

Current AD therapeutics can be categorized by mechanism into several classes: Aβ fibrillization inhibitors, tau protein modulators, antioxidants, acetylcholinesterase inhibitors, anti-inflammatory agents, and metal ion chelators. However, conventional drugs are inherently limited by poor neuronal targeting efficiency, inadequate blood-brain barrier (BBB) penetration, suboptimal biocompatibility, and chemical instability under physiological conditions. Nanomaterials possess exceptional properties such as a high surface-area ratio, nanoscale particle size, diverse dimensions and shapes, chemically tunable surfaces, excellent biocompatibility, and strong blood-brain barrier penetration capabilities[3]. Chiral molecules, including amino acids, proteins, and nucleic acids, are ubiquitous in biological systems and play crucial roles in metabolic processes. Due to the chiral environment within the human body, chiral drugs exhibit different pharmacological effects after entering the body. Many drugs have only one enantiomer that demonstrates therapeutic activity[4]. Therefore, chiral recognition is of paramount importance in the treatment of AD.



Scheme 1. Synthesis of chiral ZnO NPs, chiral ZnO NPs synergistic inhibition and disaggregation of Aβ fibrils.

References

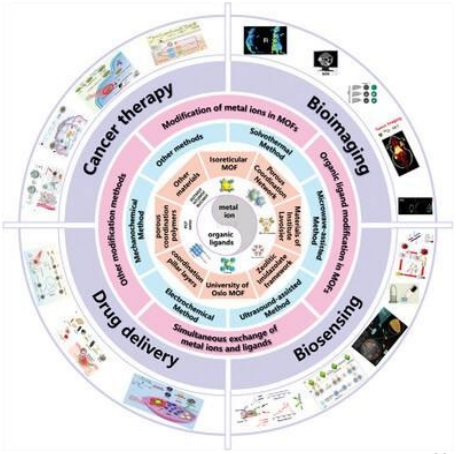
1. Long M J ,Holtzman M D .Alzheimer Disease: An Update on Pathobiology and Treatment Strategies [J].Cell,2019,179(2):312-339.
2. Huang D ,Liao W ,Li J , et al. Alzheimer's Disease: Status of Low-Dimensional Nanotherapeutic Materials [J]. Advanced Functional Materials, 2023, 34 (4):
3. A. M M ,M. S V ,Vallabh E M . Disease stages and therapeutic hypotheses in two decades of neurodegenerative disease clinical trials [J]. Scientific Reports, 2022, 12 (1): 17708-17708.
4. Barbara K . Pharmacologically active compounds in the environment and their chirality [J]. Chemical Society reviews, 2010, 39 (11): 4466-503.

The synthesis of chiral metal-organic frameworks and their applications in the treatment of neurodegenerative diseases.

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Parkinson's disease (PD) is one of the common neurodegenerative diseases, and the main pathological features are the loss of dopaminergic neurons in the substantia nigra and the formation of Lewy bodies after misfolding and aggregation of α-synuclein (α-syn)[1]. Inhibition of α-syn aggregation and depolymerization of α-syn fibers is considered to be an important strategy for the treatment of PD[2]. Chiral recognition of proteins provides a new direction for the design of highly effective inhibitors. The modifiability, versatility, biocompatibility and stability of MOFs are particularly prominent[3]. Based on this, chiral metal-organic frameworks (MOFs), including L-MOFs, D-MOFs, and DL-MOFs, were synthesized in this paper, showing a synergistic effect of inhibiting α-syn aggregation and depolymerization α-syn fibers. It was found that L-MOF had the strongest inhibitory effect on α-syn aggregation, while D-MOF and DL-MOF showed limited inhibitory effect. At the same time, cell-level experiments also confirmed that the chiral MOF could effectively reduce the cytotoxicity and cell damage of α-syn fibers by inhibiting the aggregation and depolymerization of α-syn fibers by α-syn. Therefore, this chiral MOF inhibits α-syn aggregation and depolymerization of α-syn fibers and provides a new strategy for the development of enantioselective inhibitors for PD therapy.



Scheme 1. Application of MOFs materials[4].

References

1. M. G. Spillantini, M. L. Schmidt, V. M. Lee, J. Q. Trojanowski, R. Jakes, M. Goedert, Nature 1997, 388, 839.
2. Y. Han, Y. Zhang, J. Huang, X. Jia, T.-a. Ishibashi, X. Jiang, Small Methods, n/a (2025) 2500557.

3. L. Qiu, C. Ouyang, W. Zhang, J. Liu, L. Yu, G. Chen, L. Ren, Journal of Nanobiotechnology, 21 (2023) 163.
4. D. Wang, H. Yao, J. Ye, Y. Gao, H. Cong, B. Yu, Small, 20 (2024) 2404350.

Electrochemical Characterisation of *O*-Type Diamond Electrodes: Influence of Phosphorus Doping

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Phosphorus-doped diamond (PDD) is a promising *n*-type semiconducting electrode material whose electrochemical potential remains underexplored due to historical challenges in achieving high doping levels via chemical vapor deposition (CVD). In this study, nanocrystalline PDD films with varying phosphorus concentrations were synthesised by tuning the phosphine-to-carbon ratio in the CVD gas phase [1]. Scanning electron microscopy (shown in Fig. 1(A)) and Raman spectroscopy confirmed increased nanocrystallinity and sp^2-carbon content with elevated phosphorus incorporation.

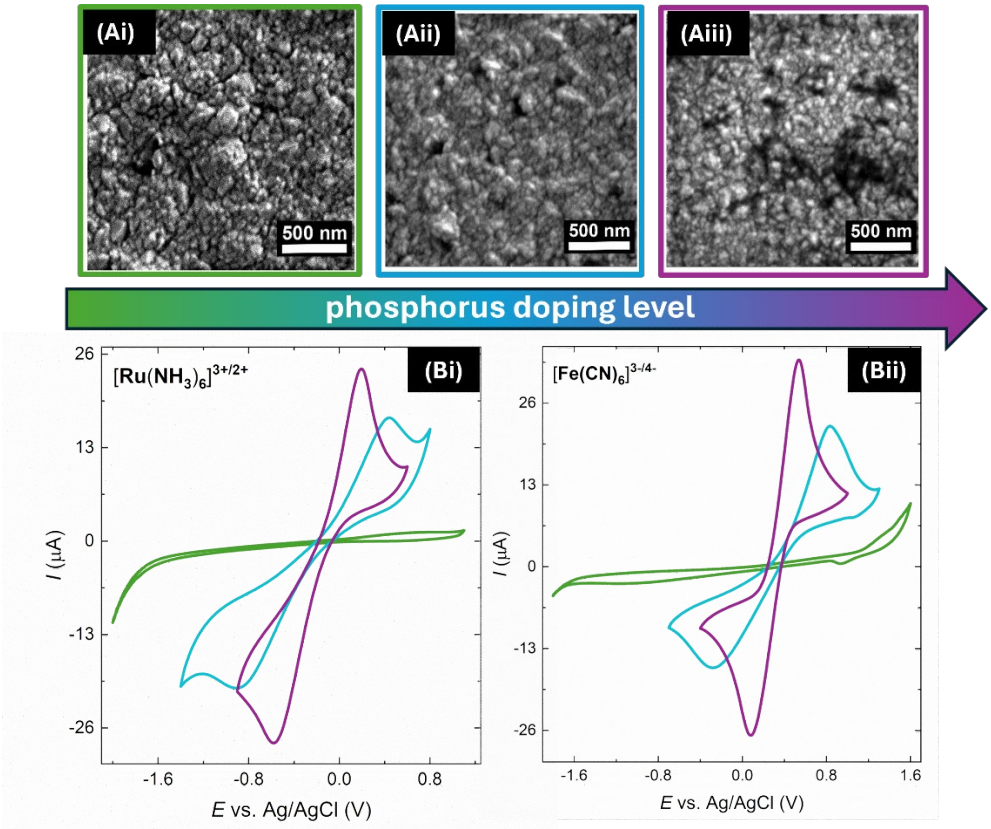


Fig. 1. (A) Scanning electron micrographs of investigated PDD layers, deposited at following P/C ratios: (Ai) 16 000 ppm (green), (Aii) 63 000 ppm (blue), and (Aiii) 250 000 ppm (purple). (B) Cyclic voltammograms recorded in the solutions of redox markers (both 1 mmol L^{-1} in 1 mol L^{-1} KCl): (Bi) $[Ru(NH_3)_6]^{3+/2+}$ and (Bii) $[Fe(CN)_6]^{3-/4-}$.

Electrochemical characterisation was performed in 1 mol L^{-1} KCl using both outer- and inner-sphere redox systems: $[Ru(NH_3)_6]^{3+/2+}$ and $[Fe(CN)_6]^{3-/4-}$ (displayed in Fig. 1(B)). Heavily doped PDD electrodes exhibited significantly reduced ΔE_p values, enhanced peak currents, and improved electron transfer kinetics compared to lower-doped electrodes, indicating efficient charge transport across the electrode–solution interface. All samples displayed low background currents and capacitive behavior typical of diamond surfaces (C_{dl} < 11 µF cm^{-2}).

Further testing with biologically relevant analytes, dopamine and ascorbic acid, demonstrated clear, well-resolved voltammetric signals, and electroanalysis of doxycycline and paracetamol further substantiated the applicability of PDD for complex organic targets. These results confirm, for the first time, that as-grown, highly P-doped diamond electrodes can achieve analytically useful signal resolution without post-treatment, positioning them as robust candidates for next-generation electrochemical sensors.

Acknowledgements

Financial support from the Czech Science Foundation (project 25-14463L) is gratefully acknowledged.

References

1. S. Baluchová, K-d. Sung, Z. Weiss, J. Kopeček, L. Fekete, J. G. Buijnsters, V. Mortet, Electrochim. Acta, 499, 144696 (2024). DOI: 10.1016/j.electacta.2024.144696.

Carbon paste electrode doped with neodymium-oxide for effective electrochemical detection of hazardous pesticide carbofuran

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Carbofuran (CBF), chemically known as 2,2-dimethyl-2,3-dihydro-7-benzofuranyl N-methylcarbamate, is the most widely used carbamate pesticide. It is applied to crops such as coffee, cabbage, peanuts, tomatoes, grapes, oranges, and corn to control various pests[1,2]. However, CBF is highly toxic, with high water solubility (700 mg L^{-1}) and poor degradability (with a half-life of 30-117 days). Due to its harmful effects, it has been banned in Canada and the European Union. CBF significantly impacts human health through ingestion, inhalation, or dermal exposure, causing symptoms such as dizziness, nausea, and confusion. Additionally, it can lead to irreversible damage to the nervous system, reproductive issues, endocrine disruption, and, in extreme cases, death. The widespread use of this pesticide on various crops has resulted in the absorption of its residues into the soil and aquatic environments. Therefore, the development of fast, sensitive, selective, and accurate methods for the detection of CBF in the environment is of great importance[3-5].

Over the last two decades, as the population has grown and the demand for agricultural products has increased, the use of pesticides in fruit and vegetable production has risen significantly. Carbofuran (CBF), a widely used carbamate pesticide, poses significant risks to human health due to its persistence and poor degradability, leading to soil and water contamination. Consequently, the development of a sensitive and reliable sensor for CBF detection is crucial for environmental monitoring. In this study, neodymium oxide (Nd_2O_3) nanoparticles, synthesized via a single-step hydrothermal method, were utilized for the first time as a carbon paste electrode (CPE) modifier to enhance the electrochemical detection of CBF. Comprehensive morphological and electrochemical analysis confirmed that Nd_2O_3 incorporation significantly improved the electrocatalytic response. The resulting sensor exhibited a broad linear detection range (3–200 µM), low detection (0.813 µM) and quantification limits (2.711 µM), and high sensitivity (0.8 µA $\mu M^{-1}cm^{-2}$). Its practical applicability was successfully demonstrated in real sample analysis, achieving excellent recovery rates and validation via UV-Vis spectroscopy. This study highlights the potential of Nd_2O_3-modified electrodes as a promising platform for effective CBF

monitoring in environmental samples.

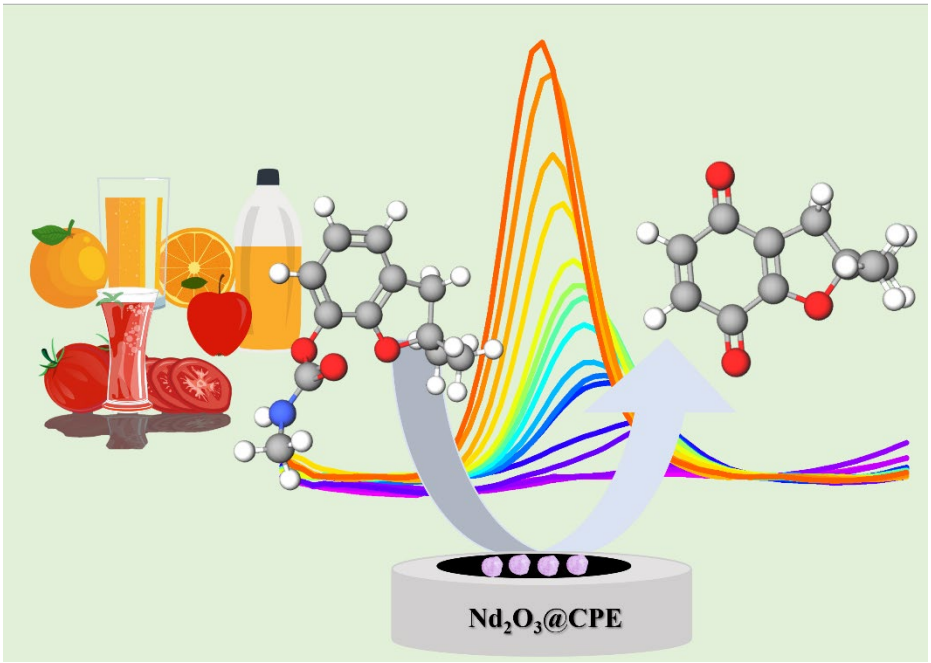


Fig. 1. Schematic illustration of the CBF detection.

Acknowledgements

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References

1. Mariyappan, et al., *J Agric Food Chem.*, **69**, 2679-2688, (2021).
2. Thiam, et al., *Chemical Engineering Journal* **335**, 133–144 (2018).
3. Maheshwaran. et al., *Environmental Science: Advances* **3**, 154–176 (2024).
4. Baksh, et al., *Monatshefte Für Chemie - Chemical Monthly* **151**, 1689–1696 (2020).
5. Ramírez Carvajal, et.al., *Microchemical Journal* **169**, 106550 (2021)

Screen-printed graphitic carbon nitride@carbon black-based electrochemical sensor for vanillin aroma detection in food

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Vanillin (VAN) is a widely used additive in the food industry, used to give products a vanilla aroma[1]. Due to the huge demand for this flavoring in food production, VAN is mainly produced synthetically. In the control doses, VAN showed different positive therapeutic properties (antioxidant, analgesic, anti-inflammatory)[2,3]. Conversely, overdoses of VAN can affect different humans' desires (nausea or headache)[4,5]. Therefore, developing methods for detecting VAN in food is of great importance.

This research deals with the development of an electroanalytical method for VAN detection. The proposed electrochemical sensor was based on graphitic carbon nitride (GCN) and carbon black (CB) nanocomposite coupled with screen printing technology. The GCN material was synthesized by polymerizing melamine at 550 degrees. The GCN was structurally and morphologically characterized by Fourier-transform infrared spectroscopy (FTIR), Raman spectroscopy, and Scanning Electron Microscopy (SEM). The GCN@CB nanocomposite printing inks were prepared by hand mixing the binder solution with different ratios of GCN and CB (thus prepared printing inks of GCN@CB in the mass ratios (*m/m*) 100:0, 75:25, 50:50, 25:75 and 0:100. Prepared printing inks were used for modification of fluorine-doped tin oxide (FTO) using screen-printed process. A schematic illustration of the preparation of the FTO-based electrodes is shown in **Fig. 1**.

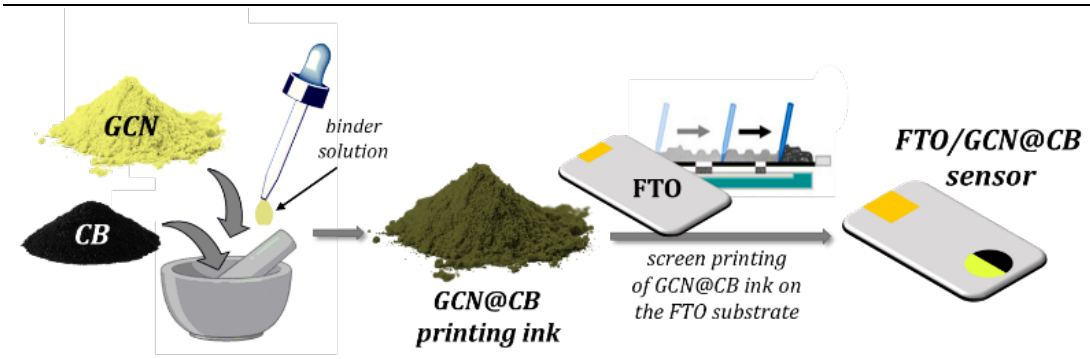


Fig. 1. Schematic illustration of the GCN@CB printing inks and FTO-based sensors preparation.

Cyclic voltammetric measurements showed two oxidation and three reduction peaks in Britton-Robinson buffer solution (BRBS) with pH 2 at FTO/GCN@CB-based sensors. The favorable electrochemical properties of VAN in BRBS pH 2 (the highest current intensities and well-defined redox peaks) were provided by the FTO/GCN@CB sensor, where the mass ratio (*m/m*) of the used materials in the final composite was 50:50. Therefore, this FTO/GCN@CB-based sensor was selected as optimal for further electrochemical measurements. Scan rate studies identified an adsorption nature of VAN at the electrode surface rather than diffusion-controlled.

Differential pulse voltammetry (DPV) was selected as an electroanalytical method for VAN detection. During the development of the detection method, the VAN oxidation peak at 0.6 V *vs.* Ag/AgCl was evaluated. To achieve the sensor's favorable electrochemical performances toward VAN, parameters of the DPV method, such as modulation amplitude, modulation time, and interval time, were optimized. Under DPV-optimized parameters, the FTO/GCN@CB sensor detected VAN in a concentration range from 0.02 to 16.20 µM. The developed method's limit of detection was 3 nM. The developed electrochemical FTO/GCN@CB sensor also provided good precision, repeatability, and selectivity toward VAN detection.

The proposed electrochemical platform was successfully applied for VAN quantification in vanilla-flavoured commercial food samples (vanilla sugar, oatmeal, whey protein, and pudding). The high-performance liquid chromatography (HPLC) was used as a comparable method. Recovery tests (103-105%) showed the screen-printed electrochemical platform's high potential for accurate, precise, and real-time quantification of VAN in food samples.

Acknowledgements

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References

1. Moradi, et al., *Food Chem. Toxicol.*, **168**, 113391 (2022).
2. Nehru, et al., *Caron*, **208**, 410 (2023).
3. Tabanlıgil & Taşkın, *Food Chem.*, **436**, 137752 (2024).
4. Chen, et al., *Sens. Actuators B: Chem.*, **377**, 133045 (2023).
5. Hui, et al., *Microchem. J.*, **186**, 108320 (2023).

Rapid, direct, visualized and antibody-free bacterial detection with extra species identification and susceptibility evaluation capabilities

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Bacterial antimicrobial resistance driven by the abuse of antibiotics is a global highlight challenge, calling for a rapid, economical and generalizable bacterial detection technology.[1] Here, in case of urinary tract infections (UTIs), a naked-eye, antibody-free and multi-functional bacterial assessment platform was designed, which consisted of concanavalin A modified gold nanoparticles (ConA-AuNPs), vancomycin modified gold nanoparticles (Van-AuNPs), and polymyxin B modified Prussian blue nanoparticles (PMB-PBNPs) (**Fig. 1**). Based on the fast agglutination of bacterial cells induced by concanavalin A, ConA-AuNPs could aggregate on bacterial cells of *Escherichia coli* (*E. coli*) and *Staphylococcus aureus* (*S. aureus*), resulting in a visible color change due to alteration of surface plasmon resonance properties within 30 min. Besides, due to the different affinity of vancomycin and polymyxin B to bacteria, Van-AuNPs preferred to bind to Gram-positive bacteria, generating colorimetric response within 2–3 h; while PMB-PBNPs could be reduced colourless Prussian white (PW) by the prior Gram-negative (G-) bacterial metabolization in contrast to Gram-positive (G+) bacterial metabolization within 4–6 h (**Fig. 2**).[2,3] Combining our platform with antibiotics, the minimum inhibitory concentration of bacteria could be determined within 4–8 h, which was proved by incubating *E. coli* and *S. aureus* with various antibiotics (**Fig. 3**). The feasibility was verified by clinical samples, which was consistent with the classical clinical test within only 1/48 of the process timing (**Fig. 4**). Therefore, this colorimetric nanoplatform orderly realized the rapid detection, species identification (G+ and G-), and susceptibility evaluation of bacteria, satisfying multiple needs from timely clinical diagnosis to accurate medication guidance.

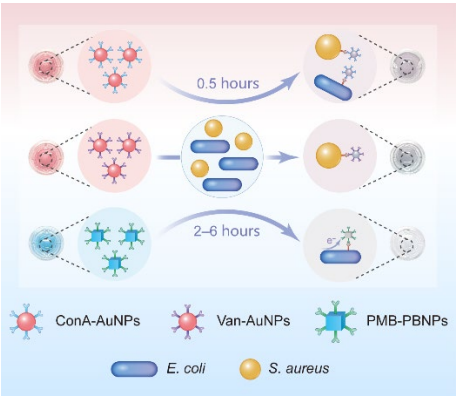


Fig.1 The mechanism of bacterial assessment platform based on AuNPs and PBNPs.

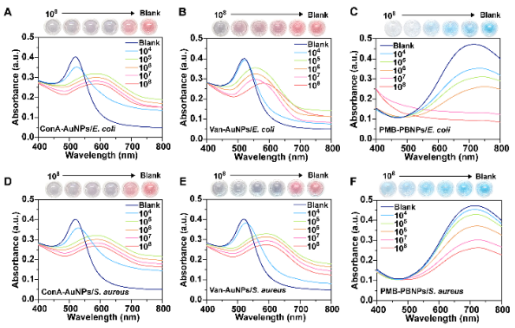
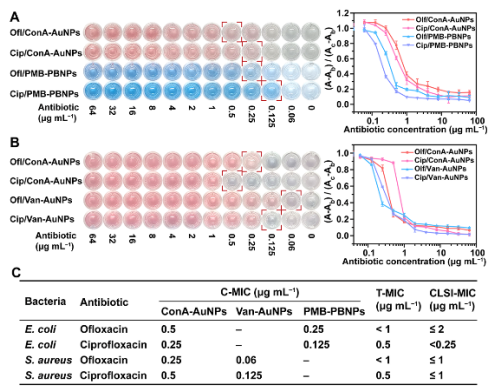
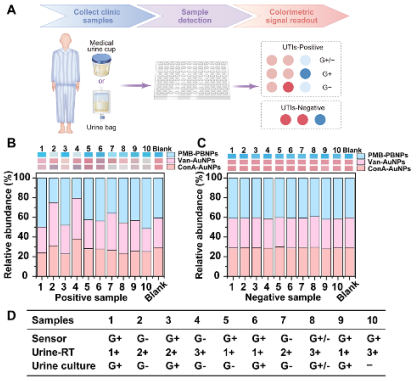


Fig.2 The colorimetric responses of ConA-AuNPs, Van-AuNPs, and PMB-PBNPs.



Bacteria	Antibiotic	C-MIC (μg mL⁻¹)			T-MIC (μg mL⁻¹)	CLSI-MIC (μg mL⁻¹)
		ConA-AuNPs	Van-AuNPs	PMB-PBNPs		
E. coli	Ofloxacin	0.5	–	0.25	< 1	≤ 2
E. coli	Ciprofloxacin	0.25	–	0.125	0.5	<0.25
S. aureus	Ofloxacin	0.25	0.06	–	< 1	≤ 1
S. aureus	Ciprofloxacin	0.5	0.125	–	0.5	≤ 1

Fig.3 The rapid antibiotic susceptibility testing and its comparisom with traditional test (T-MIC) and clinical standred (CLSI-MIC).



Samples	1	2	3	4	5	6	7	8	9	10
Sensor	G+	G-	G+	G-	G+	G+	G-	G+/-	G+	G+
Urine-RT	1+	2+	2+	3+	1+	1+	2+	3+	1+	3+
Urine culture	G+	G-	G+	G-	G-	G+	G-	G+/-	G+	–

Fig.4 The evaluation of clinical samples.

Acknowledgements

M.Zhao contributed to the conception and design of the experiments. X.Wang guided the project. This work was funded by the National Natural Science Foundation of China (No. 31860263 to Xiaolei Wang), Key Youth Project of Jiangxi Province (20202ACB216002 to Xiaolei Wang), Key Research and Development Project of Jiangxi Province (20212BBG73004 to Xiaolei Wang).

References

1. Antimicrobial Resistance Collaborators, *Lancet* **2022**, *399*, 629–655.
2. X. K. Yang, X. M. Zhou, M. J. Zhu, D. Xing, *Biosens. Bioelectron.* **2017**, *91*, 238–245.
3. J. Dietvorst, A. Ferrer-Vilanova, S. N. Iyengar, A. Russom, N. Vigués, J. Mas, L. Vilaplana, M. P. Marco, G. Guirado, X. Muñoz-Berbel, *Anal. Chem.* **2022**, *94*, 787–792.

Room-Temperature Formable Conductive Hydrogel for Sweat Glucose Biosensing

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Recent studies have demonstrated a significant correlation between sweat glucose levels and blood glucose concentrations, suggesting the potential for sweat-based monitoring to replace conventional invasive diabetes testing methods. In this study, a novel room temperature polymerizable PEDOT:PSS/polyacrylamide conductive hydrogel was successfully developed and applied to the construction of sweat glucose sensor. The hydrogel system used PEDOT:PSS and sodium dodecyl sulfate (SDS) as the conductive matrix, formed a three-dimensional network structure by free radical polymerization of acrylamide (AAm) with N,N'-methylenebisacrylamide (MBA), and introduced tetramethylethylenediamine (TEMED) to optimize its mechanical properties. The electrochemical characterization results showed that the hydrogel sensor exhibited excellent electrochemical response to ferrocenecarboxylic acid (FcA), and the biosensor constructed by further immobilizing glucose oxidase (GOx) in the hydrogel network exhibited a good linear response to glucose in the physiologically relevant concentration range of 1-10 mM (R^2=0.996), with a limit of detection of 0.5 mM. Actual sweat testing showed that the sensor detection results correlated well with commercial glucose meter data (R^2=0.94). This study provides a new material solution for the development of high-precision and wearable noninvasive blood glucose monitoring devices.

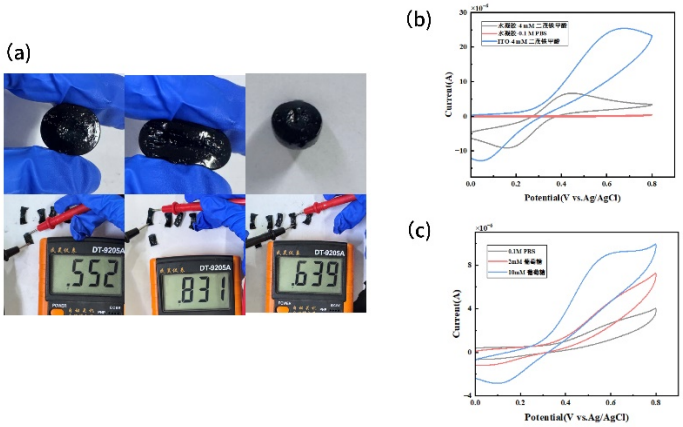


Fig.1 (a)PEDOT:PSS Conductive Hydrogel Electrode;(b)Cyclic voltammograms of PEDOT:PSS conductive hydrogel in 0.1 M PBS with 4 mM ferrocenecarboxylic acid (FcA) solution, and ITO in 4 mM FcA solution;(c) Cyclic voltammograms of FcA-CS-GOD (ferrocenecarboxylic acid-chitosan-glucose oxidase) mixed solution embedded in PEDOT:PSS conductive hydrogel electrode in (0.1 M PBS solution ,2 mM glucose solution,10 mM glucose solution)

Keywords: Conductive hydrogel, Acrylamide (AAm),PEDOT:PSS , Sweat sensor

References

1. S. Zhang, Y. Chen, H. Liu, Z. Wang, H. Ling, C. Wang, J. Ni, B. C. Saltik, X. Wang, X. Meng, H.-J. Kim, A. Baidya, S. Ahadian, N. Ashammakhi, M. R. Dokmeci, J. Travas-Sejdic, A.

Khademhosseini, Room-Temperature-Formed PEDOT:PSS Hydrogels Enable Injectable, Soft, and Healable Organic Bioelectronics. *Adv. Mater.* 2020, 32, 1904752.

2. Hossain, S., Yamamoto, Y., Baba, S. *et al.* Role of anionic surfactant addition in improving thermoelectric properties of PEDOT:PSS free-standing films. *J Polym Res* **31**, 233 (2024).

Activating Ru nanoclusters for robust oxygen reduction in aqueous wide-temperature zinc-air batteries

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Aqueous wide-temperature zinc-air batteries (AWT-ZABs) have the potential to meet the fast-growing energy demand in extreme climates (-60℃ to 60℃). However, the cathodic oxygen reduction reaction (ORR) kinetics are susceptible to temperature fluctuations. Herein, we present a highly active and durable ORR catalyst composed of Ru nanocluster and neighboring Mn-N_4 moieties (Ru_{NC}@Mn-N_4). The Ru_{NC}@Mn-N_4 achieved a half-wave potential of 0.925 V, surpassing known Ru-based electrocatalysts, with minimal decay (~19 mV) after 50,000 cycles. In AWT-ZABs, the Ru_{NC}@Mn-N_4 delivered a peak power density (P_{max}) of 320.6 mW cm^{-2} at 60℃ and 1.5-3 folds higher P_{max} at -20℃ to -60℃ compared to Pt/C. Our in-situ experiments and mechanistic investigations unveil the low temperatures induce the d-band center downshift of Ru NCs and Pt/C, by coupling electron-withdrawing single-atom Mn-N_4 moieties, electron-deficient metallic Ru with inherently overly strong adsorption of O-related intermediates can be effectively activated, which enables the optimized adsorption/dissociation of O_2 and facilitates low-temperature protonation of intermediates, resulting in speedy wide-temperature ORR kinetics. This work opens a valuable avenue for developing high-performance Ru-based hybrid electrocatalysts for temperature change-adaptive energy storage and conversion devices.

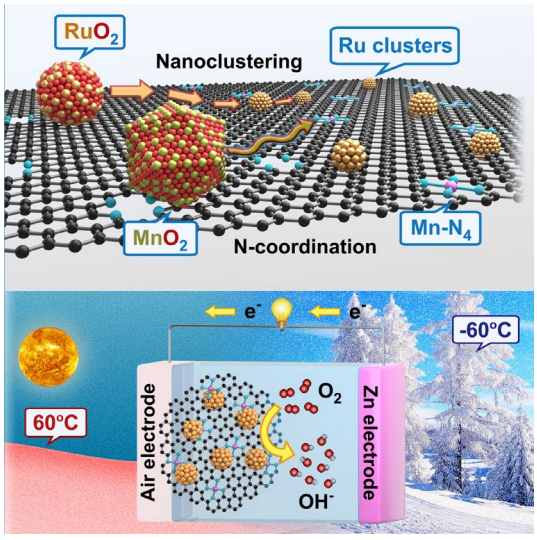


Fig.1 Schematic illustration of in-situ redistribution of commercial RuO_2 and MnO_2 powders to obtain the Ru_{NC}@Mn-N_4 catalyst.

Acknowledgements

We gratefully acknowledge the financial support provided by the National Natural Science Foundation of China (No.22374141, 22134006, U2241287) as well as the Changchun Science and Technology Bureau (No.23GZZ02). The numerical calculations in this study were carried out on the ORISE Supercomputer. We thank the BL1W1B at the Beijing Synchrotron Radiation Facility (BSRF) for conducting the X-ray absorption spectroscopy experiments.

References

1. Liu, R. et al. *Matter*, **7**, 4031-4045 (2024).

Fluorescent Nanozyme Based on Bimetallic Fe/Co-Doped Carbon Dots for Dual-Mode Detection of Ascorbic Acid and Hydrogen Peroxide

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Despite extensive research on nanozymes in analytical sensing, single-mode detection strategies remain constrained by reli-ability challenges. We developed bimetallic Fe/Co-doped carbon dots nanozymes (FeCo-CDs) for dual-mode (colorimet-ric/fluorescent) detection of ascorbic acid (AA) and hydrogen peroxide (H_2O_2). The synergistic Fe/Co co-doping strategy generates abundant catalytically active sites, significantly enhancing peroxidase (POD)-like activity while simultaneously amplifying intrinsic fluorescence. The POD-like activity of FeCo-CDs catalyzes the oxidation of 3,3′,5,5′-tetramethylbenzidine (TMB) to blue oxidized TMB (oxTMB) in the presence of H_2O_2, which subsequently quenches the blue fluorescence of FeCo-CDs due to the inner filter effect (IFE). Upon AA addition, fluorescence recovery and oxTMB reduc-tion synergistically establish a self-validating dual-mode detection platform for H_2O_2/AA. This system achieves superior sen-sitivity for AA (limit of detection (LOD): 0.39 μM for colorimetric mode; 0.35 μM for fluorescent mode) and broader detec-tion ranges for H_2O_2 (colorimetric liner range (LR): 200-1500 μM; fluorescent LR: 60-600 μM), outperforming conventional single-mode approaches. This innovative dual-mode sensing strategy overcomes the limitations of conventional unimodal systems, providing a robust and versatile platform for advanced biosensing applications.

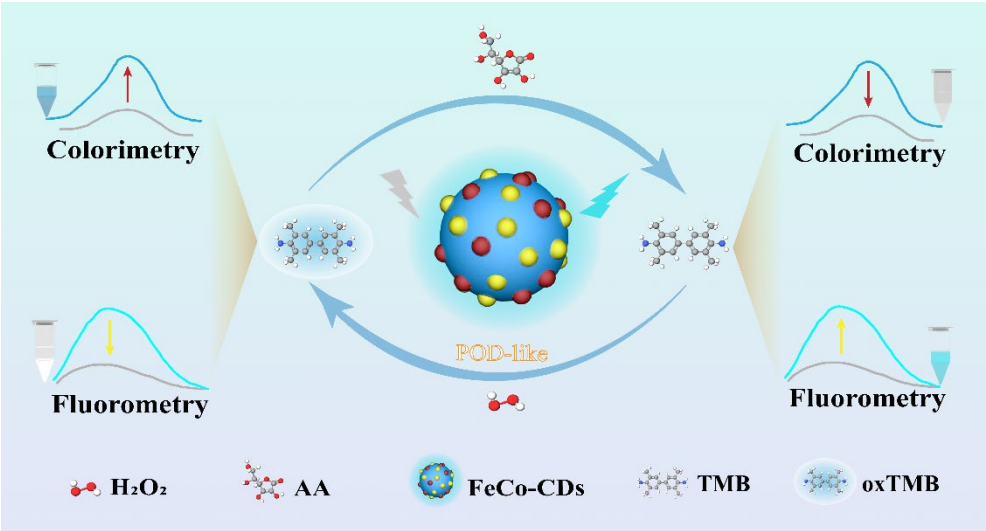


Fig.1 Schematic diagram showing the dual-mode (colorimetric/fluorescent) detection of AA and H_2O_2 by FeCo-CDs with peroxidase-like activity.

Acknowledgements

This work was financially supported by the National Natural Sci-ence Foundation of China (Nos. 22274146 and 22074137).

References

5. Ma, X.; Ou, Q.; Yuan, J.; Yang, J.; Xu, S.; Zhang, X. *Chem. Eng. J.*, **464**(2023).

Poly(3,4-ethylenedioxythiophene) bearing fluoro-containing phenylboronic acid for specific recognition of glucose

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In this study, we synthesized a new monomer, namely, 3,4-ethylenedioxythiophene bearing a fluorocontaining phenylboronic acid (EDOT–FPBA) for enzyme-free glucose sensing at physiological conditions. The EDOT–FPBA monomer is electropolymerized on a glassy carbon electrode (poly(EDOT–FPBA)/GCE) at a constant voltage. The electrochemical polymerization was optimized to obtain a low impedance film interface and then characterized by scanning electron microscopy, atomic force microscopy, water contact angle measurements, and electrochemical impedance spectroscopy. The specific interaction and pH dependence between poly(EDOT–FPBA)/GCE and glucose are detected by electrochemical impedance spectroscopy in a detection range from 0.05 to 25 mM with a detection limit of 0.05 mM at pH 7.0. The poly(EDOT–FPBA) exhibits 6 times higher sensitivity under physiological pH conditions in comparison with phenylboronic acid and 3-pyridylboronic acid conjugated poly(3,4-ethylenedioxythiophene), due to the introduction of an electron-withdrawing F substituent into the benzene ring of phenylboronic acid (PBA) reducing the pKa value of PBA. The sensitivity and the dynamic range cover all levels of blood glucose in the serum of patients with diabetes. Furthermore, with advantages of high sensitivity and wide detection range, reusability, stability, and mass productivity, poly(EDOT–FPBA) as a glucose sensor has great potential for enzyme-free glucose continuous monitoring applications. Subsequently, the research group focused on the anti-fouling performance of conductive polymers in biosensors and bioelectronic applications. Polyethylene glycol (PEG) is a well-known anti-fouling material, but controllably regulating the surface morphology of PEG without a template became our next challenge.

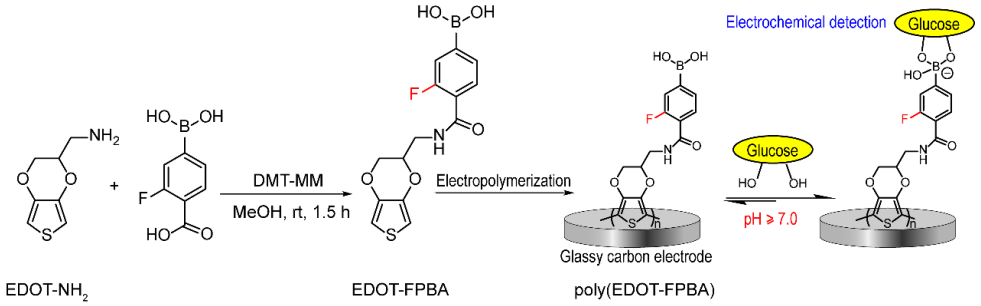


Fig.1 Scheme for the synthetic route of an EDOT derivative possessing a 3-fluorophenylboronic acid group (EDOT–FPBA) and electrochemical polymerization of EDOT–FPBA into poly(EDOT–FPBA) on a glassy carbon electrode (GCE) for glucose detection.

Acknowledgements

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References

1. Hai W, Goda T, Takeuchi H, et al. Human influenza virus detection using sialyllactose-functionalized organic electrochemical transistors[J]. Sensors and Actuators B: Chemical, 2018, 260: 635-641.
2. Huang P C, Shen M Y, Yu H, et al. Surface engineering of phenylboronic acid-functionalized poly (3, 4-ethylenedioxythiophene) for fast responsive and sensitive glucose monitoring[J]. ACS Applied Bio Materials, 2018, 1(1): 160-167.

Nanoelectrochemical synthesis of H_2O_2 to regulate intracellular stress granules formation

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Stress granules (SGs), membrane-less organelles formed in response to cellular stress, play important roles in neuronal adaptive homeostasis or degeneration, depending on spatiotemporal control of H_2O_2 concentrations[1]. Thus, achieving high spatiotemporal resolution and quantitative control over H_2O_2 generation is crucial for elucidating the mechanistic links between SG function and neuronal health. Recently, functional electrodes for electrochemical modulation[2, 3] has emerged as promising tools for the H_2O_2 generation. However, current approaches are limited by electrode dimensions and lack of quantitative control, making it difficult to achieve spatially resolved and quantitatively tunable H_2O_2 production via the oxygen reduction reaction (ORR) at the single-cell or subcellular level. Here, we developed a N_4CoO_2 single atom catalysts (SACs) functionalized carbon nanofiber electrode (N_4CoO_2-CNFE), whose atomically dispersed catalytic sites and nanoscale dimensions respectively enhances $2e^-$ ORR selectivity and spatial localization, enabling quantitatively tunable and spatially confined intracellular release of H_2O_2 for precise modulation of intracellular SGs. The integration of single-atom catalysts with nanofiber geometry allows for an optimal balance between catalytic efficiency and spatial precision. Our strategy offers a useful approach for quantitatively dissecting the regulatory roles of key molecular species in complex biological processes, offering a potential method for mechanistic studies of disease and the development of targeted therapeutic strategies.

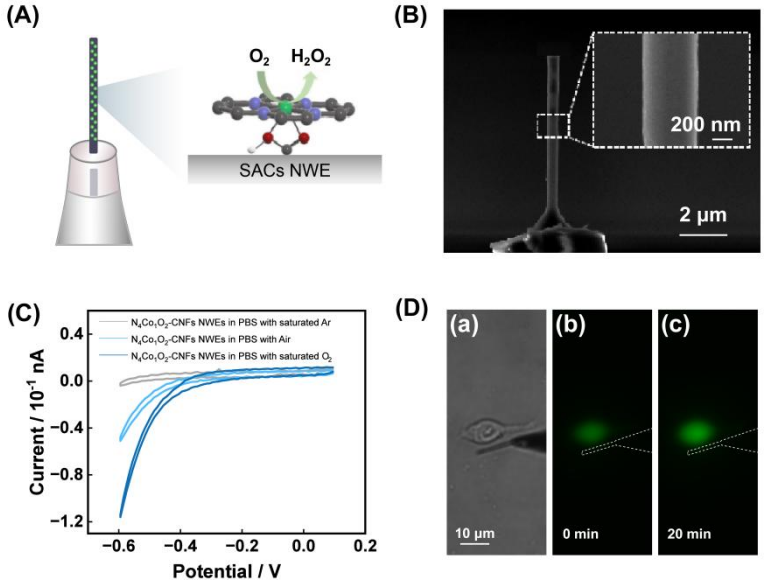


Fig.1 (A) Schematic illustration of N_4CoO_2-CNFE enabling in situ electrochemical synthesis of H_2O_2 via $2e^-$ ORR. **(B)** SEM image of a N_4CoO_2-CNFE; inset: a magnified SEM image of N_4CoO_2 carbon nanofiber. **(C)** CVs of N_4CoO_2-CNFE in PBS solution with saturated Ar (gray), Air (sky blue) and saturated O_2 (blue). **(D)** Bright-field image showing the N_4CoO_2-CNFE positioned near a PC12 cell **(a)**, and corresponding confocal fluorescence images of the cell before **(b)** and after **(c)** applying –0.6 V (*vs.* Ag/AgCl) for 20 min.

Acknowledgements

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References

1. B. Wolozin and P. Ivanov, *Nat. Rev. Neurosci.* **20**, 649–666 (2019)
2. J. B. Huang, S. Xue, P. Buchmann, A. P. Teixeira, M. Fussenegger, *Nat. Metab.* **5**, 1395–1407 (2023)
3. J. Zhang, P. J. Li, J. P. Yue, L. Y. Meng, W. Li, C. W. Yang, S. Kim, Z. Cheng, A. Kamath, S. Siahrostami, B. Z. Tian, *Nat. Nanotechnol.* (2025). https://doi.org/10.1038/s41565-025-01878-4

The effect of surface pretreatment on the corrosion resistance of AZ31

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AZ31 magnesium alloy is a lightweight and biocompatible material with great potential for biomedical and structural applications.[1] However, its practical use is limited due to its high corrosion susceptibility in chloride-rich environments. Since magnesium's behaviour largely depends on the properties of its surface oxide layer, understanding and controlling surface conditions are crucial for enhancing corrosion resistance.[2] Therefore, this study investigates how mechanical surface pretreatment and thermal oxidation affect oxide film formation and corrosion resistance of AZ31 alloy. The study workflow is shown in Figure 1.

Three surface pretreatments were studied: (i) ground (AZ31_G), (ii) ground and polished (AZ31_P), and (iii) ground, polished, and thermally oxidized (AZ31_TO). Surface morphology and composition were analyzed using Scanning Electron Microscopy with Energy-Dispersive X-ray Spectroscopy (SEM/EDS). In contrast, X-ray Photoelectron Spectroscopy (XPS) was used to evaluate oxide film composition and thickness before and after exposure to a corrosive medium. Corrosion behaviour was evaluated by potentiodynamic polarization in 0.1 M NaCl solution.

Results show that surface pretreatment strongly influences film structure and corrosion performance. The ground sample formed a thicker but more porous oxide layer, leading to higher corrosion rates. Polishing reduced surface roughness and oxide thickness, improving film uniformity. The thermally oxidized surface formed a thinner but more stable MgO/Al_2O_3-rich layer, exhibiting the highest corrosion resistance. This was also confirmed with XPS depth profiles, where the thinnest film on the thermally oxidized sample was formed.

Potentiodynamic measurements revealed the lowest corrosion current density and a more positive pitting potential for the thermally oxidized sample.

These findings highlight the importance of surface passive film formation and suggest thermal oxidation as a promising pretreatment for improving AZ31 corrosion performance in chloride environments.

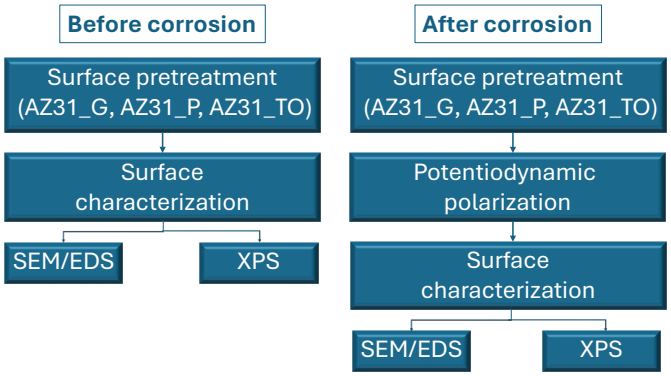


Figure 1. Workflow of the present study.

Acknowledgements

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No. P1-0134, P2-0393 and J2-60047.

References

1. Zhang, J. et al *J. Magnes. Alloys* **2023**.
2. Feliu, S.et al. *Appl. Surf. Sci.* **2015**, *347*, 736–746.

Direct electron exchange of xanthine dehydrogenase at InGaN nanowire structures

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Semiconductor nanostructures have become a valuable tool in the development of analytical detection schemes since they allow the read-out of a sensing surface by spatially resolved illumination. One interesting approach within this research field are nanowires which can directly be prepared on a chip electrode by PVD or CVD processes. InGaN nanowires have been shown not only to be valuable in evaluating photoluminescence properties [1] but also to allow defined photelectrochemical reactions to occur. One example is the oxidation and detection of NADH as a cofactor of many enzyme reactions [2].

Advantageously such semiconductor-based electrode systems can be combined with enzyme reactions in order to introduce more specifity in the reaction. Different approaches exist for establishing contact between the enzyme reaction and the semiconductor material. Besides educts/products of the enzyme reaction also mediators can be used. The direct electron transfer which has been demonstrated as valuable tool on conventional electrodes is with respect to semiconductor materials still in its infancy.

In our study xanthine dehydrogenase from *Rhodobacter capsulatus* (XDH) has been used. The enzyme can convert degradation products of the purine metabolism such as hypoxanthine and xanthine by transferring electrons to a cofactor. We have studied whether the natural cofactor NAD+ can be replaced by ínGaN nanowires. For this purpose, the nanowire electrode structure has been incubated with an enzyme solution to allow adsorption to take place. After enzyme immobilization the photoelectrochemical response has been evaluated by chopped light voltammetry. Here different concentrations of hypoxanthine have been applied in solution. It can clearly be shown that the anodic photocurrent response can be amplified by the presence of the enzyme substrate. Since this is not happening without the enzyme attached to the nanostructed surface it can be concluded that the immobilized enzyme can exchange electrons directly with the InGaN nanowires. Consequently, a signal chain from hypoxanthine via the enzyme towards the semiconductor nanostructed electrode can be verified. This may provide a solid basis for the further development of a photoelectrochemical sensing system for the enzyme substrate.

References

1. Lutsenko, E.V., Rzheutski, M.V., Pavlovskii, V.N., Alyamani, A., Aljohenii, M., Aljerwii, A., Mauder, C., Reuters, B., Kalisch, H., Heuken, M., Vescan, A., 2016. Influence of Band Tailing on Photo- and Electroluminescence Polarization of m-Plane InGaN/GaN Quantum Well Heterostructures. J. Appl. Spectrosc. 82, 956–960.
2. Riedel, M., Hoelzel, S., Hille, P., Schoermann, J., Eickhoff, M., Lisdat, F., 2017. InGaN/GaN nanowires as a new platform for photoelectrochemical sensors - detection of NADH. Biosens. Bioelectron. 94, 298–304.

Single Nanoparticle Collisions Revealing Element Segregation of Multi-Element Alloys Suppression by High-Entropy for Oxygen Evolution Reaction

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The structural reconstruction and elemental segregation of alloy catalysts in the oxygen evolution reaction (OER) are key factors influencing their activity and stability, while the irreversible structural evolution induced by high current density is the primary issue leading to performance degradation. In this study, highly monodisperse multi-element alloy nanoparticles (MEA-NPs) catalysts were synthesized via ultrafast high-temperature method. The single NP collision technique based on scanning electrochemical cell microscopy (SECCM) was employed to facilitate efficient mass transfer and ultra-high current density, thereby accelerating structural evolution during the OER process. By combining multidimensional feature extraction and clustering analysis of transient signals, it was found that increasing the number of constituent elements enhances the consistency of the catalytic response, and high-entropy systems effectively suppress phase separation and elemental segregation. Transmission electron microscopy (TEM), in situ Raman spectroscopy, and high-throughput density functional theory (DFT) calculations further confirmed the advantages of the five-element alloy in terms of structural uniformity and stability. This study established a statistical correlation between structural evolution and catalytic response at the single-particle level and proposed a strategy similar to “accelerated testing under extreme conditions,” providing new insights for the mechanistic study and rational design of OER catalysts.

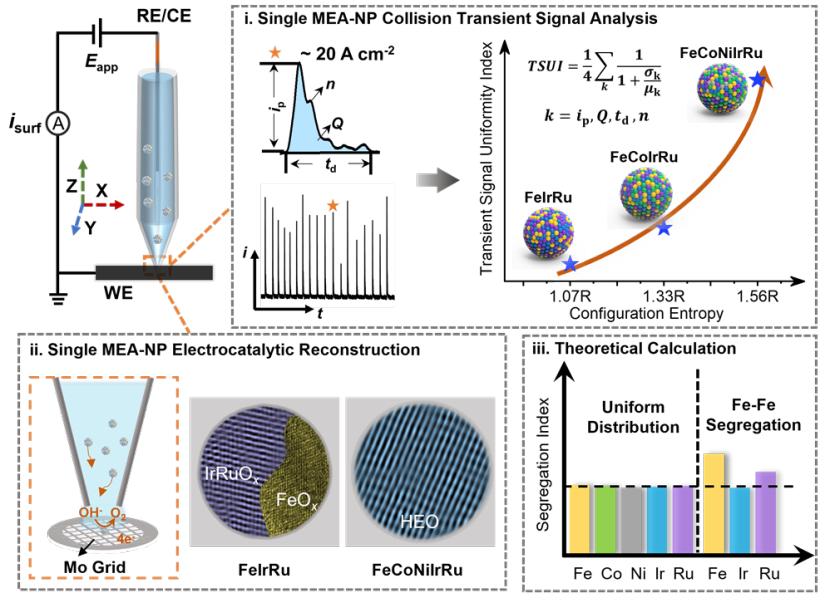


Fig.1 Single MEA-NP collision electrocatalysis. (i) Transient signal analysis: single MEA-NPs collide with a N-CFE, triggering electrocatalytic OER characterized by transient current signals. As the configurational entropy increases, signal dispersion decreases. Peak current (i_p), charge (Q), duration (t_d), and peak count (n) were four-dimensional features of transient signal. (ii) Electrocatalytic reconstruction: single MEA-NPs collide on a Mo grid and are characterized by HRTEM. FeIrRu NPs show phase segregation, while FeCoNiIrRu NPs maintain structural integrity. (iii) Theoretical analysis: DFT calculations of element-specific segregation indices were performed on randomly generated $FeIrRuO_x$ and $FeCoNiIrRuO_x$ supercells.

Acknowledgements

This work was supported by National Natural Science Foundation of China (22204159, 22304021) and the Major Project of Changchun State Key Laboratory(23GZZ05).

References

1. Yang, L.; Tu, Y.; Shan, X.; Wang, P.; Xu, J.; Gao, H.; Cai, F.; Cui, Z.; Jin, Z.; Zhou, M., Single Nanoparticle Collision Electrocatalysis Driven by Ultrafast High-Temperature Precision Synthesis. *Nano Lett. 25* (20), 8320-8326 (2025).

Single Nanoparticle Collision Electrocatalysis Driven by Ultrafast High-temperature Precision Synthesis

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Single-nanoparticle (NP) collision technology provides real-time tracking of catalytic behavior at individual NP level, overcoming limitations of conventional ensemble-averaged measurements. However, its successful implementation critically depends on the monodispersity and surface-exposed nature of catalysts. The precise fabrication of colloidal nanocatalysts with tailorable composition, uniform size, and highly exposed surfaces remains a significant challenge in materials science and catalysis. To address this challenge, this study employs Pt_xRu_{1-x} alloy as a model system. Through advanced instrumentation including high-throughput liquid dispensing workstations, ultrafast high-temperature synthesis systems, and ultrasonic disintegrators, we successfully prepared well-dispersed, composition-tunable, surface-exposed Pt_xRu_{1-x} colloidal metal nanoparticles (MNPs). Leveraging these tailored MNPs, we performed single-particle collision electrocatalytic analysis using scanning electrochemical microscopy (SECCM). This approach enabled precise measurement of the intrinsic electrocatalytic activity of individual Pt_xRu_{1-x} MNPs toward the methanol oxidation reaction (MOR) beyond mass transport limitations, revealing composition-activity relationships at industrially relevant current densities. Complementary density functional theory (DFT) calculations not only validated the experimentally observed composition-dependent activity trends, but also elucidated the synergistic mechanism of Pt-Ru alloys in MOR optimization. These computations revealed electronic structural transformations of Pt/Ru atoms during the reaction process and their impact on the adsorption/desorption behavior of key intermediates, providing fundamental insights into the high catalytic performance of Pt-Ru alloy catalysts in MOR. This work pioneers the innovative combination of ultrafast high-temperature precision synthesis with ultrasonic exfoliation technology, achieving previously unattainable colloidal catalyst characteristics and opening new avenues for the design and fabrication of advanced electrocatalysts.

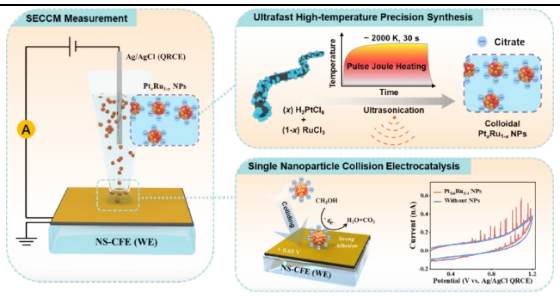


Fig.1 Schematic Illustration of Accelerated Catalyst Screening via Ultrafast High-Temperature Precision Synthesis and Ultrasonic Exfoliation Technology

Acknowledgements

This work was supported by National Natural Science Foundation of China (22204159, 22304021) and the Major Project of Changchun State Key Laboratory (23GZZ05).

References

1. Pan, Y.; Shan, X. ; Cai, F.; et al. *Angew. Chem. Int. Ed.* 63, e202407116 (2024)
2. Shan, X.; Pan, Y.; Cai, F.; et al. *Nano Lett.* 24, 11632 (2024)

Bioinspired Rhodium Single-Atom Nanozymes with 100% Selectivity for Direct Formic Acid Oxidation in Enzymatic Biofuel Cells

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Solving the dilemma of CO poisoning in electrocatalysts is the crucial step in the commercialization of direct formic acid fuel cells, however, it remains a challenge to design catalysts with high reaction tendency for the direct formic acid oxidation reaction (FAOR) as elaborately as natural enzymes. Herein, inspired by formate oxidase (FOD) with a delicate catalytic pocket, we report that rhodium single-atom nanozymes (Rh SAzymes) can catalyze direct FAOR without worrying about CO poisoning. Impressively, Rh SAzymes exhibit non-CO pathway for direct FAOR in both enzyme-like biocatalytic and electrocatalytic conditions. By combining docking studies and density functional theory calculations, we reveal that this striking reaction tendency mainly stems from thermodynamically unfavorable pathway in the generation and adsorption of CO, much more like that of natural FOD. Moreover, we successfully construct the membrane-less FA/O2 enzymatic biofuel with an open-circuit potential (OCP) of 0.68±0.01 V and a maximum power density (Pmax) of 0.41±0.01 mW cm−2. With 100 % selectivity toward direct anti-poisoning pathway and flexible configuration, the device realizes long-term stable operation and miniaturized goals. Our work not only provides a methodological template for exploring the CO-resilient reaction mechanism of enzyme-like biocatalysts as well as their homologous electrocatalysts in canonical reactions of fuel cells but also paves avenues for the integration of nanozymes in energy equipment.

Thin film liquid flow electrochemical sensor based on unmodified glassy carbon electrode for detecting Cd (II)

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Cd(II), a highly toxic heavy metal from industrial wastewater, batteries, and plating. Its bioaccumulation causes cellular damage, mutations, and organ failure [1,2]. This study utilized 3D printing technology to fabricate a thin-film flow electrochemical sensor for the rapid, efficient, and accurate detection of cadmium (II) in water. The sensor leverages the electrochemical reduction characteristics of Cd(II) on the surface of a glassy carbon electrode (GCE), combined with thin-film flow technology, to achieve efficient enrichment and detection of Cd(II). By integrating the electrochemical properties of an unmodified GCE and employing differential pulse voltammetry (DPV), the sensor enables quantitative detection of Cd(II). Experimental conditions, including pH, deposition time, deposition potential, and Bi concentration, were optimized. The results demonstrate that the sensor exhibits a linear detection range for Cd(II) from 0 μg/L to 20 μg/L in a 0.1 M acetate buffer solution (pH 4.5), with a sensitivity of 0.01088 μA·L·μg^{-1} and an R^2 of 0.998. The sensor demonstrates excellent selectivity, reproducibility, and stability, and has been successfully applied to the detection of Cd(II) in real water samples, with recovery rates ranging from 68% to 110%. This study provides a simple, low-cost, and efficient method for the rapid detection of Cd(II) in water, meeting the limit requirements (5 μg/L) specified in China's *Standards for Drinking Water Quality* (GB 5749-2006).

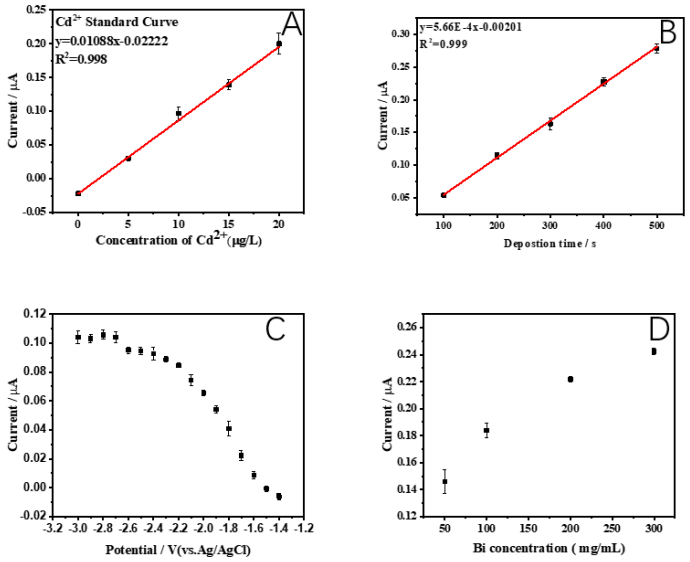


Fig.1 (A) Standard curve for the peak current of Cd (II) concentration (B) Effect of deposition time (C) Effect of deposition potential (D), Effect of Bi concentration

Acknowledgements

High tech industrialization special fund project of science and technology cooperation between Jilin Province and Chinese Academy of Sciences, water toxicity analyzer (E42B063301)

References

1. Ahmed, M.M.N.; Bodowara, F.S.; Zhou, W.; Penteado, J.F.; Smeltz, J.L.; Pathirathna, P. Electrochemical Detection of Cd(II) Ions in Complex Matrices with Nanopipets. RSC Adv.; **12**, pp. 1077-1083.(2022)
2. S. Satarug and M. R. Moore , Environ. Health Perspect., **112** , 1099 —1103 （2004）

Flexible disk ultramicroelectrode: facile preparation and high-resolution scanning electrochemical microscopy imaging

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Scanning electrochemical microscopy (SECM) is a scanning probe technology, which uses ultraelectrode (UME) to record the change of Faraday current for the probe to obtain the electrochemical information of microtopography. This work presents a simple, universal and reproducible strategy for manufacturing disk UME. By drawing borosilicate glass tubes inserted with platinum (gold, silver carbon fiber, etc.) and quickly heat sealing the tips, flexible UME with highly repeatable geometry can be quickly prepared. Optical and electrochemical characterization show that the prepared UME has good geometry and small RG value (1.7-2). Therefore, when this UME is used as a probe assembly for SECM imaging, it can achieve excellent spatial resolution and high sensitivity at short working distances with minimal damage caused by tip collision with the sample. This work helps to reduce the threshold of SECM use and the difficulty of operation.

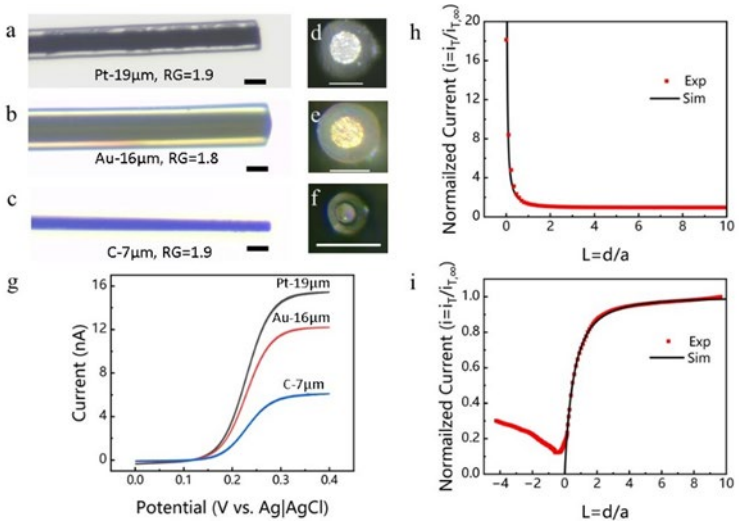


Fig.1 Characterization of the flexible disk UMEs.

Acknowledgements

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References

1. Chen, H.; Kong, X.; Wang, D.; Zhang, M., Analytical Chemistry 2022, 94 (49). A. B. Author 1, C. D. Author 2, Journal, 2006, 18, 11.

2. Danis, L.; Polcari, D.; Kwan, A.; Gateman, S. M.; Mauzeroll, J., Analytical Chemistry 2015, 87 (5), 2565-2569.

Development of an osmosis-assisted hollow microneedle array integrated with dual-functional electrochemical sensor for urea and pH monitoring in interstitial fluid

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In the realm of healthcare, the precise detection of biomarkers is of utmost significance for disease diagnosis, prevention, and personal health monitoring. This study centered on the development and validation of a hollow microneedle array (HMNA) deposited with $MgCl_2$, integrated with a dual-functional sensor system. This system is designed for osmosis-assisted enhanced extraction of interstitial fluid, as well as the simultaneous and continuous monitoring of urea and pH within interstitial fluid.

The urea sensor component was fabricated by electro-depositing Prussian blue onto a carbon electrode, followed by the application of a molecularly imprinted polymer (MIP) layer. This process ensures high specificity and sensitivity in detecting urea. The MIP serves as a recognition element for the non-electrochemically active urea molecule, offering advantages such as high selectivity, relatively low cost, and minimal susceptibility to environmental factors like temperature.

For the pH sensor, it was constructed through the electropolymerization of polyaniline (PANI). PANI, an affordable, easily synthesized, and environmentally friendly material, functions as the H^+ sensitive element, enabling the sensor to exhibit a linear response across a wide pH range.

When tested in an artificial skin matrix, the developed system demonstrated excellent in vitro electrochemical sensing performance, characterized by high linearity and repeatability. The urea sensor showed a linear relationship between the DPV response peak current and urea concentration, with a high correlation coefficient. It also exhibited good selectivity towards urea detection, with minimal interference from common substances. The pH sensor showed a linear relationship between the open circuit potential (OCP) values and pH within the range of 4.0 - 9.0, and excellent repeatability in cyclic response tests.

Moreover, the practical in vivo sensing performance of the system was verified in Sprague-Dawley (SD) rats. The HMNA, pre-soaked in saturated $MgCl_2$ solution, was able to effectively penetrate the skin and extract interstitial fluid through the combined action of osmotic pressure and external pressure. The sensor successfully monitored the changes in urea and pH levels in the interstitial fluid of rats. After simulating a high-protein diet by gavage, the sensor detected the increase in urea levels in the interstitial

fluid, and the trend was consistent with that in tail vein blood. In pH sensing tests, the sensor could respond sensitively to changes in the pH of interstitial fluid after injecting physiological saline of different pH values.

In conclusion, the successful development of this sensing system provides a novel, minimally invasive, compact, efficient, and convenient approach for biomarker detection in clinical health monitoring and disease diagnosis, highlighting its great potential as a valuable tool for continuous health monitoring.

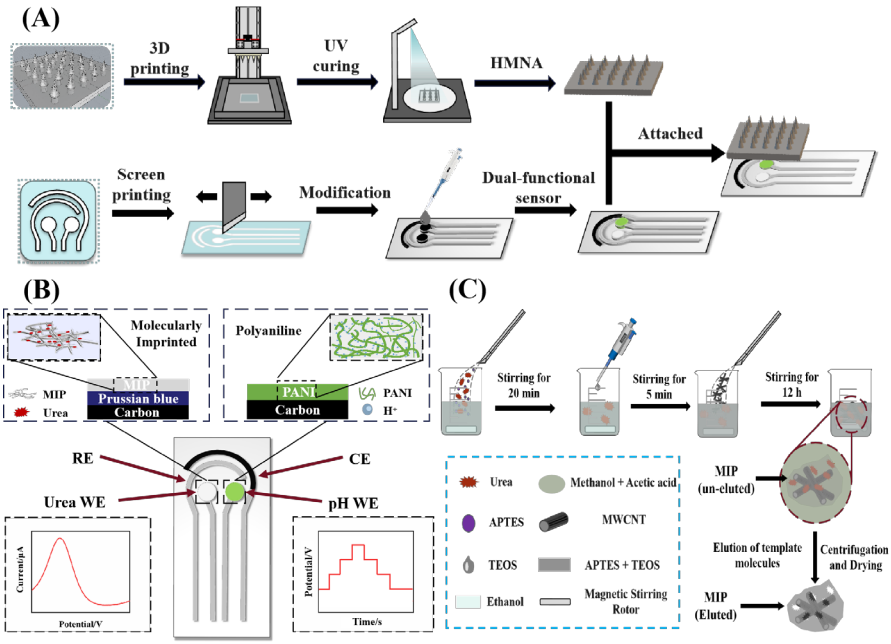


Fig.1 Schematic diagrams of (A) the HMNA 3D printing approach and dual-functional sensor screen-printing process, (B) the dual-functional sensor's structure, and (C) the preparation of MIP.

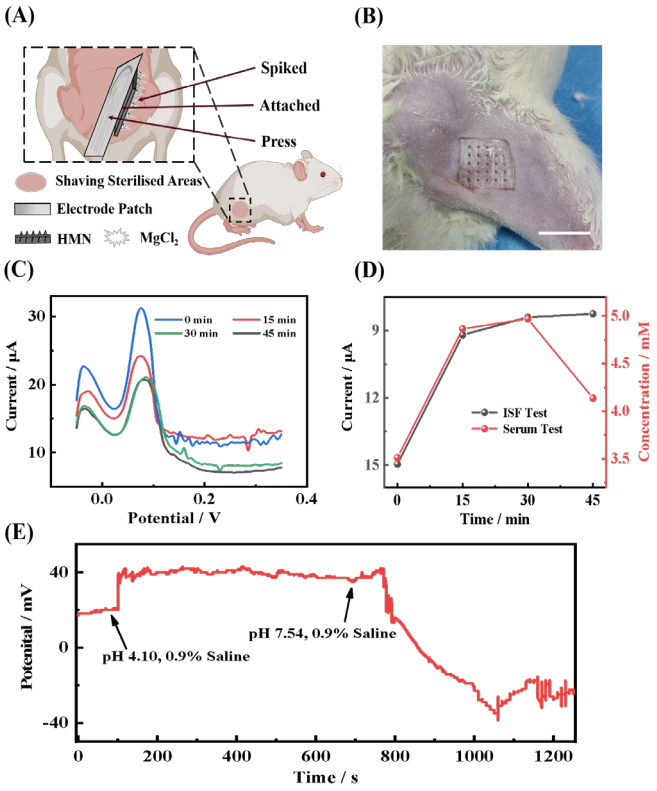


Fig.2 (A) The in vivo testing setup. (B) The interpenetration of HMNA piercing the epidermis with the subcutaneous environment, scale bar 1cm. (C) The electrochemical sensing performance of the sensor for urea in ISF. The tested time post-gavage is indicated. (D) The sensor's current response to urea in ISF compared to the urea concentration in tail vein blood. (E) The continual electrochemical sensing performance of the sensor for pH in ISF. The time points at which the saline solutions with different pH values were injected.

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A Single Carbon Microyarn-Based Integrated Wearable Textile Sweat Sensor that is Built in a Hook-and-Loop Fastener

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By fusing wearable sweat sensors for on-body sweat monitoring with textiles for daily wear, wearable textile sweat sensors (WTSSs) demonstrate the distinctive capability to real-time monitor perspiration while engaging in daily activities.[1-3] However, previous WSTSs mainly focused on "weave-in-textile" or "print-on-textile" ones, which have been permanently immobilized on the specific region of the specific type of textile prior to use and accordingly cannot be used in some but almost ineluctable actual circumstances (e.g., temporary change of textile type/immobilization region). Here, in an alternative "stick-to-textile" manner, the first example of a **S**ingle carbon microyarn-based **I**ntegrated WTSS that is built in a **H**ook-and-**L**oop **F**as-tener (SI@HLF) for on-body, dynamic, and multiplexed sweat monitoring by integrating a surface-engineered loop-based anti-gravity transport module for anti-gravity directional sweat transport, a single carbon microyarn-based sensing array module for sweat biomarkers analysis, a printed circuit board (PCB)-based data processing module for monitoring and control, along with an adhesive module that is based on a patterned adhesive film on the loop for universal immobilization, is reported. We test the performance of the SI@HLF in healthy subjects under controlled trials mimicking the daily exercise. We evaluate the utility of the SI@HLF being immobilized on various types of textile/textile regions for routine activities.



Fig. 1 Illustration of the SI@HLF for on-body and real-time monitoring of sweat Na^+, lactate, and creatinine on different types of textile/textile regions.

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Nanobioanal-ysis at Universities of Jilin Province (China), and the Analysis and Testing Center of Northeast Normal University (China).

References

1. J. R. Walter, S. Xu, and J. A. Rogers, *Nat. Commun.*, **15**, 123 (2024).
2. K. Mahato, T. Saha, S. Ding, S. S. Sandhu, A.-Y. Chang, and J. Wang, *Nat. Electron.,* **7**, 735 (2024).
3. R. Song, S. Cho, S. Khan, I. Park, and W. Gao, *Adv. Mater.*, 2419161 (2025).

A Fully Integrated Wearable Biomimetic Microfluidic Wound Tracker for *O4JU Dynamic Monitoring of Wound Exudate Oxygen

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Wearable wound exudate sensors hold great promise for providing dynamic measurements of valuable biomarkers.[1–3] However, no existing sensors are able to achieve the fully integrated, skin-on, and dynamic detection of raw wound exudate O_2, which is closely related to wound conditions and also essential for wound healing. Here, we present the first fully integrated wearable biomimetic microfluidic wound tracker (FIWBMWT) for noninvasive, skin-conformal, and dynamic monitoring of wound exudate O_2 alongside other critical biomarkers, including uric acid (UA), lactate, pH, and temperature (**Fig. 1A**).[4] This functionality is achieved through the seamless integration of microfluidic, sensing, and electronic modules. The biomimetic microfluidic system, inspired by the glandular trichomes of tomato (*Solanum lycopersicum*) stems, ensures efficient *in situ* transportation and collection of the wound exudate. The multiplexed sensor array, functionalized with nanoscale materials, enables highly sensitive and accurate detection of the aforementioned biomarkers. The performance of the FIWBMWT was evaluated using bacterium-inoculated and uninoculated wound models in mouse over extended observation periods (**Fig. 1B**). The captured biomarker data revealed temporal changes in the wound microenvironment and provided insights into wound severity, including the detection of exacerbated wound infections associated with hyperglycemia in diabetic mouse. The FIWBMWT's ability to perform simultaneous and multiplexed analysis of wound exudate O_2 and other biomarkers makes it a compelling tool for wound infection prevention, personalized diagnostics, and tailored therapeutic interventions.

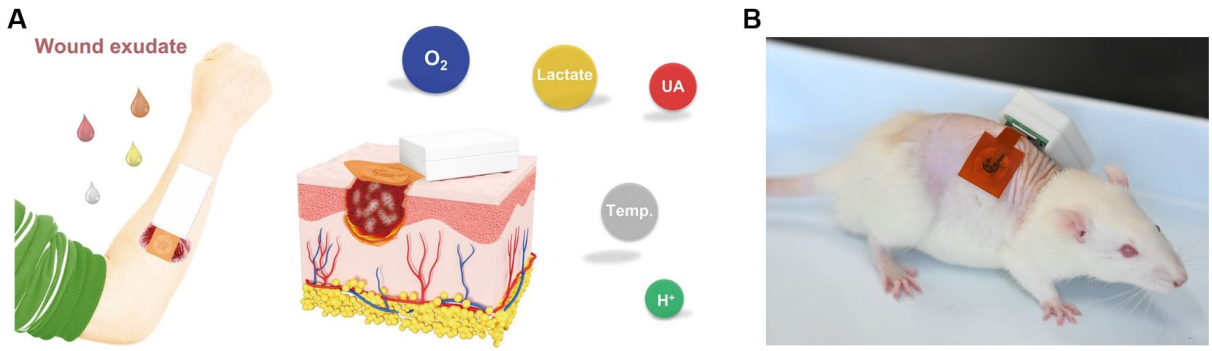


Fig. 1 (A) Schematic of a FIWBMWT for on-body and wireless wound exudate analysis. (B) Photograph of a mouse with full-thickness wound wearing the FIWBMWT.

Acknowledgements

The authors acknowledge the support from National Natural Science Foundation of China (no. 22274018), the China Postdoctoral Science Foundation (no. 2022M720698), the "111" Project (China, no. B18012), the Jilin Provincial Department of Education (China), the Key Laboratory of Nanobiosensing and Nanobioanalysis at Universities of Jilin Province (China), and the Analysis and Testing Center of Northeast Normal University (China).

References

1. C. Wang, E. Shirzaei Sani, C.-D. Shih, C. T. Lim, J. Wang, D. G. Armstrong, and W. Gao, *Nat. Rev. Mater.* **9**, 550-566 (2024)
2. N. Brasier, J. Wang, W. Gao, J. R. Sempionatto, C. Dincer, H. C. Ates, F. Güder, S. Olenik, I. Schauwecker, D. Schaffarczyk, E. Vayena, N. Ritz, M. Weisser, S. Mtenga, R. Ghaffari, J. A. Rogers, and J. Goldhahn, Nature **636**, 57-68 (2024)
3. K. Mahato, T. Saha, S. C. Ding, S. S. Sandhu, A. Y. Chang, and J. Wang, *Nat. Electron.* **7**, 735-750 (2024)
4. W. Deng, M. Sun, M. Cao, C.-B. Ma, X. Bo, J. Bai, and M. Zhou, *ACS Nano* **19**, 16163-16174 (2025)

An Integrated Wearable NanoTracker for Non-invasive Monitoring of Multiple Pharmacokinetic and Pharmacodynamic Biomarkers

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Monitoring the dynamic interactions between pharmaceutical drugs and human bodies is critical for the precision medication management of individuals in daily lives or on special missions (e.g., spaceflight) due to the high inter/intrasubject variations—stemming from influential factors including kidney/liver function, tissue penetration, and drug-drug interactions or extreme environments (e.g., microgravity)-induced changes in physiology.[1-4] In this respect, there is an urgent need for the development of non-invasive wearable sensors capable of dynamically and simultaneously tracking individualized pharmacokinetic profiles and pharmacodynamic responses; however, it remains rather extremely challenging and substantially underdeveloped. Here we report an integrated wearable nanotracker (P^2NanoTrek) that can *in situ*, non-invasively, dynamically, and simultaneously monitor multiple pharmacokinetic (PK) and pharmacodynamic (PD) biomarkers after administering the pharmaceutical drug of metoprolol (a widely prescribed medication for treating arrhythmia, which is targeted as a model drug). In human participants, we test the performance of the P^2NanoTrek for real-time measurement of [metoprolol sweat] and heart rate (HR) after metoprolol administration under real-life situations related to metoprolol absorption and elimination in the human body in controlled conditions. We also evaluate its utility for personalized pharmacotherapy by comprehensively considering both factors related to sweat metoprolol (by indirectly correlating the metoprolol levels in plasma and sweat) and HR through a standard dose administration challenge.

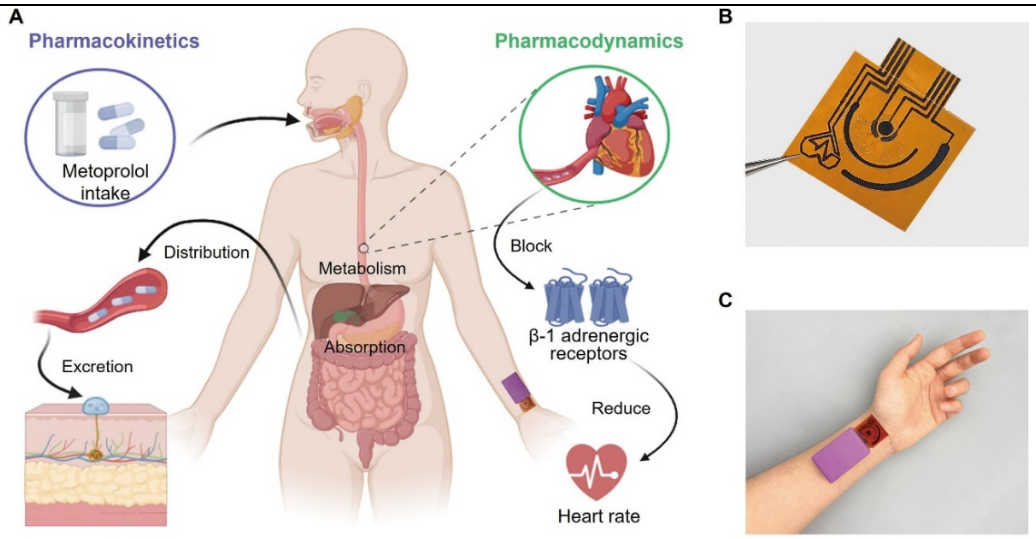


Fig.1 (A) Schematic of the PK and PD processes of metoprolol in human body. (B) Photograph of the epidermal patch. (C) Photograph of the P^2NanoTrek worn on the wrist for *in situ*, non-invasive, and dynamic monitoring of sweat metoprolol and HR.

Acknowledgements

The authors acknowledge the support from the National Natural Science Foundation of China (no. 22274018), the "111" Project (China, no. B18012), the Jilin Provincial Department of Education (China), the Key Laboratory of Nanobiosensing and Nanobioanalysis at Universities of Jilin Province (China), and the Analysis and Testing Center of Northeast Normal University (China).

References

1. Brasier. N, Wang. J, Gao. W, Sempionatto. J. R, Dincer. C, Ates. H. C, Güder. F, Olenik. S, Schauwecker. I, Schaffarczyk. D, Vayena. E, Ritz. N, Weisser. M, Mtenga. S, Ghaffari. R, Rogers. J. A, Goldhahn. J, *Nature*, **636**, 57-68 (2024)
2. Walter. J. R, Xu. S, Rogers. J. A., *Nat. Commun.* **15**, 123 (2024)
3. Song. R, Cho. S, Khan. S, Park. I, Gao. W, *Adv. Mater*, e2419161 (2025)
4. Ma. C-B, Shang. X, Sun. M, Bo. X, Bai. J, Du. Y, Zhou. M, *ACS Sensors*, **10**, 2388-2408 (2025)

A Novel Molecularly Imprinted Electrochemical Sensor for Fusaric Acid Detection

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Plant wilt is a plant disease caused by pathogens such as fungi, bacteria, or viruses. Fusaric acid (FA) is recognized as an important biomarker of wilt development[1]. Currently, methods for detecting FA include high-performance liquid chromatography, fluorescent immunochromatography, liquid chromatography-tandem mass spectrometry thin-layer chromatography, and enzyme-linked immunosorbent assay[2]. Although these methods are highly specific and sensitive, most of them are time-consuming, complex, and require stringent detection conditions. Therefore, there is an urgent need for a simple, low-cost detection technology that can enable immediate and rapid detection and assessment. Electrochemical detection methods offer several advantages, including high selectivity, high sensitivity, rapid response, and low cost. However, currently, there are few reports on the electrochemical detection methods for FA. In this paper, a highly selective and sensitive molecularly imprinted electrochemical sensor for the specific detection of FA was constructed. The FA/arginine (Arg)@ molecularly imprinted polymer (MIP)/glassy carbon electrode (GCE) was prepared by electropolymerization using FA as the template molecule and Arg as the functional monomer. The process was conducted on the surface of a GCE via cyclic voltammetry (CV). The electrochemical properties of the modified electrode Arg/FA@MIP/GCE were evaluated using CV, differential pulse voltammetry (DPV), and electrochemical impedance spectroscopy (EIS). Electrochemical studies revealed that FA could specifically bind to the Arg/FA@MIP, hindering the electron transfer from Arg/FA@MIP/GCE to $[Fe(CN)_6]^{3-/4-}$. On this basis, a molecularly imprinted electrochemical sensor based on Arg/FA@MIP/GCE was constructed, and the performance of this sensor was investigated. The results showed that the sensor exhibited a high sensitivity of 3.637 $\mu A \cdot cm^{-2} \cdot mM^{-1}$ to FA in the linear range of 10^{-11} to 10^{-5} M. Meanwhile, the sensor had excellent selectivity, reproducibility, stability, and can be used for the detection of real samples.

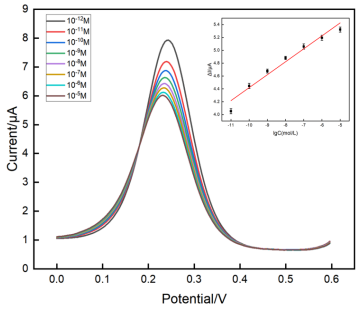


Fig.1 DPV current responses of FA at Arg/FA@MIP/GCE with varying concentrations, along with the linear calibration plot of FA.

Acknowledgments

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References

1. L.Yaling , F. Xixiang , et al. *J. Am. Chem. Soc.*, **3**(11):5818-5825(2021).
2. Q. Dang , B. Sun, et al. *J. Electrochem. Soc.*, **171**(8): 87521-87533(2024).

An Epidermal Patch for the Simultaneous Tracking of Multiple Pharmacokinetic and Pharmacodynamic Biomarkers

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Monitoring the dynamic interactions between therapeutic drugs and human bodies is critical for the precision medication management of individuals in daily lives or on special missions (e.g., spaceflight) due to the high inter/intrasubject variations—stemming from influential factors including kidney/liver function, tissue penetration, and drug-drug interactions or extreme environments (e.g., microgravity)-induced changes in physiology.[1-3] In this regard, developing non-invasive wearable sensors capable of dynamically and simultaneously tracking individualized pharmacokinetic responses and corresponding pharmacodynamic changes is urgently called for; however, it remains highly challenging and substantially underdeveloped. Here, we report a skin-interfaced integrated wearable sensor for in situ, non-invasively, dynamically, and simultaneously monitoring metformin (a widely prescribed medication for treating type 2 diabetes) pharmacokinetic profiles in sweat following its administration and pharmacodynamic parameters through sweat glucose levels. We evaluated the wearable's performance in healthy subjects under controlled environments in which certain actual situations related to the absorption and elimination of metformin in the human body. In patients with type 2 diabetes, the wearable is capable of proactive alert for drug overdose (by indirectly correlating metformin levels in plasma and sweat) and assessment of therapeutic response. The simultaneous monitoring of multiplexed sweat pharmacokinetic and pharmacodynamic biomarkers holds the potential to advance personalized pharmacotherapy and precision medicine.

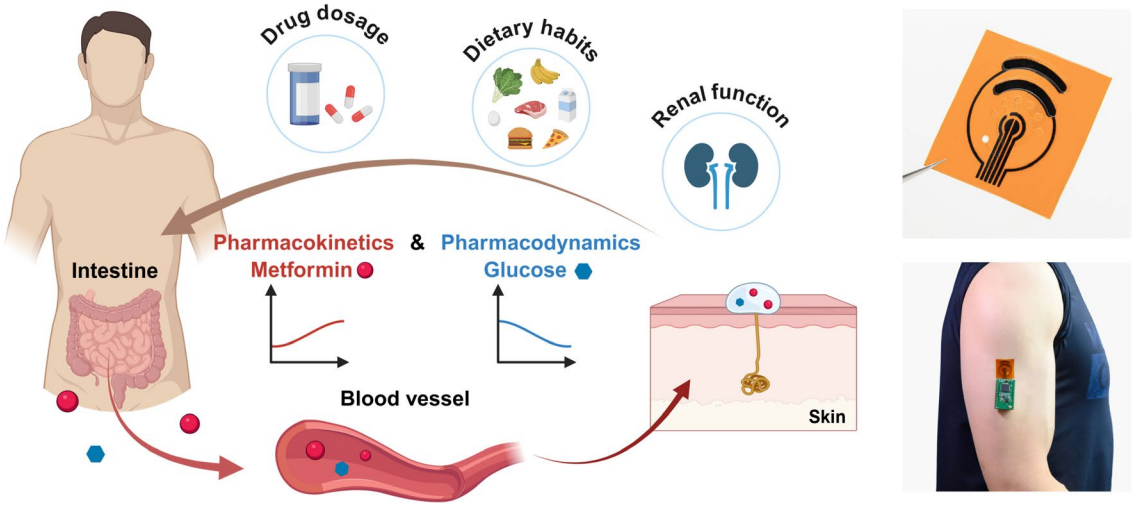


Fig.1 Schematic of the wearable for in situ, non-invasive, dynamic and simultaneously monitoring of sweat metformin and glucose

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References

1. N. Brasier, J. Wang, W. Gao, J. R. Sempionatto, C. Dincer, H. C. Ates, F. Güder, S. Olenik, I. Schauwecker, D. Schaffarczyk, E. Vayena, N. Ritz, M. Weisser, S. Mtenga, R. Ghaffari, J. A. Rogers and J. Goldhahn, *Nature*, **636**, 57-68 (2024)
2. N. Brasier, J. R. Sempionatto, S. Bourke, G. Havenith, D. Schaffarczyk, J. Goldhahn, C. Lüscher and W. Gao, *Nat. Biomed. Eng.*, **8**, 925-929 (2024**)**
3. J. Min, J. Tu, C. Xu, H. Lukas, S. Shin, Y. Yang, S. A. Solomon, D. Mukasa and W. Gao, *Chem. Rev.*, **123**, 5049-5138 (2023)

Ultrasensitive Chemiluminescence Detection Based on Titanium-doped Spinel-structured Nanoparticles with Abundant Oxygen Vacancies

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L-ascorbic acid (AA) is widely utilized for disease prevention and therapeutic interventions.[1] The deficiency of AA can cause several diseases like rheumatoid arthritis, scurvy, Parkinson's, Alzheimer's, cardiovascular malady, and malignant growth.[2] Therefore, sensitive detection of AA plays an important role in disease prevention and treatment. Current analytical techniques such as chromatography,[3] colorimetric detection,[4] fluorescence analysis,[5] and electrochemical analysis[6] face limitations in cost-efficiency, sensitivity, and operational complexity. Therefore, the development of efficient methods for the quantitative analysis of AA is necessary.

Here we successfully synthesized spinel-structured ternary nanocatalyst Ti-Co_3O_4/Fe_3O_4 nanoparticles (NPs) for the first time. Ti-Co_3O_4/Fe_3O_4 NPs can enhance the chemiluminescence (CL) intensity of the luminol/H_2O_2 system by over 3800-fold, attributed to the high density of oxygen vacancies (OVs) within the structure. Based on the inhibitory effect of L-ascorbic acid (AA) on the luminol/H_2O_2 CL system, we developed a sensitive, rapid, effective, and highly selective AA CL assay with a linear range of 0.1 μmol/L to 100 μmol/L and a limit of detection (LOD, S/N = 3) of 0.044 μmol/L. The method was successfully applied to quantify AA in vitamin C tablets with recoveries ranging from 99.7% to 106.3%. This research provides a promising prospect for the application of spinel-structured nanoparticles in CL detection platforms and offers valuable insights into nanoparticle size modulation and OV engineering for catalytic optimization.

Acknowledgments

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References

1. Y. Ma et al., Biosens. Bioelectron., **59**, 384-388 (2014).
2. R. Banavath, A. Abhinav, R. Srivastava, P. Bhargava, Electrochim. Acta, **419**, 140335 (2022).
3. C. Garnero, M. Longhi, Anal. Chim. Acta, **659**, 159-166 (2010).
4. X. Liu et al., Appl. Surf. Sci., **479**, 532-539 (2019).
5. J.-H. Zhang et al., ACS Appl. Nano Mater., **5**, 5234-5243 (2022).
6. Y. Li et al., Microchem. J., **177**, 107278 (2022).

Rapid Detection of Antibiotics Using Portable Electrochemical Analyzer and Sensor Chip

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The establishment of efficient and sensitive methods for antibiotic detection, along with the creation of portable detection devices, is crucial for ensuring food safety, protecting the environment, and curbing the spread of drug-resistant bacteria. Traditional microbiological assays are simple and cost-effective but lack sensitivity and efficiency. Modern techniques like HPLC, GC-MS, and LC-MS/MS offer high sensitivity but are complex and non-portable. Commercial immunoassays (e.g., ELISA) face enzyme instability and long detection times. While molecular imprinting (MIP) shows potential, biosensors excel with rapid response, portability, and ease of use, making them promising for antibiotic detection. Here, we present a straightforward yet highly effective electrochemical detection platform that employs aptamers[1-2], chip gold electrodes (CGE)[3-5], and a multi-channel chip, complemented by a self-developed portable multi-channel electrochemical analyzer with preliminary data processing capabilities. This system enables the rapid and accurate detection of kanamycin and tetracycline in water samples. Additionally, to improve detection sensitivity and reduce the effects of inter-batch electrode variations, we have designed a responsive DNA hydrogel switch that modulates the diffusion rate of electroactive molecules (e.g., methylene blue) to the electrode surface. This innovation has resulted in a reduction of the detection limit for tetracycline by approximately two orders of magnitude. Furthermore, this method demonstrates a degree of universality and has been validated for the detection of other small molecules, including ATP, and related nucleic acids.

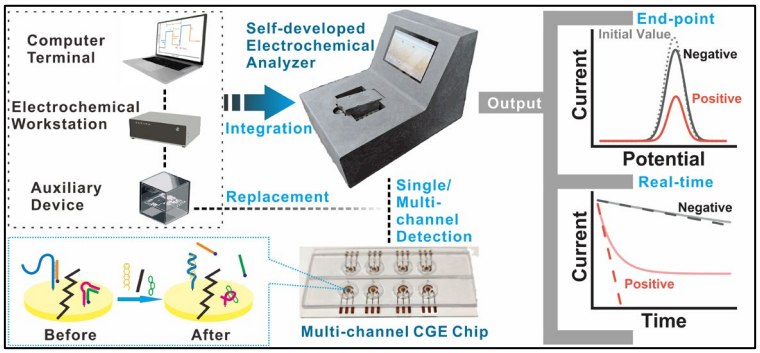


Fig. 1 Schematic diagram of electrochemical detection of kanamycin/tetracycline using multi-channel CGE chip and portable electrochemical analyzer.

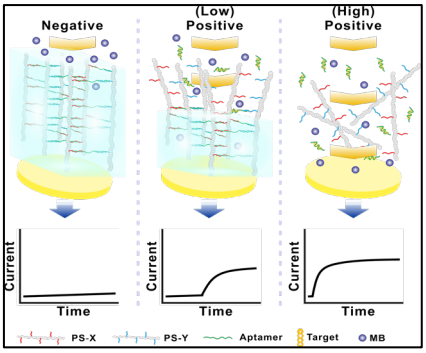


Fig. 2 Schematic diagram of responsive DNA hydrogel regulating methylene blue molecules to the electrode surface.

Acknowledgements

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References

1. X. Chen; S. Hao; B. Zong; C. Liu; S. Mao, *Biosens. Bioelectron.*,**145**, 111711 (2019).
2. Y. Zhao; S. Ong; Y. Chen; P. Huang; J. Liu, *Anal. Chem.*, **94**, 10175-10182 (2022).
3. B. Yao; Y. Liu; M. Tabata; H. Zhu; Y. Miyahara, *Chem. Commun.*, 50, 9704-9706 (2014).
4. Y. Liu; B. Lu; Y. Tang; Y. Du; B. Li, *Electrochem. Commun.*, **111**, 106665 (2020).
5. Y. Bao; K. Cai; Y. Liu; B. Li, *Chin. J. Chem.*, **42**, 171-176 (2023).

Construction of a Controllable Thickness Hot Electron Electrochemiluminescence Sensor

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Traditional electrochemiluminescence (ECL) has concentrated on studies using good conductors as carriers, making a wide range of biocompatible poor conductors difficult to apply. Hot electron-induced electrochemiluminescence (HECL) solves this problem effectively by injecting hot electrons tunneling through the insulating membrane into the solution via a strong cathodic pulse of ultrashort duration, but it is significantly affected by the thickness of the insulating membrane and the parameters of the cathodic pulse. This work proposes a method to adjust the thickness of the insulating membrane by varying the molecular chain length of the thiol self-assembled membrane (SAM) on Au electrode. Combined with our specially designed pulse generator, the optimal thickness was determined, while the hydrated electrons and the conduction band energy levels of water were able to be detected by the HECL method as well. By modifying the molecule structure of SAM, the primary antibody was immobilized on the insulating electrode, and combined with the secondary antibody-labeled $RuSiO_2$, the HECL assay for cardiac troponin I (cTnI) was realized in a sandwich structure, with a detection limit as low as 1.8 pg/mL, showing a good prospect for application. This work provides an effective solution for HECL working conditions, instruments requirements, identification and principle exploration.

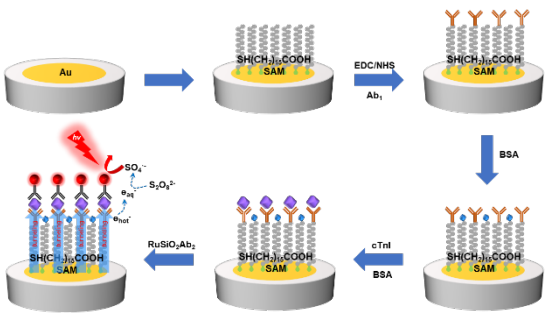


Fig.1 Thiol-based SAM as HECL insulating layer for cTnI detection

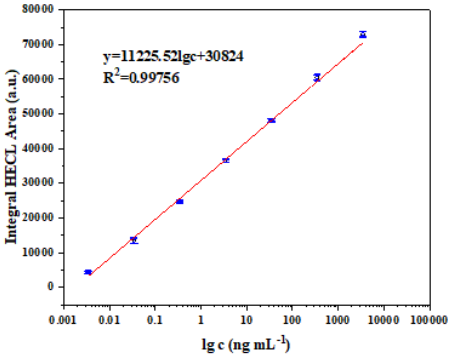


Fig.2 Linear fitting curve of cTnI concentration-HECL integral area

Acknowledgements

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References

1. J. Suomi and S. Kulmala, Rev. Fluoresc. 2009, 47–73 (2011).
2. P. Grönroos, Nur-E-Habiba; K. Salminen, M. Nissinen, T. Tuomaala, K. Miikki, Q. Zhang, N. Wei, E. Kauppinen, J. Eskola, H. Härmä and S. Kulmala, Sensors, **19**, 2751. (2019),
3. T. Zhai, Y. Xue, Y. Li, J. Zhu, J. Li and E. Wang, J. Electroanal. Chem., **924**, 116871 (2022).

A Fish-wearable System Based on Flexible Potentiometric Sensors for *in-situ* Monitoring of the Marine Carbonate System

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In-situ monitoring of the carbonate species in seawater is of great importance for fully understanding the effects of increasing atmospheric CO_2 levels on the marine carbon cycle[1, 2]. However, the deployments of the current *in-situ* marine monitoring system strongly rely on the conventional marine observation platforms[3]. Consequently, for the poorly sampled ocean regions, development of versatile and cost-effective marine monitoring platforms capable of direct *in-situ* observations continues to be urgently demanded.

In this work, we propose a submersible wireless flexible electrochemical sensor system for fish wearing, designed for *in-situ* potentiometric detection of the species related to the carbon cycle in seawater. The proposed fish-mounted sensing system consists of three primary components: (i) a sensing module for the simultaneous measurements of CO_3^{2-}, Ca^{2+}, and pH in seawater; (ii) an electronic module for device control and wireless communication; (iii) a polydimethylsiloxane-based waterproofing band protecting electronics from seawater corrosion while ensuring a tight attachment onto the fish skin. Through field deployment in the Bohai Sea, its capability for *in-situ* measurements of CO_3^{2-}, Ca^{2+}, and pH is verified. The obtained results indicate that the proposed wearable sensing system can serve as a promising tool for obtaining rapid information on chemical levels in the oceanic carbon cycle.

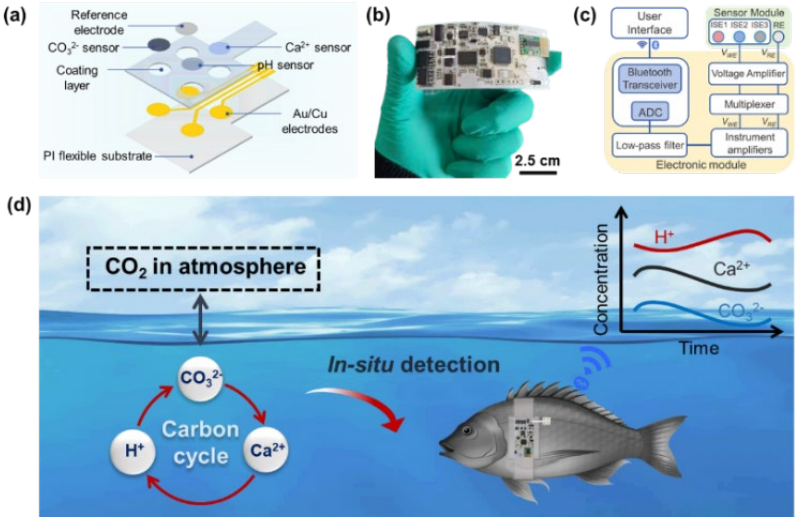


Fig.1 Scheme of the wearable potentiometric sensor system for *in-situ* monitoring of the carbonate species in seawater.

Acknowledgements

This work was financially supported by the National Key Research and Development Program (2024YFE0211700), and the National Natural Science Foundation of China (U2006208).

References

1. K. Caldeira, M. E. Wickett, *Nature,* **425,** 365 (2003)
2. M. Cuartero, N. Pankratova, T. Cherubini, G. A. Crespo, F. Massa, F. Confalonieri and E. Bakker, *Environ. Sci. Technol. Lett.,* **4,** 410−415 (2017)
3. Z. Liao, T. Jiang and W. Qin, *ACS Earth Space Chem.,* **7,** 2182−2189 (2023)

Phenol Fuel Cell Self-Powered Electrochemical Sensor based on Metal-Organic Frameworks for Mercury Ion Detection

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Mercury ion (Hg^{2+}) pollution threatens global ecosystems and human health via bioaccumulation in food chains [1]. Therefore, rapid and accurate detection of Hg^{2+} is essential. Conventional detection methods face limitations in on-site monitoring due to high costs, complex operations and high technical requirements. Enzymatic biofuel cells, which harvest energy from organic sources, show promise in the field of self-powered sensors (SPS) [2-4]. However, the use of enzymes poses critical challenges to their application in complex environments. To address this challenge, we developed a novel self-powered electrochemical sensor for the detection of Hg^{2+}. The system employs a two-dimensional porphyrin-based metal-organic framework (Cu-TCPP) as the anode, which efficiently catalyzes hydroquinone (HQ) oxidation, paired with a graphene/palladium MOF (Gr/Pd-MOF) composite cathode that selectively binds and reduces Hg^{2+}. During operation, HQ oxidation at the anode drives electron transfer through an external circuit, enabling Hg^{2+} reduction at the cathode and generating a quantifiable current signal (as shown in Fig. 1(A)). The linear sweep voltammetry (LSV) curves of the Cu-TCPP anode and Gr/Pd-MOF cathode (Figure 1B) reveal a theoretical redox onset potential difference of 0.38 V, confirming the thermodynamic feasibility of the sensor. The as-fabricated sensor achieves a wide linear detection range (0.5 nM to 5.0 μM) with a maximum power output (P_{max}) of 0.8 $\mu W \cdot cm^{-2}$(as shown in Fig. 1(C, D)). Notably, by utilizing phenolic pollutants in wastewater as fuel, the system converts waste into a functional resource, aligning with sustainable practices. Moreover, the inherent "signal-on" sensing strategy eliminates false-positive interference, offering a robust and innovative platform for self-powered environmental monitoring.

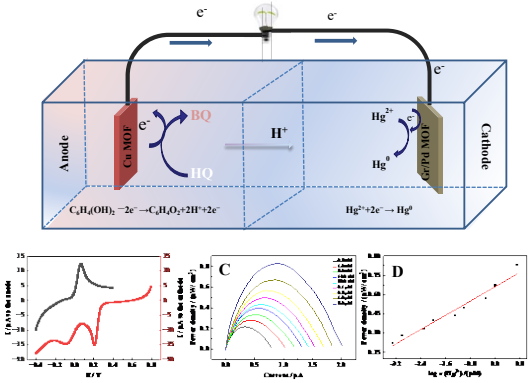


Fig.1 (A) Schematic diagram of SPS for Hg^{2+} detection, (B) LSV curves of the 2D Cu-TCPP anode in 0.1 M phosphate buffer solution (pH 7.0) with 100 μM HQ (black) and the Gr/Pd-MOF cathode in sodium acetate-acetic acid buffer with 0.1 μM Hg^{2+} (pH 5.0) (red), (C)Power output curves with different concentrations of Hg^{2+}, (D) Calibration curve between P_{max} of SPS and Hg^{2+} concentration.

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Reference

1. Y. Li, L. Chen, S. Liang, et al, *Environ. Sci. Technol.,* **56**(5), 2861-2879(2022).
2. E. Katz, F. Andreas and I. Willner, *J. Am. Chem. Soc.,* **123**(43), 10752-10753 (2001)
3. J. Xu, X. Luo, Y. Li, Y. Xing, K. J. Huang, *Chem. Eng. J.,* 150151 (2024)
4. C. Gu, J. Liu, T. Hou, W. Zheng, P. Gai, F. Li, *Anal. Chem.*, **97**(1), 928-935 (2025)

Highly sensitive amperometric response based on a surface-confined redox probe of a solid-contact lithium-selective electrode

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Lithium (Li), as the third element in the periodic table, is the lightest metal element (ρ = 0.53 g/cm^3, 20 ° C). Li is also a crucial element for advancing sustainable energy and environmental systems [1]. However, with the explosive applications of the lithium-ion batteries, Li pollution has become a globally emerging concern [2]. It is highly required for detection of Li in envrionmental media for studying the biogeochemical cycle of Li and potential Li pollution caused by the human and industrial activites.

Ion-selective electrodes (ISEs) are an effective tool for detection of the activities/concentrations of Li^+ [3], due to their high selectivity, rapid response time, and operational simplicity. However, according to the Nernst equation, the slope of these reported Li^+-ISEs are confined to be 59.1 mV/dec at 25 ^oC under the zero current condition, indicating that 1 mV potential change will cause 4% change in the activity of Li^+. Such potential response would not be favorable for high-precision detection of lithium. In recent years, our group focuses on the studies of the potential signal amplifications through the transformation of the traditional potentiometric response into other signal readout [4]. Among these works, the redox probe-based amperometric sensing for reading out the potentiometric response is a convenient and general method for translating the potential signal at mV grade to the amperometric signal at the μA/nA level. However, the complex configuration with a two-compartment electrochemical cell, containing a detection cell and a sample cell, and a salt bridge would limit the wide application.

This work proposes a redox probe confined ITO electrode based on a bipolar silica nanochannel array (bp-SNA) for reading out the potential response of the solid-contact lithium-selective electrode (Fig. 1). The mechanism is that the redox current for the confined redox probe is modulated by the potential of the Li^+-ISE through changing the concentrations/activities of Li^+ under the control of the constant applied potential. The redox probe, methylene blue (MB), is immobilized in a negatively charged SNA (n-SNA) through the electrostatic interaction, while a positively charged SNA (p-SNA) is covered on the top of the n-SNA for the confinement of MB. As compared with the two-compartment electrochemical cell, the preparation of the confined MB in the electrostatic nanage could simplify the electrochemical cell and eliminate the salt bridge.

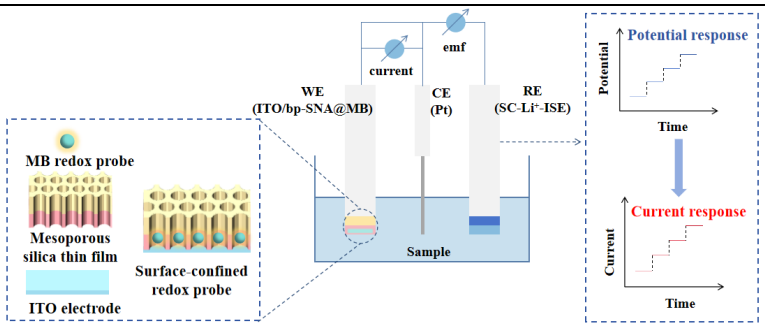


Fig. 1 Schematic illustration of the amperometric response based on a surface-confined redox probe of a solid-contact lithium-selective electrode

Acknowledgements

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References

1. Y. Huang, M. A. Afolabi, et al., *Environ. Sci. Tech.*, 58, 1359-1368 (2024).
2. Z. Yang, A. Farrell, et al., *Angew. Chem. Int. Ed.*, 64, e202413118 (2025).
3. Y. Ishige, S. Klink, et al., *Angew. Chem. Int. Ed.*, 55, 4831-4835 (2016); Y. Lyu, Y. Zhang, et al., *Anal. Chem.*, 93, 7588-7595 (2021) ; W. Xiang, X. Wang, et al., *Environ. Sci. Tech.*, 58, 22442-22455 (2024).
4. H. M. Wang, T. J. Yin, et al., *Anal. Chim. Acta*, 1129, 136-142 (2020) ; T. J. Yin, H. M. Wang, et al., *Talanta*, 232, 122489 (2021) ; X. T. Sun, T. J. Yin, et al., *Talanta* , 239, 123114 (2022) ; T. J. Yin, X. T. Sun, et al., *Sens. Actuat. B-Chem.*, 2022, 371, 132502 (2022); Y. F. Guo, T. J. Yin, et al, ACS Sens., 8, 4198-4206 (2023).

Construction of Humic Acid-Resistance Ion-Selective Electrodes with a Polyvinylidene Difluoride Outer Layer

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Polymeric membrane ion-selective electrodes (ISEs) have become attractive tools for environmental analysis, with the advantages of simple equipment, high selectivity and measurement accuracy [1]. However, reliable potentiometric sensing in complex samples remains a great challenge. Humic acid, as one of the major dissolved organic matters in natural water, can be easily adsorbed on the electrode surface due to its hydrophobicity, resulting in signal drifts [2,3]. In recent years, great efforts have been devoted to investigate the fouling caused by microorganisms and protein, while research on the interference caused by humic acid is limited [4,5].

In this work, we investigated the influences of humic acid on the conventional polyvinyl chloride (PVC) membrane-based ISEs and proposed a strategy based on a polyvinylidene difluoride (PVDF) coating to minimize the influences of humic acid on ISEs. Results show that humic acid can enter the PVC membrane phase, causing severe potential drift and deteriorating the performance of electrode (e.g. slope and detection limit). In order to solve this problem, a compact protective layer of PVDF is modified on the electrode surface via a drop-coating method. The outer layer has no prominent influence on the potentiometric response and selectivity of electrode. Moreover, after PVDF modification the potential drift of electrode caused by humic acid is significantly decreased, from 73.5 mV to almost no change within 30 min. This strategy provides an alternative way for the ISEs to mitigate the interference of dissolves organic matters, as well as improve measurement accuracy and stability during environmental analysis.

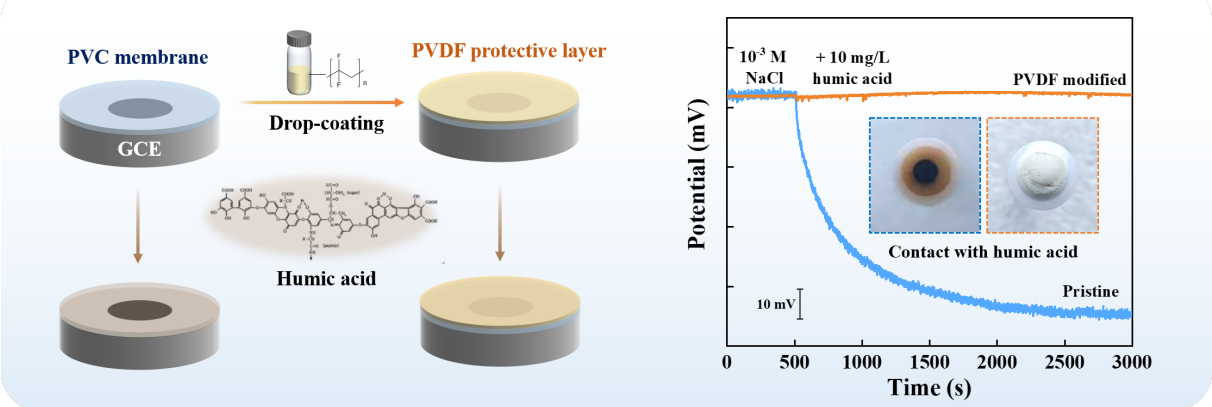


Fig 1. Schematic representation of the construction of humic acid-resistance ion-selective electrode and

effects of humic acid on the potential drift of the Cl^--ISE before and after PVDF modification.

Acknowledgements

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References

1. Gastón A. Crespo. *Electrochim. Acta*., **245**, 1023-1034 (2017).
2. Ghabbour Elham, Davies Geoffrey. Taylor & Francis, Inc. New York. 2004.
3. Susan J. Fish, Pierre Brassard. *Talanta*, **44**, 939-945 (1997).
4. Longbin Qi, Rongning Liang, Tianjia. Jiang et al. *Trends Anal. Chem.* **150**, 116572 (2022).
5. Narender Kumar Joon, Ning He, Tautgirdas Ruzgas et al. *Anal. Chem*. **91**, 10524-10531 (2019).

Nanopipette-Coupled Dimeric DNA Nanocarriers Enable Ultrasensitive Small-Molecule Detection through Split Aptamer Recognition

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Solid-state nanopore-based electrical analysis technology enables single-molecule resolution while maintaining multiple advantages of ultrahigh sensitivity, label-free operation, rapid processing capabilities, and high-throughput applications[1-3]. However, current nanopore configurations failed to capture detectable signals during small-biomolecule translacation due to the dimensional incompatibility, rapid transit dynamics and inherent signal-to-noise constraint. Popular strategies have emerged for solid-state nanopore detection of small biomolecule, including chemical modification of nanopore, precise pore size constriction, and implementation of high-bandwidth signal amplifiers[4-7]. Implementation barriers for these sensing strateges are limited production yield of functional nanopores, poor stability and durability of nanopores, and complicated fabrication and operational procedures.

Herein, a novel sensing strategy utilizing DNA tetrahedral nanostructures (DTN) as carriers was proposrd for glass naopipette-based small-molecule detection (Fig. 1a). A split aptamer specific to target small molecules was integrated on one vertex of the DTN (DTN-SApt). Upon binding to small-molecule targets, a pair of split aptamers reassembled to trigger the formation of dimeric DTN (D-DTN, Fig.1b). Compared to monomeric DTN, these target-bound dimers exhibit significantly enhanced pulsed ion-current signals when translocating through ~30 nm nanopipette, enabling highly sensitive small molecule detection based on this size-amplified signal transduction mechanism (Fig.1c & Fig. 2a-c). This nanopipette-coupled-DTN plaform could provide an advanced approach for ATP detection with good performance of low detection limit (0.2 nM, Fig. 2d), high selectivity (Fig. 2e), and especially superior signal-to-noise ratio (SNR), which mainly depending on small molecule-mediated assembly of tailing split aptamers. Additionally, we employed this platform to systematically investigate the kinetic interaction between DTN-SApt and ATP (Fig. 2f), while validating its practical applicability through the determination of ATP in serum samples. This finding has motivated us to leverage the synergized DTN—nanopipette system for detecting various small molecules or metal ions, including asenosine, vancomycin and Hg^{2+}. This methodological advancement significantly enhances the potential for developing high-precision diagnostic platforms in clinical tools.

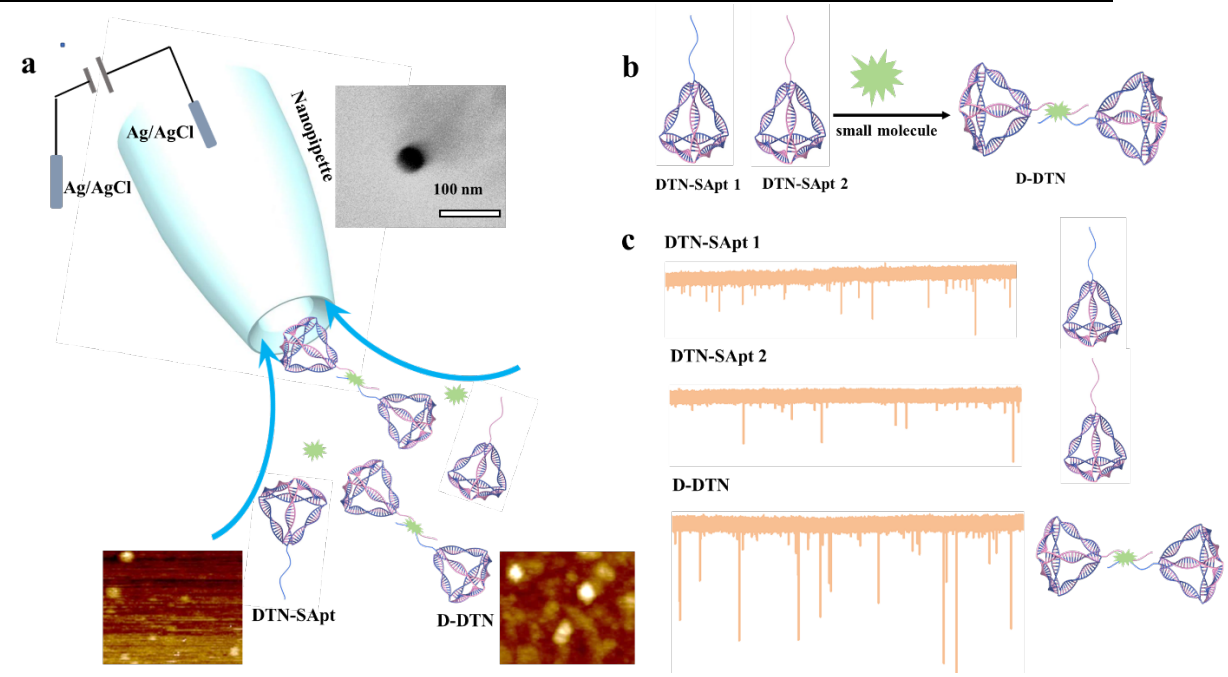


Fig.1 Schematic of the platform and a cartoon representation of DTN-SApt and dimeric DTN (D-DTN) translocated though theglass nanopipette (~30 nm). The ionic current signal can be used to differentiate between DTN monomers and dimers and as a result selectively determine the small-molecule targets.

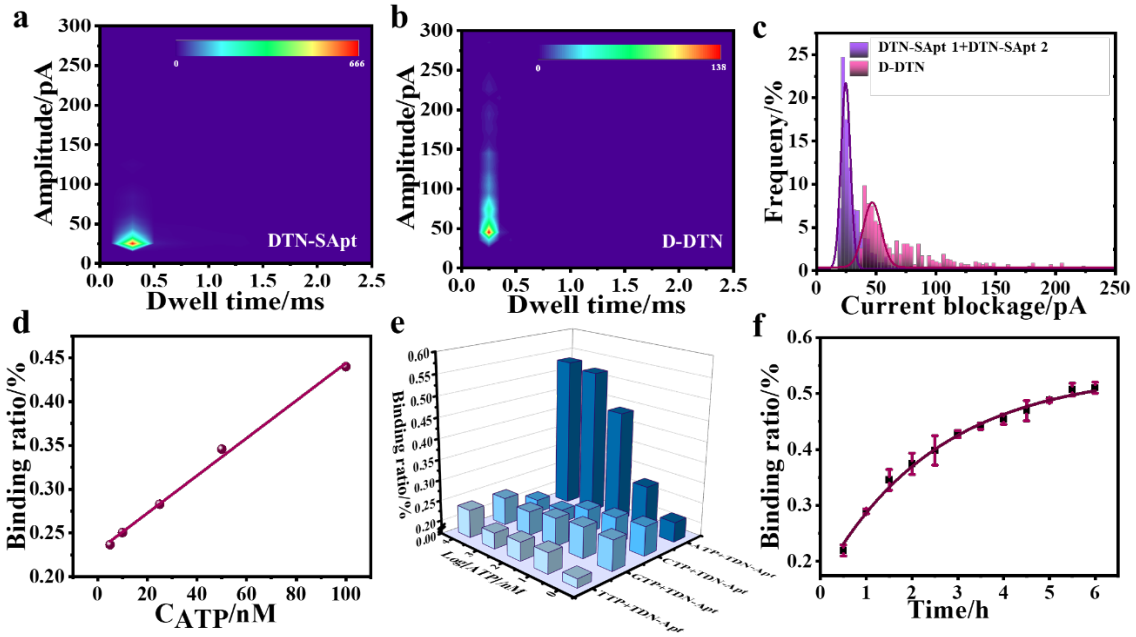


Fig.2 Surface density plots of translocating signals for (a) DTN-SApt and (b) ATP mediated dimeric DTN (D-DTN), and (c) the corresponding statistical analysis of pulsed ion-current amplitude. Investigation on the (d) sensitivity and (e) specificity of ATP detection, and the binding kinetics between ATP and DTN-SApt using this nanopipette-coupled-DTN plaform.

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References

1. X. Zhang, D. Luo, Y.-W. Zheng, X.-Q. Li, J. Song, W.-W. Zhao, H.-Y. Chen and J.-J. Xu, *ACS Nano*, 15108-15114 (2022).
2. W. Yi, C. Zhang, Q. Zhang, C. Zhang, Y. Lu, L. Yi and X. Wang, *Top. Curr. Chem.*, **381**, 13 (2023).
3. L. Xue, H. Yamazaki, R. Ren, M. Wanunu, A. P. Ivanov and J. B. Edel, *Nat. Rev. Mater.*, 2020, **5**, 931–951 (2020).
4. J. Song, C. H. Xu, S. Z. Huang, W. Lei, Y. F. Ruan, H. J. Lu, W. Zhao, J. J. Xu and H. Y. Chen, *Angew. Chem. Int. Ed.*, **57**,13226 –13230 (2018).
5. L. Guo, Y. Han, H. Yang, J. Fu, W. Li, R. Xie, Y. Zhang, K. Wang and X.-H. Xia, *Nano Lett.*, **24**, 5639-5646 (2024).
6. Z. Xie, Z. Chen, A. Li, B. Huang, C. Guo and Y. Zhai, *Anal. Chem.*, **96**, 8528-8533 (2024).
7. R. Wang, Y. Zhang, Q. D. Y. Ma and L. Wu, *Talanta*, **277**, 126323 (2024).

Silver-decorated nanobeads for label-free electrochemical analysis of *4I JHFNBE EZTFOUFSJBF* in food samples using a paper-based aptasensor

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Shigella dysenteriae (S. dysenteriae) is a serious foodborne pathogen that is often overlooked, increasing the risk of outbreaks. Traditional detection methods involve complex and slow cell culture techniques. To improve this, we developed a simple, cost-effective, portable paper-based aptasensor using silver-decorated magnetic beads (Ag/MBs) to detect S. dysenteriae. This aptasensor allows for both rapid screening and sensitive detection in food samples through voltammetric and impedance analyses. The chemistry involves depositing Ag on carboxyl-functionalized MBs and attaching an aptamer probe. The current response from Ag indicates the presence of the pathogen. When S. dysenteriae binds to the aptamer, the Ag signal decreases due to its insulating properties, detectable via differential pulse voltammetry (DPV). Simultaneously, electrochemical impedance spectroscopy (EIS) measures an increase in charge transfer resistance (Rct), further lowering detection limits. MB-based assays preconcentrate S. dysenteriae, achieving broad linearity (DPV = 102 – 108 CFU/mL, EIS = 101 – 109 CFU/mL) and high sensitivity (DPV = 90 CFU/mL, EIS = 10 CFU/mL), validated against standard methods. The sensor also includes near-field communication technology for convenient on-site analysis, making it an effective, sensitive, portable, and disposable option for detecting S. dysenteriae and similar microorganisms.

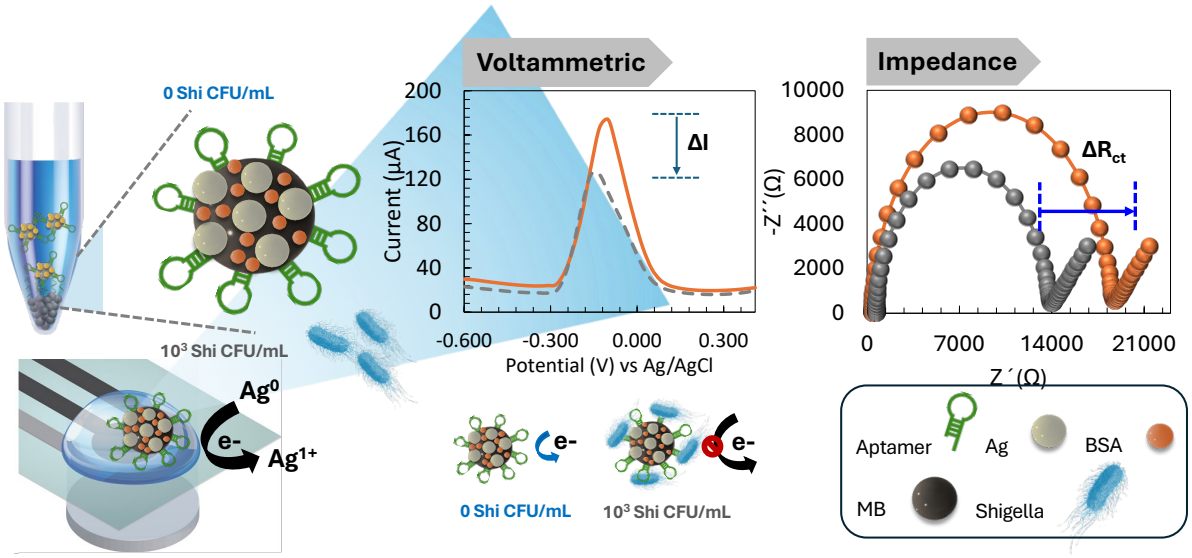


Fig.1 DPV and EIS measuring results as a sensing concept for *S. dysenteriae* assessment using the introduced paper-based aptasensor. Testing at 10^3 CFU/mL inactivated *S. dysenteriae*.

Acknowledgements

Dr. Sakda Jampasa would like to thank Walailak University International Research Collaboration Mobility Fund for financial support

References

1. S. Jampasa, N. Sangthong, T. Ozer, W. Panphut, S. Naorungroj, N. Ngamrojanavanich, T. Kaneta, O. Chailapakul, W. Wonsawat, Microchemical Journal **211**, 113144 (2025).

Multiplex Pathogen Aptasensor Based on Dual-Function Silver Nanocoral-Modified Laser-Induced Graphene Electrode for On-Site Detection

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The rapid and accurate detection of multiple pathogens at the point of need is vital for safeguarding public health, food safety, and environmental quality. Traditional diagnostic methods, such as culture-based assays and polymerase chain reaction (PCR), are highly sensitive but remain time-consuming and dependent on centralized laboratory infrastructure. To overcome these limitations, we developed a multiplex electrochemical aptasensor based on a dual-function silver nanocoral-modified laser-induced graphene electrode (AgNC/LIGE) for portable, simultaneous detection of foodborne pathogens. The platform comprises two individually addressable working electrodes fabricated via direct laser writing on polyimide substrates, followed by plasma treatment to clean the surface and enhance hydrophilicity. AgNCs were electrochemically deposited onto the treated surface, functioning both as electrochemical signal generators and high-affinity interfaces for aptamer immobilization. Specific aptamers targeting *Salmonella typhimurium* and *Shigella dysenteriae* were immobilized on separate electrodes, enabling parallel detection within a compact format. The aptasensor exhibited high sensitivity and selectivity, with low detection limits and negligible cross-reactivity. Notably, it maintained robust performance in complex matrices such as serum, milk, and tap water, without extensive sample preparation. Its compatibility with portable potentiostats and wireless readout systems supports its deployment in field-based diagnostics. This integrated and scalable approach offers a cost-effective solution for on-site, multiplex pathogen detection.

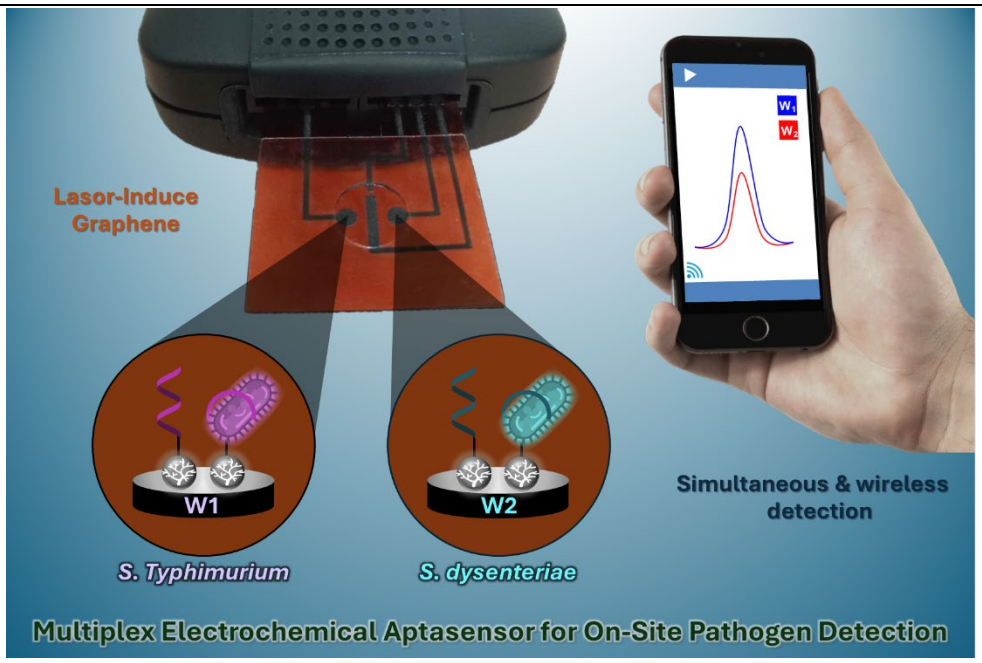


Fig.1 A wireless multiplex electrochemical aptasensor based on laser-induced graphene for simultaneous detection of *S. Typhimurium* and *S. dysenteriae* via smartphone readout.

Acknowledgements

The authors gratefully acknowledge the support from the National Research Council of Thailand (NRCT), the Second Century Fund (C2F), and the Thailand Science Research and Innovation Fund, Chulalongkorn University.

References

1. G. R. Bruno, et al., *Biosens. Bioelectron.*, **23**, 114050 (2022)

A portable microfluidic device coupled with DNase I amplification for alpha-fetoprotein detection

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A rapid and highly sensitive electrochemical aptasensor was developed by integrating DNase I-assisted signal amplification within a capillary-driven microfluidic platform for alpha-fetoprotein (AFP) detection. A label-free aptamer was immobilized on a screen-printed graphene electrode, where target binding induced aptamer dissociation and triggered a signal-off response based on Ru(III)-methylene blue (Ru-MB) redox cycling. DNase I enzymatically cleaved the released aptamer, enabling target recycling and multiple binding events, thereby amplifying the current signal. The microfluidic device, designed for sequential fluid control through burst valves, automated the assay with only two simple pipetting steps: sample and buffer loading. This automation streamlined complex bioreactions and electrochemical measurements without the need for external pumps or sophisticated instruments. The platform demonstrated a linear detection range of 0.5–500 ng/mL, a low detection limit of 0.14 ng/mL, excellent reproducibility, and high specificity against interfering substances. Clinical validation with human serum samples confirmed comparable accuracy to standard hospital methods. This work highlights a promising, user-friendly, and portable platform for point-of-care testing (POCT) applications in early hepatocellular carcinoma (HCC) diagnosis.

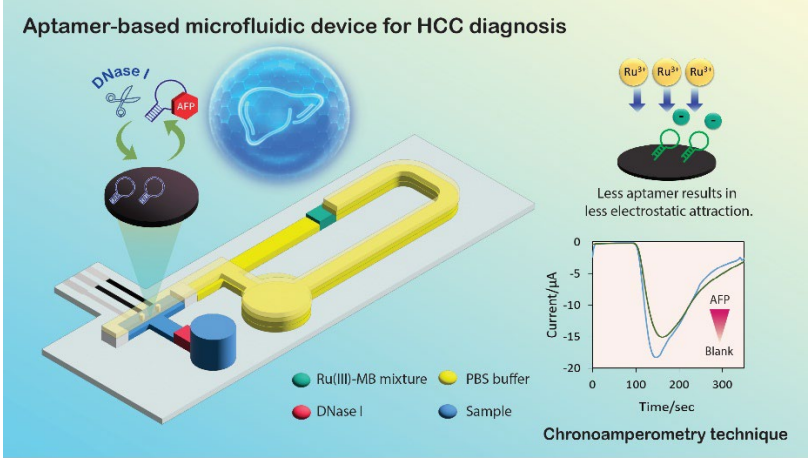


Fig.1 Illustration of electrochemical aptasensor integrated microfluidic system using DNase I assisted amplification and Ru-MB redox cycling for sensitivity enhancing strategy.

Acknowledgements

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References

1. D. Tang, J. Tang, Q. Li, B. Su, G. Chen, Analytical Chemistry, 83(2011) 7255-9.

Electroanalysis Using Isostatic Graphite Electrode

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This study introduces isostatic graphite (ISG) as a novel electrode material for electroanalysis. ISG is known for its homogeneous and isotropic structure.[1] It has features of excellent isotropic electrical conductivity, high mechanical strength, strong thermal and chemical resistance, and ultra-high density.[2] Additionally, ISG is cost-effective, making it a suitable alternative to many well-known, expensive carbon-based electrodes such as glassy carbon electrode (GCE) and HOPG. Despite its widespread industrial applications in mold-making, battery electrodes, crucibles, and heat shields, ISG has not yet been explored for electroanalysis.[3] The recent demands on healthcare necessitate quick and accurate biochemical substance screening in order to manage chronic health conditions.[4] Measuring small bio-molecule levels in biological fluids, including urine and blood plasma, has become a significant focus in medical diagnostics, particularly due to its relevance to various physiological disorders.[5-7] In this work, ISG was employed for the simultaneous electrochemical detection of dopamine, ascorbic acid, and uric acid using cyclic voltammetry and square wave voltammetry. The ISG electrode demonstrated a linear relationship between the current response and the concentration of these biomolecules. Real sample analysis, including human urine samples, dopamine, and ascorbic acid artificial serums, demonstrated good recovery and excellent reproducibility.

Acknowledgements

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References

1. Inagaki M. et al. in Advanced Materials Science and Engineering of Carbon 387-410 (2014).
2. Carmichael D. C. et al. Isostatic compaction of graphite hot isostatic compaction of graphite **39** (Missouri University of Science and Technology 1965).
3. Duan, S.-Z. et al. Recent progress in the research and development of natural graphite for use in thermal management, battery electrodes and the nuclear industry. Carbon **206**, 434-435 (2023).
4. Zhang L. et al. Highly sensitive and simultaneous detection of ascorbic acid, dopamine,

and uric acid using Pt@g-C_3N_4/N-CNTs nanocomposites. iScience 27**,** 109241 (2024).
5. Yu T. et al. A dual fluorometric and colorimetric sensor for dopamine based on BSA-stabilized Au nanoclusters. Biosens. Bioelectron. **42**, 41 (2013).
6. Westley C. et al. Absolute quantification of uric acid in human urine using surface-enhanced Raman scattering with the standard addition method. Anal. Chem. **89**, 2472-2477 (2017).
7. Liu Y. et al. Co Single-atom nanozymes for the simultaneous electrochemical detection of uric acid and dopamine in biofluids. ACS Appl. Nano Mater. **7**, 6273-6283 (2024).

Leveraging Nanodiamond–Poly(L-proline) Synergy for Sensitive Electrochemical Detection of Levodopa and L-Tyrosine: Toward Melanoma Screening

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Early melanoma and associated disease diagnosis requires accurate, sensitive, easily available techniques for tracking relevant biomarkers. Levodopa (L-DOPA) and L-Tyrosine (L-Tyr) are directly involved in the melanogenesis pathway, and fluctuations in their ratio levels can signal the onset or progression of melanoma. This work presents a straightforward approach to develop a sensitive electrochemical sensor capable of detecting both L-DOPA and L-Tyr simultaneously. The sensor was prepared by modifying a screen-printed graphene electrode (SPGE) with a nanodiamond (ND) deposition, followed by thin layer of polymerized L-Proline (poly(L-Pro)). The electrode preparation process, taking 10 minutes, combines the advantages of both materials to improve sensitivity and reduce signal interference. To better understand the sensor's structure and performance, we used scanning electron microscopy (SEM), energy-dispersive X-ray spectroscopy (EDS), and Raman spectroscopy for physical characterization, and employed cyclic voltammetry (CV), differential pulse voltammetry (DPV), electrochemical impedance spectroscopy (EIS), and chronoamperometry for electrochemical analysis. Computational simulations were also carried out to explore the interaction between the sensor interface and target analytes. Under optimal conditions, the sensor showed a linear response to L-DOPA in the range of 0.075–50 µM, with a detection limit of 0.021 µM. For L-Tyr, it responded linearly between 2.5–120 µM, with a 0.74 µM detection limit. Practical applicability was validated in human serum and urine samples, yielding satisfactory recoveries. In addition, this proposed sensor exhibited good selectivity, reproducibility, and long-term stability. These results suggest that the poly(L-pro)/ND-modified SPGE platform holds strong potential as a portable, low-cost electrochemical tool for clinical screening of melanoma and other metabolically linked diseases.

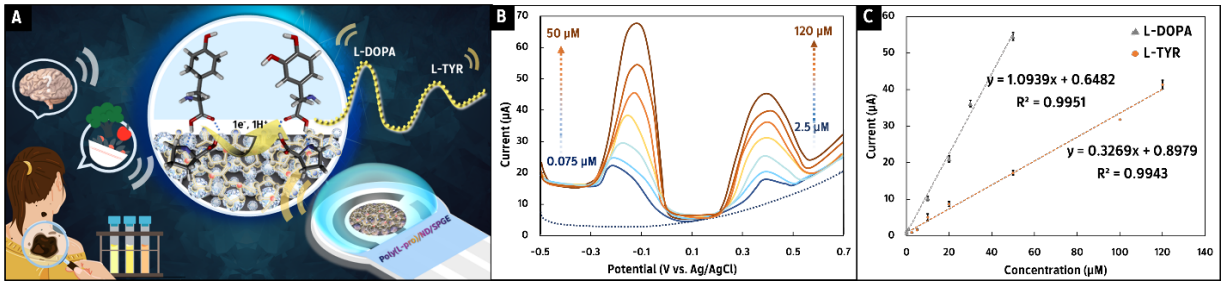


Fig.1 (A) Graphical representation of poly(L-pro)/ND/SPGE, (B) DPV signals and (C) Calibration plot for various concentrations of a mixture of L-DOPA and L-Tyr at modified electrode.

Acknowledgements

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Reference:

1. K. Kaewjua and W. Siangproh, *Microchim. Acta*, **190(10)**, 398. (2023)

Self-Referencing Electropolymerization: Toward Self-Detecting Monomer Systems in Electrochemical Sensors

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This study presents a novel concept for fabricating chemical sensors using itself as a monomer for a self-referencing detection mechanism. Utilizing electropolymerization, a thin film of the monomer-derived polymer is formed directly onto a working electrode, generating a sensor surface with high specificity and affinity toward its free monomer in solution. First, we introduced a novel L-cysteine sensor using cysteine as a monomer for modifying electrode surfaces. The developed sensor provided a linear concentration range of 10–800 µM with a limit of detection of 5.5 µM. For application, the device was successfully applied to detect cysteine in different food products such as wheat flour, bread, and cake with satisfactory results, yielding excellent intra-day and inter-day relative standard deviations (1.5-4.9%) and recoveries (84.2-110.8%).

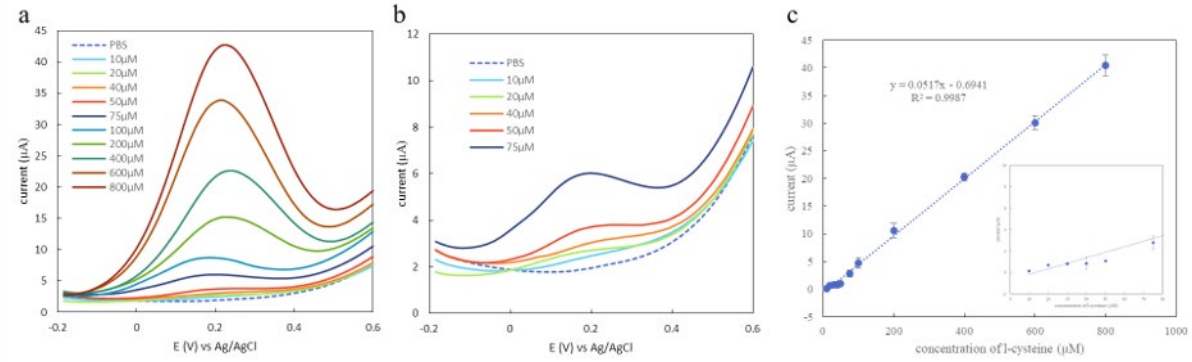
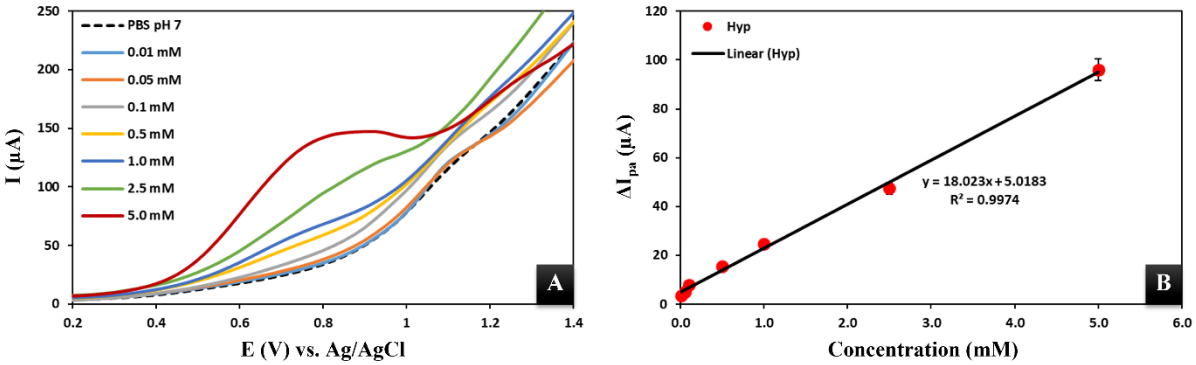


Fig.1 (a) and (b) DPV current responses from 0 µM to 800 µM cysteine in PBS pH 8.0. (c) Linear relationship of cysteine concentrations and oxidation currents. Error bars were obtained based on three replicates (n=3), and standard deviations were shown in the range of 0.04 –1.8 µA.

Second, we demonstrated a non-enzymatic sensor for L-hydroxyproline detection based on synthesizing poly(L-hydroxyproline) on the area of the working electrode. Initially, the bismuth film electrodeposition was produced on the screen-printed graphene surface, followed by the Poly(L-hydroxyproline) electropolymerization, resulting in the obtained Poly(Hyp)/BiF/SPGE. Using the optimal conditions, the quantification of the proposed sensor was found to be linearly related to L-hydroxyproline concentrations in the range of 0.01 to 5.0 mM with a limit of detection of 9.2 µM. In real applications, the proposed assay successfully analyzed L-hydroxyproline in human urine samples, yielding satisfactory results with recoveries in the acceptable range of 98% to 102%. Therefore, this finding introduces a new paradigm in electropolymer-based sensors, emphasizing self-awareness and self-detection in material functionality that can be applied to various applications.

Fig.2 (A) Differential pulse voltammograms obtained from Poly(Hyp)/BiF/SPGEs recorded in the absence (dashed curve) and presence (solid curve) of 0.01 – 5.0 mM L-hydroxyproline in PBS pH 7.0. (B) The linear relationship between ΔI_{pa} values and various L-hydroxyproline concentrations.



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References:

1. W. Khamcharoen, C.S. Henry and W. Siangproh, *Talanta*, **237**, 122983 (2022)
2. P. Yomthiangthae, M. del Valle, W. Siangproh, *Talanta*, **267**, 125250. (2024)

Tuning the solubility of novel ionic liquids based on (nonafluorobutanesulfonyl)(trifluoromethanesulfonyl)amide anions for salt bridge applications in low ionic strength region

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Introduction:

Ionic liquid salt bridge (ILSB) is composed of hydrophobic ionic liquid (IL) having only slight solubility in water[1]. Utilizing IL as the salt bridge electrolyte enables potentiometric measurements in low ionic strength regions where the Debye–Hückel limiting law (DHLL) applies. In our laboratory, we have employed tributyl(2-methoxyethyl)phosphonium bis(pentafluoroethanesulfonyl)amide ([TBMOEP][C_2C_2N]), whose solubility in water 0.21 mmol dm^{-3} at 298 K[2]. To conduct analysis over wider DHLL region, it is preferable to reduce the solubility of the IL. In the present study, we synthesized new ILs, having the anion, (nonafluorobutanesulfonyl)(trifluoromethanesulfonyl)amide ([C_1C_4N]$^-$), in combination with cations [TBMOEP]$^+$ and *N*-ethyl-*N*-decylpyrrolidinium ([C_2C_{10}pyrl]$^+$).

Experimental:

The ILs, [TBMOEP][C_1C_4N] and [C_2C_{10}pyrl][C_1C_4N], prepared from [TBMOEP]Cl and [C_2C_{10}pyrl]Br, respectively, with Li[C_1C_4N], were both in the liquid state at room temperature.

I	II	III	IV	V	VI	VII
Ag	AgCl	1.03 mM NaCl	ILSB (BA)	aq. BX soln.	AgX	Ag

The solubility of BA, where B stands for [TBMOEP]$^+$ or [C_2C_{10}pyrl]$^+$, respectively, and A for [C_1C_4N]$^-$, was determined potentiometrically by use of the electrochemical cell. In the cell above X stands for Cl^- and Br^- for [TBMOEP]$^+$ and [C_2C_{10}pyrl]$^+$, respectively. The cell voltage (E_{cell}) at 298 K was measured with an electrometer at different concentrations of BX in V. The ILSB used was in the form of a disk in which the IL was gelled with PVDF-HFP co-polymer.

Results and Discussion:

The solubility of [C_2C_{10}pyrl][C_1C_4N] and [TBMOEP][C_1C_4N] was determined based on $E_{\mathrm{cell}} + \frac{2RT}{F}\ln c_{\mathrm{BX}}^{0,\mathrm{V}} = \frac{2RT}{F} \times \ln 10 \times 0.5108\sqrt{I} + \frac{RT}{F}\ln \gamma_{\mathrm{Cl}^-}^{\mathrm{III}} c_{\mathrm{Cl}^-}^{\mathrm{III}} + \frac{RT}{2F}\ln K_{\mathrm{BA}} + (E^{\circ}_{\mathrm{AgX\,|\,Ag}} -$

$E^{\circ}_{\mathrm{AgCl\ |\ Ag}}$) where $c^{0,\mathrm{V}}_{\mathrm{BX}}$ is the initial concentration of BX as prepared in V, $\gamma^{\mathrm{III}}_{\mathrm{Cl}^-} c^{\mathrm{III}}_{\mathrm{Cl}^-}$ are the activity coefficient and the concentration of NaCl in III, and K_{BA} is the solubility product of BA in V. First, for [C_2C_{10}pyrl][C_1C_4N], the relationship between the E_{cell} and $\sqrt{I}$ was plotted, and the linear portion was extrapolated to $I = 0$; the intercept value of the potential was found to be -0.6007 V. Based on this result, the solubility of [C_2C_{10}pyrl][C_1C_4N] was calculated to be 0.025 mmol dm^{-3}[3]. Similarly, for [TBMOEP][C_1C_4N], analysis of the relationship between the E_{cell} and I revealed an intercept value of -0.4328 V, from which its solubility was determined to be 0.049 mmol dm^{-3}[3]. The solubilities of both ionic liquids are less than one-fourth of that of [TBMOEP][C_2C_2N], suggesting their potential application as salt bridges over a wider DHLL region.

References

1. T. Kakiuchi, et al., *Electrochem. Commun*, **5**, 159-164 (2003).
2. I. Ikeda, et al., 92nd Electrochemistry Workshop, Presentation No. S6_1_11 (2025).
3. T. Kakiuchi, et al., *J. Electroanal. Chem.*, **909**, 116036 (2022).

Surface Enhanced Infrared Absorption Spectroscopy as a tool to study Adsorption Behaviour & Confinement Effects

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Confinement effects are a quickly emerging topic in electrochemical research due to their potential to alter electrochemical behaviour.[1]–[4] These effects arise upon the addition of another interface, which also means that the electrode itself can induce confinement on a reactant. As the reaction occurs at the electrode, complementary spectroscopic techniques are desired to deepen the understanding of a given system. In this work, we want to present how one can utilize electrochemical surface enhanced infrared absorption spectroscopy (EC-SEIRAS) to probe the electrode interface directly. To do this, we want to present two separate studies, which we believe highlight the utility of EC-SEIRAS. First, to understand the potential-dependent adsorption behaviour of a heterocycle in oxidative potential ranges on an Au electrode, we looked at a aromatic heterocycle as an example molecule. We found that while more oxidative potentials were applied, the associated vibration of the aromatic ring (1625-1650 cm^{-1}), became negative while no change in the aliphatic C-H stretch vibrations were observed. Following the surface selection rules in EC-SEIRAS, the vibrations of the planar heterocycle are hidden if they are planar to the electrode surface, but as the C-H stretch vibrations are out of plane they should not change. We, thereby, interpret this as the heterocyclic compound rearranging to a planar orientation as more oxidative potentials are applied, which in the context of the oxidation of this heterocyclic compound led to a decrease in activity. The second study we want to present is how one can follow the potential-dependent hydrogen bond network of confined water inside covalent organic frameworks (COFs) on an Au electrode. Three COF films with pore sizes of 2.5 nm, 2.7 nm, and 2.9 nm were investigated. Two of them form an isoreticular series. This means that they share the same topology but differ in pore size due to an additional benzene ring in one. While the third incorporates an Azo-functionalized linker, helping to distinguish between pore-size effects and chemical functionality effects. The first two COFs enhanced the water network's response to applied potential, leading to more pronounced changes in hydrogen-bonded water vibrations (3200–3500 cm^{-1}) and a shift in their band center to lower wavenumbers with increasing pore size. This suggests that pore size dictates whether the water network changes are dominated by strongly or weakly hydrogen-bonded water. In contrast, the Azo-functionalized COF suppressed changes in the water network, implying either an already rigid network or hindered network formation. Furthermore, the Azo-functionalized COF revealed that the pore size effect seen in the isoretciular series is also reliant on the chemical structure of the COF. In both studies, EC-SEIRAS allowed us to observe the electrode interface directly and thereby lead to a deeper understanding of the behaviour of molecules at this interface, which were inaccessible by other electrochemical methods.

Reference

1. S. Li, L. Wu, Q. Liu, M. Zhu, Z. Li, C. Wang, X. Jiang, J. Li, Uncovering the Dominant Role of an Extended Asymmetric Four-Coordinated Water Network in the Hydrogen Evolution Reaction, Journal of the American Chemical Society 2023, 145, 26711–26719.
2. M. Jaugstetter, N. Blanc, M. Kratz, K. Tschulik, Electrochemistry under confinement, Chemical Society reviews 2022, 51, 2491–2543.
3. J. Wordsworth, T. M. Benedetti, S. V. Somerville, W. Schuhmann, R. D. Tilley, J. J. Gooding, The Influence of Nanoconfinement on Electrocatalysis, Angewandte Chemie (International ed. in English) 2022, 61, e202200755.
4. P. Hosseini, A. Rodríguez-Camargo, Y. Jiang, S. Zhang, C. Scheu, L. Yao, B. V. Lotsch, K. Tschulik, Shedding Light on the Active Species in a Cobalt-Based Covalent Organic Framework for the Electrochemical Oxygen Evolution Reaction, Advanced science (Weinheim, Baden-Wurttemberg, Germany) 2025, 12.

Machine Vision-Assisted High-Throughput Screening Accelerates the Discovery of Iridium-Based High-Entropy Oxide Electrocatalysts

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The rapid advancement of Artificial Intelligence (AI) and automation technologies has significantly accelerated the high-throughput development of catalytic materials. High-entropy oxides (HEOs) have attracted considerable attention in the field of energy catalysis due to unique compositional design, synergistic multi-element interactions, and excellent physicochemical properties. Nevertheless, the immense number of possible elemental configurations in HEOs leads to a combinatorial explosion, posing a major obstacle to the efficient screening and discovery of optimal catalytic compositions. We proposed a machine vision-assisted high-throughput screening technology to accelerate the discovery of Ir-based high-entropy oxide electrocatalysts. covering high-throughput solid dispensing, high-throughput liquid dispensing, high-throughput advanced material synthesis and high-throughput advanced material screening, thereby enabling high-throughput integration and automation across the entire catalyst development workflow.

Based on this high-throughput technology, we have made important progress in the research of HEO electrocatalysts: (1) Establish an integrated one-stop catalyst development platform, incorporating large language models (LLMs) to assist in the design of Ir-HEOs compositions, enabling data-driven and automated catalyst discovery. (2) Propose a novel strategy for preparing combinatorial catalyst chips, enabling parallel testing of Ir-HEOs catalysts under identical experimental conditions and greatly accelerating the efficient screening process. (3) Develop a machine vision–driven high-throughput screening system for fast and precise electrochemical assessment of Ir-HEOs catalyst chips.

The approach delivers a high-efficiency and versatile solution for energy catalysis research, fostering the advancement of autonomous intelligent laboratory infrastructure.

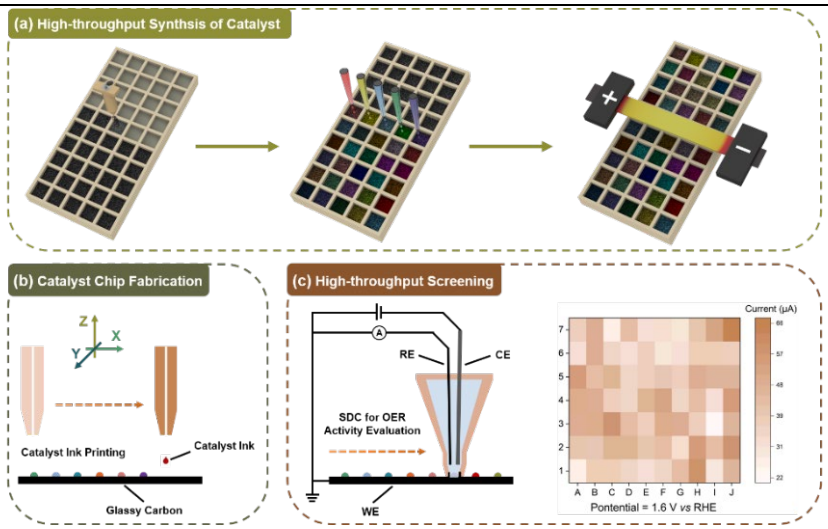


Fig.1 Workflow for Machine Vision-Assisted High-Throughput Screening Accelerates the Discovery of Iridium-Based High-Entropy Oxide Electrocatalysts

Acknowledgements

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References

1. Shan, X.; Pan, Y.; Cai, F.; et al. *Nano Lett.* 24, 11632-11640 (2024)
2. Pan, Y.#; Shan, X. #; Cai, F.; et al. *Angew. Chem. Int. Ed.* 63, e202407116 (2024)

Functionalized Nucleic Acid Tetrahedron Delivery System for Cervical Cancer Treatment via Silencing Multi-Metabolic Genes and Biomarker Monitoring

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Cancer remains one of the leading causes of mortality worldwide, and the limited efficacy of current therapies highlights the urgent need for innovative treatment strategies. Cervical cancer cells are metabolically dependent on glucose, glutamine, and lipids, suggesting that targeting these metabolic vulnerabilities offers a promising therapeutic avenue.[1] While small interfering RNA (siRNA) can effectively silence disease-associated genes, its clinical application is significantly hindered by low cellular uptake efficiency.[2] Tetrahedral framework nucleic acids (tFNAs), self-assembled from four single-stranded DNA molecules, have recently emerged as promising delivery platforms with inherent structural stability and biocompatibility.[3] In this study, we engineered tFNAs co-loaded with multiple metabolism-targeting siRNAs to simultaneously downregulate key metabolic genes, thereby disrupting cancer cell energy homeostasis, inhibiting proliferation and migration, and inducing apoptosis. To enhance cellular uptake, the DNA aptamer AS1411 was functionally integrated into the tFNA nanostructure, resulting in significantly improved internalization efficiency. Additionally, a miR-21-responsive strand displacement probe was embedded within the system, enabling real-time monitoring of therapeutic efficacy and prognostic evaluation.

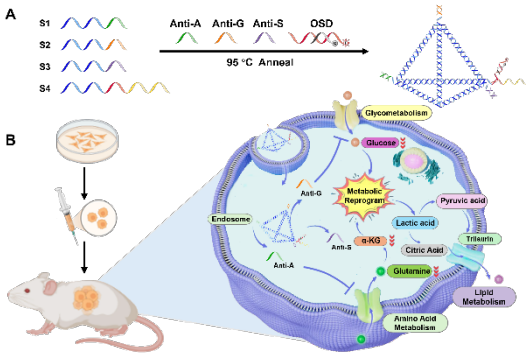


Fig.1 Synthesis and therapeutic application of tFNAs-siRNA-OSD nanostructures. (A) Schematic illustration of the fabrication process of tFNAs co-loaded with siRNAs and an output strand displacement (OSD) probe. (B) Schematic representation of tFNAs-siRNA-OSD mediating tumor suppression in mice via simultaneous silencing of multiple metabolic genes.

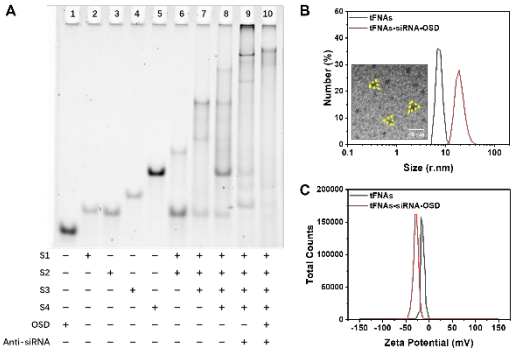


Fig.2 Synthesis and characterization of tFNAs-siRNA-OSD nanostructures. (A) 8% PAGE analysis confirming the successful assembly of tFNAs-siRNA-OSD. (B) TEM image showing the morphology of the tFNAs-siRNA-OSD nanostructure. (C) Dynamic light scattering (DLS) measurements of hydrodynamic particle size for tFNAs and tFNAs-siRNA-OSD. (D) Zeta potential analysis of tFNAs and tFNAs-siRNA-OSD

By integrating bioinformatics-guided metabolic target selection with the rational design of multifunctional nucleic acid nanostructures, this work presents a dual-functional platform for both targeted metabolic interference and dynamic biomarker sensing. The strategy offers a new perspective for precision oncology that combines therapeutic intervention with on-treatment monitoring.

Acknowledgements

This work was supported by the National Natural Science Foundation of China (Nos. 22174137 and 22322410), the Science and Technology Development Plan Project of Jilin Province (Nos. SKL202302030, SKL202402017, JJKH20231296KJ and 20230204113YY), International Partnership Program of the Chinese Academy of Sciences (No. 029GJHZ2023146FN), Jilin province and Chinese Academy of Sciences Science and Technology Cooperation High Tech Special Fund project (No. 2024SYHZ0016).

References

1. Fan, D. et al. Nanomedicine in cancer therapy. Sig Transduct Target Ther **8**, 293 (2023).
2. Paunovska, K. et al. Drug delivery systems for RNA therapeutics. Nat Rev Genet **23**, 265-280 (2022).
3. Tian, T. et al. A dynamic DNA tetrahedron framework for active targeting. Nat Protoc **18**, 1028-1055 (2023).

Tuning the Dynamic Reaction Balance of LAMP and Transcription in One Pot: A Key to Switch Nucleic Acid Quantification

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Loop-mediated isothermal amplification (LAMP) is a widely adopted technique for nucleic acid amplification, offering the significant advantage of isothermal operation and thereby eliminating the need for complex thermal cycling equipment.[1] However, conventional LAMP methods face substantial challenges in quantitative detection. The commonly used inflection-point fluorescence quantification method requires costly real-time fluorescence instrumentation, while turbidity-based measurements are susceptible to interference from solution impurities, compromising both accuracy and reliability.

Drawing inspiration from Linear-After-The-Exponential (LATE) PCR, which enables endpoint fluorescence quantification,[2] we developed a novel approach termed LAMP-Initiated Fluorescence Endpoint Quantification (LIFE-Q). In this method, promoter and RNA aptamer sequences are engineered into LAMP products, allowing simultaneous amplification and transcription to occur in a competitive fashion. By fine-tuning the key parameters governing these two reactions, a balanced reaction state is achieved. The target concentration is then quantified based on label-free endpoint fluorescence emitted by RNA aptamers transcribed during the process. LIFE-Q integrates the simplicity of LAMP with the practicality of endpoint fluorescence detection, effectively overcoming the quantification limitations of conventional LAMP. This innovative strategy offers enhanced sensitivity, improved accuracy, and operational convenience, presenting a promising tool for early disease diagnosis, disease progression monitoring, and mechanistic studies. It holds strong potential for widespread application in clinical diagnostics and biomedical research.

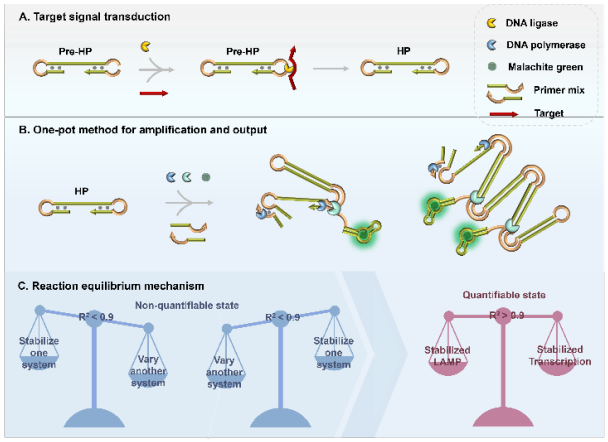


Fig.1 Schematic illustration and theoretical framework of the LIFE-Q strategy. (A) Signal transduction process based on RNA aptamer-mediated fluorescence generation. (B) Coupled processes of LAMP-based DNA amplification and transcription-driven RNA aptamer synthesis. (C) Mechanistic overview of the competitive balance between amplification and transcription reactions enabling endpoint fluorescence quantification.

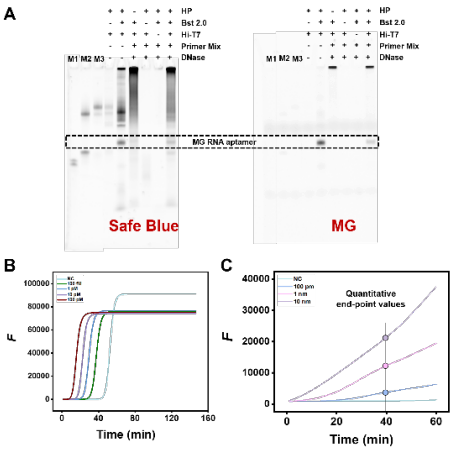


Fig.2 Feasibility validation of the LIFE-Q method. (A) Polyacrylamide gel electrophoresis (PAGE) results confirming the successful amplification and transcription in the LIFE-Q system. (B) Real-time fluorescence curve of conventional LAMP showing the dependence on continuous signal monitoring. (C) Real-time fluorescence curve of LIFE-Q demonstrating its capability for target quantification based on endpoint fluorescence intensity.

Acknowledgements

This work was supported by the National Natural Science Foundation of China (No. 22322410), the Science and Technology Development Plan Project of Jilin Province (No. SKL202302030), International Partnership Program of the Chinese Academy of Sciences (No. 029GJHZ2023146FN), Jilin province and Chinese Academy of Sciences Science and Technology Cooperation High Tech Special Fund project (No. 2024SYHZ0016).

References

1. Arumugam Selva Sharma, Nae Yoon Lee, Coord. Chem. Rev, 509, 215769 (2024)
2. Rice, J., Sanchez, J., Pierce, Nat Protoc, 2, 2429–2438 (2007)

A urea-based approach to synthesize single atom iron catalysts for catalyzing peroxymonosulfate to degrade antibiotics

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Single-atom catalysts (SACs) demonstrate remarkable performance in advanced oxidation processes. However, their widespread application is hindered by the complex nitrogen-doping pretreatment process and the high cost of support materials. To address these challenges, a new approach has been developed. This method employs molten urea as both a solvent and a nitrogen source, while polyethylene glycol serves as the carbon source to synthesize the u-Fe_x-N-C (x = 1, 2, 3) catalysts. Among these, the u-Fe_1-N-C catalyst achieved an impressive degradation efficiency of 92% for oxytetracycline (OTC) and maintained consistent performance across a wide pH range of 3-11. It further exhibited catalytic degradation activity towards a broad spectrum of environmental pollutants, including sulfamethoxazole (SMZ), naproxen (NPX), ofloxacin (OFL), rhodamine B (RhB), and bisphenol A (BPA), and the degradation efficiencies reached 67%, 83%, 77%, 99%, and 93%, respectively. A series of characterizations revealed that the prepared u-Fe_1-N-C catalyst possesses a unique FeN_4 structure. Electron paramagnetic resonance (EPR) and radical quenching experiments confirmed that singlet oxygen ($^1O_2$) and Fe (IV) play crucial roles in the reaction system. In-situ Raman spectroscopy and electrically coupled oxidation systems further demonstrated that the non-radical degradation pathway involving electron transfer in the u-Fe_1-N-C/PMS system is the primary mechanism for PMS activation. Additionally, the degradation efficiency of OTC in real water samples reached 84%. This work presents a simple and cost-effective strategy for synthesizing SACs, offering promising prospects for applications in water treatment and environmental remediation.

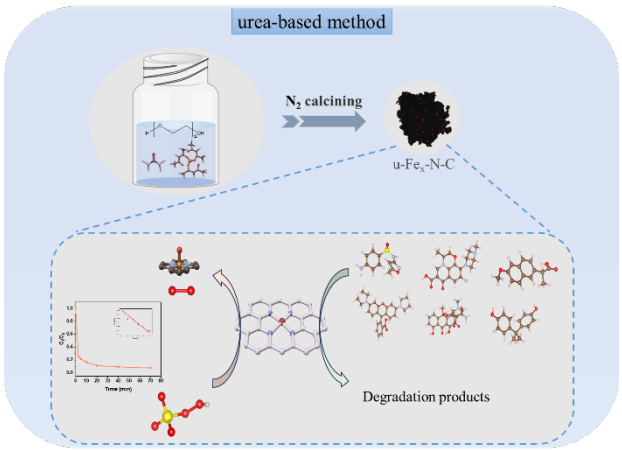


Fig.1 Degradation of Antibiotics by Urea-Derived u-Fe_1-N-C Catalyst.

Acknowledgements

This work received partially financial support from the National Natural Science Foundation of China (Nos. 22074137 and 22206182).

References

1. M.H. Li, J.X. Chen, W.W. Wu, S.L. Wu, L.L. Xu, S.J. Dong, *Nano Res.*, **16**, 4678-4684 (2023).
2. J.X. Chen, Q. Ma, X.L. Zheng, Y.X. Fang, J. Wang, S.J. Dong, *Nat. Commun.*, **13**, 2808 (2022).

The Interaction of SIRT5 with Histone H3 Influences Angiogenesis Under High Glucose Conditions

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Diabetic retinopathy (DR) is a serious microvascular complication of diabetes, marked by pathological neovascularization that can lead to vision-threatening outcomes such as vitreous hemorrhage and tractional retinal detachment, ultimately resulting in irreversible damage to retinal tissues.[1] Current clinical interventions primarily depend on anti-VEGF agents to inhibit neovascular growth; however, this strategy only addresses downstream pathological effects without targeting the underlying mechanisms of aberrant angiogenesis.[2] Hence, the development of novel therapeutics capable of actively modulating vascular dysregulation remains an urgent unmet need.

In this study, we demonstrate that liposome-based nanotherapeutics can effectively mitigate hyperglycemia-induced rapid proliferation of retinal microvascular endothelial cells and restore the expression of cell adhesion proteins, thereby suppressing abnormal neovascularization. Integrated transcriptomic analysis and co-immunoprecipitation assays reveal that the nanodrugs regulate SIRT5 expression and disrupt its interaction with histone H3, leading to a reprogramming of downstream glycolytic gene networks. Notably, we report for the first time the use of SIRT family inhibitors as key therapeutic agents delivered via nano-formulated eye drops to regulate microvascular remodeling under hyperglycemic conditions. These findings represent a paradigm shift in DR therapy—from passive symptom suppression to active, mechanism-driven vascular modulation.

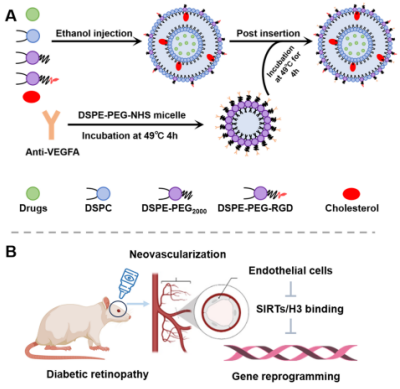


Fig.1 (A) Schematic illustration of the liposome synthesis process. (B) Schematic representation of the therapeutic mechanism of the liposomal nanodrug for diabetic retinopathy treatment.

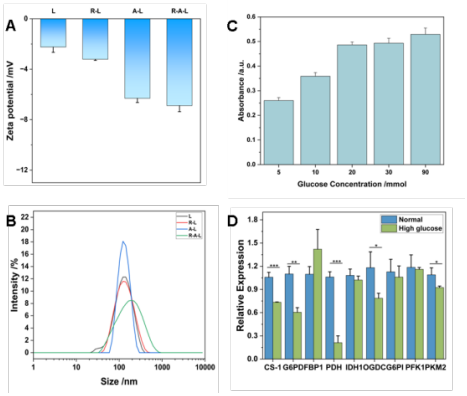


Fig. 2. Characterization of liposomes and regulatory effects of the SIRT family. (A) Zeta potential distribution of liposomes with various surface modifications. (B) Particle size distribution profiles of differently modified liposomes. (C) Effect of varying glucose concentrations on retinal endothelial cell proliferation. (D) Regulatory effects of SIRT family members on genes associated with glucose metabolism.

Acknowledgements

This work was supported by the National Natural Science Foundation of China (Nos. 22174137 and 22322410), the Science and Technology Development Plan Project of Jilin Province (Nos. SKL202302030, SKL202402017, JJKH20231296KJ and 20230204113YY), International Partnership Program of the Chinese Academy of Sciences (No. 029GJHZ2023146FN), Jilin province and Chinese Academy of Sciences Science and Technology Cooperation High Tech Special Fund project (No. 2024SYHZ0016).

References

1. Blodi B, Gardner TW and Gao X . Diabetes Care., 47 (9): 1522-1529(2024).
2. Bethel M A, Diaz R and Castellana N. Diabetes Care., 44 (1): 290-296 (2021).

Ir(III)ONa Photosensitizer Loaded Antibacterial Hydrogel Dressing for Dynamic Water Purification

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Antimicrobial photodynamic therapy (APDT) employs photosensitizers to generate reactive oxygen species (ROS) upon light irradiation in the presence of oxygen, leading to effective bacterial inactivation.[1] However, conventional photosensitizers often suffer from aggregation-induced quenching (ACQ), which compromises ROS generation efficiency and shortens their lifespan. Moreover, enhancing the immobilization stability of photosensitizers remains a critical challenge. Hydrogels, due to their high water content and excellent loading capacity, offer a promising platform for improving the performance and stability of APDT systems.[2]

In this study, we developed a photodynamically active antimicrobial hydrogel, FT-PVA@Ir(III)ONa, by incorporating an Ir(III)-based photosensitizer into a polyvinyl alcohol (PVA) matrix via hydrogen bonding, followed by cyclic freeze–thaw cross-linking. The resulting hydrogel exhibits excellent elasticity and structural integrity. Upon blue light irradiation, the hydrogel efficiently generates singlet oxygen ($^1O_2$), achieving up to 98.7% inactivation of Gram-negative bacteria within 30 minutes. Scanning electron microscopy (SEM) and live/dead bacterial staining confirmed that $^1O_2$ induced severe membrane deformation and cellular disruption. Additionally, after 8 hours of co-culture with Luria–

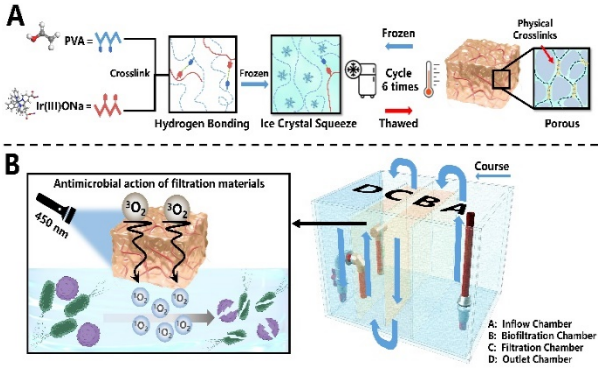


Fig.1 Schematic illustration of the synthesis of FT-PVA@Ir(III)ONa hydrogel and its application in dynamic antimicrobial water purification.

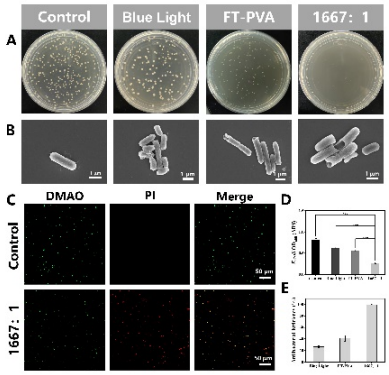


Fig.2 Evaluation of the antibacterial activity of FT-PVA@Ir(III)ONa hydrogel against E. coli. (A) Representative images of agar plates showing E. coli colonies after different treatments. (B) SEM images revealing morphological changes in E. coli cells subjected to various treatments. (C) Fluorescence staining images of E. coli showing live (green) and dead (red) cells after treatment. (D) Optical density (OD_{600}) of E. coli suspensions measured after 8 hours of incubation in LB medium post-treatment. (E) Quantitative antibacterial efficiency against E. coli, calculated based on colony counts from agar plates.

Bertani (LB) medium, the optical density (OD_{600}) of the treated bacterial suspension was reduced to 0.26, indicating sustained antimicrobial activity. Owing to its robust elasticity and efficient ROS release, the FT-PVA@Ir(III)ONa hydrogel holds great potential as a filtration material in pump-driven water purification systems for continuous pathogen inactivation, suppression of secondary contamination, and real-time maintenance of water quality.

Acknowledgements

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References

1. S. Gnanasekar and E.-T. Kang, *Bioact. Mater.*, **21**, 157-174 (2023)
2. H. Wang and J. Zhu, *Adv. Funct. Mater.*, 33, 2306025 (2023)

Novel Chemiluminescent Nanozyme Sensor for Total Antioxidant Capacity Assessment

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ABSTRACT: Accurate evaluation of total antioxidant capacity (TAC) plays a vital role in assessing food nutritional content, ensuring the quality of pharmaceuticals and cosmetics, and monitoring health status. Recent advances have demonstrated the utility of nanomaterials with peroxidase (POD)-like and oxidase (OXD)-like activities for TAC determination.[1-5] Herein, we present a simple, rapid, and cost-effective chemiluminescence sensing assay for TAC determination. The assay leverages the oxidase-like catalytic activity of a bimetallic metal–organic gel (MOG), termed P-CoFe-T, synthesized through a dual-ligand coordination method using trimesic acid and phytic acid as the organic ligands.[6] This rational design strategy resulted in a structurally robust material with both oxidase- and peroxidase-like activities, outperforming conventional nanozymes in catalytic performance and stability. The core sensing principle is based on the ability of antioxidants to inhibit the oxidase-mimicking activity of P-CoFe-T, thereby attenuating the chemiluminescence signal in a concentration-dependent manner. Quantitative analysis was enabled through calibration using individual antioxidants—ascorbic acid (AA), glutathione (GSH), cysteine (CYS)—as well as their combined mixture, as standard antioxidants, affording detection limits of 2, 0.8, 1.6, and 1 μM, respectively. Owing to its simplicity, sensitivity, and versatility, this nanozyme-based chemiluminescence platform represents a robust approach for TAC evaluation in a wide range of complex matrices, including food, beverages, pharmaceuticals, cosmetics, and biological fluids.

Acknowledgements

This work was financially supported by the National Natural Science Foundation of China (22174136) and the Alliance of International Science Organizations.

References

1. Huang, W., Wen, H., Li, Y., Wang, W., Long, D. (2025). Antioxidants recognition colorimetric sensor array based on multicolor system. Applied Organometallic Chemistry, 39(3), e7886.
2. Pour, S. R. S., Calabria, D., Nascetti, A., Caputo, D., De Cesare, G., Guardigli, M., Mirasoli, M. (2024). Easy-to-use chemiluminescent-based assay for a rapid and low-cost evaluation of the antioxidant activity of cosmetic products. Chemosensors, 12(2), 25.
3. Hu, P., Zuo, Z., wen Ma, X., Zhu, C., Hu, L., & Gu, W. (2024). Self-sacrificing-induced defect enhances the oxidase-like activity of MnOOH for total antioxidant capacity evaluation. Analytica Chimica Acta, 1308, 342664.
4. Gupta, S., Finelli, R., Agarwal, A., Henkel, R. (2021). Total antioxidant capacity—Relevance,

methods and clinical implications. Andrologia, 53(2), e13624.
5. Wang, Y., Zhang, P., Fu, W., Zhao, Y. (2018). Morphological control of nanoprobe for colorimetric antioxidant detection. Biosensors and Bioelectronics, 122, 183-188.
6. Dong, X., Shi, W., Wang, G., Chen, J., Wang, R., Zhang, J. (2024). Dual-Ligand strategy to construct metal organic gel catalyst with the optimized electronic structure for high-efficiency overall water splitting and flexible metal–air battery. Small, 20(13), 2307407.

Ampere-level ammonia synthesis with low overpotential via porous multilayer graphite confined spatially separated Ru/Ag catalysts

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Ammonia, commonly used in chemical and agriculture, has always been produced by the energy-intensive Haber-Bosch process.[1] Electrochemical nitrate reduction to ammonia (NO_3RR), as an ideal decarbonization synthesis route potentially driven by generated renewable energy, promotes denitrification of wastewater and improves the nitrogen cycle.[2] However, to obtain a large current density, while often operating at high reaction overpotentia, results in an imbalance between energy efficiency and ammonia yield.[3] Here, spatially confined cascade catalyst made of multilayer graphite support with ruthenium and silver nanoparticles encapsulated inside. During Electrochemical NO_3RR, porous multilayer graphite hinders the diffusion of NO_2^- generated by the Ag sites outward, creating a high-concentration NO_2^- environment, which enhances kinetics of converting NO_2^- to NH_3 on the Ru sites. Due to the synergistic effect between the Ru and Ag sites, the system achieves current density of ~1 A cm^{-2} with NH_3 Faradaic efficiency (FE) of 93.8±1.4% at 0 V versus reversible hydrogen electrode (vs RHE), and even retains current density of ~0.5 A cm^{-2} at a low overpotential (0.1 V vs. RHE). A galvanic Zn–NO_3 battery with high power density of 230.6 mW cm^{-2} at 0.4 V vs Zn/Zn^{2+} was developed with good stability at 400 mA cm^{-2} for more than 120 h.

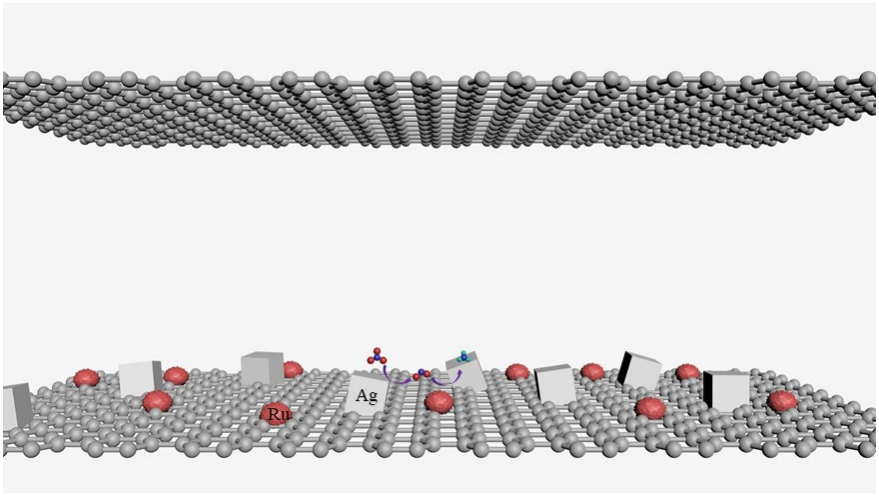


Fig.1 Schematic diagram of the proposed NO_3RR mechanism over the catalysis.

Acknowledgements

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References

1. P. H. Van Langevelde, I. Katsounaros and M. T. Koper, *Joule* **5**, 290–294 (2021).
2. F. Y. Chen, Z. Y. Wu, S. Gupta and et al., *Nat. Nanotech.* **17**, 759-767 (2022)
3. S. Han, H. Li, T. Li and et al., *Nat. Catal.* **6**, 402-414 (2023)

Underpotential Hydrogen-Mediated Catalytic Nitrate Reduction for Efficient Ammonia Synthesis

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While H*-mediated nitrate reduction mechanisms have been reported, existing studies predominantly focus on overpotential adsorbed hydrogen (*H_{OPD}) interactions at negative potentials. However, the role of underpotential adsorbed hydrogen (*H_{UPD}) in driving this process at positive potentials remains unexplored. This work presents a series of Ag-PGM catalysts, notably Ag/Ru-15, as effective *H_{UPD} supply systems for energy-efficient NH_3 electrosynthesis from NO_3RR. We developed a 3D hierarchical architecture that incorporates nanoconfined Ag and Ru sites to mimic enzymatic substrate channels. Kinetic assessments and DFT calculations confirm significant synergistic interactions between isolated Ag and Ru phases, enabling cascade NO_3RR pathways that couple improved onset potentials for NO_3^- reduction on Ag with enhanced proton transfer kinetics for NO_2^- reduction on Ru. We elucidate the correlation between *H_{UPD} binding strength, coverage, and accessibility, demonstrating that Ru's oxophilicity, activated by the Ag substrate, reduces *H_{UPD} coverage through dynamic H_2O production, while competitive NO_x adsorption promotes *H_{UPD} participation in NO_3RR. The Ag/Ru-15 catalyst achieves an NH_3 partial current density of 1.2 A cm^{-2} (166.6 mg h^{-1} cm^{-2}) in 1 M NO_3^- at 0 V, a maximum half-cell energy efficiency of 52% and H_2-driven NH_3 production costs below the commercial threshold of 1.15 USD kg^{-1}. Our findings present *OH adsorption strength as a critical descriptor for assessing the reactivity of *H_{UPD} and guiding the design of more efficient NO_3^- hydrogenation catalysts.

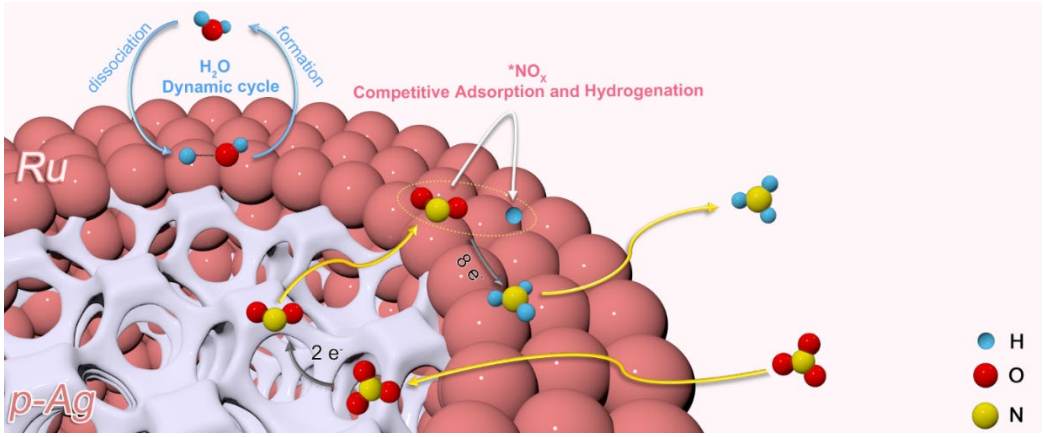


Fig.1 Schematic diagram of the proposed cascade NO_3RR mechanism over the Ag/Ru-15 catalysts.

Modulating the Lewis Acidity-Basicity of Fe Sites to Enhance the ORR Activity and Stability of FeNC Catalysts

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In non-precious metal catalysts, single-atom Fe catalysts supported on nitrogen-doped carbon substrates (FeNC) are considered the most promising alternatives to Pt-based catalysts owing to their high oxygen reduction reaction (ORR) activity, near-optimal atom utilization efficiency, and tunable electronic structure of active sites. However, Fe-N_4 sites struggle to balance O_2 adsorption strength and the desorption capability of key intermediates (*OOH, *OH), leading to a high reaction energy barrier that ultimately limits catalytic activity and kinetics. Furthermore, during ORR operation, the two-electron reaction pathway promotes carbon support corrosion, while Fe-N bond cleavage induces active-site demetallation, resulting in poor FeNC stability that falls short of long-term durability requirements. Previous studies have demonstrated that the electronic structure of Fe centers can be modulated via axial coordination with ligands of varying Lewis acidity [1,2]. In this work, we anchor FeNC onto a Lewis-acidic ZrO_2 support to construct an axially coordinated Fe site structure, which fine-tunes the electronic environment of Fe and optimizes the adsorption energy of oxygenated intermediates. In 0.1 M KOH, the ZrO_2@FeNC catalyst delivers exceptional ORR performance, achieving a half-wave potential ($E_{1/2}$) of 0.928 V (vs. RHE) and remarkable stability (only a 10 mV $E_{1/2}$ degradation after 30,000 cycles), surpassing both Pt/C and pristine FeNC benchmarks. The ZrO_2 integration markedly enhances the intrinsic activity and durability of Fe sites, offering a viable strategy to advance non-precious metal catalysts for fuel cell applications.

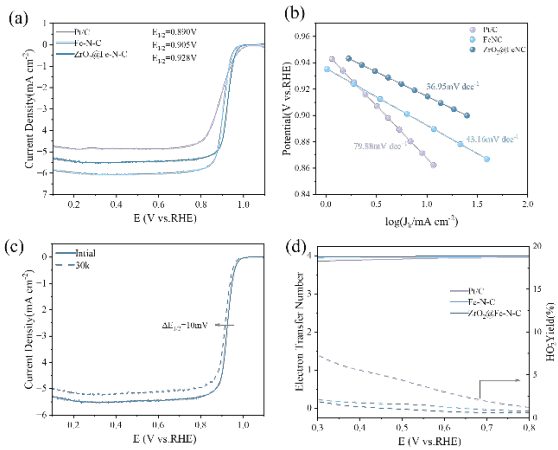


Fig.1 (a) LSV curves of ZrO_2@FeNC, FeNC, and Pt/C. (b) Tafel Slopes. (c) LSV curves of ZrO_2@FeNC before and after continuous 30000 CV cycles. (d) Percentage of peroxide yield and electron transfer number of various catalysts and Pt/C.

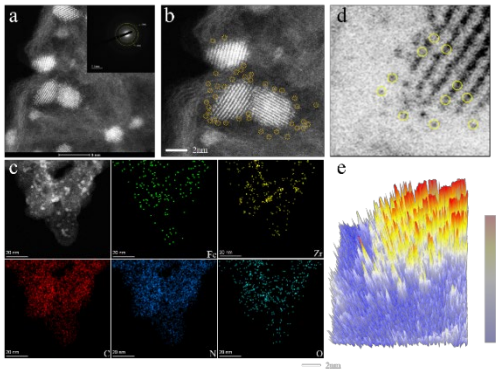


Fig.2. Structural characterization of ZrO_2@FeNC. (a) HRTEM image with SAED pattern inset. (b) AC-HAADF-STEM image. (c) EDS elemental mapping images. (d) Image negatives and 3D fitting plot (e).

Acknowledgements

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References

1. Qu, Q.; Mao, Y.; Ji, S.; Liao, J.; Dong, J.; Wang, L.; Wang, Q.; Liang, X.; Zhang, Z.; Yang, J.; Li, H.; Zhou, Y.; Wang, Z.; Waterhouse, G. I. N.; Wang, D.; Li, Y., J. Am. Chem. Soc., 147, 6914−6924 (2025)
2. Yin, L.; Sun, M.; Zhang, S.; Huang, Y.; Huang, B.; Du, Y., Adv. Mater. 37, 2416387 (2025)

Synergy of Ni single atom and RuNi alloy nanocluster enables boosted hydrogen evolution at industrial current densities

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Ruthenium (Ru) has emerged as a promising alternative to platinum (Pt) for alkaline hydrogen evolution reaction (HER), yet its practical application is severely hindered by sluggish water dissociation kinetics and unfavorable hydrogen adsorption behavior. [1-3] We address this by constructing a Ru_3Ni alloy nanocluster/single-atom Ni heterointerface (Ru_3Ni-N-C), where alloyed Ni tunes the hydrogen adsorption energy of Ru while Ni single-atom sites promote water dissociation. The optimized Ru_3Ni-N-C achieves ultralow overpotentials of 5 and 63 mV at 10 and 100 mA cm^{-2}, respectively, surpassing Ru/C (67 and 230 mV) and Pt/C (27 and 186 mV). In practical anion-exchange membrane water electrolysis (AEMWE), Ru_3Ni-N-C delivers 2376 mA cm^{-2} at 2 V, significantly outperforming Pt/C (1493 mA cm^{-2}). Furthermore, the price activity of the Ru_3Ni-N-C-based AEMWE is as high as 515.3 A $\$^{-1}$ at 2 V, which represents about an order-of-magnitude enhancement compared to Pt/C benchmark (51.9 A $\$^{-1}$ at 2 V). The strong coupling interaction also endows the Ru_3Ni-N-C electrode with excellent stability as it can operate stably at an industrial current density of 500 mA cm^{-2} for more than 200 h with a decay rate of only 56.7 μV h^{-1}. Mechanistic studies via in-situ Raman and DFT reveal that Ni single-atom sites lower the water dissociation barrier by 0.76 eV via regulating the interfacial water structure, while Ru d-band center downshifting accelerates hydrogen desorption. By bridging single-atom engineering and alloying strategies, this work provides an economically viable pathway for industrial hydrogen production.

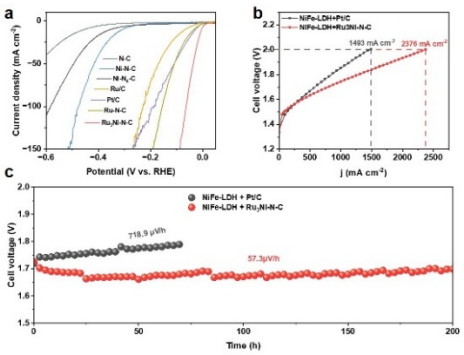


Fig.1 (a) Polarization curves of N-C, Ni-N-C, Ni-N_4-C, Ru/C, Pt/C, Ru-N-C and Ru_3Ni-N-C. (b) Polarization curves of the AEMWE using NiFe LDH + Pt/C and NiFe LDH + Ru_3Ni-N-C. (c) Chronopotentiometry curve of the AEMWEs

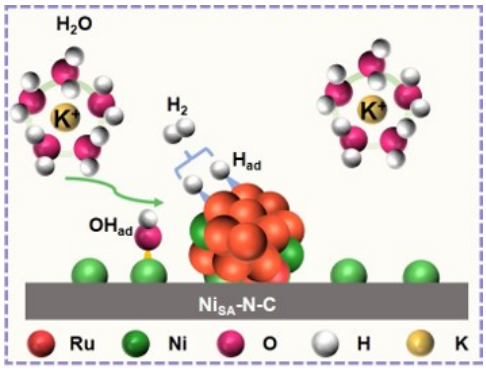


Fig.2 Schematic illustration of the reaction mechanism of Ru_3Ni-N-C.

Acknowledgements

This work was supported by the National Nature Science Foundation of China (22279129) and the Jilin Province Science and Technology Development Program (20230101367JC and 20230201154GX).

References

1. C. Steven and M. Arun, *Nature*., **488,** 294-303 (2012)
2. X. Yu, Z.Y. Yu, X.L. Zhang, et al., *J. Am. Chem. Soc.*, **141**, 7537-7543 (2019)
3. J. Mao, C.T. He, J. Pei, et al., *Nat. Commun.*, **9**, 4958 (2018)

Universal detection method based on CRISPR/Cas12a

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The CRISPR/Cas12a system, due to its reliance on a single protein, high programmability, rapid and accurate DNA target recognition, and straightforward operation, has become a core technology in fields such as gene editing and molecular detection. However, despite its immense potential in various applications, molecular detection technologies based on CRISPR/Cas12a still face several challenges, including limited target types, complex crRNA design, and reduced sensitivity due to mutations, which constrain its application in low-cost, universal, rapid field detection. To address these issues, this study proposes an innovative CRISPR/Cas12a detection system based on a duplex switch. By introducing transduction probes, we effectively broaden the detection range, enabling the system to efficiently recognize not only DNA but also RNA (including miRNA and viral RNA) and small molecules, significantly expanding its application scope. This improvement not only simplifies the crRNA design process but also reduces experimental costs, laying the foundation for widespread use [1]. Building on this, we conducted an in-depth study on the role of split crRNA in activating Cas12a and identified the key impact of spacer RNA and complementary DNA sequences on the performance of the CRISPR/Cas12a system. By systematically optimizing the length of the complementary DNA, we significantly enhanced the system's ability to differentiate mutations, overcoming the limitations of traditional CRISPR/Cas12a systems in DNA target detection. Notably, this system not only performs well in DNA detection but also successfully detects non-nucleic acid targets, further enhancing its versatility. Furthermore, we integrated electrochemical technology, enabling highly sensitive detection of miRNA and other small molecules, thus providing technical support for the miniaturization and portability of molecular detection instruments. By combining with lateral flow immunoassay technology, our system also offers convenient on-site operation and intuitive result visualization, greatly improving detection efficiency and meeting the demand for rapid, accurate, and sensitive diagnostic solutions. In summary, the CRISPR/Cas12a detection system proposed in this study not only extends the application range of this technology and overcomes traditional detection limitations but also provides flexible and efficient technical support for instant diagnostics in various scenarios, with significant potential for future applications.

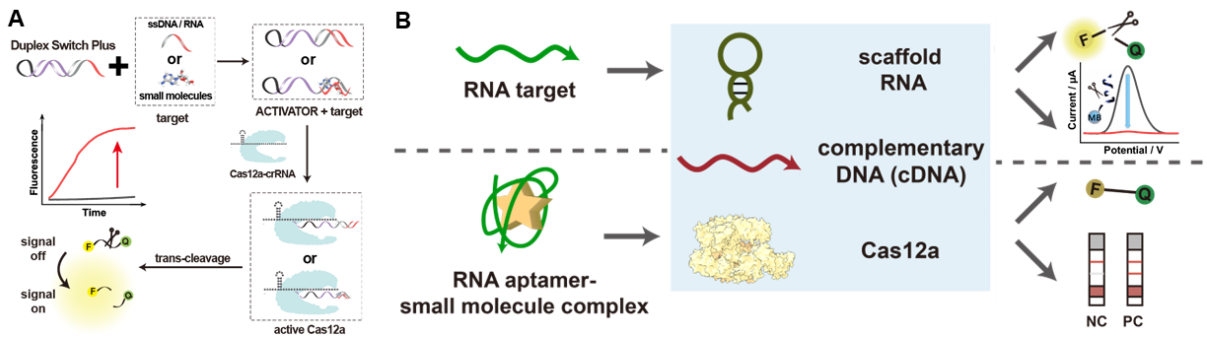


Fig.1 A) A universal detection system based on dupelx switch plus for CRISPR/Cas12a. B) Analysis and detection of multiple targets using the split crRNA-Cas12a complex.

Acknowledgements

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References

1. Y. Xiao, H. Li, Y. Tang, B. Li, *Anal. Sens.*, **3**, e202300018 (2023)

Metal-Oxygen Octahedra Regulation of Iridium-based Perovskites for Efficient and Durable Acidic Water Oxidation

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The dissolution and inactivation of anodic oxygen evolution reaction (OER) electrocatalysts remain significant barriers to the development of acidic water electrolysis.[1] Here, the activity and stability of $BaIrO_3$ (BIO) perovskite were enhanced through the controlled regulation of metal-oxygen octahedra via B-site substitution with Co (BICO). During OER process, the dissolution of Ba and Co leads to the formation of highly active $IrCoO_x$ nanoparticles on the amorphous surface layers of BICO. The introduction of Co not only increases the concentration of high-valence Ir species with high activity, but also prevents the excessive oxidation and dissolution of Ir by taking over its oxidation role during the reaction. Pourbaix diagrams and density functional theory (DFT) calculations reveal a substantial reduction in the energy barrier of rate-determining step (RDS) after Co doping. BICO-2 electrocatalyst demonstrates exceptional OER performance, requiring an overpotential of 216 mV to achieve a current density of 10 mA cm^{-2}, while maintaining continuous operation for over 140 h without significant degradation, and boasting a stability number (S-number) of 4.3×10^5. Additionally, BICO-2 exhibits excellent activity and durability in proton exchange membranes (PEM) water electrolysis. This work introduces a novel approach for designing and fabricating efficient, long-lasting electrocatalysts, offering significant insights for advancing acidic water electrolysis technologies.[2]

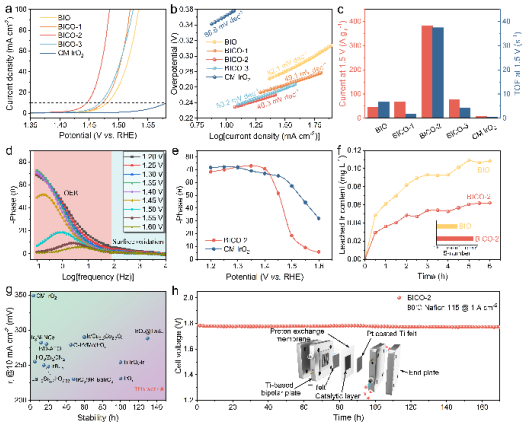


Fig.1 Electrochemical measurements of electrocatalysts.

Acknowledgements

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References

1. L. C. Seitz, C. F. Dickens, K. Nishio, Y. Hikita, J. Montoya, A. Doyle, C. Kirk, A. Vojvodic, H. Y. Hwang, J. K. Norskov and T. F. Jaramillo, *Science*, **353**, 1011-1014 (2016)
2. Y. Yang, Y. Chen, Y. Yan, B. Yao, H. Xing, D. Jiao, Z. Xing, D. Wang and X. Yang, *Adv. Funct. Mater.*, 2506467 (2025)

High-entropy pyrochlore oxides for efficient oxygen evolution reaction in acidic water electrolysis

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Ruthenium (Ru)-based pyrochlore oxides have emerged as promising electrocatalysts for the oxygen evolution reaction (OER) in acidic media. However, their further development has been hindered by structural instability and suboptimal activity under strongly acidic conditions. Herein, we design a high-entropy pyrochlore oxide, $(Y_{0.2}Pr_{0.2}Eu_{0.2}Ho_{0.2}Lu_{0.2})_2Ru_2O_{7-\delta}$ (YPEHLRO), through an entropy engineering strategy. The incorporation of multiple rare-earth elements induces synergistic lattice distortion and oxygen vacancies, effectively modulating the electronic structure of Ru active sites. Combined experimental characterizations and theoretical calculations reveal that the optimized *d*-band center position reduces the energy barrier for oxygen-containing intermediates, thereby accelerating adsorption-desorption kinetics. Concurrently, the high-entropy configuration enhances the covalency of Ru—O bonds, significantly suppressing Ru dissolution during prolonged operation. The catalyst exhibits exceptional OER performance in 0.5 M H_2SO_4, requiring an overpotential of only 264 mV to achieve 10 mA cm^{-2} with a low Tafel slope of 38 mV dec^{-1}, surpassing both single-rare-earth pyrochlores and commercial RuO_2. Notably, the material retains its initial activity after 50 h of chronopotentiometry testing, demonstrating superior stability among reported Ru-based pyrochlore catalysts. This work highlights the critical role of entropy-driven lattice engineering in balancing activity and stability, offering a strategic framework for designing robust electrocatalysts for acidic water electrolysis and renewable energy systems.

Acknowledgements

This work was supported by the National Key Research and Development Program of China (2022YFF0710000), the National Natural Science Foundation of China (22393930 and 22034006) and Jilin Talent Development Foundation (E41S2001).

References

1. B. Yao and X. Yang, *Angew. Chem. Int. Ed.*, **64**, e202416141 (2025)
2. D. Zhang and S. Lu, *Nat. Commun.*, **14**, 2517 (2023)

Harnessing CRISPR/Cas12a System Flexibility for Next-Generation Nucleic Acid Detection: From Label-Free Fluorescence to Field-Deployable Colorimetry

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In the realm of biomedical research, nucleic acid sequences, particularly deoxyribonucleic acid (DNA)/ribonucleic acid (RNA) genomes and their associated microRNAs (miRNAs), have increasingly demonstrated their pivotal role as critical biomarkers in the diagnosis of viruses, bacteria, mycoplasmas, chlamydiae, and cancers. Currently, the gold standard for nucleic acid detection in laboratories is quantitative polymerase chain reaction (qPCR), renowned for its high sensitivity. However, the advent of isothermal amplification technologies has ushered in a paradigm shift in nucleic acid detection, circumventing the reliance on intricate temperature-controlled equipment and enabling rapid, convenient operations in small, constant-temperature devices. Nonetheless, both qPCR and isothermal amplification techniques grapple with false positives stemming from non-specific amplification, and qPCR's implementation hinges on costly precision instruments, posing a significant application hurdle in resource-constrained regions. Consequently, exploring and developing a novel nucleic acid biomarker detection method that combines high specificity, sensitivity, versatility, and portability has emerged as a pressing research imperative.

This study presents a breakthrough CRISPR/Cas12a-mediated biosensing platform that enables rapid adaptation for diverse nucleic acid biomarkers through simple crRNA sequence replacement. We systematically optimized signal transduction mechanisms through three evolutionary stages: 1) Initial fluorescent probe-based detection, 2) Advanced label-free fluorescent signal amplification, and 3) Instrument-free colorimetric visualization. The developed platform achieves single-copy sensitivity while eliminating dependency on expensive instrumentation and complex labeling procedures.

This technological advancement addresses critical needs in point-of-care testing (POCT) by combining laboratory-grade accuracy with field-deployable simplicity. The modular design allows seamless adaptation for emerging pathogens, antibiotic resistance genes, and cancer biomarkers. Our work provides a versatile framework that bridges the gap between molecular diagnostics and resource-limited settings, with immediate applications in clinical decision-making, epidemic surveillance, and home-based testing.

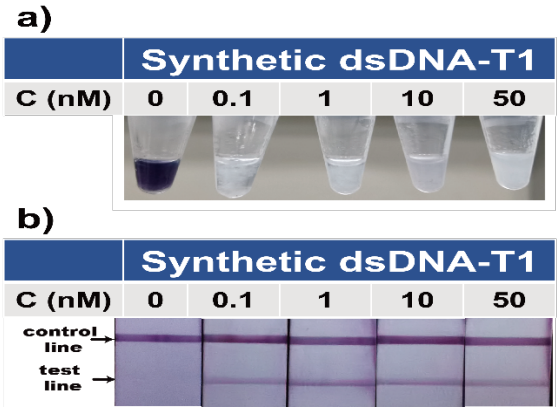


Fig.1 Pathogen detection using amylase and commercial pregnancy test strips based on CRIs-Gel platform.

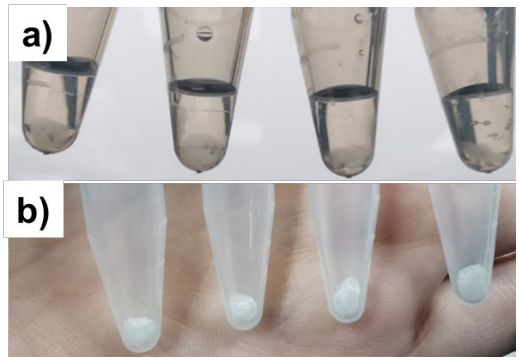


Fig.2 Photographs of RCA hydrogels stored at 4°C; b) Photographs of lyophilizedRCA hydrogels.

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References

1. Zhao, R.; Tang, Y.; Lu, B.; Li, B. *ACS sensors.*, 2024 9 (9), 4803-4810.
2. Zhao, R.; Lu, B.; Li, B. *Anal. Chem.*, 2023, 95, 18522-18529.
3. Zhao, R.; Yu, C.; Lu, B.; Li, B. *RSC Adv.*, 2022, 12, 10374.

Enhancing diabetic wound healing: A two-pronged approach with ROS scavenging and ROS-independent antibacterial properties

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The complex microenvironment often hinders the healing process of diabetic wounds. The primary culprits are the prolonged low-grade inflammation induced by high levels of reactive oxygen species (ROS) and the bacterial infections caused by the susceptibility of the vulnerable diabetic wounds. Nanomedicine is considered as one of the potential solutions to this issue. However, there is a conflict that urgently needs to be resolved, that is, the ROS-dependent antibacterial properties and the ROS-scavenging ability for anti-inflammation of most materials [1]. In this work, we report a MOF-199/GO with strong ROS scavenging capacity and ROS-independent antibacterial properties [2]. It can accelerate the healing of diabetic wounds by improving the wound microenvironment, leading the wounds to transition from the inflammatory phase to the proliferative phase, and promoting wound tissue remodeling. In a skin wound model on type I diabetes rats, the MOF-199/GO efficiently orchestrates the healing process, achieving a remarkable 96 % wound closure by day 10. When employed as a drug, MOF-199/GO exhibits minimal biological toxicity *in vivo*. Moreover, when combined with various dressing materials, the drug's performance remains unchanged, indicating its practical application value. This work paves a new way for the treatment of diseases troubled by bacterial infections and excessively high ROS levels, such as periodontitis, pressure ulcers, and burns.

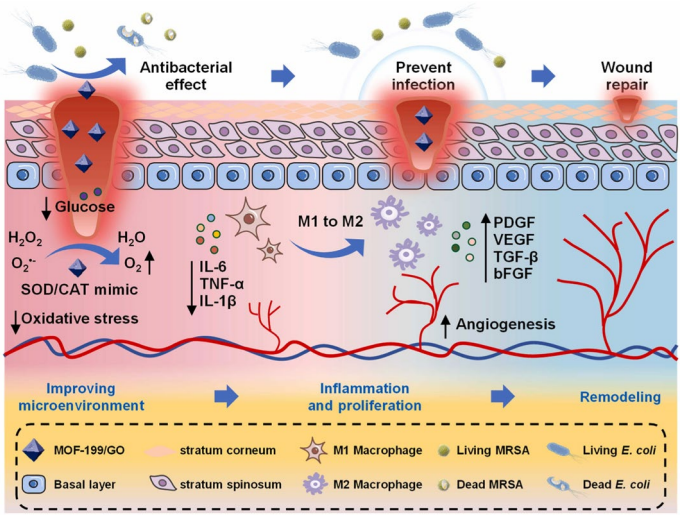


Fig.1 Schematic illustration of MOF-199/GO promoting healing of diabetic wound.

Acknowledgements

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References

1. Y. Guo, S. Ding, C. Shang, C. Zhang, M. Li, Q. Zhang, L. Gu, B. C. Heng, S. Zhang, F. Mei, Y. Huang, X. Zhang, M. Xu, J. Jiang, S. Guo, X. Deng and L. Chen, *Adv. Mater.*, **36**, 2306292 (2024)
2. Z. Yu, L. Yang, H. Liu, T. Li, J. Chen, L. Liu and S. Dong, *Anal. Chem.*, **97**(10), 5546-5553 (2025)

Exploration of the Universality of Flexible Electrochromic Devices

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Electrochromic materials, which exhibit reversible color and optical property modulation under applied voltages, demonstrate tremendous potential for advanced applications. With technological advancements, electrochromic technology has attracted significant attention in displays, smart windows, optical filters, and military camouflage due to its energy-efficient operation, environmental compatibility, and eye-friendly characteristics. The rapid development of flexible electronics, including wearable sensors and foldable devices, has created new opportunities to overcome the limitations of conventional rigid electrochromic devices by developing universal flexible electrochromic systems. In this study, we systematically investigate the universal applicability of flexible electrochromic devices by employing three representative electrochromic materials: Prussian blue (PB), tungsten trioxide (WO_3), and polyaniline (PANI). All fabricated devices were evaluated under identical electrolyte conditions (1M lithium perchlorate in propylene carbonate, 1M $LiClO_4$/PC). Remarkably, all three flexible electrochromic devices exhibited outstanding electrochemical performance, superior electrochromic behavior (demonstrating rapid and stable color switching), and excellent cycling stability (maintaining optical contrast above 85% throughout 7000 seconds of step-cycling tests). This universal system features simple fabrication and operation procedures, while the resulting devices consistently show high power density, fast response times, and long-term operational stability across different material systems. Our findings regarding the universal compatibility of flexible electrochromic devices provide valuable insights and design principles for next-generation flexible electrochromic technologies.

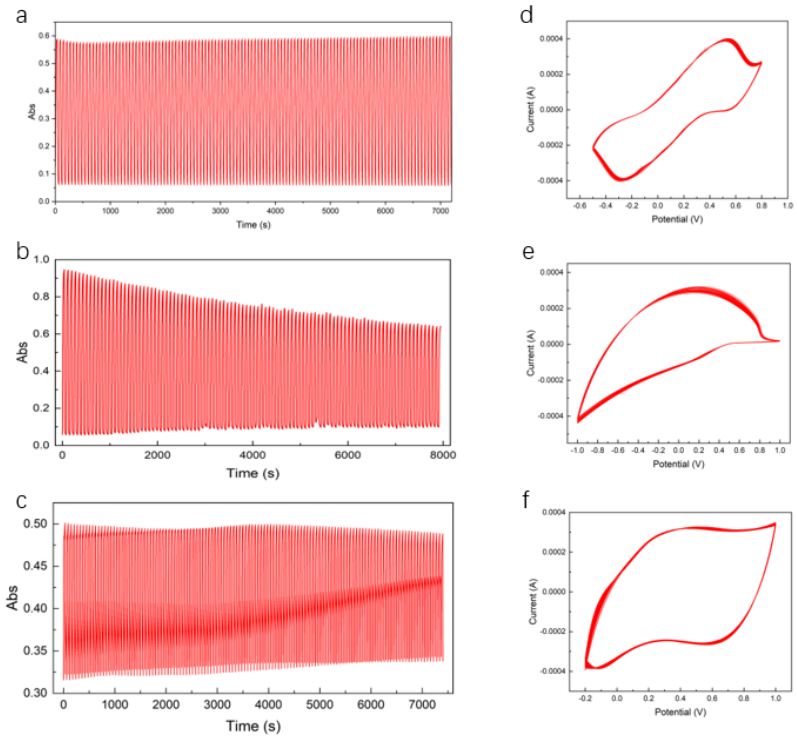


Fig.1 Long-term step stability testing of flexible electrochromic electrodes (a) PB/ITO/PET, (b) WO_3/ITO/PET, (c) PANI/ITO/PET, along with multiple cyclic voltammetry (CV) cycling tests of the electrodes (d) PB/ITO/PET, (e) WO_3/ITO/PET, (f) PANI/ITO/PET

References

1. Ding Y, Wang M, Mei Z, et al, ACS Appl. Mater. Interfaces 2023, 15, 15646−15656
2. Guofa C, Mengqi C, Pooi See Lee, et al, Chem. Sci., 2016, 7, 1373

Rational design of artificial nuclease based on ligand modulation strategy for efficient degradation of environmental DNA

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Harmful environmental DNA (eDNA) contamination in water poses significant health threats, yet traditional treatments fail to efficiently remove it. Some phosphatase mimics have been found capable of cleaving the phosphate bonds, making them potential approaches to dealing with harmful eDNA contamination. However, their activities towards phosphodiester bonds often remain relatively low, and the strategy to regulate their activities remains an enigma. Here, we designed a kind of Zr-based metal-organic framework (MOF) nanozyme by rational ligand modulation. The introduction of V-shaped ligands in building units serving as the binding domain can effectively enhance the activity of artificial nuclease, making the best 3,5-PDA-Zr achieve a DNA hydrolysis rate approximately 30 times greater than that of UiO-66 REO, the previous best Zr-based MOF catalyst. Then, we proposed two strategies for treating eDNA-contaminated water: one approach employed 3,5-PDA-Zr directly as a water treatment agent, while the other involved utilizing a portable filtration device loaded with 3,5-PDA-Zr on tourmaline. Our strategies efficiently removed over 90% of residual antibiotic resistance genes (ARGs) and plasmids carrying DNA fragments of various viruses (HBV, HPV, MERS-CoV, SARS-CoV-2, Ebola, and Zika). Our work provided strong theoretical support and practical tools for preventing the spread of ARGs and the outbreak of large-scale pandemic diseases in the future.

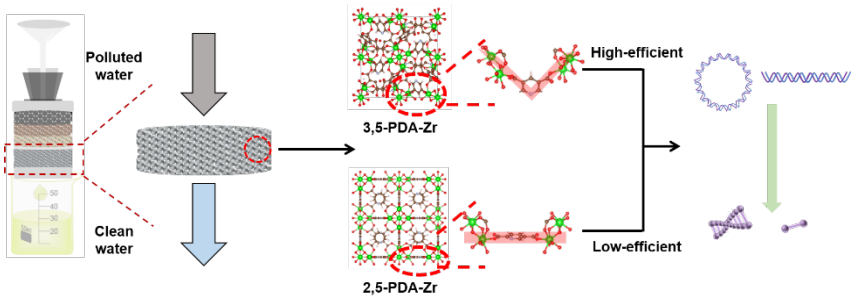


Fig.1 Schematic illustration of V-shaped ligands in building units enhancing the artificial nuclease activity.

Acknowledgements

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References

1. Z. Yu, L. Yang, H. Liu, T. Li, J. Chen, L. Liu and S. Dong, *Anal. Chem.*, **97**(10), 5546-5553 (2025)

Enhanced Luminol Chemiluminescence with Mn-based Metal-Organic Framework for Sensitive Detection of Dopamine

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Dopamine (DA) is a crucial neurotransmitter in the human brain that plays a vital role in regulating numerous physiological processes, including mood, motivation, reward, and motor control[1,2]. It is involved in neural pathways that affect cognitive functions, emotions, and behavior[3]. Dysregulation of dopamine levels has been implicated in several neurological and psychiatric disorders, including Parkinson's disease, schizophrenia, and depression[4,5]. Consequently, the precise and sensitive detection of dopamine is essential for advancing our understanding of its role in health and disease.

Here, we synthesize a manganese-based Metal-Organic Frameworks (Mn-MOFs) via a one-pot method and apply for CL analysis for the first time. The CL intensity of luminol/H_2O_2 system is significantly enhanced. After the addition of DA, a significant decrease in the luminescence intensity of the system is observed. Based on this, it becomes possible to achieve a highly sensitive detection of dopamine.

Acknowledgements

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References

1. R. Wise and C. Jordan, *J Biomed Sci.*, **28**, 83 (2021)
2. M. Saqib, S. Bashir, H. Li, S. Wang and Y. Jin, *Anal. Chem.*, 91, 3070-3077 (2019)
3. R. Wise and M. Robble, *Annu. Rev. Psychol.*, **71**, 79-106 (2020)
4. Y. Cai, B. Nielsen, E. Boxer, J. Aoto and C. Ford, *Neuron.*, **109**, 1137-1149 (2021)
5. B. Channer, S. Matt, E. Nickoloff-Bybel, V. Pappa, Y. Agarwal, J. Wickman and P. Gaskill, *Pharmacol Rev.*, **75**, 62-158 (2023)

Investigating Cellular Mechanosignaling and Regulatory Mechanisms through Combined Microscopy

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Cells continuously decode mechanical stimuli through sophisticated mechanotransduction networks that orchestrate vital biological processes including stem cell differentiation, immune response, and cancer metastasis. Traditional approaches in mechanobiology have been constrained by either insufficient force resolution (>100 pN) or limited optical resolution (>200 nm), making it impossible to simultaneously perturb and observe nanoscale mechanosensitive events in living systems. Our integrated AFM-dSTORM-CLSM platform overcomes these limitations by synergizing capabilities of sub-10 pN force control with nanometer spatial precision, 20 nm-resolution fluorescence imaging via direct stochastic optical reconstruction microscopy (dSTORM), and real-time confocal tracking of signaling dynamics. Using this approach, we quantified the location, amplitude and duration of single-cell mechanical stimulation by precise mechanical modulation, and simultaneously observed the mechanical force induced YAP nuclear and cytoplasmic distribution translocation[1]. Furthermore, we dissected the Piezo1 distribution and microfilament morphological changes induced by mechanical forces in the tumor and normal cells (Fig. 1)[2]. Also, we explored the roles of Piezo1, microfilament dynamics, calcium signaling, and integrin-mediated adhesion in propagating mechanical cues from the membrane to the nucleus. Our results reveal how mechanical forces are transduced into biochemical signals to regulate cell fate decisions. This multimodal imaging platform provides a powerful tool for unraveling fundamental mechanobiological mechanisms with implications for development, disease, and bioengineering.

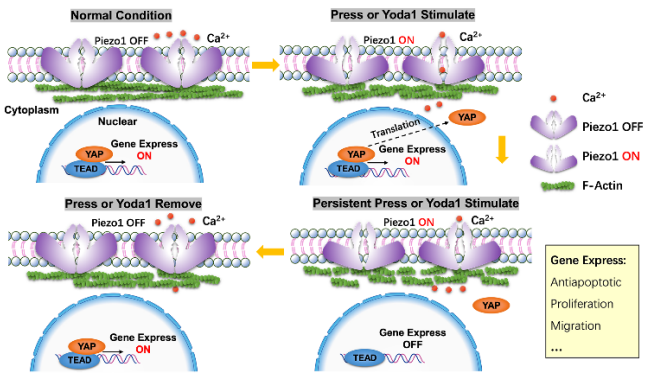


Fig.1 Schematic diagram of the Piezo1 status, Ca^{2+} location, microfilament morphology, and YAP distribution. Application of mechanical pressure or the specific activator Yoda1 stimulates Piezo1 channels, facilitating calcium ion influx. This influx induces alterations in microfilament organization and YAP localization. Upon cessation of mechanical pressure and Yoda1 stimulation, both the microfilament structure and YAP distribution revert to their original states.

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References

1. H. Li[#], Y. Liu[#], J. Zhang, M. Cai, Z. Cao, J. Gao, H. Xu, L. Shao, J. Sun, Y. Shi* and H. Wang*, *Nanoscale*, **14**, 15516-15524 (2022).
2. J. Duan[§], H. Li[§], J. Zhang, H. Xu, J. Gao, M. Cai, Y. Pan*, Y. Shi*, and H. Wang*, *Anal. Chem.*, **97**, 147−156 (2025).

Align d-orbital energy level of dual-atom sites for high-performance anion exchange membrane fuel cells

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The inherent scaling relationships between adsorption energies of oxygen-containing intermediates impose an intrinsic limitation on the maximum oxygen reduction reaction (ORR) activity, which represents one of the fundamental bottlenecks for the practical application of anion exchange membrane fuel cells (AEMFCs). To address this persistent challenge, we strategically align the $3dz^2$ orbital energy levels of Fe and Co to selectively customize the dissociative ORR pathway without the formation of OOH* intermediates, thereby effectively circumventing the conventional OH*-OOH* scaling relations. This novel catalyst design is achieved by atomic phosphorus (P) substitution, which not only optimizes orbital matching towards O–O cis-bridge adsorption, but also further stabilizes the spontaneously adsorbed OH ligand as an effective electronic modifier. Due to these unique attributes, the well-designed FeCo-N/P-C catalyst demonstrates exceptional ORR performance with a current density of 251 $mA{\cdot}cm^{-2}$ at 0.9 $V_{iR\text{-}free}$ under 1.5 bar H_2–O_2, significantly outperforming the state-of-the-art Pt-free electrocatalysts and the 2025 DOE target (44 $mA{\cdot}cm^{-2}$). More importantly, the peak power density reaches as high as 0.805 $W{\cdot}cm^{-2}$ under 1.5 bar H_2–air with virtually negligible degradation observed over 10,000 cycles of voltage accelerated stress testing. This work offers a highly competitive electrocatalyst for AEMFCs and opens a promising new avenue to fundamentally bypass the constraints of linear scaling relations for ORR and beyond.

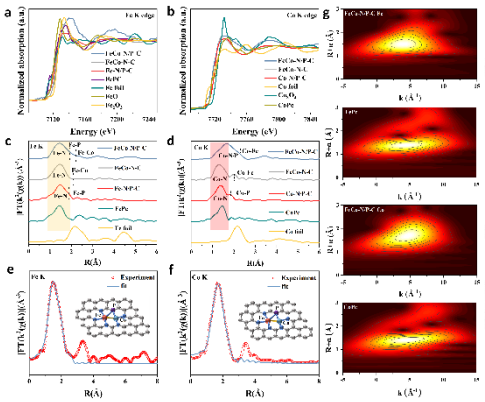


Fig.1 Characterization of catalyst

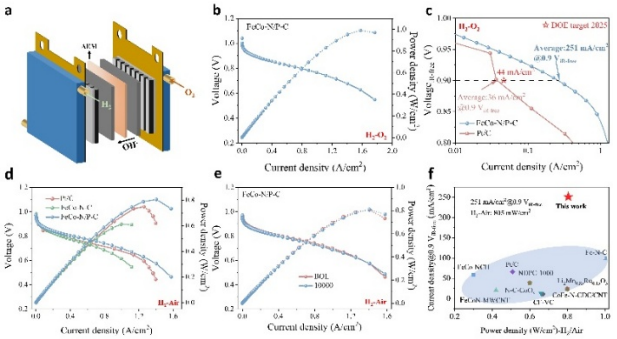


Fig.2 Performance of anion exchange membrane fuel cells

Acknowledgements

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References

1. Chu, S. & Majumdar, A. Opportunities and challenges for a sustainable energy future. *Nature*. **488**, 294-303 (2012).
2. Debe, M. K. Electrocatalyst approaches and challenges for automotive fuel cells. *Nature.* **486**, 43-51 (2012).

Encapsulation of Enzymes into Hydrophilic and Biocompatible Metal Azolate Framework: Improved Functions of Biocatalyst in Cascade Reactions and Its Sensing Applications

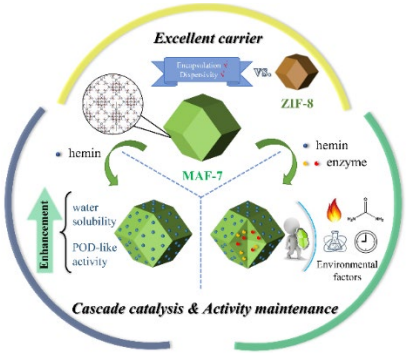
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Cascade biocatalytic reactions induced by multiple enzymes are with extreme significance whether in vivo or in vitro, given considering of the basic biofunction preservation in living organism and signals transduction for biosensing platform. Despite the powerful functions and widespread applications, natural enzymes can hardly counter the changeable factors and will lose their activity in harsh environment. Therefore, mild conditions and pure matrixes always have to take into consideration when utilize natural enzymes or establish biomimetic systems, which is inconvenient for researches. Encapsulated them into porous and biocompatible metal organic frameworks (MOFs) have gradually become a mature and skillful strategy to provide sheltering for natural enzymes and boost their catalytic performance of cascade reactions. However, selecting and synthesizing a proper MOF carrier from numerous classes for specific protein with particular structure is always with great difficulty. Herein, adopting this enzyme@MOF method, where Acetylcholinesterase (AChE) and choline oxidase (ChOx) were represented as the enzymes, while MOF was chosen as MAF-7, a category of metal azolate framework (MAF), we designed and constructed a bioreactor regarded as AChE@ChOx@MAF-7/hemin. The excellent capacity of the carrier and the protection against different external factors were respectively demonstrated by the comparation of MAF-7 and ZIF-8, encapsulated and free enzymes. In addition, detection for several substates or inhibitors (even when replacing the embedded enzymes) with favorable sensitivity and selectivity were carried out, indicating the properties above expectation of different aspects of the established platform were successfully realized.



Scheme 1. The comprehensive properties and applications of MAF-7 and derived composites.

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References

1. Q Zhao and X Yang, *Small* 2024, 20, 2307192.

Iron-induced Localized Oxide Path Mechanism Boost Alkaline Oxygen Evolution Reaction Kinetics

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The sluggish reaction kinetics for anodic oxygen evolution reaction (OER) and insufficient catalytic activities of the non-noble metal based electrocatalysts seriously hindered the development of anion exchange membrane water electrolyzer (AEMWE). Here, a three-dimensional (3D) nanoflower-like electrocatalyst (CFMO) was synthesized through a simple one step method. The substitution of Co by Fe induces a localized oxide path mechanism (LOPM) which allows direct O–O radical coupling for O_2 evolution. The CFMO-2 exhibits excellent OER activity (217 mV at 10 mA cm^{-2}) and long-term stability with minimal degradation after 1000 h operation in 1.0 M KOH, which are even better than those of noble metal based electrocatalysts. Additionally, with a mere 1.65 V cell voltage, the assembled AEMWE produces a current density of 1.0 A cm^{-2}. The *in situ* attenuated total reflection surface-enhanced infrared absorption spectroscopy (ATR-SEIRAS) and differential electrochemical mass spectrometry (DEMS) indicate that in addition to the adsorbate evolution mechanism (AEM) at isolated Co sites, a new LOPM occurred around the Fe and Co bimetallic sites. First-principles calculations confirm the LOPM greatly reduced the energy barriers. This LOPM significantly improves the OER activities without compromising the stabilities of the electrocatalysts, which is beneficial to the design and synthesis of non-noble metal based electrocatalysts and the development of AEMWE.

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References

1. B. Yao, Y. Chen, Y. Yan, Y. Yang, H. Xing, Y. Xu, D. Jiao, Z. Xing, D. Wang and X. Yang, *Angew. Chem. Int. Ed.*, **64**, e202416141 (2025)

Label-free miRNA fluorescent biosensor based on duplex-specific nucleases and silver nanoclusters

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MicroRNAs (miRNAs) are considered reliable biomarkers for a variety of diseases. However, its low abundance in organisms and high sequence similarity of homologous miRNAs make its accurate detection challenging. In this work, we developed a label-free miRNA detection method based DSN-assisted amplification and DNA-AgNCs as a fluorescence signal probe. A hairpin DNA was deliberately designed to serve as the template of AgNCs. In the presence of miR-155, the enzyme cleavage cycle was triggered and cDNA was cleaved by the DSN, allowing the hairpin DNA to maintain its secondary structure and to produce fluorescent DNA-AgNCs. The concentration of the target RNA was reflected by the intensity of the fluorescence signal. The DSN-assisted enzyme cleavage cycle can convert unstable miRNAs into stable DNA, increasing their resistance to degradation under complex environmental conditions and enhancing the sensitivity of this detection method. Due to the programmability of DNA, this method can be applied to other miRNA detection only by changing the corresponding cDNA and hairpin DNA sequences. This biosensor shows excellent selectivity, reproducibility, wide linear range (1-600 nM) with detection limit of 0.86 nM, and potentiality for real sample detection. Overall, we proposed a label-free fluorescent biosensor that avoids complex and expensive labeling processes, and has the potential as a universal platform for detecting diverse target RNAs.

Acknowledgements

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References

1. Ma, L.; Wang, J.; Li, Y.; Liao, D.; Zhang, W.; Han, X.; Man, S., A ratiometric fluorescent biosensing platform for ultrasensitive detection of Salmonella typhimurium via CRISPR/Cas12a and silver nanoclusters. *Journal of Hazardous Materials* **2023,** *443*, 130234.
2. Yang, C.; Shi, Y.; Zhang, Y.; He, J.; Zhang, Z.; Jia, X.; Yuan, R.; Xu, W., A bivariate fluorescence biosensor based on Janus DNA nanoarchitecture-loaded dual-emissive Ag nanoclusters as bi-responsive signaling reporters. *Biosensors and Bioelectronics* **2024,** *263*, 116621.

Metal-Defect Engineering to Optimize NADH Oxidase-like Nanozymes against Tumor Heterogeneity

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Tumor heterogeneity presents an ongoing obstacle to cancer therapy, which describes the observation that a bulk solid tumor harbors distinct tumor cells along with differential sensitivity to treatment. Oxygen, in particular, has been considered to be one of the decisive factors accounting for intratumor heterogeneity. On the one hand, the endogenous O_2 is heterogeneously distributed across tumor, which sets up obstacles to the current therapy methods, such as chemotherapy, radiotherapy and phototherapy; on the other hand, hypoxic and normoxic region also induce occurrence of the differential metabolism events, mainly glycolysis and oxidative phosphorylation (OXPHOS) process, respectively, which further opens up possibilities for pursuing survival, invasiveness and resistance of tumor. Nanozymes that are capable of disrupting cellular NADH homeostasis offer unique opportunities to cancer treatment.[1-3] However, NADH oxidase (NOX)-like nanozymes are largely limited by different susceptibility toward hypoxic and normoxic cancer cells in solid tumors. To address this issue, we herein demonstrate a metal-defect engineering strategy to devise NOX-like nanozyme structure with abundant Cu vacancy. Taking advantages of distinctive electronic configuration and dehydrogenation energetics around Cu-defect active sites, $Cu_{2-x}Se$ nanozymes optimize the absorption energies of NAD* intermediates and ensure selective $4e^-$ O_2 reduction process, thus leading to superior NOX-mimicking activity even in case of oxygen deprivation. The resulting $Cu_{2-x}Se$ nanozymes deliver a significant anticancer efficacy by consuming intratumor NADH indiscriminately and inducing severe metabolic collapse. This work provides new insights for developing metal-defect nanozymes to fight against tumor heterogeneity.

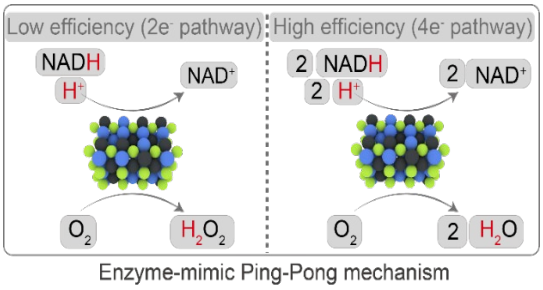


Fig.1 Schematic illustration of the NOXmimicking Ping-Pong mechanism on $Cu_{2-x}Se$ nanozymes.

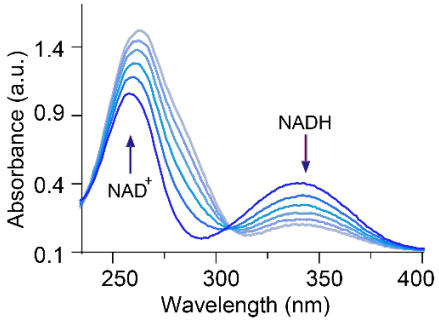


Fig.2 The oxidation of NADH by $Cu_{2-x}Se$ nanozymes during 25 min.

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References

1. B. Yu, W. Wang, W. Sun, C. Jiang and L. Lu, *J. Am. Chem. Soc.*, **143**, 8855-8865 (2021)
2. X. Liu, J. Li, A. Zitolo, M. Gao, J. Jiang, X. Geng, Q. Xie, D. Wu, H. Zheng, X. Cai, J. Lu, F. Jaouen and R. Li, *J. Am. Chem. Soc.*, **145**, 3108-3120 (2023)
3. H. Huang, S. Banerjee, K. Qiu, P. Zhang, O. Blacque, T. Malcomson, M. Paterson, G. Clarkson, M. Staniforth, V. Stavros, G. Gasser, H. Chao and P. Sadler, *Nat. Chem.*, **11**, 1041-1048 (2019)

A Novel Strategy for in vitro Portable Diagnosis of Infectious Diseases

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Accurate, rapid and portable nucleic acid detection is an important prerequisite for the effective prevention, control of epidemic and sudden infectious diseases. Yet most laboratory-grade molecular assays rely on complex thermal cyclers, fluorescence readers, or specialized microfluidic platforms that are neither affordable nor accessible in low-resource or point-of-care settings. Moreover, the need for cold-chain reagent storage and multi-step liquid handling further limits widespread field deployment. The main purpose of this paper is to improve the portability of nucleic acid detection. Commercial portable equipment with stable performance and widely available, such as blood glucose meter and test strip, is used as the final signal output. Nucleic acid circuit transducer with high specificity is used to undertake the upstream isothermal amplification which transfer isothermal amplicons to the direct testing object of commercial portable equipment, specifically. This process can finally realize sensitive, specific and portable detection of infectious diseases. At present, accurate and portable analysis of infectious pathogens such as human papillomavirus, novel coronavirus and Zika virus has been successfully achieved by using commercial glucose meters and test strips. Our approach leverages existing, widely distributed diagnostic hardware to democratize molecular testing in resource-limited settings. By integrating bespoke nucleic acid circuitry with common consumer devices, we provide a flexible, low-cost platform capable of rapid, on-site infectious disease surveillance and outbreak response.

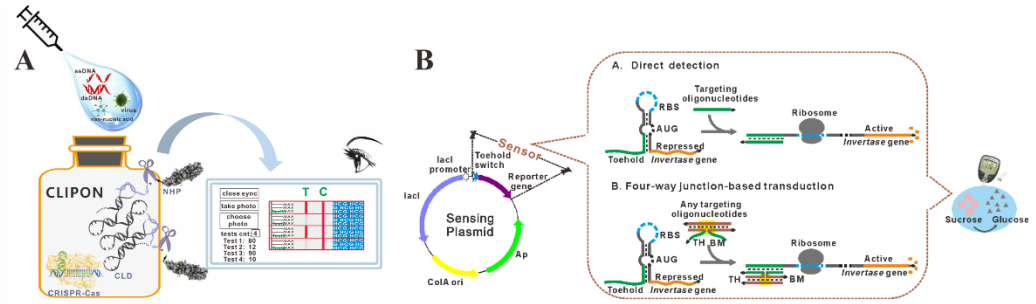


Fig. 1 (A) Pathogen detection using commercial pregnancy test strips based on CRISPR technique (B) Pathogen detection using commercial glucometer based on riboswitches

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References

1. Y. Tang, L. Qi, Y. Liu, L. Guo, et al. *Angew. Chem. Int. Ed.*, 61, e202115907 (2022)
2. M. Yang, Y. Tang, L. Qi, S. Zhang, et al. *Anal. Chem.*, 93, 11956 (2021)
3. Y. Tang, H. Li, B. Li, *Chem. Commun.*, 56, 2483 (2020)
4. H. Li, Tang, Y, Li. B, *ChemBioChem.*, 21, 1418 (2020)

Defect-Boosted Piezoelectric and Nanozymatic Synergetic Catalysis for Deep Bacterial Abscess Therapy

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Piezocatalytic therapy, distinguished by its superior tissue penetration under ultrasound activation and its low dependence on oxygen concentration for generating multiple reactive oxygen species (ROS), has emerged as a promising strategy for deep abscess treatment. However, its efficacy remains constrained by suboptimal bandgap, weak piezoelectric responses, and inadequate surface-active sites. To address these limitations, a facile Ru-atom doping strategy is firstly proposed using the $Bi_4O_5Br_2$ - based nanosystem ($Bi_4O_5Br_2$@Ru) to tailor the bandgap and boost the piezo- and enzyme-like catalysis. The Ru dopants induce lattice distortions and elevate oxygen vacancies simultaneously, thereby enhancing piezoelectric responses while conferring peroxidase (POD)- and catalase (CAT)-like enzymatic activities. Under ultrasound excitation, the piezoelectric field optimizes the conduction band alignment of $Bi_4O_5Br_2$@Ru, enhancing its POD-like activity to generate multiple ROS including ·OH, $^1O_2$ and $O_2^{\cdot-}$. The mixed Ru (III/IV) valence states in $Bi_4O_5Br_2$@Ru induce glutathione (GSH) depletion, thereby further enhancing the oxidative stress capacity to combat biofilms. The enhanced CAT-like activity further alleviates hypoxia within biofilm microenvironments. RNA transcriptomic analysis confirms that $Bi_4O_5Br_2$@Ru disrupts energy metabolism by interfering with the tricarboxylic acid cycle. The dual-modality therapy leverages doping engineering to seamlessly combine piezoelectric properties with enzyme-like catalytic functions, paving the way for the treatment of deep-seated infectious diseases.

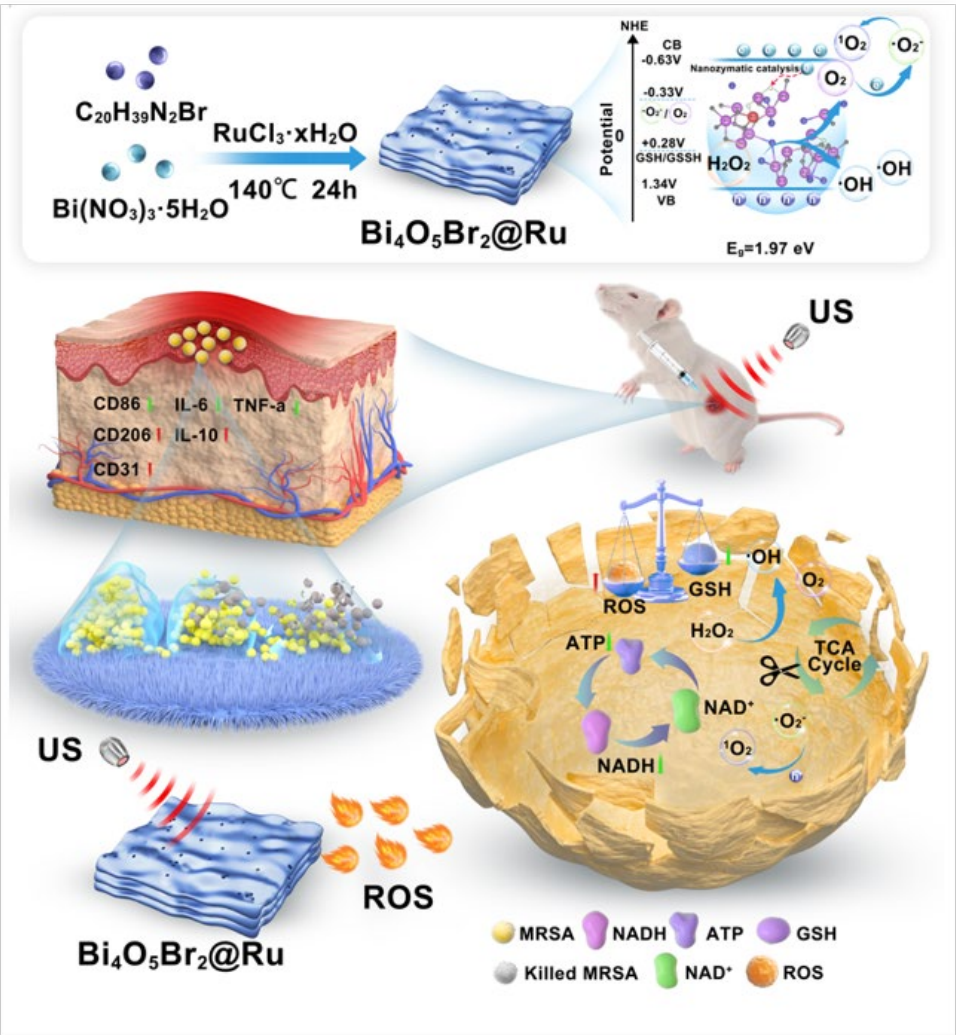


Fig.1 Defect engineering to boost the piezo-nanozymatic catalysis for deep MRSA infections abscess treatment.

Acknowledgements

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References

1. M. Ge; W. Zhu; J. Mei; T. Hu; C. Yang; H. Lin; J. Shi, *Adv. Mater.*, **37,** 2409633 (2025).
2. L. Yang; B. Tian; Y. Xie; S. Dong; M. Yang; S. Gai; J. Lin, *Adv. Mater.*, **35**, e2300648 (2023).

A Novel Long-Lasting Chemiluminescence Platform Based on Deep Eutectic Solvent for The Detection of Alkaline Phosphatase

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Glow chemiluminescence is of better controllability and less demanding on instruments, compared with flash chemiluminescence. A novel long-lasting chemiluminescence platform based on classic Deep eutectic solvents (DES) ChCl-Urea is put forward in this work. Co^{2+} is filtered as the catalytical site for its high activity and suitable solubility in DES along with synergetic effect of DES itself after a series of screening. While Co^{2+} is firmly fixed through the coordination bond, aqueous phase possesses better affinity leading to the diffusion of Co^{2+}. As for the luminophore in the aqueous phase, enrichment is observed in the lower part of the aqueous phase under the effect of DES's extraction, so that a considerable concentration of luminophore maintains. As Co^{2+} enter aqueous phase slowly due to the control release effect of the DES, ROS is generated as a result of the decomposition of the H_2O_2 in the presence of Co^{2+} and electron transfer takes place sequently. Reaction between adequate supply of ROS as well as stable concentration lumiphore lasts for more than 70 h under the optimal condition, of which emission time is greatly improved by 3 orders of magnitude. Moreover, this long-lasting CL platform is applied in the sensitive detection of ALP based on the quenching mechanism. The introduction of DES provides a novel strategy for achieving long-term chemiluminescence totally varying from former methodology.

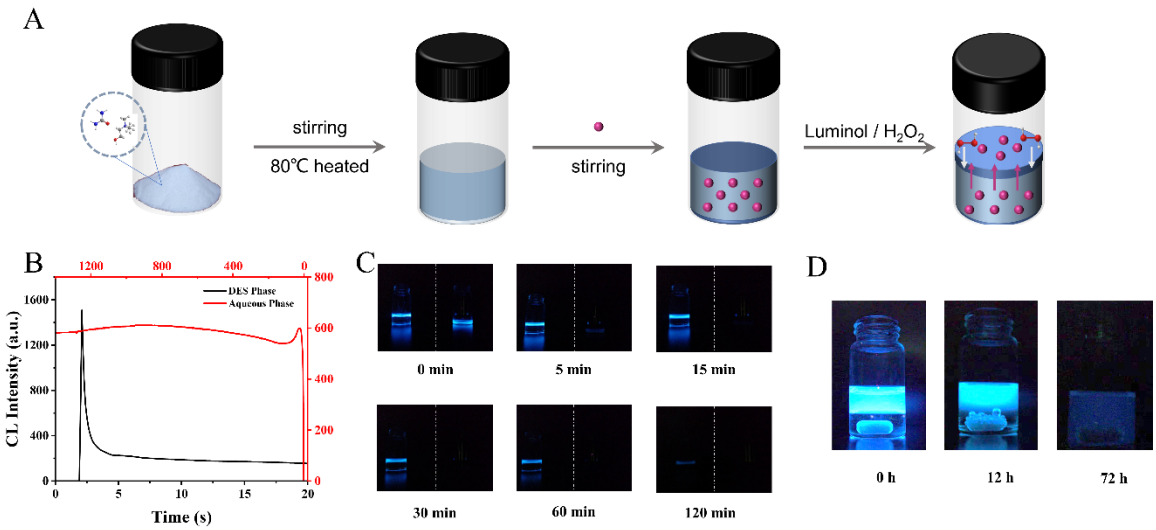


Fig.1 A: the synethese and light emission of DES. B: CL kinetic curves of luminol-H_2O_2 in aqueous phase and DES system. C: Smartphone pictures shot at 0 min, 5 min, 15 min, 30 min, 60 min, 120 min (from left to right). D: the long-lasting chemiluminescence performance

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References

1. Peng,Y.; Yu,L.Y.; Sheng,M.T.; Wang,Q.; Jin,Z.Y.; Huang,J.S.; Yang,X.R., *Anal. Chem.*, **95**, 18436-18442 (2023)
2. Saqib,M.; Lou,B.H.; Halawa,M.I.; Kitte,S.A.; Liu,Z.Y; Xu,G.B., *Anal. Chem.*,**89**, 1863-1869 (2017)

Lady Tasting Tea Revisited: A Nanozyme-Based Artificial Taste Sensor for Tea Differentiation and Brewing Process Analysis

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The "Lady Tasting Tea" is a classic experiment in statistics, often celebrated for its contribution to the field, though the lady's extraordinary taste sensitivity is less frequently acknowledged [1]. The inevitable subjective influence and ethical problems of human sensory evaluation make it urgent to construct an *in vitro* evaluation technology that simulates the human taste system. Recently, noble metal-based nanomaterials exhibiting enzyme-like properties have been utilized to construct cross-response multi-sensor systems, enabling the evaluation of complex food and beverage samples by simulating the process of direct reaction or indirect inhibition (promotion) between target analytes and enzymes [2, 3].

Herein, from the perspective of Lady Tasting Tea experiment, PdSb alloy nanocrystals (NCs) with excellent peroxidase-like (POD) activity were synthesized to build an artificial taste simulation platform to taste the differences in the taste of milk tea during brewing processes (Fig.1) [4]. PdSb alloy with concave nanocubes structure were obtained by the combination of seed-mediated growth method and the underpotential deposition (UPD) of Sb. The enhancement of the activity of PdSb concave nanocubes (PdSb cNCs) comes from the introduction of oxophilic metal Sb and its special concave morphology. Based on PdSb nanozymes, a multi-channel sensing platform was constructed, which can identify six typical tea polyphenols (TPs) simultaneously and successfully distinguish nine black teas (BTs) from different producing areas and processing technologies. Most importantly, by virtue of the multiple differentiation ability of this platform to simulate human taste, the order of adding milk and tea in milk tea with different tea contents is perfectly judged, which provides an objective experimental basis for Lady Tasting Tea experiment from the chemical field for the first time. Looking ahead, the nanozyme-based sensor offers a complementary alternative to HPLC for tea polyphenol analysis and quality assessment, with the potential for real-time, cost-effective, and on-site monitoring requiring minimal sample preparation.

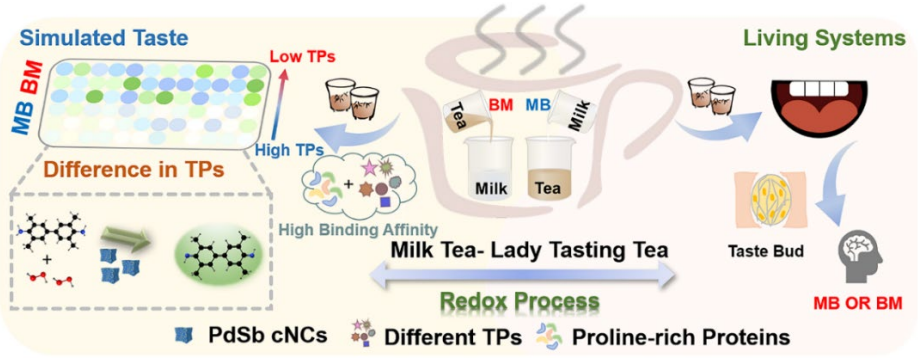


Fig.1 Schematic diagram of the artificial taste platform for revealing "Lady tasting Tea" based on the PdSb nanozymes. TPs: tea polyphenols (TPs); Milk added to black tea water (MB); Black tea water added to milk (BM).

Acknowledgements

This work is supported by the National Natural Science Foundation of China (Nos. 22374144, 22072144, and 22102171).

References

1. J. D. Potter, *Nat. Med*, **7**, 885-886 (2001).
2. F. Li, J. Jiang, H. Peng, C. Li, B. Li, J. He, *Sens. Actuators B Chem.*, **369**, 132334 (2022).
3. J. Duan, S. Xia, X. Sang, Y. Chen, H. Wei, J. Nie, G. Xu, Y. Yuan, W. Niu, *Talanta*, **276**, 126209 (2024).
4. H. Wei, S. Xia, X. Sang, J. G. Kauno, Z. Dong, Y. Zhang, J. Nie, Y. Yuan, G. Xu, W. Niu, *Chem. Eng. J.*, **512**, 162682 (2025).

D-band Center Engineered High Entropy Nanozymes for Point-of-care Testing of Gastric Cancer Markers

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The catalytic activity of high-entropy nanozymes (HEzymes) with the unique cocktail effects exhibits the nonlinear enhancement due to the d-electron interactions of the transition metal components. Precise fine-tuning of their electronic structures has significant development potential in improving the catalytic kinetics of high-entropy catalysts. Herein, a class of efficient RuMnCuCoNi HEzymes catalysts is screened through density functional theory calculations and experiments, whose increased electron abundance near the Fermi energy level and downward shift of the entire d-band center further effectively accelerate the electron transfer between the catalyst and the substrate, thus improving the catalytic performance. Finally, RuMnCuCoNi HEzymes with superior peroxidase-like activity are used to construct the point of care testing analytical platform with excellent sensitivity and selectivity for the detection of D-amino acids as the gastric cancer markers. The proposed RuMnCuCoNi HEzymes highlight the tunability of d-orbital electronic structures, which offers significant potential for improving enzymatic activity and novel insights into the rational design of high-performance nanozymes.

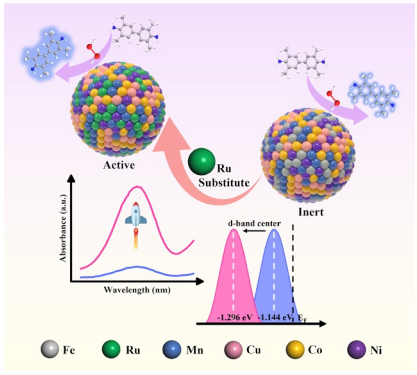


Fig.1 Schematic diagram of RuMnCuCoNi HEzymes with high-performance POD-like activity via tuning d-band center.

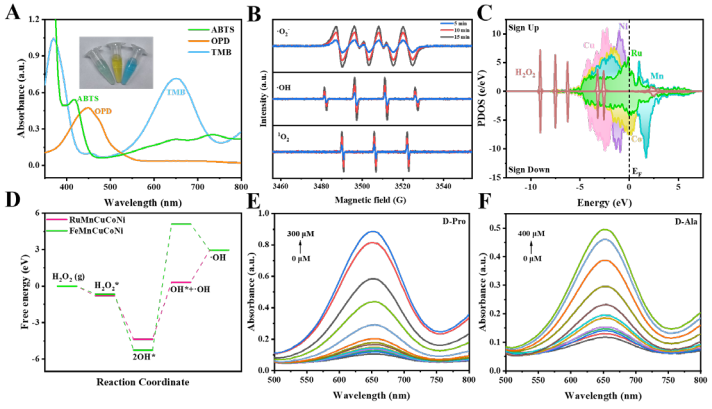


Fig.2 (A) UV-vis absorption spectra and visual colors image of different chromogenic reactions; (B) EPR spectra of $\cdot O_2^-$, ·OH and $^1O_2$ at 5, 10 and 15 min; (C) PODS of RuMnCuCoNi HEzymes and H_2O_2* adsorbed on the HEzymes surface; (D) Free energy diagrams of the reaction pathway for RuMnCuCoNi and FeMnCuCoNi HEzymes. UV-vis absorption spectra of different (E) D-Pro and (F) D-Ala concentrations.

Acknowledgements

This work is funded by the National Natural Science Foundation of China (No. 22404154, 22374143), Jilin Province Science and Technology Development Plan (No.

20230505013ZP), Natural Science Foundation of Jilin Province (SKL20230203).

References

1. Z. Yu, Z. Xu, R. Zeng, M. Xu, H. Zheng, D. Huang, Z. Weng and D. Tang, Angew. Chem. Int. Ed., e202414625 (2024)
2. D. Choi, Y. Boo, S. Park, L. Xu, S. Kim, S. Yi, S. Lee, R. Wu, W. Kim and J. Lee, Adv. Healthcare Mater., **14**, 2402005 (2025)
3. B. Jiang, D. Duan, L. Gao, M. Zhou, K. Fan, Y. Tang, J. Xi, Y. Bi, Z. Tong, G. F. Gao, N. Xie, A. Tang, G. Nie, M. L. and X. Yan, Nat. Protoc., **13**, 1506–1520 (2018)
4. Z. Li, W. Liu, P. Ni, C. Zhang, B. Wang, G. Duan, C. Chen, Y. Jiang and Y. Lu, Chem. Eng. J., **428**, 131396 (2022)

Boosted Chemiluminescence Emission from Gold-silver Bimetallic Nanoclusters for Bioanalysis

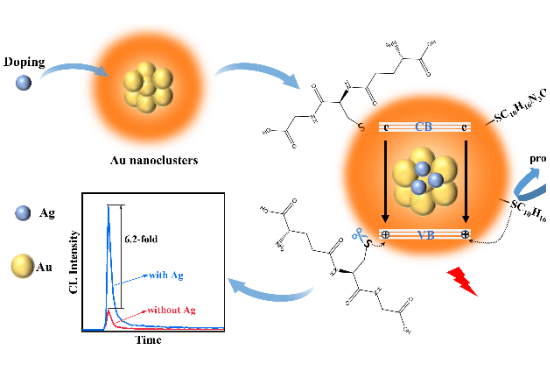
Tongtong ZHAI[a, b], Jing LI[a] *, Erkang WANG[a, b] *

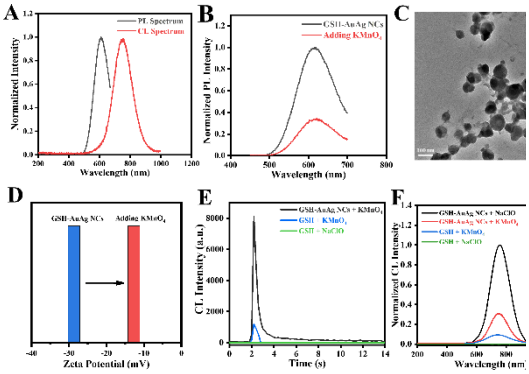
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Chemiluminescence (CL) has recently attracted growing interest as a powerful analytical technique. However, traditional molecular-based CL luminophores suffer from intrinsically limited photon yield per molecule, resulting in insufficient emission quantum efficiency that fails to meet the requirements of high-precision analytical demands. In this context, luminescent nanoclusters (NCs) have emerged as promising alternative emitters owing to their exceptional photophysical properties. The synergistic integration of CL systems with NC-based luminophores provides novel strategies for developing highly sensitive detection platforms. Herein, a series of glutathione-coated Au-Ag bimetallic NCs (GSH-AuAg NCs) were synthesized with varying metal precursor ratios, ultimately exhibiting maximum CL intensity at an optimized Au:Ag molar ratio of 5:1. The bimetallic NCs showed a 6.2-fold enhancement in CL intensity compared to monometallic NCs, attributed to intermetallic synergistic effects enhancing radiative efficiency. Spectroscopic analysis revealed a maximum CL emission peak at ca. 750 nm with a notable 140 nm red shift compared to the corresponding photoluminescence spectrum, which confirms surface-defect-involved CL. Mechanistic studies revealed that $KMnO_4$ oxidizes GSH ligands through redox reactions, generating holes in the valence band that undergo radiative recombination with pre-existing electrons to produce CL emission. The redox-triggered CL system based on GSH-AuAg NCs exhibited excellent response to H_2O_2 and glucose, demonstrating the potential of GSH-AuAg NCs as CL emitters in analytical applications.





Left: Fig.1 Schematic illustration of the CL mechanism of GSH-AuAg NCs/oxidant.

Right: Fig.2 (A) PL and CL spectrum of GSH-AuAg NCs. (B) PL intensity of GSH-AuAg NCs before and after the reaction. (C) HRTEM characterization of the GSH-AuAg NCs after the reaction. (D) Zeta potentials of GSH-AuAg NCs before and after the reaction. (E) CL intensity profiles of GSH-AuAg NCs triggered by $KMnO_4$; 100 mM GSH triggered by $KMnO_4$ and NaClO. (F) CL spectra of 100 mM GSH and GSH-AuAg NCs triggered by $KMnO_4$ and NaClO.

Acknowledgements

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References

1. Z. Luo; X. Yuan; Y. Yu; Q. Zhang; D. T. Leong; J. Y. Lee and J. Xie, *J. Am. Chem. Soc.*, **134**, 16662-16670 (2012)
2. L. Fu; X. Gao; S. Dong; H. Y. Hsu and G. Zou, *Anal. Chem.*, **93**, 4909-4915 (2021)
3. Y. Fan; H. Xing; Q. Zhai; D. Fan; J. Li and E. Wang, *Anal. Chem.*, **90**, 11651-11657 (2018)

Deep learning-enhanced diagnostics for quantitative detection of targets using commercial test strips and a cloud-based smartphone application

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Point-of-care testing (POCT) continues to face critical challenges in accurately distinguishing positive and negative samples at low analyte concentrations due to the background noise and limited quantification capability.[1] To address these limitations, we developed an advanced deep learning (DL)-assisted POCT platform that integrates commercial pregnancy test strips (PTSs) with a cloud-based EfficientNet model and a smartphone application for real-time, quantitative diagnostics. This platform leverages aptamer-mediated molecular recognition and Cu^{2+} specific DNAzyme nanoflower (CuDZNF)-based cascade signal amplification, incorporated into a portable four-channel microfluidic device (FCMD) to produce precise and reproducible signal outputs on PTSs.[2] The EfficientNet architecture, deployed in the cloud, processes captured PTS images to perform high-throughput, low-latency quantitative analysis, effectively reducing the detection limit and expanding the dynamic detection range. In benchmarking studies, the system demonstrated >90.0% classification accuracy and significantly improved the sensitivity and specificity, particularly in distinguishing low-abundance targets from background interference for ochratoxin A (OTA) and aflatoxin M1 (AFM1). The accompanying smartphone application (App) enables a seamless user interface, delivering intuitive, reliable diagnostic results within seconds. With its modular design and broad applicability for detecting environmental pollutants, infectious pathogens, and clinical biomarkers, this DL-assisted POCT platform offers a transformative solution that bridges the gap between laboratory-level analytical performance and real-world, field-deployable diagnostics.

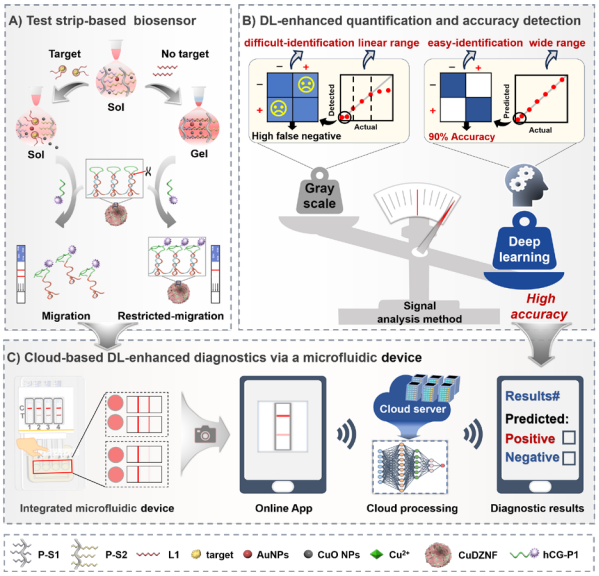


Fig.1 Schematic illustration of the DL-assisted POCT platform. (A) Mechanism of visual and quantitative detection using AuNPs/CuO NPs-encapsulated, target-responsive DNA hydrogel on commercial pregnancy test strips (PTSs) for non-original targets. (B) Comparison between traditional and DL-assisted signal analysis methods, highlighting the enhanced quantification accuracy and noise discrimination achieved by DL-based image processing. (C) Overview of the cloud-integrated smartphone application powered by the EfficientNet model, enabling real-time POCT diagnostics and result interpretation through a four-channel microfluidic device.

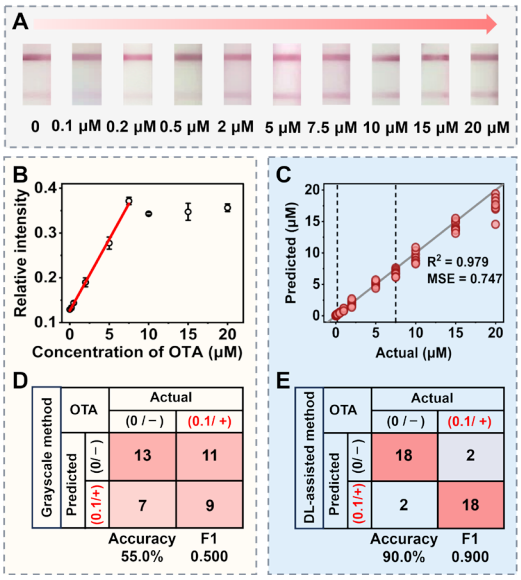


Fig.2 (A) PTS images to different concentrations of OTA. (B) Signal responses of PTS and relative intensity to varying concentrations of OTA, followed by ImageJ analysis for TL and CL quantification (n = 3). (C) Actual vs. predicted concentrations for the test set of OTA. Confusion matrices for distinguishing between negative (background) and positive (0.1 μM) samples of OTA via the grayscale method (D) and the DL-assisted method (E) on the test set (n = 20 per concentration).

Acknowledgements

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References

1. S. Lee, J. S. Park, H. Woo, Y. K. Yoo, D. Lee, S. Chung, D. S. Yoon, K.-B. Lee, J. H. Lee, Nat. Commun., 15, 1695 **(2024)**.
2. Y. Du, A. Pothukuchy, J. D. Gollihar, A. Nourani, B. Li, A. D. Ellington, Angew. Chem. Int. Ed., 56, 992-996 **(2017)**.

Boosting Cu-based nanozyme catalysis by introducing imidazole as enzyme-like cofactor

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The catalytic active centers of natural metalloenzymes typically consist of metal centers and organic cofactors, where the cofactors play a critical role in the catalytic cycle [1]. Inspired by the structure–function relationship of natural enzymes, nanozymes have been developed to mimic the active center structures to achieve enzyme-like activity [2]. Building on previous work [3], we explored the potential of various nitrogen-containing molecules as external cofactors for nanozymes, using CuO nanoparticles with phenol oxidase-like activity as a model catalyst. Among them, imidazole was found to have significantly enhance the catalytic performance of CuO, with the V_{max} of 2,4-dichlorophenol chromogenic oxidation improving by more than 100-fold in the presence of imidazole. Based on the results from HPLC, XPS, and *in situ* surface-enhanced infrared absorption spectroscopy, we propose that imidazole acts as a co-catalyst by dynamically adsorbing onto the CuO surface to form Cu–N active sites, while also activating the chlorophenol substrates. Furthermore, electrochemical studies revealed that imidazole facilitates the Cu(I)/Cu(II) redox cycling, resembling the role of organic cofactors in natural enzymatic systems. Together, these findings demonstrate that small molecules and inorganic nanomaterials can also effectively mimic the synergistic action of metal ion and organic cofactors in natural enzymes by simple interactions such as adsorption and coordination, providing experimental evidence supporting the hypothesis of the nanozymes acting as prebiotic catalysts before the emergence of life [4].

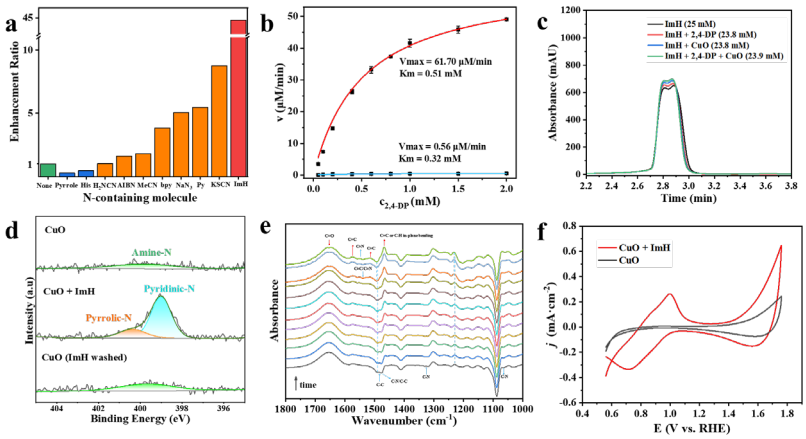


Fig.1 (a) The influence of varied N-containing molecules toward CuO-catalyzed oxidation of 2,4-dichlorophenol (2,4-DP) reflected by enhancement ratio normalized by absorbance at 510 nm of blank control contrail without supplemented molecules; (b) characterization of the catalytic kinetics of CuO nanozymes with (red line) or without (blue line) imidazole (ImH) under optimized condition by Michaelis–Menten curve; (c) separation of ImH in different mixed systems by HPLC to validate dynamic adsorption of ImH on CuO during catalytic oxidation of 2,4-DP; (d) high resolution XPS spectra of N 1s of pristine CuO, CuO after ImH adsorption and CuO after ImH adsorption followed by washing; (e) *in situ* SEIRA spectra in range of 1000−1800 cm^{-1} for CuO catalyzed 2,4-DP oxidation in the presence of ImH; (f) CV curves of the CuO or CuO+ImH modified GCE in PB-KCl electrolyte.

Acknowledgements

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References

1. M. Rolff, J. Schottenheim, H. Decker, F. Tuczek, *Chem. Soc. Rev.*, **40**, 4077-4098 (2011).
2. Y. Wu, H. Zhong, W. Xu, R. Su, Y. Qin, Y. Qiu, L. Zheng, W. Gu, L. Hu, F. Lv, S. Zhang, S.P. Beckman, Y. Lin, C. Zhu, S. Guo, *Angew. Chem. Int. Ed.*, **63**, e202319108 (2024).
3. W. Wu, C. Peng, Y. Wang, J. Li, E. Wang, *J. Colloid Interface Sci.*, **680**, 785-794 (2025).
4. L. Ma, Z. Liang, Y. Hou, R. Zhang, K. Fan, X. Yan, *Adv. Mater.*, **37**, 2412211 (2025).

Aptamer-based lateral flow assay for sensitive detection of Vascular endothelial growth factor 165

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Vascular endothelial growth factor (VEGF) is one of the platelet-derived growth factors[1], its overexpression might induce a variety of diseases such as nasopharyngeal carcinoma[2], and would lead to the increase of capillary permeability, high tumor blood perfusion, and ultimately tumor proliferation and metastasis[3]. Therefore, VEGF as a significant biomarker can be used to diagnose early cancer and evaluate the effect of treatment[4]. Lateral flow assay (LFA) has been widely used in many fields including food supervision, environmental monitoring and disease diagnosis, etc., due to its advantages of portability, low cost and simple operation[5]. However, it is still urgent to further improve its sensitivity and develop LFA methods for detection of early cancers. In this study, we explored a LFA test strip for sensitively and conveniently detecting one of VEGF variants, VEGF165 (Fig.1). To resolve the bottleneck derived from the VEGF165 antibody because of high cost and limited types, an aptamer for VEGF165 was introduced, and modified on the surfaces of gold nanoparticles (AuNPs), by the binding interaction between biotin and streptavidin, resulting in a signal nanoprobe. A sandwiched structure can be formed through the molecular recognition among the VEGF165 antibodies on the test zones of test strips, VEGF165 proteins and the signal nanoprobes. Thus, visual detection of VEGF165 was realized, since a red band from AuNPs can be generated, upon addition of VEGF165. Subsequently, we adopted an in-situ gold growth strategy for signal amplification, the sensitivity of the test strips was effectively improved, and as low as 0.12 ng/mL VEGF165 can be detected. The research results are significant for construction of methods and devices for point-of-care screening of diseases in the future.

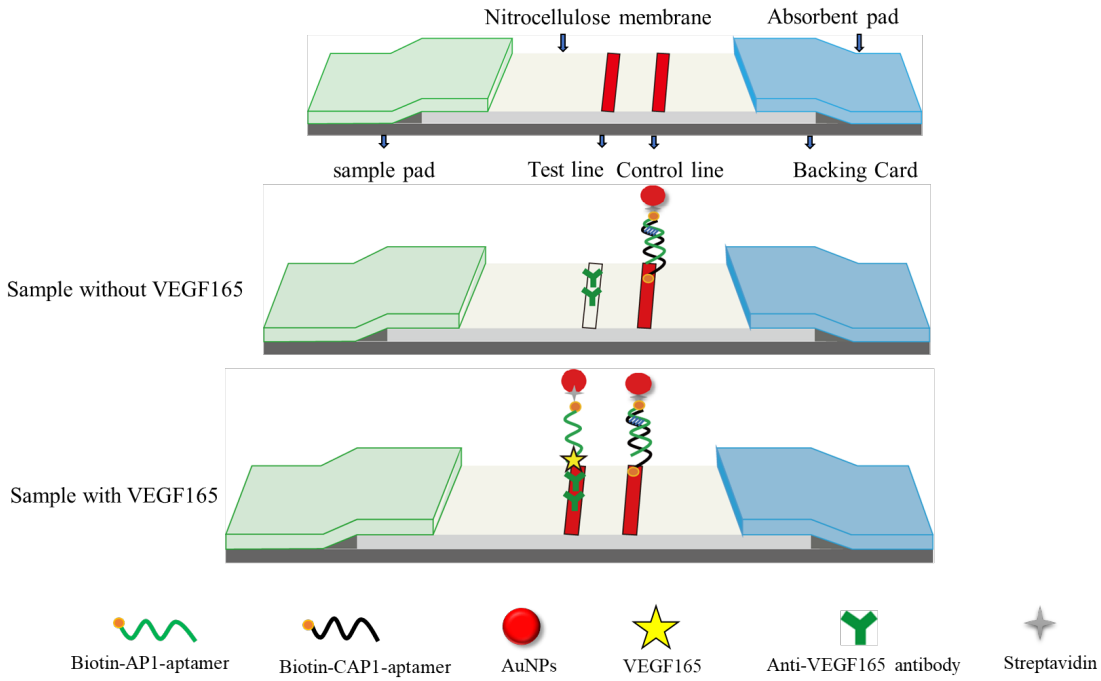


Fig.1 Schematic illustration of a LFA strip for VEGF165 analysis

Acknowledgements

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References

1. I. Zachary, *Am. J. Physiol.*, **280**, 1375-1386 (2001)
2. Y. Lai, X. Wang, T. Zeng, S. Xing, S. Dai, J. Wang, S. Chen, X. Li, Y. Xie, Y. Zhu, W. Liu, *J. Cancer.,* **9**, 1538-1547 (2018)
3. L. Chen, G. Lin, K. Chen, R. Liang, F. Wan, C. Zhang, G. Tian, X. Zhu, *J. Cancer.*, **11**, 7291-7301 (2020)
4. A. Qureshi, Y. Gurbuz, J.H. Niazi, *Sens. Actuator B-Chem.,* **209**, 645-651 (2015)
5. D. Calabria, M.M. Calabretta, M. Zangheri, E. Marchegiani, I. Trozzi, M. Guardigli, E. Michelini, F. Di Nardo, L. Anfossi, C. Baggiani, M. Mirasoli, *Sensors.,* **21**, 3358 (2021)

Label-Free Exosomal SERS Detection Assisted by Machine Learning for Accurately Discriminating Cell Cycle Stages and Revealing the Molecular Mechanisms during the Mitotic Process

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Cell cycle analysis is crucial for disease diagnosis and treatment, especially for investigating cell heterogeneity and regulating cell behaviors. Exosomes are highly appealing as noninvasive biomarkers for monitoring real-time changes in the cell cycle due to their abundant molecular information inherited from their metrocyte cells and reflecting the state of these cells to some extent. However, to our knowledge, the relationship between exosomes and the cell cycle has not been reported. Herein, we successfully monitored the variation of exosomal surface-enhanced Raman spectroscopy (SERS) spectra to discriminate different cell cycle stages (G_0/G_1, S, and G_2/M phases) based on label-free surface-enhanced Raman spectroscopy (SERS) combined with the machine learning method of linear discriminant analysis (LDA). An average accuracy of 85% based on the trained SERS spectra of exosomes from different cell cycle stages confirmed the high reliability of the support vector machine (SVM) algorithm for analyzing dynamic changes in the cell cycle at different time points. Importantly, the related molecular mechanisms among mitotic processes (prometaphase, metaphase, and anaphase/telophase) and unique biomolecular events between cancerous (HeLa) and normal (H8) cells were also revealed by the present label-free SERS detection platform. Based on SERS analysis, the content of phenylalanine (Phe) within HeLa cells increased, and some structures of proteins containing Phe and tryptophan (Trp) residues may be transformed during the mitotic process. Notably, the α-helix and β-sheet of proteins coexisted in HeLa cells; meanwhile, the α-helix of the proteins was more dominant in H8 cells than in HeLa cells. The strategy is effective for discriminating cell cycle stages and elucidating the associated molecular events during the cell mitotic process and will provide potential application value for guiding the cell cycle treatment strategies of cancer in the future.

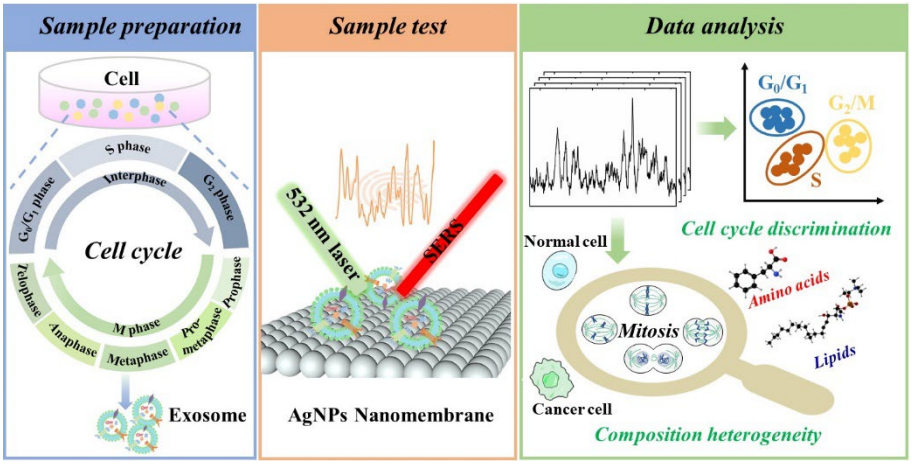


Fig.1 Label-Free SERS Detection of Exosomes Secreted from Metrocytes for Discriminating Different Cell Cycle Stages and Analyzing Composition Heterogeneity among Different Mitotic Processes and Different Cells (Cancer and Normal Cells) using Plasmonic AgNPs-NM as the SERS Substrate Assisted by Machine Learning

Acknowledgements

This work was supported by the Science and Technology Development Plan Project of Jilin Province (grant nos. 20240101185JC, 20230505013ZP, and SKL202401008), the National Natural Science Foundation of China (Grant Nos. 22374143, 22474078, and 22004117), the Youth Innovation Promotion Association CAS (No. 202055), and research startup funding support of Shenzhen University.

References

1. Diao, X.; Qi, G.; Li, X.; Tian, Y.; Li, J.; Jin, Y. Anal. Chem., 2025, 97 (9), 5093-5101.

Generalized Synthesis of Chiroplasmonic Helicoidal Metal Nanoparticles and Their Application in Anti-Interference Chiroplasmonic Sensing

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The rising interest in chiral metal nanomaterials with helicoidal morphologies is driven by their unique and tailorable chiroptical properties [1] and unconventional applications in chirality-related fields [2]. However, existing synthesis strategies have been mainly limited to gold, highlighting the need for a versatile strategy to achieve enantioselective synthesis of chiral metal nanoparticles with tunable shapes and structures. Furthermore, helicoidal chiroplasmonic nanocrystals are particularly promising for ultrasensitive and anti-interference biochemical detection [3], as their strong and stable chiroptical signals confer high robustness against cross-talk and interference from non-target analytes and background noise.

In this work, we demonstrate a robust and versatile strategy for the enantioselective synthesis of helicoidal nanoparticles beyond gold, leveraging chiral nanoconfinement provided by chiral SiO_2 nanoshells [4]. The chiral nanoconfinement strategy enables the decoupling of ligand-directed crystal growth from chiral induction. Using this approach, we successfully synthesized helicoidal Pt, Au@Pt, Au@Pd, Au@Ag, and Au@Cu nanoparticles with chiroplasmonic properties. Notably, the nanoparticles not only replicate the chiral shapes of the chiral nanoshells but also form alternative chiral shapes (Fig.1). The chiral nanoconfinement strategy enriches the toolbox for creating chiral nanoparticles and open new avenues for expanding their material diversity and functionality.

In addition, capitalizing on the ultrasensitive structure-dependent chiroptical activity of helicoidal Au nanoparticles, we developed an etching-based chiroplasmonic sensing platform for biochemical detection [5]. The sensing mechanism relies on chiroptical signal response induced by morphological changes resulting from H_2O_2-assisted etching (Fig.2). Notably, the method exhibits excellent anti-interference performance, enabling reliable detection even in complex and colored environments. The platform's robust performance in real colored samples highlights its potential for practical applications in biochemical analysis and diagnostics.

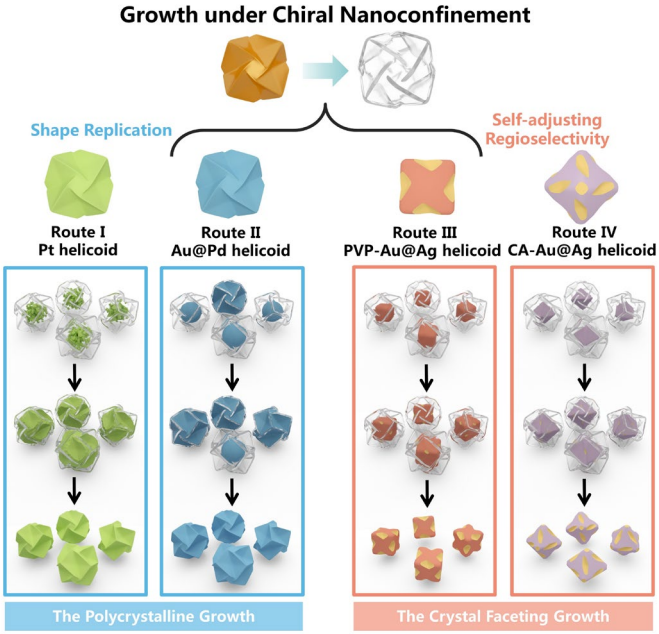


Fig.1 Schematic representation for the growth mechanisms of various helicoid NPs under chiral nanoconfinement.

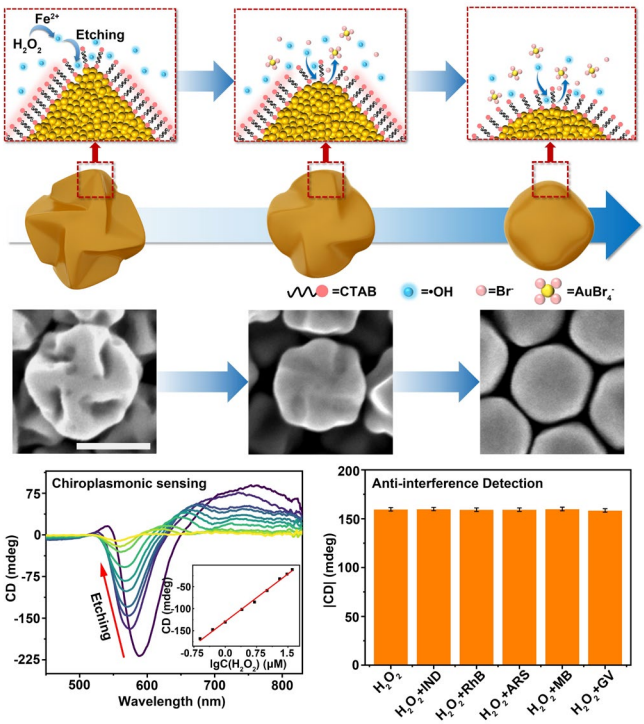


Fig.2 Schematic illustration of chiroplasmonic sensing based on L-helicoid Au etching strategy.

Acknowledgements

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References

1. F. Wu, Y. Tian, X. Luan, X. Lv, F. Li, G. Xu and W. Niu*, *Nano Lett.*, **22**, 2915-2922 (2022).
2. Y. Tian, F. Wu, X. Lv, X. Luan, F. Li, G. Xu and W. Niu*, *Adv. Mater.*, **36**, 2403373 (2024).
3. X. Luan, Y. Tian, F. Wu, L. Cheng, M. Tang, X. Wang, F. Li, G. Xu and W. Niu*, *Nat. Commun.*, **16**, 2418 (2025).
4. X. Lv, F. Wu, Y. Tian, P. Zuo, F. Li, G. Xu and W. Niu*, *Adv. Mater.*, **35**, 2305429 (2023).
5. X. Luan, F. Wu*, X. Lv, F. Li, Y. Tian, G. Xu, X. Wang, G. Zheng, W. L. Wong, K. Y. Wong and W. Niu*, *Small*, DOI: 10.1002/smll.202500888

Visualization of Mechanical Force Regulation of Exosome Secretion Using High Time-Spatial Resolution Imaging

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Exosomes are small endosome-derived extracellular vesicles that play a crucial role in intercellular communication, particularly in cancer progression, where their secretion is tightly regulated by the tumor microenvironment[1]. Although accumulating evidence suggests that mechanical forces may enhance exosome release, the precise molecular mechanisms underlying this relationship remain poorly understood[2]. In this study, we developed a dual-color CD63 reporter-based high-speed live-cell imaging system to dynamically track exosome secretion in real time under controlled mechanical stimulation. This cutting-edge approach allowed us to capture, for the first time, the complete process of multivesicular body (MVB) docking and fusion with the plasma membrane (PM), followed by instantaneous exosome release at single-vesicle resolution. Our quantitative analysis revealed that mechanical pressure triggers a rapid, force-dependent burst of exosome secretion. Through pharmacological and genetic perturbation experiments, we further demonstrated that force-induced actin cytoskeletal remodeling - particularly the formation of cortical actin networks - serves as a critical molecular switch governing mechanical stimulation of exosome release. These findings not only establish a direct causal link between physical forces and exosome secretion but also identify the actin cytoskeleton as a key mechanosensitive regulator of this process. The study provides novel insights into the biomechanical control of intercellular communication and opens new avenues for developing therapies that target mechano-regulated exosome pathways in cancer and other diseases.

Acknowledgements

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References

1. Teng, F.; Fussenegger, M. Shedding Light on Extracellular Vesicle Biogenesis and Bioengineering. *Adv. Sci.*, **8**, 2003505 (2021).
2. Jin, Y.; Ma, L.; Zhang, W.; Yang, W.; Feng, Q.; Wang, H. Extracellular signals regulate the biogenesis of extracellular vesicles. *Biol. Res.*, **55**, 1-16 (2022).

Cascade DNA Logic Strategy for Profiling MiRNA-Targeted Signaling Pathway in the Warburg Effect of Triple-Negative Breast Cancer

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The Warburg effect is regulated by intricate signaling networks involving microRNAs (miRNAs) and metabolic modulators.[1,2] However, conventional approaches for pathway analysis often fall short in dynamically detecting multiple molecular inputs simultaneously within live-cell environments.[3,4] In this study, we developed a cascaded INHIBIT-AND logic gate to map Warburg effect–related signaling pathways in living cells. Firstly, the YES logic operation is executed through the H_2O_2-responsive Dz, which cleaves the RNA substrate (Fragment) into two parts (Fuel 1 and Fuel 2). Fuel 2 facilitates the release of the Cy3-labeled strand from substrate probe (SP) 1/2 via a toehold-mediated strand displacement reaction (SDR), thereby generating a Cy3 fluorescence signal associated with H_2O_2. Secondly, an INHIBIT logic gate is introduced into the EDR to represent the relationship between miR-210 and CYGB mRNA. Here, CE1 responds to miR-210 and releases the catalyst strand ST to activate the EDR circuit with assistance of Fuel 1. CE2 hybridizes with CYGB mRNA through toehold-mediated assembly, with the exposed loop domain binding to the catalyst ST to inhibit the FAM signal amplification. Finally, the INHIBT-AND cascaded logic gate is applied to profile the miR-210-3p/CYGB/p53 signaling pathway associated with the Warburg effect in TNBC cells. Specifically, in TNBC cells, overexpression of miR-210 and suppression of downstream CYGB mRNA synergistically activate the INHIBIT logic gate (1,0), while p53 downregulation leads to intracellular H_2O_2 accumulation, triggering Dz-mediated substrate cleavage. Therefore, compared to other breast cancer subtypes, the amplified Cy3 and FAM fluorescence readouts from the cascaded logic gate can simultaneously reflect variations in H_2O_2, miR-210, and CYGB mRNA, enabling in situ visualization of the Warburg effect signaling pathway in TNBC cells. This work presents a novel strategy for live-cell logic computation and offers a powerful platform for deciphering metabolic reprogramming and enabling targeted cancer diagnostics.

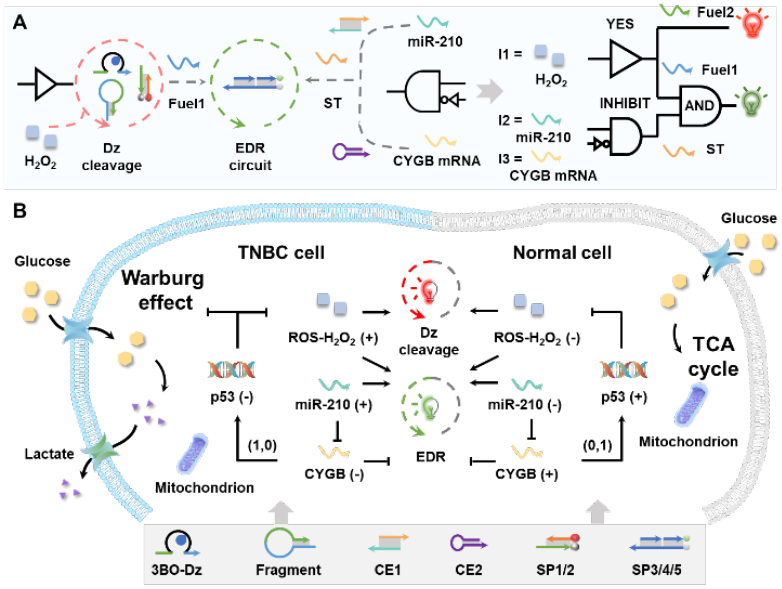


Figure 1. Cascaded logic gate for profiling the Warburg effect signaling pathway. (A) Schematic illustration of the cascaded logic gate design integrating dual signal amplification. (B) Simultaneous monitoring of H_2O_2, miR-210, and CYGB using the cascaded logic gate, enabling dual fluorescent readouts for mapping the miR-210/CYGB/p53 signaling axis in the Warburg effect of triple-negative breast cancer (TNBC) cells.

Acknowledgements

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References

1. Z. E. Stine, Z. T. Schug, J. M. Salvino and C. V. Dang, *Nat. Rev. Drug Discov.*, **21**, 141-162 (2021)
2. Y. Tian, Z. H. Chen, P. Wu, D. Zhang, Y. Ma, X. F. Liu, X. Wang, D. Ding, X. C. Cao and Y. Yu, *Adv. Sci.*, **10**, 2204819 (2023)
3. D. Li, Y. Liu, Y. Li, Y. Xiang, and R. Yuan, *Anal. Chem.*, **96**, 3329-3334 (2024)
4. F. Yang, S. Li, X. Bi, R. Yuan and Y. Xiang, *Anal. Chem.*, / //12514-12520 (2023)

Construction of Frustrated Lewis Pairs on Copper Nanoclusters with Enhanced Enzyme-like Activity for Pharmaceutical Analysis

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Efficient activation of substrate molecules is a highly developed strategy for screening high-performance enzyme-like catalysts. Frustrated Lewis pairs (FLPs) formed by Lewis acid (LA) and Lewis base (LB) pairs have been reported to efficiently promote activation and dissociation of small molecules. Herein, monodisperse Cu NCs were synthesized by one-pot rapid titration by selecting 6-aza-2-thiothymidine (ATT) as a structural template and reducing agent, and the FLP active sites were successfully immobilized on the surface of Cu NCs with atomic precision. Specifically, Cu NCs exhibited excellent enzyme-like activity (peroxidase-like) and high stability, with Cu as the LA active site and N, O, and S atoms in the ligand as the LB active sites, thereby successfully constructing the frustrated Lewis acid-base pairs. The complex and precise coordination structure on the cluster surface was resolved by high-resolution electrospray ionization mass spectrometry, revealing a well-defined molecular structure formed by the coordination of four copper atoms with seven ATT ligands ($[Cu_4(ATT)_7]$). Based on its enhanced enzyme-like catalytic properties, a sensor array was successfully constructed to enable accurate characterization and concentration detection of three non-steroidal anti-inflammatory drugs (NSAIDs, including acetaminophen, ibuprofen, and aspirin). Thus, this study provides a new strategy for screening efficient enzyme-like catalysts, showing promising applications in the field of drug analysis.

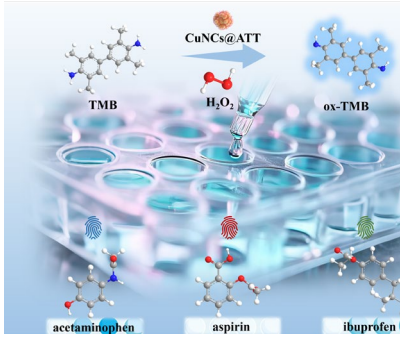


Fig.1 Schematic Diagram of CuNCs@ATT used for the detection of three NSAIDs.

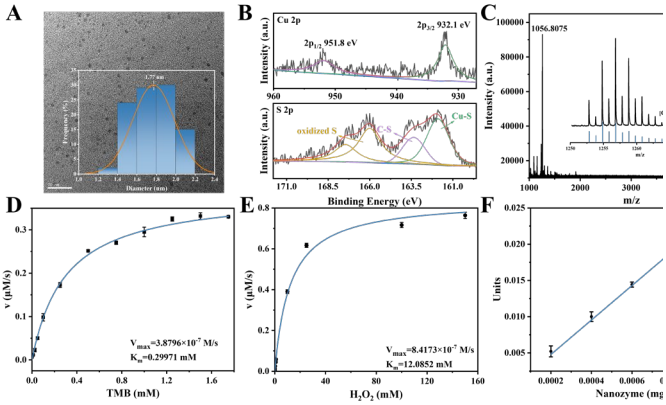


Fig.2 (A) HRTEM images of CuNCs@ATT; (B) XPS of CuNCs@ATT; (C) HR-ESI-MS of CuNCs@ATT; Steady-state kinetic assays of CuNCs@ATT for (D) TMB and (E) H_2O_2; (F) The specific activities of CuNCs@ATT.

Acknowledgements

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References

1. B. Jiang, D. Duan, L. Gao, M. Zhou, K. Fan, Y. Tang, J. Xi, Y. Bi, Z. Tong, G. F. Gao, N. Xie, A. Tang, G. Nie, M. L. and X. Yan, Nat. Protoc., **13**, 1506–1520 (2018)
2. H. Deng, X. Shi, F. Wang, H. Peng, A. Liu, X. Xia and W. Chen, Chem. Mater., **29**, 1362–1369 (2017)
3. S. Li, Q. Wu, X. You, X. Ren, P. Du, F. Li, N. Zheng and H. Shen, J. Am. Chem. Soc., **146**, 27852–27860 (2024)

Regulating the Catalytic Activity of DNA-Templated Copper Nanoclusters Based on DNA Structural Transition

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Artificial nanocatalysts have been developed to mimic the catalytic activity of natural enzymes (e.g., peroxidase, oxidase and superoxide dismutase, etc.)[1], but mostly their catalytic activity is “always-on”. DNA-stabilized nanomaterials have attracted much more attention, of which properties may be modulated with different DNA sequences and structures[2, 3]. In this study, copper nanclusters protected with different DNA templates were synthesized, and DNA homopolymer polyG-templated CuNCs (5G-CuNCs) exhibited the highest catalytic activity toward reduction of 4-nitrophenol (4-NP) by sodiyum borohydride. The influences of DNA species and structures on the catalytic activity of 5G-CuNCs were systematically investigated. Distinct inhibition effects were observed, particularly for different structures, namely, polyA ≈ poly(AT) duplex >> poly(TAT) triplex. Accordingly, catalytic properties of 5G-CuNCs were encoded by different DNA structures, and regulated reversibly through fuel-driven DNA allostery between poly(AT) and poly(TAT), thus yielding intriguing a switchable catalytic nanosystem (Figure 1). It is believed that our research will contribute to formulating controllable nanocatalysts for precise detection and therapy in the future.

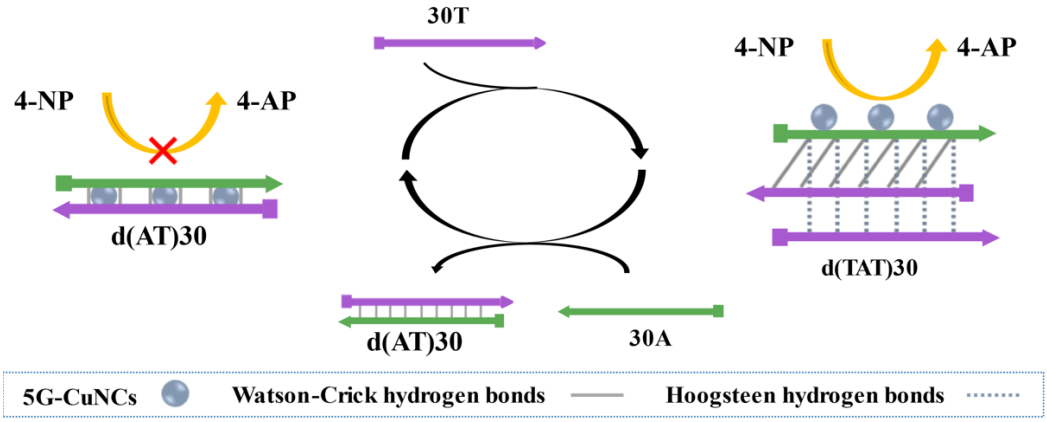


Figure 1. Schematic illustration of a simple switchable catalytic nanosystem with polyT (30T) and polyA (30A) as fuel strands, for reversibly regulating the catalytic activity of 5G-CuNCs. The squares and arrows on the DNA strands represent the 5' and 3' ends, respectively.

Acknowledgements

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References

1. C. Peng; R. Pang; J. Li and E. Wang, *Adv. Mater.*, *36*, 202211724 (2024)
2. F. Yin; J. Ren and E. Wang, *Chemistry-Switz.*, *5*, 2418-2440 (2023)
3. Y. Guo; M. Lv; J. Ren and E. Wang, *Small*, *17*, 2006553 (2021)

An LFIA based on AuPd@Fe_xO_y nanozymes for a sensitive and timely quantitative detection of D-dimer

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D-dimer is a biomarker of activated human coagulation and fibrinolytic systems that can be measured in whole blood or plasma. It plays a critical role in the timely and accurate diagnosis of thrombotic diseases such as venous thromboembolism (VTE), pulmonary embolism (PE), and disseminated intravascular coagulation (DIC).[1] In this study, the specific antibodies of D-dimer were immobilized on the surface of AuPd@Fe_xO_y nanoparticles to fabricate the detection probes of a lateral flow immunoassay (LFIA) platform. AuPd@Fe_xO_y NPs was synthesized according to our previously established protocol.[2] The LFIA was developed for the quantitative detection of D-dimer in human plasma with excellent stability and sensitivity, which incorporates two detection mode: a conventional colorimetric mode and an enhanced colorimetric mode. In the conventional mode, the LFIA exhibits a limit of detection (LOD) as 0.043 μg/mL (Fig. 2b). In the enhanced colorimetric mode, owing to the excellent peroxidase-like activity of AuPd@Fe_xO_y nanoparticles, the LFIA exhibits a low LOD as 0.0024 μg/mL with the nanozyme-triggered catalytic oxidation of 3,3',5,5'-tetramethylbenzidine (TMB) by H_2O_2 (Fig. 2c). The visual sensitivity was significantly enhanced by approximately 20-fold (Fig. 1). In conclusion, the AuPd@Fe_xO_y-LFIA, with its exceptional analytical performance of D-dimer detection, offers a novel strategy for on-site detection and large-scale screening of thrombotic diseases.

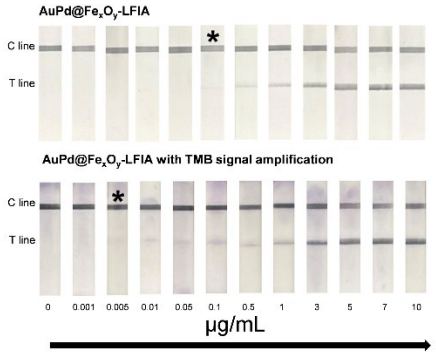


Fig.1 Photographs of AuPd@Fe_xO_y-LFIA for detecting different concentrations of D-dimer in standard solutions. The asterisks indicate LODs by the naked eye (*).

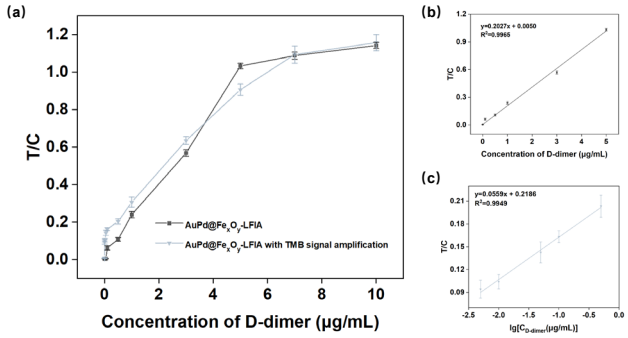


Fig.2 (a) The T/C value as a function of the D-dimer concentration (n=3), linear curves of T/C value obtained from (b) AuPd@Fe_xO_y-LFIA and (d) AuPd@Fe_xO_y-LFIA after the AuPd@Fe_xO_y catalyzed oxidation of TMB by H_2O_2.

Acknowledgements

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References

1. E. D. Johnson, J. C. Schell and G. M.Rodgers, *American journal of hematology*, **94**, 833-839 (2019).
2. Y. Sun, H. Chen, Y. Huang, et al., *Biomaterials*, **274**, 120821 (2021).

Synthesis of polyacrylic acid coated AuPd@Fe_xO_y nanoparticles for synergistic chemodynamic and photothermal therapy of osteosarcoma

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Osteosarcoma (OS) is the primary malignant bone tumour, characterized by generating osteoid and immature bone by mesenchymal cells/osteoblastic progenitor cells. The surgery and adjuvant chemotherapy are first-line strategy for treatment of OS. However, the outcomes of chemotherapy are poor for recurrent OS and metastatic OS because the rapid progression of disease and chemotherapy resistance [1]. In addition, the conventional OS chemotherapeutics can lead to severe side effects. Therefore, there is an urgent need to develop new therapeutic modalities with low biotoxicity for effective treatment of OS [2].

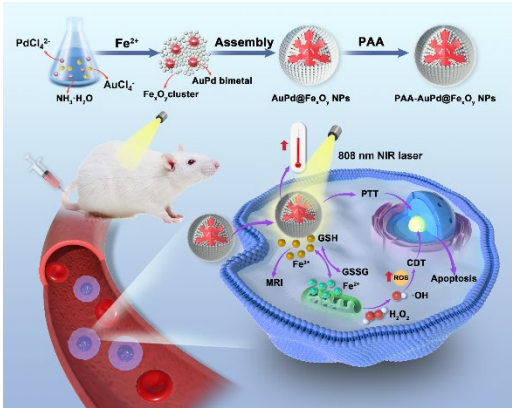


Fig.1 Schematic illustration of the synthetic process of PAA-AuPd@Fe_xO_y NPs, and their application in tumour therapy.

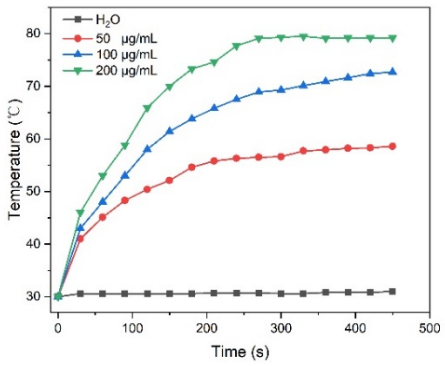


Fig.2 Temperature profiles of PAA-AuPd@Fe_xO_y NPs solutions at different concentrations under 808 nm NIR laser irradiation at 2.0 W/cm^2

In this report, the polyacrylic acid coated AuPd@Fe_xO_y core@shell nanoparticles (termed as PAA-AuPd@Fe_xO_yNPs) have been synthesized for magnetic resonance imaging (MRI)-guided synergistic chemodynamic therapy and photothermal therapy (CDT-PTT) of OS through a simple two-step process. The amorphous Fe_xO_y shell of PAA-AuPd@Fe_xO_yNPs not only exhibits a pH-responsive T_1-weighted MRI contrast ability, but also can generate massive hydroxyl radicals (·OH) by the glutathione (GSH) amplified Fenton reaction.

Furthermore, the production of reactive oxygen species (ROS) can be enhanced by 808 nm near infrared (NIR) laser irradiation because the PAA-AuPd@Fe_xO_y NPs exhibit excellent photothermal conversion capability. The features of PAA-AuPd@Fe_xO_y NPs improve the tumour-MRI sensitivity, and facilitate synergistic CDT-PTT of tumour. The growth of MG63 OS in mouse model is effectively suppressed by the PAA-AuPd@Fe_xO_y NPs with 808 nm NIR laser irradiation.

Acknowledgements

The authors would like to thank the Jilin Provincial Science and Technology Department (Grant No. SKL202302030, 20230204074YY and 2024SYHZ0016) for financial support.

References

1. X.Q. Wang, W. Wang, et al. *Biomaterials.* **266**, 120474(2021).
2. Y. Zhu, Y. Wang, et al, *Advanced Science,* **7**, 2000272(2020).

Quantitative Detection of Multiple Cathepsin Activities by a Peptide Microarray-Based Metal-Enhanced Fluorescence Assay

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Osteosarcoma (OS) is a primary malignant bone tumor with a high rate of recurrence and lung metastasis. Cathepsins (CTSs) play a crucial role in the invasion and metastasis of OS. Herein, a Förster resonance energy transfer (FRET)-peptide microarray-based metal enhanced fluorescence (MEF) assay (PMMEFA) is proposed to detect the activities of CTS B, D, G, K, and L. The assay involves immobilization of FRET-peptides on a poly (glycidyl methacrylate-co-2-hydroxyethyl methacrylate) coated gold nanorods modified glass slide (GNR@P (GMA-HEMA)) [1,2]. After adding CTSs, the FRET-peptide is specifically cleaved by CTSs, disrupting the FRET effect. Meanwhile, the fluorescence signal is restored and further enhanced by the MEF effect of GNRs (Fig.1). The activity of CTSs in different matrices is quantitatively analyzed by calculating the fluorescence recovery rate. This method exhibits excellent selectivity and sensitivity. The Limits of Detection (LOD) for CTS B, D, G, K, and L are 3.4 fg mL^{-1}, 25.5 fg mL^{-1}, 1.4 fg mL^{-1}, 2.5 fg mL^{-1}, and 4.3 fg mL^{-1}, respectively. The PMMEFA is used to quantitatively analyze the activity of CTSs in cell lysates and cell culture media of 4 human OS cell lines (MG 63, 143 B, U2OS, and Saos-2), indicating that the activities of CTSs have a certain correlation with the type and degree of malignancy of cells. The PMMEFA was also applied to detect the CTSs activities in tissue homogenates of 143 B tumor-bearing mice, which demonstrated that the activity of CTSs is closely related to the progression of OS (Fig.2).

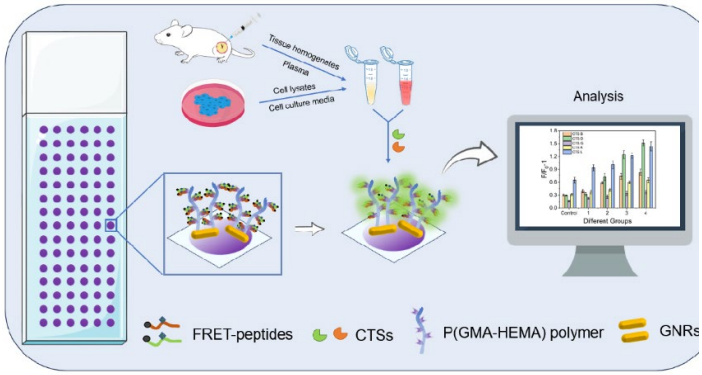


Fig.1 Schematic representation of the as-proposed PMMEFA on the GNR@P(GMA-HEMA) slide for simultaneously determining CTS activities

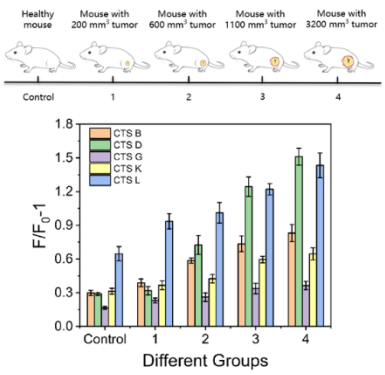


Fig.2 Profiling of CTS activities in 5% tissue homog-enate samples, which were obtained from the mice with different stages of 143 B tumor-bearing mice by the PMMEFA.

Acknowledgements

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References

1. M. H. Jian, X. D. Sun, H. Zhang, X. T. Li, S. S. Li and Z. X.Wang, *Biosens Bioelectron.,* **246**, 115871 (2024).
2. Z. Lei, J. X. Gao, X. Liu, D. J. Liu and Z. X. Wang, *ACS Appl Mater Interfaces.,* **8**, 10174-10182 (2016).

Development of Ratiometric Fluorescence Nanosensor for Evaluating Precision Chemotherapy of Osteosarcoma Through Real-Time Monitoring of Caspase-3 Activity

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It is well-known that chemotherapy is the first-line strategy for treatment of Osteosarcoma (OS), and the conventional OS chemotherapeutic drugs can lead to severe side effects. There is an intensive demand for developing personalized precision chemotherapy. In situ monitoring Caspase-3 activity in tumor is vital for evaluating the efficacy of chemotherapy because Caspase-3 is a critical execution enzyme in chemotherapeutic drug-induced apoptosis of cancer cells. Various nanomaterials, including quantum dots, plasma nanoparticles, magnetic nanoparticles, 2D nanomaterials, and rare-earth doped upconversion nanoparticles (UCNPs), have been used to sense Caspase-3 activity. Among these, UCNPs are especially suited for in vivo detection due to their excellent photostability, deep tissue penetration under near-infrared excitation, and low background interference [1,2]. Polydopamine (PDA), a bioinspired polymer, serves as an effective photothermal agent and FRET acceptor because of its strong NIR absorbance and fluorescence quenching. PDA-coated UCNPs (UCNP@PDA) have been developed for real-time monitoring of anticancer activity in vivo.

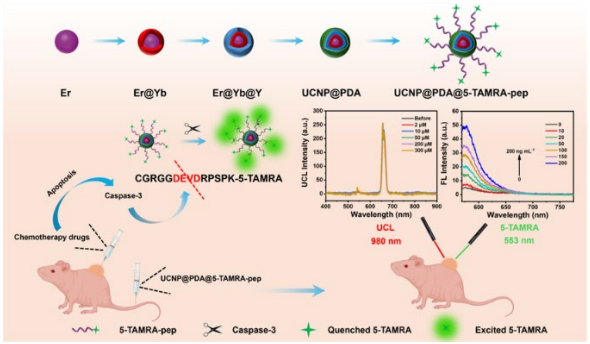


Fig.1 The schematic illustration of the FRET-based UCNP@PDA@5-TAMRA-pep sensing platform for evaluating drug-induced apoptosis of OS cells through real-time monitoring of Caspase-3 activity.

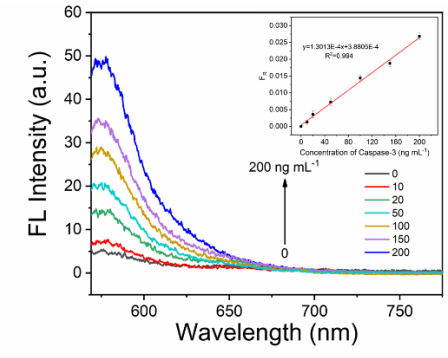


Fig.2 Detection of Caspase-3 in buffer solution.

Herein, a FRET-based ratiometric fluorescent nanosensor, UCNP@PDA@5-TAMRA-pep, has been designed for in situ monitoring Caspase-3 activity in tumor through covalent conjugation of 5-TAMRA modified peptide substrate (5-TAMRA-pep) on the UCNP@PDA. In the proof-of-principle, UCNP@PDA@5-TAMRA-pep was successfully used to arcuately evaluate cis-Pt's concentration-dependent apoptotic effect on mouse-bearing MG-63 tumor through 5-TAMRA fluorescence and UCL imaging, providing a powerful tool for clinical drug efficacy evaluation and drug dose optimization. As shown in Fig. 1, the 5-TAMRA is utilized as the energy donor, PDA is employed as the energy acceptor, and UCNP is used as the internal reference. In the presence of Caspase-3, the FRET between 5-TAMRA and PDA is broken because of enzymatic cleavage of DEVD motif, resulting in the recovery of 5-TAMRA fluorescence. On the contrary, the UCL of UCNP@PDA@5-TAMRA-pep is kept as constant during the Caspase-3 cleavage process. In the practical applications, the intensity of 5-TAMRA fluorescence is strongly dependent on the activity of Caspase-3 and the amount/concentration of UCNP@PDA@5-TAMRA-pep. Specially, the higher Caspase-3 activity and larger amount of UCNP@PDA@5-TAMRA-pep lead to stronger 5-TAMRA fluorescence emission in vivo. This phenomenon could affect the detection accuracy of Caspase-3 activity in vivo. As shown in Fig. 2, for evaluating its analytical performance, 100 μL UCNP@PDA@5-TAMRA-pep (50 μg mL^{-1} Yb content) were mixed with various concentrations of Caspase-3 (0, 10, 20, 50, 100, 150 and 200 ng mL^{-1}) in 200 μL enzymatic cleavage buffer and incubated at 37 °C for 1 h, respectively. The 5-TAMRA fluorescence was gradually increased with increasing the concentration of Caspase-3, while UCL intensity at 656 nm remained almost unchanged with the concentration of Caspase-3. The result further confirms that the UCL can be used as an internal reference for the ratiometric fluorescence nanosensor. The F_R values exhibit a strong linear correlation with the Caspase-3 concentrations in the range of 10 to 200 ng mL^{-1}.

Acknowledgements

We would like to thank the Jilin Provincial Science and Technology Department (Grant No. SKL202302030 and No. 20220203113SF) for financial support. We also thank the assistance provided by the Figdraw platform in the drawing process.

References

1. L. Liu, X. T. Li, H. Zhang, H. D. Chen, M. M. A. Abualrejal, D. Q. Song and Z. X. Wang, *Sens. Actuat. B-Chem.,* **333**, 129554 (2021).
2. F. Y. Liu, X. X. He, Z. Lei, L. Liu, J. P. Zhang, H. P. You, H. M. Zhang and Wang, Z. X. *Adv. Healthc. Mater.*, **4**, 559-568 (2015).

Orally Inflammatory Colon-Targeting Nanoplatform for Computed Tomography Imaging and Antioxidant/Transien Mild Photothermia Therapy of Colitis

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Nanomaterials have shown great potential in the diagnosis and treatment of inflammatory bowel disease. For example, it can visualize the treatment process through imaging guidance to achieve accurate diagnosis and treatment of inflammatory sites [1]. If combined with combination therapy, better treatment results can definitely be achieved [2]. In this study, a colon-targeted delivery nanoplatform (ACeP/Eudragit) was designed for the treatment of IBD and CT imaging of the gastrointestinal tract. First, he Au@CeO_2 NPs core was coated with negatively charged poly(acrylic acid) abbreviated as ACeP. Second, ACeP was encapsulated using the enterosoluble material Eudragit S100 (Fig. 1). The delivery system can protect ACeP from destruction passing through gastric acid and deliver it to the colonic site. The negatively charged ACeP preferentially adhere to positively charged inflammation sites (Fig. 2b). In colitis model, ACeP/Eudragit stayed longer in the inflamed colon. The synergistic effect of photothermal enhanced antioxidant effect and transient mild photothermal (TMP) was able to efficiently scavenge ROS, reducing pro-inflammatory cytokines (TNF-α, IL-1β, and IL-6), and promoting restore intestinal barrier function (Fig. 1 and 2a, c). It also has the ability of CT imaging of the gastrointestinal tract in colitis model (Fig. 2d). In summary, this study provides a promising approach for the integration of IBD treatment and diagnosis.

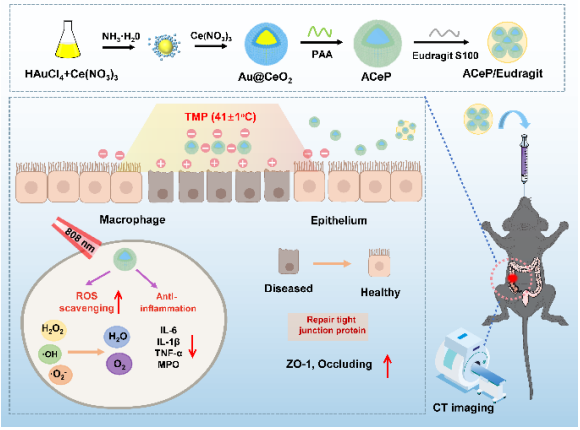


Fig.1 Schematic illustration of the application of ACeP/Eudragit nanoprobes for inflammatory bowel disease treatment and CT imaging.

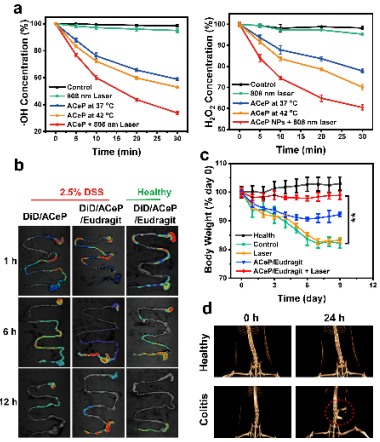


Fig.2 (a) The ability of the nanozymes to eliminate reactive H_2O_2 and ·OH (b) In vivo distribution of nanoplatform (c) Daily changes of body weight (d) Colitis-targeting CT imaging.

Acknowledgements

The authors would like to thank the Jilin Provincial Science and Technology Department (Grant No. SKL202302030, 20230204074YY and 2024SYHZ0016) for financial support.

References

1. L. Cao, D. Duan, J. Peng, et al., *J Nanobiotechnol.* **22**, 484 (2024).
2. Y. Ma, S. Gou, Z. Zhu, et al., *Adv. Mater.* **36**, 2309516 (2024).

Multiple Matrix Metalloproteinases Activity of Different Thyroid Tumor Types Detected via Peptide Microarrays

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Thyroid carcinoma, the most prevalent endocrine malignancy, represented the ninth most diagnosed cancer globally in 2020[1]. It is classified into four major subtypes: papillary thyroid carcinoma (PTC), follicular thyroid carcinoma (FTC), medullary thyroid carcinoma (MTC), and anaplastic thyroid carcinoma (ATC). Five-year survival rates vary widely: 92-96% for PTC, 80% for FTC, 50-58% for MTC, and a sharp decline to 5% for ATC. These differences highlight the urgent need for early diagnosis and molecular stratification to guide personalized therapeutic strategies and optimize clinical outcomes. Advances in molecular research have driven exploration of tumor biomarkers in thyroid cancer. Matrix metalloproteinases (MMPs), a family of zinc-dependent endopeptidases known for their ability to degrade extracellular matrix (ECM) and basement membrane, are involved in physiological and pathological processes including tumor proliferation, invasion, angiogenesis, and metastasis. Accumulating evidence supports the involvement of MMPs in the pathogenesis and progression of thyroid cancer[2].

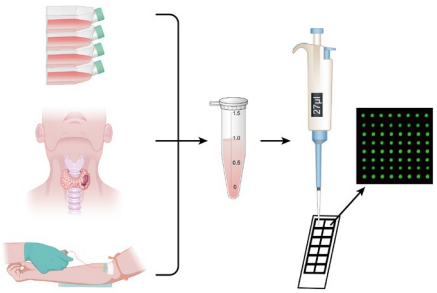


Fig.1 Schematic figure of multiple profiling for matrix metalloproteinases activity in thyroid carcinoma via high-throughput peptide microarray

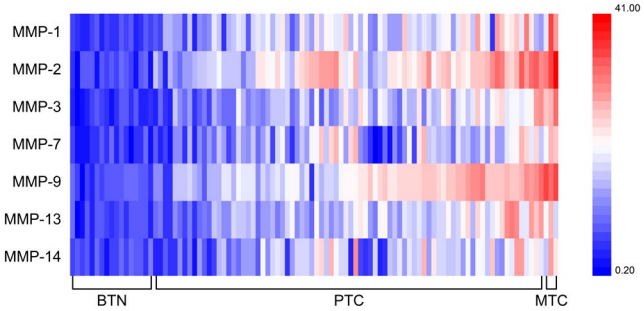


Fig.2 Activity of multiple matrix metalloproteinases in circulating plasma of thyroid cancer patients

In this work, a high-throughput polypeptide microarray detection method was developed based on our team's previous work to analyze the expression and enzymatic activity of MMPs in both cell line models and plasma samples derived from different thyroid cancer subtypes, as shown in Fig 1. Our results demonstrated that MMPs are highly expressed

in thyroid cancer cells and are closely associated with tumor malignancy, disease progression, and TNM staging. Furthermore, MMP expression was evaluated in peripheral blood samples from patients with thyroid cancer to explore their potential as auxiliary diagnostic biomarkers, as shown in Fig 2. All findings indicate that MMP levels in plasma can effectively distinguish between benign and malignant lesions and assist in disease staging and classification. Moreover, they may reduce the reliance on invasive procedures such as fine-needle aspiration (FNA), thereby minimizing patient discomfort and procedural risks.

Acknowledgements

The authors would like to thank the Jilin Provincial Science and Technology Department (Grant No. SKL202302030, 20230204074YY and 2024SYHZ0016) for financial support.

References

1. D. W. Chen, B. H. H. Lang, D. S. A. McLeod, et al. *Lancet,* **401**, 1531-1544 (2023).
2. L. G. N. Almeida, H. Thode, Y. Eslambolchi, et al. *Pharmacol Rev.,* **74**, 712-768 (2022).

High-Throughput Cytokine Detection System Combining Antibody Microarrays with Metal-Enhanced Fluorescence

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As the third most common malignant tumour in the world, the pathogenesis of colorectal cancer (CRC) involves a multifactorial combination of genetic variants, epigenetic regulatory abnormalities and a chronic inflammatory tumor microenvironment. In particular, recent studies have demonstrated that persistent inflammation of epithelial tissue following genetic abnormalities is an important pathogenetic mechanism. Inflammation impacts all stages of carcinogenesis, including initiation, promotion, and progression[1,2]. Among other medi-ators of inflammation, cytokines seem to have a unique but complicated role in driving or preventing malignant transformation. Studies have shown that in the chronic inflammatory tumor microenvironment, cytokines are key mediators involved in tumour development through multiple pathways. Therefore, accurate detection of the expression levels of inflammation-related cytokines is of great clinical value for early diagnosis and disease monitoring of colorectal cancer.

In this work an antibody microarray-based metal-enhanced fluorescence assay has been developed to simultaneously profile five pro-inflammatory cytokines on the GNR@P(GMA-HEMA) slide (Fig.1). In addition, the microarray has been applied to quantitatively analyze five pro-inflammatory cytokines in 35 clinical serum samples including healthy donors (HDs) and CRC patients (Fig.2). Furthermore, the least absolute shrinkage and selector operator (LASSO) regression was performed to demarcate individuals with HDs and CRC patients. The area under receiver operator characteristic curve (AUC) of CRC is 0.92.

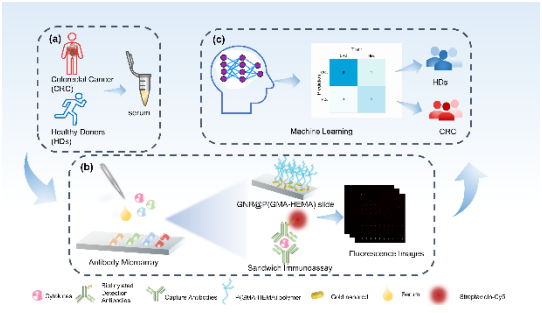


Fig.1 Schematic representation of the detection of cytokines in clinical serum samples with antibody microarrays and data analysis based on machine learning for

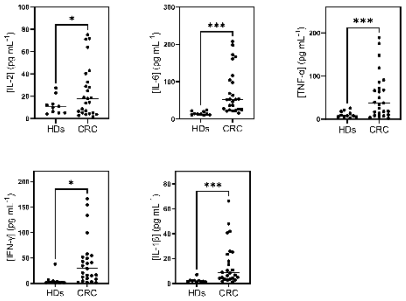


Fig.2 To demonstrate the comparative distribution of serum concentrations of IL-2 ,IL-6, TNF-α ， IFN-γ and IL-1β , respectively, are shown in HDs (10 samples), CRC patients (25 samples).

Acknowledgements

The authors would like to thank the Jilin Provincial Science and Technology Department (Grant No.2024SYHZ0016) for financial support.

References

1. F. R. Greten and S. I. Grivennikov, *Immunity,* **51**, 27-41 (2019).
2. D. Briukhovetska, J. Dörr, S. Endres, P. Libby, C.A. Dinarello and S. Kobold, *Nat Rev Cancer.,* **21**, 481-499 (2021).

Developing a simple assay for detection of caspase-3 activity through combination of magnetic separation and dual-mode lateral flow immunoassay

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The aberrant expressions of proteases are strongly associated with the occurrence and development of many diseases. It is important to develop rapid, simple and low-cost assays for profiling protease activities in complex samples. In this study, we developed a universal assay by combing a paper-based signal reading device and a magnetic separation-based reaction platform. The AuPt@Fe_xO_y NPs labeled lateral flow immunoassay (LFIA) is employed as the signal reading device with colorimetric sensing/photothermal imaging dual-mode signal outputs, which provide a direct color display and a specific temperature for quantitative analysis. Caspase-3 was utilized as the target. The reaction platform is based on the covalent conjugation of magnetic bead (MB) with the peptide including a His-tag, a biotin modified Lys (biotin-K) and a caspase-3 substrate motif. After caspase-3 cleavage, the peptide fragments with His-tag and biotin-K are released from the peptide substrate functionalized MB surface, separated by external magnetic field, and recognized by the anti-His-tag antibody functionalized AuPt@Fe_xO_y NPs. Streptavidin (SA) coated on test (T) line was used to capture the biotin on the released peptide fragment. The binding of peptide fragments yields an increase of color intensity and photothermal conversion efficiency of T line, while the color intensity and photothermal conversion efficiency of C line shows negligible change during the process. The as-proposed MP-LFIA exhibits a total assay time of 1.5 h, and a linear range from 10 ng/mL to 500 ng/mL with the limits of detection of 1.61 ng/mL in colorimetric mode, and 2.59 ng/mL in photothermal mode.

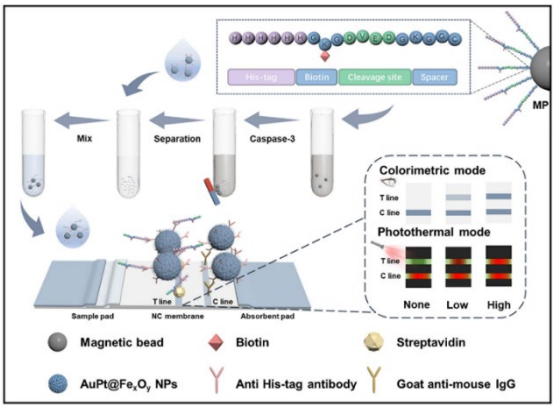


Fig.1 Schematic illustration of MP-LFIA for caspase-3 activity detection.

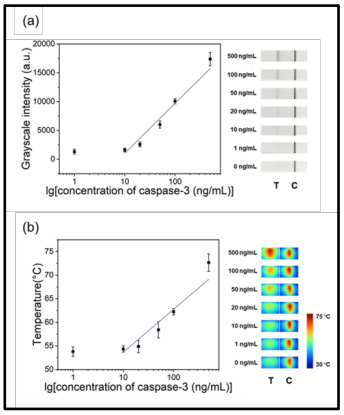


Fig.2 Photographs (a and b), corresponding grayscale intensity (a) and temperature (b) as a function of caspase-3 concentrations.

Acknowledgements

The authors would like to thank the Jilin Provincial Science and Technology Department (Grant No.20230204074YY) for financial support.

References

1. H. D. Wang, C. Q. Yao, J. W. Fan, et al., *Biosens. Bioelectron.*, **237**, 115508 (2023).
2. L. Liu, X. T. Li, H. Zhang, et al., *Sens. Actuators, B*, **333**, 129554 (2021).

Accurate Diagnosis of Colorectal Cancer using a Combination of Lectin-Induced Recombinase Polymerase Amplification and CRISPR/Cas12a Assay on Point-of-Care Testing Platform with Deep Learning Assistant

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Specific glycosylation patterns on exosome surfaces represent novel diagnostic biomarkers for cancer liquid biopsy. Lectin can induce exosome aggregation through multiple binding with exosomal glycoproteins.[1] In this work, we developed a one-pot lectin-induced recombinase polymerase amplification (RPA) and CRISPR/Cas12a-mediated cleavage assay (LI-RPA-CRISPR/Cas12a) for diagnosing colorectal cancer (CRC) through the interactions abundant α-fucose residues on CRC cell-derived exosome surfaces with Ulex Europaeus Agglutinin I (UEA-I). Combination of a home-made portable isothermal amplification device, the as-proposed LI-RPA-CRISPR/Cas12a method exhibits a wide detection range from 2×10^6 to 1×10^2 extracellular vehicles (EVs) μL^{-1} with a visual limit of detection (LOD) as low as 1.0×10^2 EVs μL^{-1}, and has been successfully utilized to dynamically monitor the progression of tumor in mice-bearing SW480 CRC subtype at early stage.[2] After integrated with a Long Short-Term Memory (LSTM) deep learning model, the LI-RPA-CRISPR/Cas12a method achieves accurate diagnosis of primary colorectal cancer with a drop of blood through a smartphone-based data analysis application, reaching an accuracy of 95% in 100 clinical samples. This rapid, sensitive, and user-friendly approach provides a promising platform for point-of-care testing (POCT) diagnosis of colorectal cancer, enabling early detection and monitoring of disease progression through minimally invasive liquid biopsy.

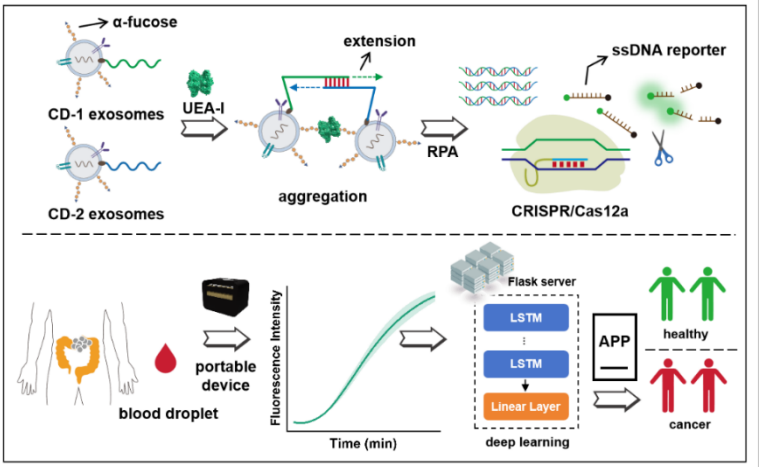


Fig.1 Schematic illustration of LI-RPA-CRISPR/Cas12a method for diagnosing colorectal cancer.

Acknowledgements

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References

1. G. Zhang, X. Huang, Y. Gong, Y. Ding, H. Wang, H. Zhang, L. Wu, R. Su, C. Yang and Z. Zhu, *J. Am. Chem. Soc.*, **146**, 29053-29063 (2024).
2. X. Sun, Y. Shan, M. Jian and Z. Wang, *Anal. Chem.*, **95**, 15146-15152 (2023).

One-pot synthesis of AuPt@Fe_xO_y nanoparticles with excellentperoxidase-like activity for development of ultrasensitive colorimetric lateral flow immunoassay of cardiac troponin I

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In the presence of acute myocardial ischemia, acute myocardial injury associated with abnormal cardiac troponin I (cTnI) is a critical characteristic in the clinical definition of patients with acute myocardial infarction (AMI).[1] As a powerful point-of-care test (POCT) approach, lateral flow immunoassay (LFIA) has been widely used for the detection of various targets, due to its low cost, rapidness, and user-friendliness. Up-to-date, gold/platinum (Au/Pt) bimetallic nanozymes have been extensively employed to develop immunosensing platforms including LFIA because they process the excellent catalytic ability of PtNPs and unique plasmonic property of AuNPs.[2] However, there are great challenges in synthesizing Au/Pt bimetallic nanozymes with a large scale to integrate with the industrial production of LFIA. Herein, a new kind of trimetallic spherical AuPt@Fe_xO_y core@shell nanoparticles (termed as AuPt@Fe_xO_y NPs) have been one-pot synthesized by directly utilizing redox reactions of Fe^{2+}, $PtCl_6^{2-}$ and $AuCl_4^-$. The AuPt@Fe_xO_y NPs are successfully introduced as labels to establish LFIA for detection of cTnI in a fast and sensitive manner. Benefit from its excellent peroxidase-like activity, AuPt@Fe_xO_y NPs can efficiently catalyze the oxidation of chromogenic substrate 3,3',5,5'-tetramethylbenzidine (TMB) by H_2O_2, increasing the sensitivity of LFIA significantly. Results indicate that the as-developed AuPt@Fe_xO_y NP labeled LFIA (AuPt@Fe_xO_y-LFIA) can reliably detect cTnI with low LOD (26.0 pg mL^{-1}) under the nanozyme-triggered colorimetric mode. This work provides a new signal amplification strategy based on peroxidase-like catalysis of AuPt@Fe_xO_y NPs for development of highly sensitive immunoassays including LFIA.

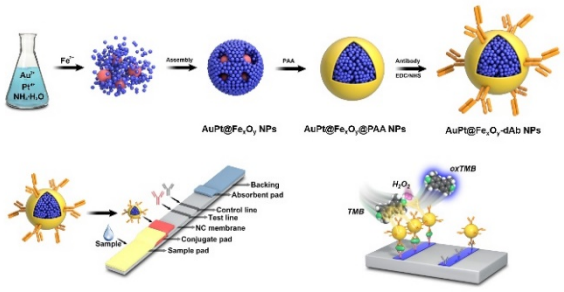


Fig.1 The schematic diagram of preparation of AuPt@Fe_xO_y-dAb NPs, and detection of cTnI

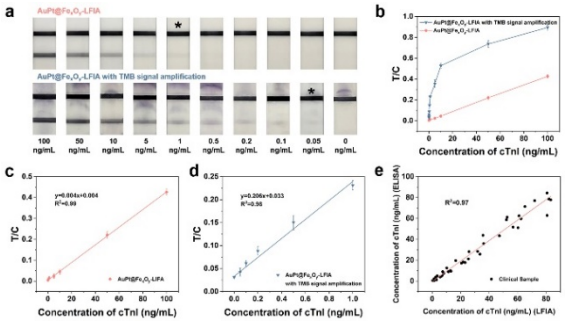


Fig.2 (a) Photographs of AuPt@Fe_xO_y-LFIA for detecting cTnI in standard solutions. (b-d) the T/C value as a function of the cTnI concentration. (e) detection concentrations of cTnI in 40 clinical seral samples using AuPt@Fe_xO_y-LFIA and ELISA kit.

Acknowledgements

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References

1. B. A. Bergmark, N. Mathenge, P. A. Merlini, et al. *The Lancet*, **399**, 1347-1358 (2022).
2. M. Zhang and X. Guo. *Coordination Chemistry Reviews*, **465**, 214578 (2022).

Molecular Engineering of NIR Emission AIE Photosensitizers for Rapid and Efficient ROS Generation

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Near-infrared (NIR) photosensitizers with rapid reactive oxygen species (ROS) production capabilities are highly sought after for enhancing photodynamic therapy (PDT) and deep-tissue imaging. However, guidelines for designing efficient photosensitizers remain unclear.1-3 Here, three AIEgens: DBP, TBP, and TBP-SO_3, were designed and synthesized using precise donor-acceptor (D-A) molecular engineering to elucidate structure-property-application relationships (Figure 1A). All compounds exhibit AIE characteristics with strong long-wavelength emission in aggregates and efficiently produce ROS under white light irradiation. By modulating D-A units, TBP-SO_3 achieves NIR emission and faster ROS generation due to enhanced intersystem crossing compared to DBP and TBP (Figure 1B). Additionally, NIR-emitting TBP-SO_3 demonstrates specific endoplasmic reticulum targeting and excellent PDT efficacy against cancer cells and bacteria. This molecular engineering approach provides a valuable strategy for developing advanced photosensitizers with AIE properties, efficient ROS generation, and intense emission for fluorescent-imaging and PDT.

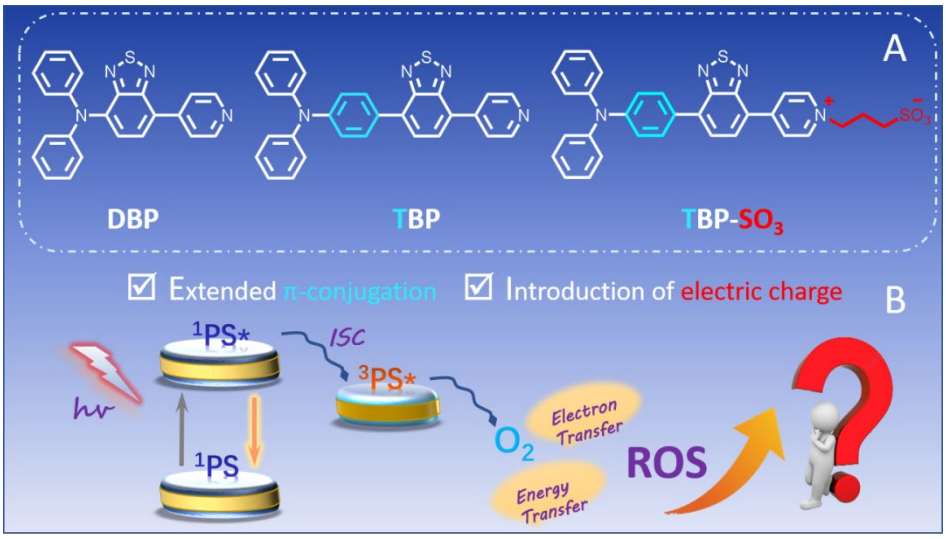


Fig 1. Molecular structures and design strategy of DBP, TBP, and TBP-SO_3

Acknowledgements

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References

1. T. Sun, K. Wang, Y. Ma, X. Liu, D. Ji, Z. Zhang, X. Xie, Z. Yuan, L. Wang, G.-Q. Liu, Y. Ling, Eur. J. Med. Chem. 2025, 290, 117523
2. L. Fang, Z. Chen, J. Dai, Y. Pan, Y. Tu, Q. Meng, Y. Diao, S. Yang, W. Guo, L. Li, J. Liu, H. Wen, K. Hua, L. Hang, J. Fang, X. Meng, P. a. Ma, G. Jiang, Adv. Sci. 2025, 12, 2409157
3. S. Y. Liang, G. Jiaerheng, C. J. Huang, Y. Q. Xie, X. N. Zou, X. F. Liang, C. Li, L. H. Liu, Adv. Funct. Mater. 2025, 2424108

Sulfate-Driven Lattice Oxygen Activation in NiFe Layered Double Hydroxide for Efficient Oxygen Evolution

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Nickel-iron layered double hydroxide (NiFe-LDH) is a benchmark electrocatalyst for the oxygen evolution reaction (OER) in alkaline media, yet its activity is typically constrained by the adsorption evolution mechanism (AEM), which suffers from scaling relationships between *OOH and *OH intermediates[1]. To circumvent these limitations, we propose a strategy to activate the lattice oxygen mechanism (LOM) by introducing sulfate (SO_4^{2-}) via wet-chemical etching with S^{2-} followed by in situ reconstruction. Experimental and theoretical analyses reveal that the leaching of S^{2-} during etching induces oxygen vacancies, which enhance the metal-oxygen (M-O) bond covalency and lower the energy barrier for lattice oxygen participation in OER. This modification shifts the OER pathway from AEM to LOM, in which lattice oxygen oxidation enables direct O-O coupling[2]. This bypasses the rate-limiting *OOH formation step and allows S-NiFe-LDH to achieve a low overpotential of 230 mV at 10 mA cm^{-2} in alkaline media. The stabilized SO_4^{2-} surface layer further optimizes the electronic structure of catalytic sites, promoting efficient oxygen redox. Experiments and theoretical calculations reveal that introducing sulfate enhances the metal—oxygen hybridization and strengthens the metal—oxygen bond covalency in NiFe LDH phases, thereby activating the lattice oxygen and successfully triggering the LOM pathway. This work provides a simple strategy to unlock lattice oxygen activity in conventional catalysts, advancing the design of high-performance OER systems.

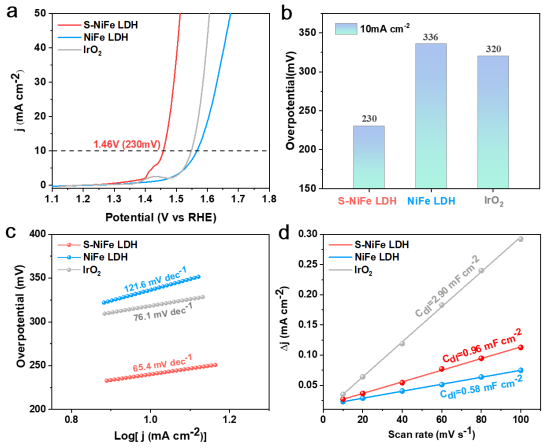


Fig.1 (a) LSV curves of S-NiFe LDH, NiFe LDH and IrO_2. (b) Overpotentials of S-NiFe LDH, NiFe LDH and IrO_2 to achieve the current densities of 10 mA cm^{-2}. (c) Tafel Slopes. (d) Capacitance.

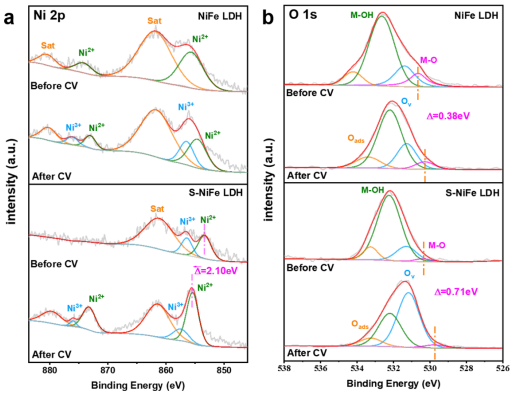


Fig.2. High-resolution XPS of (a) Ni 2p and (b) O 1s for obtained samples before and after CV activation.

Acknowledgements

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References

1. Luo, X.; Zhao, H.; Tan, X.; Lin, S.; Yu, K.; Mu, X.; Tao, Z.; Ji, P.; Mu, S., *Nat Commun* **2024**, *15* (1), 8293.
2. Chen, R.; Wang, Z.; Chen, S.; Wu, W.; Zhu, Y.; Zhong, J.; Cheng, N., *ACS Energy Lett* **2023**, *8* (8), 3504-3511.

A small molecule inhibitor of Bromodomain-containing protein 4 for cervical cancer therapy

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Cervical cancer has a high morbidity and mortality rate. Due to the serious side effects and drug resistance of chemotherapy drugs, current treatments have limited effect on advanced cervical cancer. The development of new therapeutic drugs is therefore urgently needed. Bromodomain-containing protein 4 (BRD4) is a member of the Bromodomain and extraterminal domain (BET) protein family, which interacts with various cytokines, such as Positive transcription elongation factor b, to regulate gene transcription. BRD4 expression is up-regulated in a variety of cancers. It plays a crucial role in regulating the cell cycle, gene transcription and cellular proliferation [1]. JQ1, a small molecule inhibitor of BRD4, reduces oncogene expression, inhibits tumor cell proliferation and promotes apoptosis, thus rendering it a suitable candidate for use as an anti-cancer drug [2,3].

In this study, we examined the expression levels of BRD4 in cervical cancer tissues and assessed the impact of JQ1 on cancer cells. Our findings revealed that BRD4 was significantly overexpressed in cervical cancer tissues (Fig.1), indicating a potential association with the process of cervical cancer. At the cellular level, the small molecule inhibitor JQ1 was found to inhibit the growth of cervical cancer cells (Fig.2). These findings suggest that JQ1, an inhibitor of BRD4, has potential clinical applications in the treatment of cervical cancer.

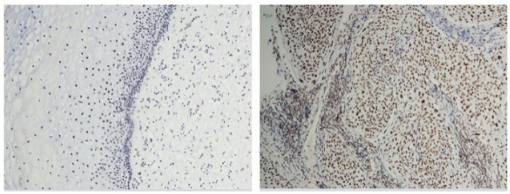


Fig.1 Immunohistochemical images of BRD4 expression in normal tissues (left) and cervical cancer tissues (right) (200 *)

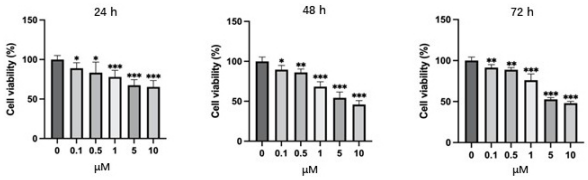


Fig.2 The effect of JQ1 on the proliferation of cervical cancer cells

Acknowledgements

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References

1. D.L. Liang, Y.F. Yu, Z.H. Ma, *Eur J Med Chem*, **200**, 112426 (2020)
2. G.J. Jiang, W.L. Deng, Y. Liu, C.D. Wang, *Mol Med Rep*, **21**, 1021-1034 (2020).
3. L.N. Wang, Y.B. Chen, Y.J. Mi, J.H. Qiao, H. Jin, J.T. Li, Z.D. Lu, Q.M. Wang, Z.Z. Zou, *Biochem Biophys Res Commun*, **558**, 216-223 (2021).

Engineered hydrogen-bonded supramolecular assemblies to boost luminol-dissolved oxygen chemiluminescence over 4000 folds

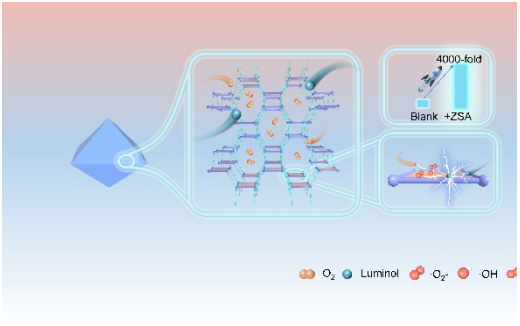
Sipeng TIAN[a, b], Jing LI[a]*, Erkang WANG[a, b]*

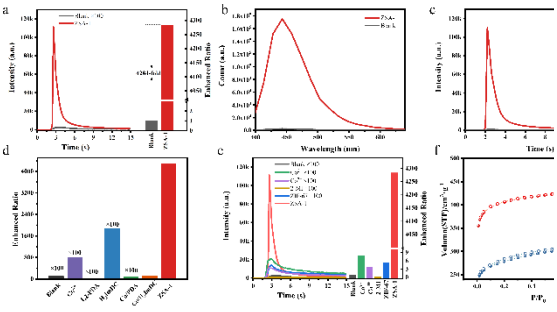
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Classic luminol-H_2O_2 chemiluminescence (CL) systems suffer from the self-decomposition, which inevitably influences the detection accuracy. While inherent ultralow reactivity of luminol-dissolved oxygen (DO) motivates people to deliberately design multifunctional microreactors that preferentially attracts reactants with integrated catalyzing sites for amplifying CL emission. Herein, for the first time we reported that the weak luminol-DO CL emission was lightened ca. 4000 folds by using hydrogen-binding organic frameworks (HOFs) (named ZSAs) assembled with the metal-organic square as building units and 1,2-propanediamine as the terminal ligands for additional hydrogen-bonding sites. ZSAs not only acted as co-reaction accelerator to efficiently adsorb and activate O_2 to generate reactive oxygen species (ROS) but also as the enriching host for capturing emitters in the confined cages, which shortened the electron-transfer path between ROS and luminol anion radical and reduced the energy loss. Theoretical calculations have demonstrated that the ZSA-1 has a strong adsorption affinity to both O_2 and luminol due to highly active Co sites optimized by the tetrahedral coordination with N/O atoms. The adsorption of O_2 and luminol in ZSA-1 optimizes the electron transfer pathways to promote CL emission performances. This work not only expands the application of HOF in the field of CL but also provides new insights for engineering materials to boost the CL photon emission efficiency of weak luminol-DO systems.





Left: Fig.1 Schematic Illustration of the coordination structure of ZSAs and the CL mechanism of luminol/O_2.

Right: Fig.2 The CL intensity–time curves and the corresponding enhanced ratio (a), and spectrum (b) of luminol-O_2 system in the absence or presence of ZSA-1; (c) The CL response under different atmospheres using the proposed CL system; (d) The CL intensity enhanced ratio of luminol-O_2 system after adding ZSA-1, its precursors; (e) The CL intensity of luminol-O_2 system after adding ZIF-67, its precursors or ZSA-1; (f) The O_2 adsorption–desorption isotherms of ZSA-1 and ZIF-67, respectively. Final concentrations: 45 μM luminol, 0.2 mg/ml ZSA-1.

Acknowledgements

This work was supported by the National Natural Science Foundation of China (Grant no. 22374143) and the Major Science and Technology Project of Jilin Province (SKL202402018).

References

1. L. Li; X. Zhang; Y. Ren; Q.Yuan; Y. Wang; B. Bao; M. Li and Y. Tang, *J. Am. Chem. Soc.*, **146**, 5927-5939 (2024)
2. H. Xing; C. Peng; Y. Xue; Y. Fan; J. Li and E. Wang, *Anal. Chem.*, **92**, 10108-10113 (2020)

Structural regulation of metal-free defective electrocatalysts switching electron-transfer pathways of ORR

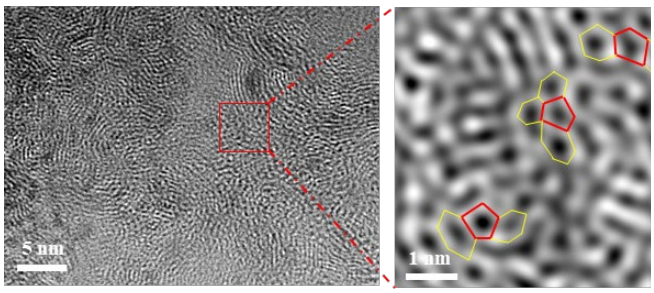
Qian ZENG[a, b], Jing LI[a, b]*, Erkang WANG[a, b]*

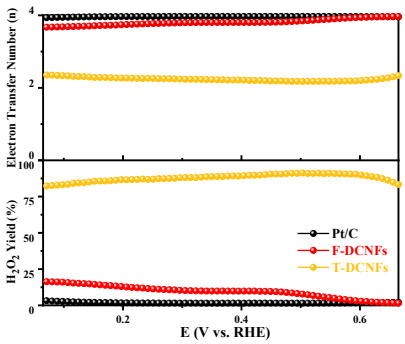
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Well-defined electrocatalysts with both high activity and selectivity are vital for the practical utilization of electrocatalysis processes involving oxygen reduction reaction (ORR). Herein, we implemented a dual-template assisted strategy and successfully synthesized two types of metal-free carbon based electrocatalysts which are nanofibers with abundant carbon defects (DCNFs) and can boost ORR efficiently in different pathways. The defective configurations were demonstrated by electron microscopy experiments and the subsequent characterizations further determined the discrepancy of atomic structures related to the selectivity of DCNFs. The DCNFs boosting two-electron pathway ORR (T-DCNFs) showed a superior H_2O_2 yield of 88 % and the flow cell equipped with T-DCNFs exhibited a H_2O_2 production rate of 4.45 mol $g_{catalyst}^{-1}$ h^{-1}. Meanwhile, the DCNFs facilitating four-electron pathway ORR (F-DCNFs) also displayed an outstanding half-wave potential ($E_{1/2}$) of 0.835 V and an excellent power density of 181.3 mW/cm^2. T-DCNFs and F-DCNFs are confirmed as ORR electrocatalysts combing superb activity and high selectivity compared with many representative metal-free ORR electrocatalysts. Density functional theory (DFT) calculations and in-situ spectroscopy further reveal the correlation between defective structures and ORR activity and selectivity. This work provides a new perspective for the regulation of ORR selectivity and a novel route for designing of metal-free electrocatalysts.





Left: Fig.1 AC-TEM image and corresponding FTT-iFTT filtered image of carbon defects.
Right: Fig.2 Electron transfer number and H_2O_2 yield of DCNFs and commercial Pt/C at various potentials.

Acknowledgements

This work was supported by the National Natural Science Foundation of China (Grant no. 22374143) and the Major Science and Technology Project of Jilin Province (SKL202402018).

References

1. H. Xia; R. Pang; X. Dong; Q. Liu; J. Chen; E. Wang and J. Li, *J. Am. Chem. Soc.*, **145**, 25695-

25704 (2023)
2. R. Pang; H. Xia; X. Dong; Q. Zeng; J. Li and E. Wang, *Adv. Sci.,* **11**, 2407294 (2024)

Nanocarrier Nanomechanics: A Key to Unlocking Endocytosis in Cancer Cells Navigating Epithelial-Mesenchymal Transition Dynamics

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Epithelial-mesenchymal transition (EMT) is a complex, multistep biological process that is frequently associated with advanced-stage cancers, making it a primary contributor to the failure of cancer therapies [1,2] This process involves the loss of epithelial characteristics, such as cell-cell adhesion and polarity, and the acquisition of mesenchymal traits, including enhanced migratory and invasive capabilities. These transformations not only drive tumor progression and metastasis but also contribute to therapeutic resistance, posing significant challenges for cancer treatment. Additionally, during the EMT process, changes in gene and protein expression within cells significantly influence their internalization capacity, thereby disrupting the efficacy of conventional treatments. In response to these challenges, nanocarrier-based drug delivery systems have emerged as a promising approach to enhance therapeutic outcomes. Particularly, polymer-based nanocarriers have garnered substantial attention due to their ability to regulate biodistribution, target specific tissues, and overcome various biological barriers, such as the tumor microenvironment and cellular membrane barriers. These systems offer advantages in terms of controlled drug release, reduced systemic toxicity, and improved therapeutic efficacy. The efficiency of nanocarrier systems in delivering drugs is critical for treating cancer cells, as it directly impacts the ability to achieve therapeutic concentrations at the tumor site. Enhancing this efficiency can be achieved by modifying the physical or chemical properties of nanocarriers, such as surface functionalization, particle size, and mechanical modulus, which is essential for improving cancer treatment outcomes and overcoming therapeutic resistance. In this study, we synthesized nanocarriers with varying moduli and utilized them as drug delivery carriers to explore their interactions with cells at different EMT stages. By investigating the cellular internalization of these nanocarriers in cells undergoing EMT, we aimed to uncover the modulus-dependent mechanisms that govern cellular uptake. This work represents the first comprehensive demonstration of how the mechanical properties of nanocarriers influence cellular internalization across various EMT stages, providing critical insights into the relationship between nanocarrier design and therapeutic efficiency.

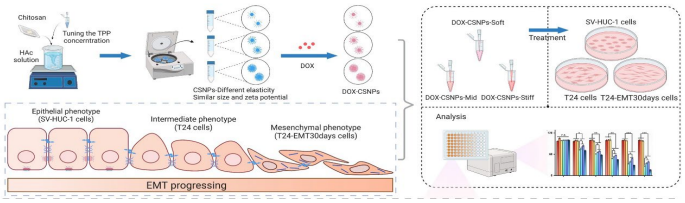


Fig.1 The illustration of the synthesis of nanocarriers and drug-loaded nanocarriers with different moduli, and the cellular characteristics of bladder cancer at different EMT stages. We explored the mechanisms by which bladder cancer cells at different EMT stages internalized nanocarriers with varying moduli, and provided the explanation of the cellular mechanical response mechanisms of bladder cancer cells at different EMT stages during

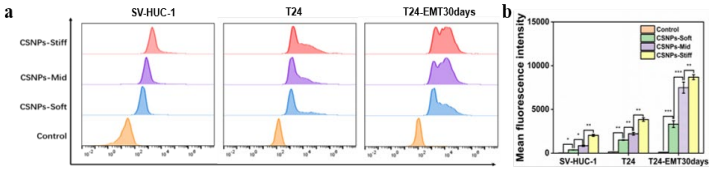


Fig.2 (a) Cellular internalization of fluorescence-labeled nanocarriers with various moduli by cells in various EMT stages. (b) Mean fluorescence intensity of FITC in (a).

Acknowledgements

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References

1. Wang, H. and Mei, Y.. Single-Cell Analyses Reveal Mechanisms of Cancer Stem Cell Maintenance and Epithelial–Mesenchymal Transition in Recurrent Bladder Cancer. Clinical Cancer Research 2022, 27 (22), 6265-6278.
2. Ping, Q. and Wang, C.. TGF-β1 dominates stromal fibroblast-mediated EMT via the FAP/VCAN axis in bladder cancer cells. Journal of Translational Medicine 2023, 21 (1), 475.

A 2D Self-cascade Catalytic System Based on CoCuFe-LDH Nanosheets for Accelerated Healing of Infected Wounds

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The emergence of drug-resistant bacteria has rendered traditional antibiotics ineffective, posing a serious threat to human health. There is an urgent need to explore alternative antimicrobial agents[1]. Inspired by enzyme immobilization and multi-enzyme biocatalysis, we designed a cascade catalytic system based on trimetallic layered double hydroxides (LDHs)-CoCuFe-LDH@Gox nanosheets-for treating drug-resistant bacterial infections and promoting wound healing. The synergistic effects of Co, Cu, and Fe in the trimetallic LDH structure endow CoCuFe-LDH nanosheets with exceptional peroxidase (POD)-like activity[2]. The unique two-dimensional nanosheet architecture of CoCuFe-LDH nanosheets provides high-density anchoring sites for glucose oxidase (Gox), constructing an efficient cascade catalytic interface. The CoCuFe-LDH@Gox nanosheets can catalyze glucose to generate hydrogen peroxide (H_2O_2) and gluconic acid, with the latter creating a localized acidic microenvironment that positively regulates the POD -like activity of LDH. Subsequently, the nanosheets continuously convert the in-situ generated H_2O_2 into highly oxidative hydroxyl radicals, enabling effective eradication of drug-resistant bacteria. This synergistic integration of LDH catalysis and Gox components results in an exceptionally potent bactericidal effect against drug-resistant pathogens. Beyond its remarkable antibacterial performance, this LDH-based system demonstrates excellent biocompatibility and significant immunomodulatory capabilities. It accelerates the healing of drug-resistant bacterial infected wounds by suppressing inflammatory responses and regulating macrophage polarization, achieving multidimensional therapy from antibacterial to anti-inflammatory effects. These multifunctional characteristics make CoCuFe-LDH@Gox nanosheets a highly promising candidate material for future clinical applications in treating drug-resistant bacterial infections.

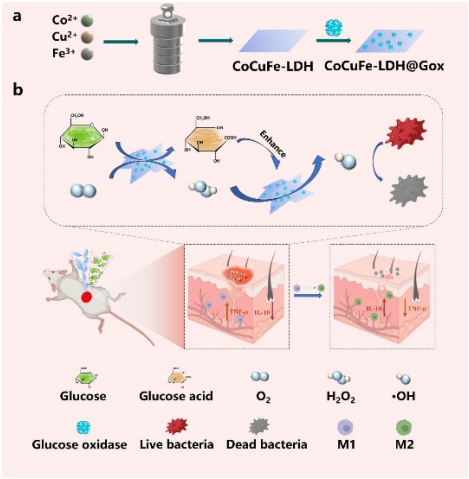


Fig.1 Schematic diagram of (a) synthesis CoCuFe-LDH@Gox nanosheets and (b) application in drug-resistant bacteria-infected wounds.

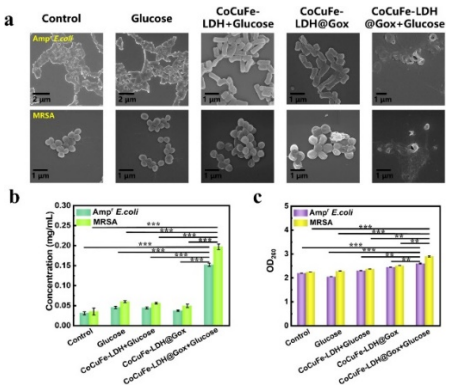


Fig.2 (a) SEM images of Ampr *E. coli* and MRSA after different treatments. (b) Protein leakage and (c) nucleic acid leakage of bacteria after different treatments

Acknowledgements

This work was supported by the Project of Intergovernmental In ternational Science and Technology Innovation Cooperation (2022YFE0113000), Special Project for High-tech Industrialization of Science and Technology Cooperation between Jilin Province and Chi nese Academy of Sciences (2022SYHZ0045, 2023SYHZ0030), the Nat ural Science Foundation of Jilin Province (20240101179JC).

References

1. V. Falanga and R.R. Isseroff, *Nat. Rev. Dis. Primers.*, **8**, 50 (2022)
2. F. Gao and T. Shao, *Nat. Commun.*, **12**, 745 (2021)

A Multifunctional MXene@CeO_2-Enhanced Hydrogel Dressing for Synergistic Photothermal Antibacterial and Antioxidative Therapy in Wound Healing

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Wound infections continue to pose substantial clinical challenges, especially in treating chronic and surgical wounds. Bacterial colonization and growth can significantly impair the healing progression, extending patient recovery times and escalating medical costs [1-2]. Furthermore, sustained inflammatory responses and excessive reactive oxygen species (ROS) generation at wound sites aggravate oxidative damage, creating additional barriers to tissue regeneration. To address these issues, it is crucial to develop sophisticated hydrogel systems with integrated functionalities that can responsively adapt to the dynamic pathological conditions of infected wounds. In this study, we designed an innovative multifunctional hydrogel wound dressing (MXene@CeO_2/GMAG-GEL) to overcome these obstacles. This composite material combines cerium oxide-incorporated MXene nanosheets with a glycidyl methacrylate-functionalized gelatin network, creating a near-infrared (NIR)-sensitive hybrid hydrogel system. Upon photothermal stimulation, the nanocomposite hydrogel demonstrates strong antimicrobial activity. Following microbial clearance, the hydrogel system effectively reduces oxidative damage, stimulates blood vessel formation, and reprograms macrophages toward anti-inflammatory activation, collectively promoting efficient wound recovery.

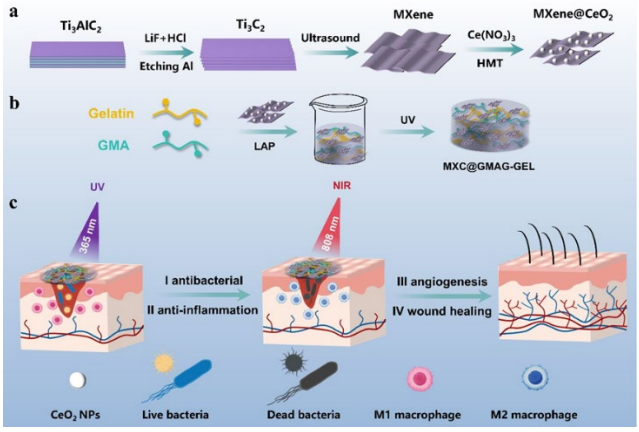


Fig.1 Schematic diagram of preparation and application of nanocomposite hydrogel.

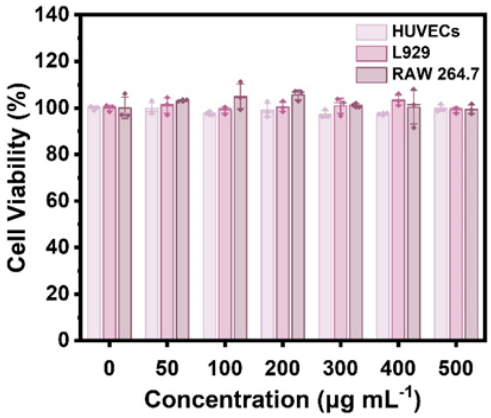


Fig.2 Cell viability of MXene@CeO_2 nanosheets.

As shown in Fig. 1, CeO_2 nanoparticles were loaded onto MXene nanosheets and incorporated into the GMA-Gelatin matrix to form the nanocomposite hydrogel. This combination can enhance the hydrogel's antibacterial efficacy. After bacterial eradication, it' s not only reduces oxidative stress and promotes angiogenesis but also drives macrophage polarization toward an anti-inflammatory phenotype, ultimately accelerating wound healing. To assess cytocompatibiliy, we evaluated the effects of MXene@CeO_2 nanosheets on the viability of L929, HUVECs, and RAW 264.7 macrophages using the CCK-8 assay. The results demonstrated that the MXene@CeO_2 nanosheets maintained cell viability above 95%, confirming its excellent biocompatibility (Fig. 2).

Acknowledgements

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References

1. L. Wang, Y. Luo, Y. Song, X. He, T. Xu, X. Zhang, Acs Nano 2024, 18, 3468.
2. M. Yan, S. Hu, Z. Wang, R. Hong, X. Peng, M. Kuzmanovic, M. Yang, R. Dai, Y. Wang, J. Gou, K. Li, J. Xu, Z. Li, Biomacromolecules 2024, 25, 2438.

Aptamer-Based Rolling Circle Amplification Coupled with Silver Nanoparticles for Sensitive Exosome Detection

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Exosomes (30-150 nm in size) are nano-vesicles secreted by nearly all cell types, carrying biologically significant cargo, including lipids, RNAs, and proteins that reflect their cell of origin[1]. Present in diverse bodily fluids (e.g., blood, saliva, urine, and breast milk), exosomes mediate intercellular communication and hold transformative potential for clinical diagnostics and therapy monitoring[2]. Conventional exosome detection techniques, such as Western blotting, ELISA, nanoparticle tracking analysis (NTA), NanoFCM, and flow cytometry (FCM), are limited by their time-consuming protocols, labor-intensive workflows, or reliance on expensive instrumentation[3]. These challenges underscore the need for simpler, user-friendly methods capable of sensitive and specific exosome detection.

In this study, we present a rapid, accurate, and cost-effective method for highly sensitive and specific exosome detection, tailored for clinical applications. Our approach employs CD63 aptamer-complementary DNA (cDNA) conjugates immobilized on streptavidin-coated magnetic beads (SA-MBs) as a capture probe. When exosomes bearing CD63 proteins bind to the aptamer, the released cDNA triggers rolling circle amplification (RCA), exponentially amplifying cDNA copies. The resulting negatively charged RCA products induce aggregation of positively charged spermine-functionalized silver nanoparticles (AgNPs) via electrostatic interactions. This aggregation generates a naked-eye-readable color change and can be quantified using UV-vis spectroscopy, achieving exceptional detection limits of 800 particles/mL (spectroscopy) and 4.0×10^4 particles/mL (visual). Furthermore, we validated the method's clinical utility by successfully detecting exosomes in human serum samples, demonstrating its promise for liquid biopsy applications

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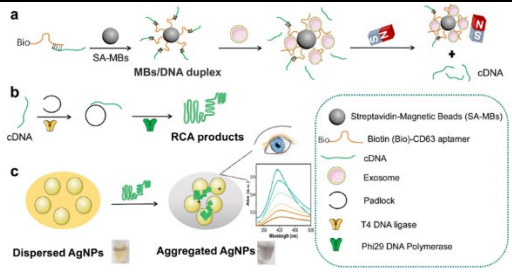


Fig.1 Schematic illustration of the process of exosomes detection. (a) Exosomes concentration converted to the cDNA evaluation. (b) Amplification of the released cDNA using RCA. (c) RCA products detected through the AgNPs aggregation by the colorimetric method, visualized

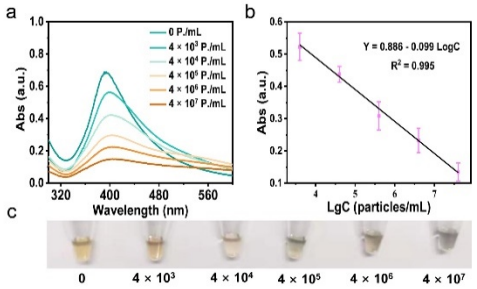


Fig.2 Sensitivity investigation. (a) The absorption spectra of the AgNPs in the presence of RCA products generated by the exosomes at various concentrations. (b) The calibration curve of absorption values versus the logarithm of the concentration of exosomes (Log*C*) (*n* = 3). (c) The

Acknowledgements

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References

1. C. Liu, J.X. Zhao, F. Tian, L.L. Cai, W. Zhang, Q. Feng, J.Q. Chang, F.N. Wan, Y.J. Yang, B. Dai, Y.L. Cong, B.Q. Ding, J.S. Sun, W.H. Tan. *Nat. Biomed. Eng.*, **3**, 183-193 (2019).
2. Y.-T. Kang, T. Hadlock, T.-W. Lo, E. Purcell, A. Mutukuri, S. Fouladdel, M.D.S. Raguera, H. Fairbairn, V. Murlidhar, A. Durham, S.A. McLean, S. Nagrath. *Adv. Sci.*, **7**, 2001581 (2020).
3. C. Liu, Y. Qie, W.P. Qin, K.D. Zhao, J.Q. Zhu, L.X. Zhao, M.J. Li, L.H. Guo. *Sens. Actuators B Chem.* **345**, 130336 (2021).

Anisotropic Response of Two-Dimensional Metal–Organic Framework Films to Volatile Organic Compounds at Room Temperature

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In the realm of gas detection, traditional semiconductor gas sensors primarily rely on the gas-sensitive properties of metal oxide semiconductors under specific conditions (e.g., high temperatures). Developing low-power chemiresistive gas sensors that operate at ambient temperature remains challenging [1]. Two-dimensional conjugated metal–organic frameworks (2D c-MOFs) feature extended in-plane d–π conjugation between metal ions and ligands, forming graphene-like structures while retaining the permanent porosity of traditional MOFs. These materials possess enhanced electron transfer efficiency and inherent porosity for guest-molecule interactions, making them highly promising for fabricating a variety of MOF-coated sensing devices for numerous applications, including gas sensing [2]. Cu-HHTP exemplifies this with its extended π-conjugated plane and high conductivity, exhibiting oriented growth along the [001] facet on SAM-OH surfaces. Leveraging this interfacial growth behavior, we designed an in-plane multi-channel chemiresistive gas sensor achieving high sensitivity and selectivity at ambient temperature. Subsequently, we used surface-enhanced infrared spectroscopy to reveal the gas-sensing mechanism: introduction of ethanol displaces water molecules from MOF pores, generating a negative peak in the framework's stretching vibration, while nitrogen flow drives ethanol desorption, returning the stretching vibration to a positive peak. This adsorption/desorption cycle at open metal sites induces framework contraction/expansion, thereby modulating the response current.

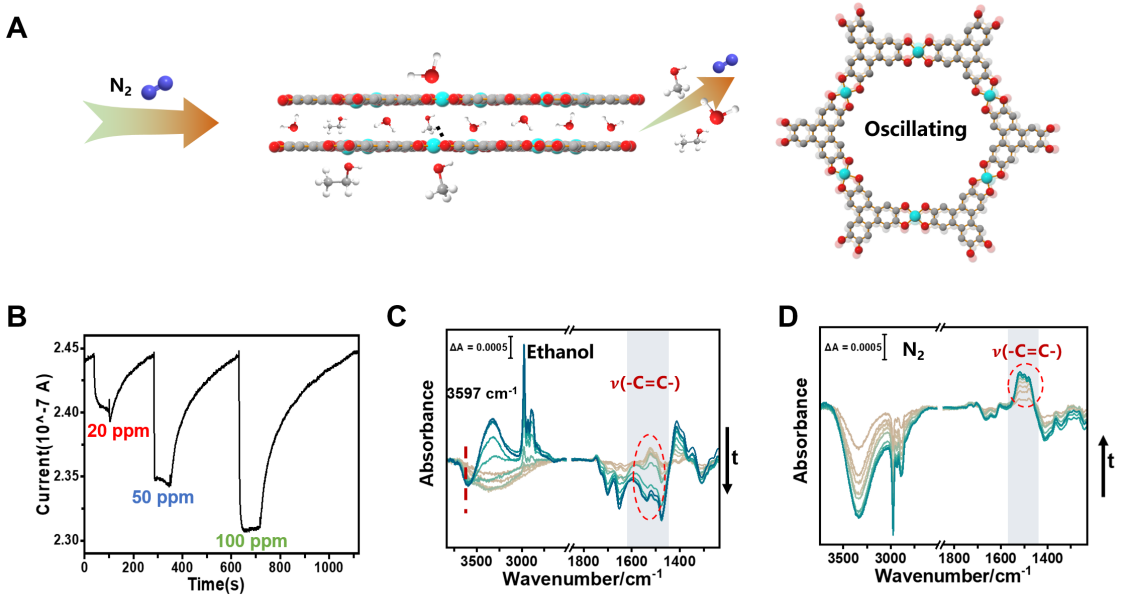


Fig.1 A) Schematic diagram of the interaction between gas and MOF. B) Gas sensing current response at different concentrations of Ethanol. C) Surface-enhanced infrared spectroscopy during ethanol adsorption. D) Surface-enhanced infrared spectroscopy during N_2 flow.

Acknowledgements

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References

1. Y.-M. Jo, D.-H. Kim, J. Wang, J. J. Oppenheim, M. Dincă, *J. Am. Chem. Soc.*, **146,** 20213-20220 (2024)
2. P. Chen, X. Su, C. Wang, G. Zhang, T. Zhang, G. Xu, L. Chen, *Angew. Chem. Int. Ed.*, **62**, e202306224 (2023)

Synergistic Integration of Photothermal Therapy and Redox Responsive Vascular Normalization for Tumor Therapy

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Photothermal therapy (PTT) as non-invasive therapeutic strategies of cancer have received extensive concern in recent years.[1] However, the aberrant tumor extracellular matrix and vasculature[2] within the tumor region significantly impede the penetration of photothermal agents (PTAs), leading to their heterogeneous distribution and consequent localized temperature disparities during PTT. This can result in subtherapeutic areas below the 42°C ablation threshold, potentially causing incomplete tumor ablation and recurrence.[3] Herein, we designed a vanadium-based dexamethasone (DEX) prodrug nanoplatform (VN@PD). This system was fabricated by cross-linking the amphiphilic polymer resin F68 and tannic acid with vanadium ions to form nanospheres. Peptone was incorporated to enhance hydrophilicity, followed by loading with a polyethyleneimine-dexamethasone conjugate. The resulting nanoparticles absorb 808 nm laser light for photothermal therapy (PTT). Simultaneously, the released vanadium ions kill tumor cells via Fenton-like reactions.[4] Both PTT and vanadium-mediated cytotoxicity induce immunogenic cell death (ICD), releasing substantial damage-associated molecular patterns (DAMPs) to promote immune cell maturation and facilitate tumor immunotherapy. Concurrently, the glutathione-responsive prodrug releases dexamethasone, which suppresses vascular endothelial growth factor (VEGF) and hyaluronan synthase 2 (HSE2) expression in tumor cells.[2] This normalizes aberrant vasculature, remodels the extracellular matrix, enhances immune cell infiltration, and synergistically augments tumor immunotherapy. [5]Consequently, this nanoplatform integrates chemotherapy, photothermal therapy, and chemodynamic therapy. Collectively, these modalities break the immunological "silence," remodel the tumor microenvironment (TME), engage the immune system, and enable more effective tumor eradication.

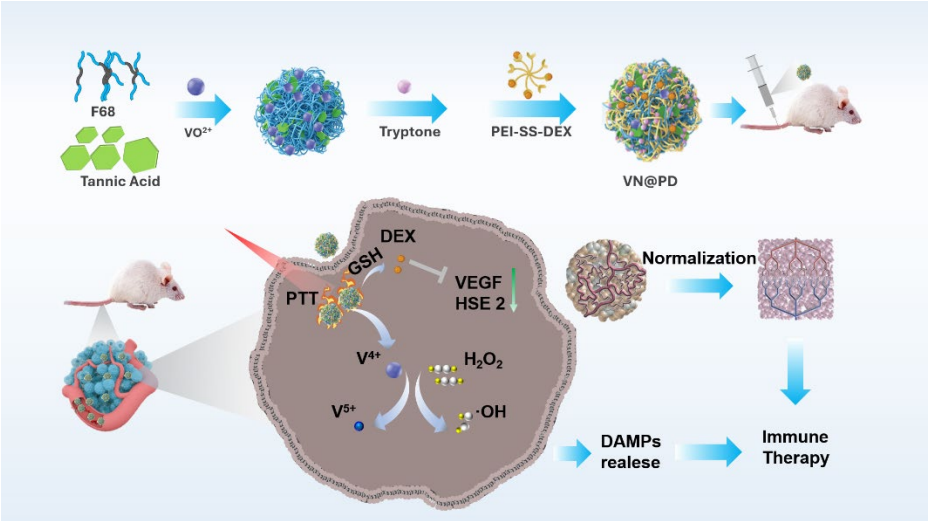


Fig.1 Schematic for the preparation of VN@PD and treatment in cancer

Acknowledgements

This work was supported by the Inter-Government International Science and Technology Innovation Cooperation project from Ministry of Science and Technology of China (2022YFE0113000), National Science Fund for Distinguished Young Scholars (22025406), the National Natural Science Foundation of China (22204162), Science and Technology Innovation Foundation of Jilin Province (YDZJ202101ZYTS039, 20220101065JC).

References

1 J. Q. Chen, C. Y. Ning, Z. N. Zhou, P. Yu, Y. Zhu, G. X. Tan, C. B. Mao, *Prog Mater Sci* , 99, 1-26 (2019).

2 J. D. Martin, M. Panagi, C. Wang, T. T. Khan, M. R. Martin, C. Voutouri, K. Toh, P. Papageorgis, F. Mpekris, C. Polydorou, G. Ishii, S. Takahashi, N. Gotohda, T. Suzuki, M. E. Wilhelm, V. A. Melo, S. Quader, J. Norimatsu, R. M. Lanning, M. Kojima, M. D. Stuber, T. Stylianopoulos, K. Kataoka, H. Cabral, *Acs Nano*, 13, 6396-6408 (2019).

3 J. J. Huo, Q. Y. Jia, H. Huang, J. Zhang, P. Li, X. C. Dong, W. Huang, *Chemical Society Reviews*, 50, 8762-8789 (2021).

4 S. Li, Y. Chen, W. Zhu, W. Yang, Z. Chen, J. Song, X. Song, X. Chen, H. Yang, *Advanced Functional Materials*, 31, 2010337 (2021).

5 J. S. Lan, R. F. Zeng, Z. Li, X. G. Yang, L. Liu, L. X. Chen, L. Y. Sun, Y. Shen, T. Zhang, Y. Ding, *Advanced Materials*, 36, 2408511 (2024).

SEIRA Spectroscopy and Vibrational Stark Effect Reveal Aggregation–Propensity Structure of Amyloid–β42 at Membrane Interface

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Intermediate species of amyloid–β (Aβ) play a critical role in fibrillogenesis[1,2], yet the interfacial mechanisms driving disordered monomers to aggregation–propensity structure remain unclear. Addressing this knowledge gap requires in situ methods that simultaneously resolve membrane-associated protein structures and map molecular-scale binding epitopes. We develop an integrated platform combing highly sensitive surface–enhanced infrared absorption spectroscopy (SEIRAS) [3] with vibrational Stark effect (VSE) [4,5] that is sensitive to interfacial electric fields generated by charge–redistributing residues. This multimodal approach enables real-time tracking of Aβ42-membrane interactions under physiomimetic conditions, simultaneously resolving membrane-bound structural transitions and interaction domains (**Fig.1**). Through pH-dependent adsorption analyses, we demonstrate that long-range hydrogen-bonded water networks mediate membrane-protein and subsequent protein-protein interactions, while short-range water dipoles regulate interfacial Aβ42 clustering. Correlation with aggregation morphologies, we identify β–hairpin structural as structural determinants accelerating membrane-associated oligomer nucleation. Our methodology establishes a transformative framework for elucidating early aggregation biophysics, directly connecting molecular-scale interfacial phenomena with pathological assembly processes.

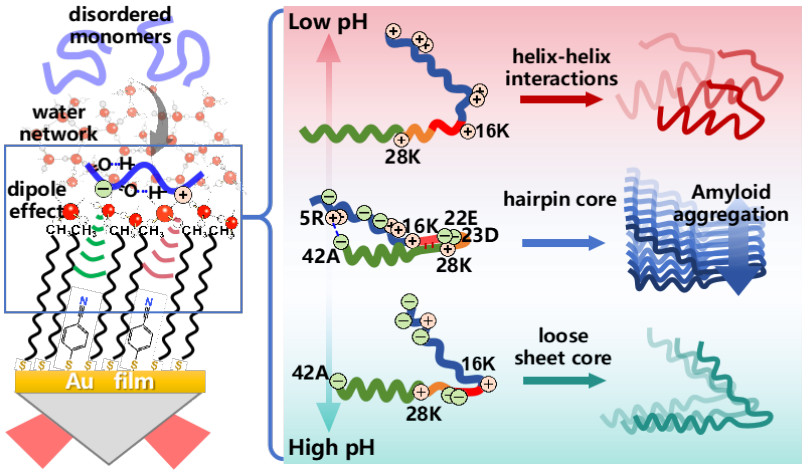


Fig.1 The VSE-SEIRAS platform tracking Aβ42-membrane and Aβ-Aβ interactions under different pH conditions to reveal (1) the correlation between Aβ adsorption kinetics and the pH–dependent dual regulatory effect of interfacial water struc-ture at hydrophobic surfaces (i.e. long–range hydrogen bond network suppresses the interfacial adsorption, while short–range water dipole polarization promotes aggregation), and (2) the dynamic folding structures of Aβ induced by hydrophobic interfaces and residue–specific interactions.

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References

1. Wu, H. & Fuxreiter, M. The Structure and Dynamics of Higher-Order Assemblies: Amyloids, Signalosomes, and Granules. *Cell* **165**, 1055-1066 (2016). https://doi.org:10.1016/j.cell.2016.05.004
2. Iadanza, M. G., Jackson, M. P., Hewitt, E. W., Ranson, N. A. & Radford, S. E. A new era for understanding amyloid structures and disease. *Nat. Struct. Mol. Biol.* **19**, 755-773 (2018). https://doi.org:10.1038/s41580-018-0060-8
3. Kozuch, J., Ataka, K. & Heberle, J. Surface-enhanced infrared absorption spectroscopy. *Nat. Rev. Methods Primers* **3** (2023). https://doi.org:10.1038/s43586-023-00253-8
4. Fried, S. D. & Boxer, S. G. Measuring Electric Fields and Noncovalent Interactions Using the Vibrational Stark Effect. *Acc. Chem. Res.* **48**, 998-1006 (2015). https://doi.org:10.1021/ar500464j
5. Lake, W. R., Meng, J., Dawlaty, J. M., Lian, T. & Hammes-Schiffer, S. Electro-inductive Effect Dominates Vibrational Frequency Shifts of Conjugated Probes on Gold Electrodes. *J. Am. Chem. Soc.* **145**, 22548-22554 (2023). https://doi.org:10.1021/jacs.3c07489

Zinc-Tannic Acid Nanoparticles Enables ROS Scavenging and Removes α-Synuclein fibrils for Parkinson's Disease

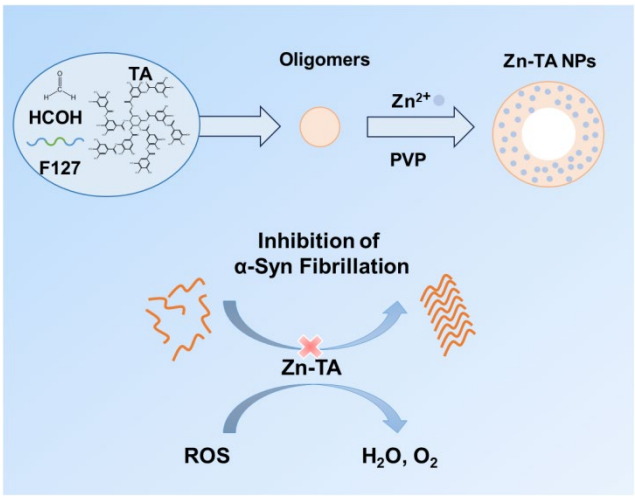
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Polyphenolic substances are widely recognized for their potential therapeutic implications in neurodegenerative diseases typified by amyloid protein deposition,the aggregation of amyloid proteins via mechanisms such as π-π stacking and hydrogen bonding.[1-3] Moreover, their remarkable antioxidant properties play a crucial role in effectively mitigating the levels of reactive oxygen species (ROS) during the progression of Parkinson's disease (PD).Nanoparticles have emerged as promising candidates for the treatment of neurodegenerative diseases, primarily due to their large specific surface area and amenability to modification. This characteristic allows for precise tailoring of their properties to enhance their therapeutic efficacy. [2, 4-6]In this study, tannic acid was coordinated with zinc to synthesize hollow nanoparticles. The fabricated nanoparticles exhibited excellent stability, enabling them to effectively inhibit the aggregation of α-synuclein, a key pathological hallmark in PD, and depolymerize pre-formed fibers. Leveraging the inherent antioxidant property of tannic acid, the tannic acid-zinc nanoparticles demonstrated remarkable ROS scavenging capabilities, further underscoring their potential in counteracting the oxidative stress associated with neurodegenerative diseases. Notably, these nanoparticles were found to synergistically rescue neuronal cell death induced by α-synuclein. Overall, this research presents a compelling candidate for the comprehensive treatment of PD. The findings not only contribute to the growing body of knowledge on the therapeutic potential of polyphenolic-based nanoparticles but also offer new perspectives for their application in the development of novel therapies for neurodegenerative diseases.



Scheme 1. Synthesis and therapeutic mechanism of the Zn-TA NPs.

Acknowledgements

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References

1. L. Fernandes, B. Messias, A. Pereira-Neves, E.P. Azevedo, J. Araújo, D. Foguel, F.L. Palhano, ACS Biomater., **6**, 4414-4423 (2020)
2. Y. Porat, A. Abramowitz, E. Gazit, Chem Biol Drug Des., **67**, 27-37(2005)
3. J. Zhang, X. Zhou, Q. Yu, L. Yang, D. Sun, Y. Zhou, J. Liu, ACS Appl. Mater. Interfaces., **6**, 8475-8487 (2014)
4. Y. Zhao, J. Cai, Z. Liu, Y. Li, C. Zheng, Y. Zheng, Q. Chen, H. Chen, F. Ma, Y. An, L. Xiao, C. Jiang, L. Shi, C. Kang, Y. Liu, Nano Lett., **19**, 674-683 (2018)
5. K. Debnath, S. Shekhar, V. Kumar, N.R. Jana, N.R. Jana, ACS Appl. Mater. Interfaces., **8**, 20309-20318 (2016)
6. N. Slekiene, V. Snitka, I. Bruzaite, A. Ramanavicius, MATERIALS., **15**, (2022)

Stability-Enhanced Proton Exchange Membrane Fuel Cells Enabled by Lanthanum-Doped $L1_2$-Pt_3Co Ordered Alloy Catalysts

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Proton exchange membrane fuel cells (PEMFCs) have emerged as highly promising energy conversion devices due to their exceptional energy density, remarkable energy conversion efficiency, and environmentally benign operation. However, the oxygen reduction reaction (ORR) at the cathode suffers from intrinsically sluggish kinetics, primarily attributed to the challenging molecular oxygen activation and unfavorable O-O bond cleavage. Pt alloys with post-transition metals (Fe, Co, Ni) demonstrate enhanced ORR activity through electronic and strain effects. However, their random fcc solid-solution structures undergo severe oxidation/dissolution at operational conditions (60-80°C, 0.6-1.0 V). This degradation not only diminishes catalytic activity but also generates corrosive byproducts that damage both carbon supports and proton exchange membranes, leading to rapid PEMFC performance decay.

Herein, we synthesized $L1_2$-ordered La-Pt_3Co intermetallic compounds with core-shell structures via metal-organic framework (MOF)-anchored rare-earth oxo-ligand precursors, using lanthanum as a representative example. The incorporation of rare-earth La enables precise modulation of electronic structure through its unique $4f^0 5d^1 6s^2$ configuration and induces beneficial strain effects via its large atomic radius, while simultaneously enhancing thermodynamic stability. The catalyst demonstrates exceptional performance in membrane electrode assembly (MEA) tests: achieving a mass activity (MA) of 1.29 A mg_{Pt}^{-1} at 0.9 $V_{iR\text{-}free}$, representing a 3 times improvement over commercial Pt/C and exceeding the U.S. DOE 2025 target by 2.93 times. Remarkable peak power densities of 2.5 W cm^{-2} (200kPa, H_2/O_2 cell) and 1.27 W cm^{-2} (200kPa, H_2/air cell) were attained. Most importantly, the catalyst exhibits outstanding durability, maintaining 87% of its initial activity (1.13 A mg_{Pt}^{-1}) after 30,000 accelerated stress test cycles, with a minimal voltage decay of only 12 mV at 0.8 A cm^{-2}, far exceeding the DOE targets for MA retention (>60%) and voltage decay (<30 mV), demonstrating excellent activity and cycling stability.

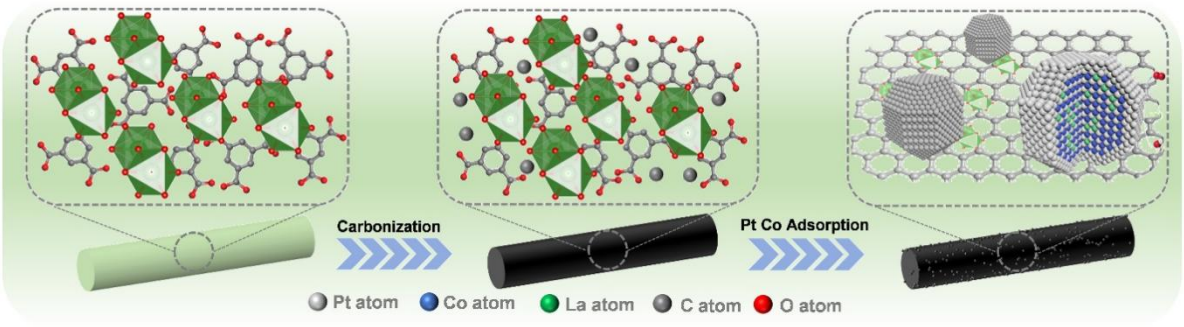


Fig.1 Schematic illustration of the synthetic route to La-MOF and $L1_2$-La-Pt_3Co.

Acknowledgements

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References

1. Escudero-Escribano M, et al. *Science*, **352**, 73-76 (2016)
2. Yang L, et al. *Angew. Chem. Int. Ed.*, **63**, e202315119 (2024)
3. Zhu S, et al. *Natl Sci Rev.*, **10**, nwad162 (2023)
4. Yang L, et al. *ACS Cata.*,**12**, 13523-13532 (2022)

Enhancing the ORR Catalytic Performance of Platinum-Based Intermetallic Compounds via Interface-Coordinated Rare Earth Single Atoms

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Proton exchange membrane fuel cells (PEMFCs) are highly promising for applications in transportation and stationary power generation due to their high energy density, high energy conversion efficiency, environmentally friendly byproducts, and low operating temperature. However, the slow kinetics of the oxygen reduction reaction (ORR) at the cathode and the reliance on expensive platinum-based catalysts significantly increase the cost of PEMFCs, hindering their widespread adoption. Numerous studies have shown that alloying platinum with transition metals, particularly forming ordered intermetallic compounds, can enhance catalytic activity while reducing platinum usage. Yet, the leaching of transition metals in acidic environments remains a critical issue affecting catalyst stability.

In this study, we introduced rare earth single-atom sites on carbon support and employed an interface coordination strategy to strengthen the interaction between alloy particles and the support. This approach remarkably improved both the activity and stability of the catalyst. At the atomic level, the 4f orbitals of rare earth elements offer stronger spin-orbit coupling and a broader range of electron delocalization effects compared to 3d orbitals. The robust electron interaction between rare earth elements and platinum not only modulated the electronic structure of platinum sites, increasing their charge density and lowering the d-band center and oxygen species adsorption energy, but also anchored alloy particles. This inhibition of metal sintering during pyrolysis and metal migration/dissolution during operation, along with the formation of an electron-rich platinum shell, suppressed platinum oxidation and transition metal leaching, further enhancing stability. In MEA tests, the catalyst achieved a peak power density of 1.7 W/cm² (atmospheric pressure, H_2/O_2) and a mass activity of 0.56 A/mg_{Pt} (@0.9 $V_{iR\text{-}free}$, H_2/O_2). After 30,000 acceleration stress test cycles, the mass activity decay was only 26.8% (<40%), and the voltage loss at 0.8 A/cm² was just 3 mV (<30 mV), far exceeding the 2025 targets set by the U.S. DOE.

Acknowledgements

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Changchun Science and Technology Development Program (23GZZ02) for financial support.

References

1. Fan Zhang et al, *Joule*, **9**, 101853 (2025)
2. Lin Tian et al, *Adv. Mater.*, **37**, 2417095 (2025)
3. Leilei Yin et al, *Adv. Mater.*, **37**, 2416387 (2025)

Cobalt-Induced Charge Redistribution Enables Ultrastable Oxygen Evolution over NiFe Layered Double Hydroxides

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NiFe layered double hydroxide (LDH) catalysts present a highly attractive platform for the oxygen evolution reaction (OER) in alkaline environments due to their controllable morphologies, tunable chemical compositions, natural abundance of constituent elements, low cost, all while demonstrating commendable intrinsic catalytic activity. However, a critical challenge during electrochemical operation is their inherent structural instability. These catalysts undergo significant anodic reconstruction, where the initial LDH structure transforms into the catalytically active metal (oxy)hydroxide phase. Concurrently, metal dissolution occurs, particularly involving Fe species. While some dissolved metal ions may re-deposit onto the catalyst surface, this process often leads to detrimental phase segregation, disrupting the material's homogeneity and ultimately compromising its long-term operational durability. To address these stability limitations, this work introduces a trimetallic NiFeCo LDH catalyst synthesized directly on nickel foam (NF) via a facile one-step hydrothermal method. The strategic incorporation of cobalt effectively stabilizes the valence state of the iron cations, mitigating their dissolution tendency and concurrently enhances the overall structural order and crystallinity of the nickel framework within the LDH lattice. Remarkably, the NiFeCo LDH/NF shows excellent stability with a low decay rate of 0.067 mV h^{-1} over 2100 hours in anion exchange membrane water electrolyzer (AEMWE). This outstanding stability metric positions NiFeCo LDH/NF as a highly durable and promising anode material for efficient and sustainable water electrolysis.

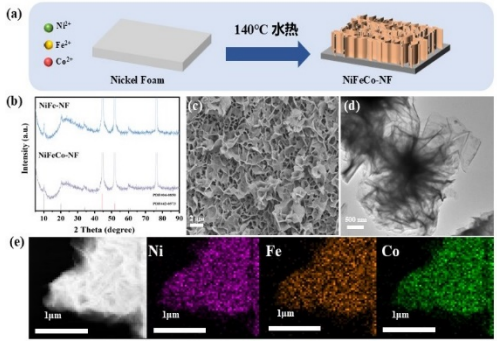


Fig.1 Synthesis diagrama and physical characterization of NiFeCo/NF

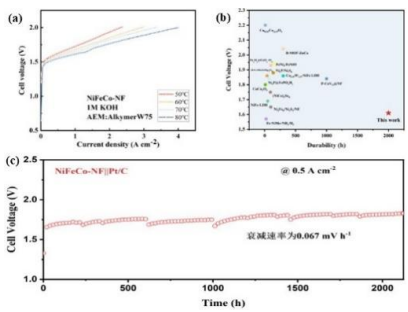


Fig.2 Performance and performance comparison of NiFeCo/NF||Pt/C in AEMWE

Acknowledgements

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References

1. Zhang, Q., Xiao W., et al, *ACS Catalysis*, **13**,14975−14986 (2023)
2. Qian, Z., Liang, G., et al, *Journal of the American Chemical Society*, **147**, 1, 1334–1343 (2025)
3. Lee, S., Bai L., et al, *Angew. Chem.,* **132**, 8149–8154 (2020)

Ultrafine coordination-unsaturated IrOx nanoclusters for highly efficient acidic water oxygen evolution electrocatalysis

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The low intrinsic activity and high cost due to scarce reserves of Ir severely restrict the large-scale application of Proton Exchange Membrane Water Electrolysis (PEMWE). In pursuit of enhancing the intrinsic activity of iridium oxide, this study presents an innovative catalyst design featuring ultrafine IrOx nanoparticles supported on Nb_2O_5. The IrOx nanoparticles exhibit an average size of 1.13 nm, which significantly increases the specific surface area and thereby provides a greater number of active sites. Additionally, the under-coordinated nature of IrOx further contributes to the high catalytic activity of this material. This unique structural configuration endows the catalyst with exceptional performance for the oxygen evolution reaction (OER). Our experiments show that $IrOx/Nb_2O_5$ exhibits good activity in electrochemical tests, with a low overpotential of 261 mV and excellent operational stability of about 300 hours at a current density of 10 mA/cm^2. In the single electrolytic cell test of PEMWE, $IrOx/Nb_2O_5$ achieves an electrolytic voltage of 1.789 V at the current density of 3 A/cm^2, reaching the 2026 target of the US Department of Energy (DOE). These results demonstrate the promising application prospects of $IrOx/Nb_2O_5$ in PEMWE. The unique structure of $IrOx/Nb_2O_5$ provides abundant active sites for the OER process, which is crucial for improving the overall performance of PEMWE. Further investigations into refining the catalyst's composition and architecture is imperative to unlock its full potential for extensive hydrogen generation via PEMWE.

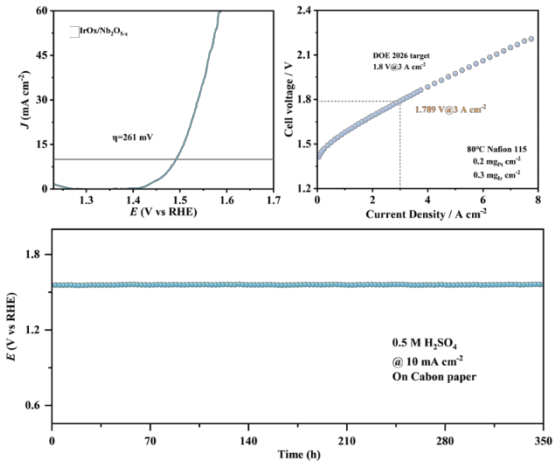


Fig.1 Electrochemical activity and stability of IrOx/Nb_2O_5

Acknowledgements

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References

1. Lu, B., Wahl, C., dos Reis, R. et al. Nat Catal **7**, 868–877 (2024).
2. Wu, G., Zheng, X., Cui, P. et al. *Nat Commun* **10**, 4855 (2019).
3. Liang, C., Rao, R.R., Svane, K.L. et al. *Nat Catal* **7**, 763–775 (2024).

Mesoporous carbon confined Pt-based nano-alloys with enhanced atomic utilization for oxygen reduction reaction

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To reduce the cost of proton exchange membrane fuel cells (PEMFCs), developing cathode catalysts with high Pt atomic utilization is critical. However, two key challenges hinder this goal: (a) During the thermal annealing process of Pt-alloy catalysts, excessive nanoparticle growth leads to buried Pt atoms in the particle interior that cannot participate in catalytic reactions; (b) The spatial distribution of carbon supports, Pt nanoparticles, and ionomers significantly affects effective triple-phase boundary formation—surface Pt nanoparticles may be poisoned by ionomer coverage, while those without ionomer contact cannot establish proton transport pathways for catalytic activity.

To address these issues, this study proposes a novel ammonia-etching strategy to construct accessible mesoporous structures. The engineered mesoporous architecture demonstrates dual functionalities: (a) The mesopore confinement effect effectively suppresses nanoparticle agglomeration during synthesis, yielding uniformly dispersed Pt nanoparticles (5.2±0.5 nm); (b) Strategic deposition of Pt nanoparticles near mesopore openings creates a "proton-accessible but ionomer-shielded" configuration, simultaneously ensuring efficient proton transport and minimizing ionomer poisoning.

Compared to conventional microporous catalysts, the accessible mesoporous supported catalyst exhibits superior performance, achieving: 2.3-fold increase in mass activity(0.51 A mg_{Pt}^{-1} at 0.9 V), the half-wave potential ($E_{1/2}$) shows negligible decay after 50000 accelerated stress test cycles in rotating disk electrode test; Peak power density of 2.3 W cm^{-2} (H_2/O_2, 80°C, 100% RH, 200$kPa_{back\ pressure}$) in fuel cell test. This work demonstrates fundamental insights into the structure-activity relationship of accessible mesoporous designs, offering a viable pathway toward high-performance and cost-effective PEMFC catalysts.

Acknowledgements

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References

1. W Mengnan, Z Jiaguang,. Nat Commun, 15, 9390 (2024)
2. Y. Venkata, C. Michael ACS Energy Letters,3, 618-621(2018).

Fe-Co bimetallic synergistic cathode catalyst for High-Efficiency and Durable Proton Exchange Membrane Fuel Cells

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Amidst growing global imperatives for sustainable energy solutions, fuel cells have emerged as a transformative technology in the green energy transition, distinguished by their exceptional energy density and carbon-neutral operational characteristics. While recognized as pivotal enablers of clean energy systems, their widespread commercialization faces a critical challenge: The reliance on expensive platinum-based oxygen reduction reaction (ORR) catalysts at the cathode poses a major challenge, as their scarcity and high cost create significant barriers to scalable deployment.

Metal-nitrogen-doped carbon-based catalysts (M-N-C) catalysts, with MN_x groups as the primary active sites, exhibit high intrinsic ORR activity and have emerged as the most promising alternatives to Pt-based catalysts. Despite these advances, maintaining stability under high-current-density operation continues to pose significant challenges. Radical-induced degradation has been established as a predominant failure mechanism in catalytic systems, with strategic inhibition of reactive oxygen species (ROS) formation emerging as the most viable pathway toward enhancing catalyst operational longevity.

In this work, we precisely engineered the catalytic microenvironment to redirect reaction pathways and effectively suppress radical formation through cobalt incorporation-induced electronic structure modulation. Crucially, secondary metal doping synergistically reconstructed the nanoscale architecture, enhancing mass transport kinetics at triple-phase boundaries while maintaining optimal active site accessibility in membrane electrode assemblies. The optimized catalyst demonstrated an outstanding power density of 1.45 W cm^{-2} under H_2-O_2 conditions, retaining about 80% of its initial performance after 40,000 potential cycles, confirming it has significant practical application value.

Acknowledgements

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References

1. Proietti, E. et al. *Nat. Commun*, **2**, 416 (2011)

2. Yuyi Chu et al,*Chem Catalysis*, **3**, 100532 (2023)
3. Xiaohong Xie et al, *Nat. Catal*,**3**,1044-1054 (2020)

RuO_2/Ru-Co_3O_4 catalyst triggers the coupling of oxygen radicals for durable acidic water oxidation

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The urgency to develop novel, eco-friendly, and economically efficient energy conversion technologies is driven by the worsening environmental pollution and the insufficiency of fossil fuel reserves. Hydrogen, a green chemical energy with a high energy density of 140 MJ kg^{-1} , is highly promising. Proton exchange membrane water electrolysis (PEMWE), one of the significant methods for hydrogen production, faces limitations due to its harsh acidic and strongly oxidative working conditions, which restrict the practical application of most oxygen evolution reaction (OER) catalysts. To date, only Ir and its oxides have sufficient corrosion resistance for long - term industrial anode application.

However, the high cost of proton exchange membranes and the noble metal Ir has limited PEMWE's large - scale commercialization. Thus, finding an alternative to Ir is crucial to reduce production costs. Ru, with a higher economic advantage over Ir in terms of balancing activity and stability, emerges as a strong candidate for substitution. Yet, under harsh working conditions, Ru - based catalysts exhibit unsatisfactory stability, often losing activity within a few hours. Recently, researchers have tried various methods to prolong the working life of Ru - based catalysts, such as constructing metal heterojunctions, doping metal elements, and designing acid - resistant solid solution oxides. These approaches aim to modify the electronic structure and trigger new reaction mechanisms.

In this study, we rationally designed and prepared a RuO_2/Ru-Co_3O_4 catalyst, which significantly enhances the activity and stability of Ru - based catalysts. In three - electrode tests, current densities of 10 mA cm^{-2} and 100 mA cm^{-2} are achieved with overpotentials of just 215 mV and 276 mV, respectively. In constant current tests at 100 mA cm^{-2}, it demonstrates long-term stability exceeding 1000 hours. In PEMWE tests, at an operating temperature of 80℃, a current density of 1 A cm^{-2} is achieved at 1.568 V. Moreover, at 60℃ and a current density of 0.5 A cm^{-2}, it exhibits stability over 200 hours.

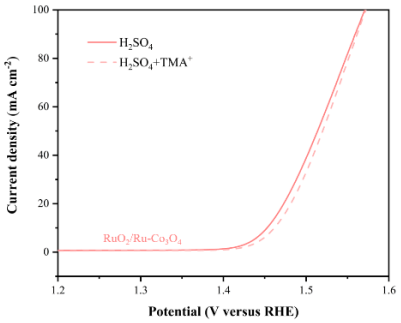


Fig.1 LSVs with and without TMA^+

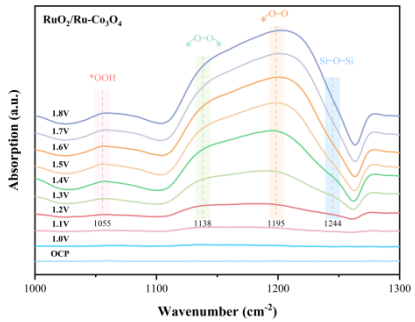


Fig.2 Insitu ATR-SEIRAS spectra of RuO_2/Ru-Co_3O_4

Acknowledgements

Thank the National Key R&D Program of China (No.2022YFB4002000), the National Natural Science Foundation of China (No. 22232004), the Jilin Province Development and Reform Commission Program (2023C032-6), and the Jilin Province Science and Technology Development Program (No. 20240302002ZD, 20240101019JC and 20210502002ZP) for financial support.

References

1. Chang, J. et al. Oxygen Radical Coupling on Short-Range Ordered Ru Atom Arrays Enables Exceptional Activity and Stability for Acidic Water Oxidation. J. Am. Chem. Soc. 146, 12958–12968 (2024).
2. Lin, C. et al. In-situ reconstructed Ru atom array on α-MnO2 with enhanced performance for acidic water oxidation. Nat Catal 4, 1012–1023 (2021).

Impact of Ionomer Content on the Electrocatalytic Performance and Durability of Fuel Cell Membrane Electrode Assemblies

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Significantly reducing platinum (Pt) usage is crucial for the large-scale application of proton exchange membrane fuel cells (PEMFCs), a key hydrogen energy technology pivotal for achieving future carbon neutrality. However, lowering the Pt loading in the cathode electrode leads to high voltage losses. Catalyst layer (CL) design offers a viable pathway towards the commercialization of PEMFCs. A deep understanding of catalyst ink is essential for achieving optimal CL structure and cell performance.

In this work, the influence of ionomer content within the ink on the formation of the three-phase boundaries (TPBs) is specifically considered to elucidate the structure-performance correlation between ionomer content, TPBs, and fuel cell performance. Different ionomer contents in the ink influence the formation of the TPB structure. Membrane electrode assemblies (MEAs) fabricated with an appropriate ionomer content exhibit a denser pore structure within the ionomer network, superior proton conduction capabilities, and lower mass transport resistance. Simultaneously, an optimal I/C ratio provides better voltage stability and reduced voltage decay.

Under complex fuel cell operating conditions, the catalyst ink formulation with an ionomer-to-carbon ratio (I/C) of 0.5 is preferred. This formulation provides an appropriate distribution of ionomer and pore sizes to optimize the TPB structure, thereby delivering satisfactory fuel cell performance.

Acknowledgements

Thank the National Natural Science Foundation of China (U23A20137) for financial support.

References

1. Shengchu Liu et al,*Chem. Eng. J.*,**472**,145050(2023)
2. Meihua Tang et al,*J. Am. Chem. Soc.*,**147**,19931-19940(2025)

Using surface-enhanced infrared spectroscopy to measure the interfacial electric field of microdroplets.

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It's well known that the chemical reactions in aqueous microdroplets can be several orders of magnitude faster compared with those in bulk.[1,2] This might be related to the interfacial electric field of the microdroplets[3], but there is a lack of appropriate tools to measure the electric field of aqueous microdroplets directly.[4,5] Herein, we constructed a hydrophobic enhanced substrate with nitrile groups and use surface-enhanced infrared spectroscopy to measure the electric field of microdroplets. The nitrile of 4-Mercaptobenzonitrilehas exhibits a Δμ of 0.6 cm^{-1}/(MV/cm)[6], the 0.5 cm^{-1} blue shift indicates a local electrostatic field of ~1 MV/cm. When the dipole direction of the nitrile probe is opposite to the direction of the external electric field, the wavenumber of the probe will appear blue shift. Therefore, we infer that the electric field direction at the interface of microdroplets is from the air to the water. The formation of the electric field might be due to the aggregation of OH^- and the adsorption of negative ions at the gas-liquid interface,[7] the H^+ inside the microdroplets responds to the aggregation of OH^- by setting up an electric double layer at the same time. We think that this strong electric field might partially explain the unique properties of chemical reactions in microdroplets.

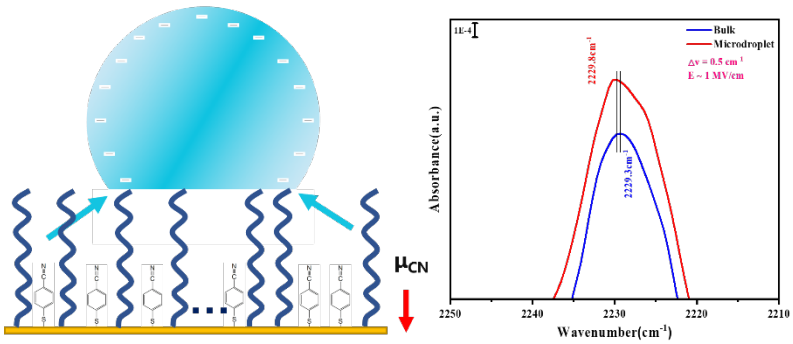


Fig.1 Schematic diagram of the electric field of microdroplets

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References

1. Wang, Y.; Luo, J.; Fang, Y.-G.; Nan, Z.-A.; Cui, X.; Chen, T.; Zeng, X.; Wang, X.; Song, X.; Zhao, J.; Li, W.; Zeng, C.; Chen, D.; Zhu, C.; Wei, Z.; Tian, Z.-Q.; Fan, F. R. Catalyst-Free Nitrogen Fixation by Microdroplets through a Radical-Mediated Disproportionation Mechanism under Ambient Conditions. *J. Am. Chem. Soc.* **2025**, *147* (3), 2756–2765.
2. Chen, X.; Xia, Y.; Yang, Y.; Xu, Y.; Jia, X.; N. Zare, R.; Wang, F. Microdroplet-Mediated Multiphase Cycling in a Cloud of Water Drives Chemoselective Electrolysis. *J. Am. Chem. Soc.* **2024**, *146* (43), 29742–29750.
3. Kathmann, S. M.; Kuo, I.-F. W.; Mundy, C. J. Electronic Effects on the Surface Potential at the Vapor−Liquid Interface of Water. *J. Am. Chem. Soc.* **2008**, *130* (49), 16556–16561.
4. Hao, H.; Leven, I.; Head-Gordon, T. Can Electric Fields Drive Chemistry for an Aqueous Microdroplet? *Nat. Commun.* **2022**, *13* (1), 280.
5. Shi, L.; LaCour, R. A.; Qian, N.; Heindel, J. P.; Lang, X.; Zhao, R.; Head-Gordon, T.; Min, W. Water Structure and Electric Fields at the Interface of Oil Droplets. *Nature* **2025**.
6. Schkolnik, G.; Salewski, J.; Millo, D.; Zebger, I.; Franzen, S.; Hildebrandt, P. Vibrational Stark Effect of the Electric-Field Reporter 4-Mercaptobenzonitrile as a Tool for Investigating Electrostatics at Electrode/SAM/Solution Interfaces. *Int. J. Mol. Sci.* **2012**, *13* (6), 7466–7482.
7. Poli, E.; Jong, K. H.; Hassanali, A. Charge Transfer as a Ubiquitous Mechanism in Determining the Negative Charge at Hydrophobic Interfaces. *Nat. Commun.* **2020**, *11* (1), 901.

Construction of Ce-Zr-O Nanozymes with Defect-Rich Polycrystalline Based on a Solid Solution Strategy for Dual Catalysis and Targeted Phosphate Sensing in Urine

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Metal doping enhances nanozyme performance and broadens its functionalities [1, 2]. Although both oxidase and phosphatase functions are employed in nanozyme-based sensing, they operate via different mechanisms: the oxidase function entails electron transfer and the activation of oxygen [3], while the phosphatase function relies on Lewis acid catalysis coupled with the nucleophilic attack [4]. Present sensing platforms that utilize these functions are constrained by their single-mode detection, making them vulnerable to interference in real samples. To address this, we present a solid solution (SS) strategy for designing multifunctional Ce-Zr-O nanozymes specifically for dual-mode detection of PO_4^{3-}. Doping with Zr^{4+} creates defect-rich polycrystalline structures within Ce-Zr-O, significantly enhancing phosphatase activity through the hydrolysis of 4-methylumbelliferyl phosphate (4-MUP) and generating specific PO_4^{3-} recognition sites. Concurrently, the presence of Ce^{4+}/Ce^{3+} provides oxidase-mimicking catalytic activity, facilitating the oxidation of 3,3',5,5'-tetramethylbenzidine (TMB). In addition, the Ce-Zr-O nanozymes achieve a high sensitivity and selectivity for phosphate detection in both methods, confirming their effectiveness for monitoring phosphate levels in urine. This research provides key insights into high-efficiency nanozyme design and introduces a novel synthesis strategy with significant implications for biomedical diagnostics.

Acknowledgements

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References

1. C. Liu, X. Cao, X. Ma, Y. Wang, M. Zhang, J. Qiu, J, Chen and H. Xue, *Small,* **21**, 2411212 (2025).
2. J. Duan, S. Xia, X. Sang, Y. Chen, H. Wei, J. Nie, G. Xu, Y. Yuan and W. Niu, *Talanta*, **276**, 126209 (2024).
3. X. Li, S. Ding, Z. Lyu, P. Tieu, M. Wang, Z. Feng, X. Pan, Y. Zhou, X. Niu, D. Du, W. Zhu and Y. Lin, *Small,* **18**, 2203001 (2022).
4. S. Li, Z. Zhou, Z. Tie, B. Wang, M. Ye, L. Du, R. Cui, W. Liu, C. Wan, Q. Liu, S. Zhao and Q. Wang, *Nat. Commun.,* **13**, 827 (2022).

Electrochemical Probing the Photo-Enhanced Intrinsic ClER Activity of Fluorinated Cobalt Sites via SECM/SECCM

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The electrocatalytic chlorine evolution reaction (ClER) provides a sustainable approach for converting abundant seawater chloride into highly reactive chlorine species for in-situ marine purification.1-2 Although cobalt-based catalysts have demonstrated certain apparent ClER activity, their chlorine selectivity remains unsatisfactory under conditions of low Cl- concentration and neutral pH, and their intrinsic ClER activity is still unclear.3-4 Here, we demonstrate a solar-driven strategy employing surface-fluorinated cobalt hydroxide nanosheets (Co(OH)xFy) as an efficient, highly selective catalyst for neutral-pH ClER. Building on this, we combine SI-SECM and SECCM technologies to detect the intrinsic ClER activity of individual nanosheets at the micro/nano-scale and reveal the mechanism underlying their enhanced activity. 5-6 Studies show that this catalyst demonstrates outstanding chlorine selectivity (86.84% at 10 mA cm-2 in 0.5 M NaCl, pH 7.0) and enables highly efficient removal of a broad spectrum of common marine

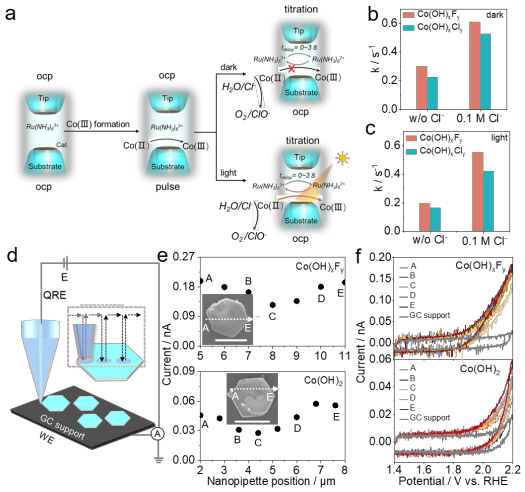


Fig.1 (a) Schematically illustrated active sites quantification and kinetic rate determination of $Co(OH)_xF_y$ and $Co(OH)_xCl_y$ under dark and light condition with SI-SECM. Pseudo-first-order reaction kinetic rate constants for ClER and OER under (b) dark and (c) light conditions. (d) Schematic diagram of SECCM hopping mode. Hopping distance is 0.8/1.0 μm. A glassy carbon (GC) support with dispersed isolated nanosheets serves as the working electrode (WE). (e) ClER current at different positions of a single $Co(OH)_xF_y$ and $Co(OH)_2$ at 2.2 V vs. RHE. (insert: SEM images of $Co(OH)_xF_y$ and $Co(OH)_2$ dispersed on the GC support. The scanning direction is indicated by the dotted white arrows, and the important points are represented by letters. Scale bars, 5 μm.) (f) corresponding CV curves at those positions. CV curves were recorded at 0.5 V s^{-1}.

pollutants, including NH4+-N, tetracycline, sulfamethoxazole, phenol, bisphenol A, and Escherichia coli. In-situ SI-SECM and SECCM studies reveal that fluorination accelerates the ClER rate and boosts activity across both edge and basal regions of the nanosheets,

while light irradiation promotes the formation of more CIER active sites and further elevates selectivity. DFT calculations corroborate that fluorination lowers the chloride adsorption energy and suppresses OER, with the edge regions exhibiting reduced activation barriers and faster kinetics.

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References

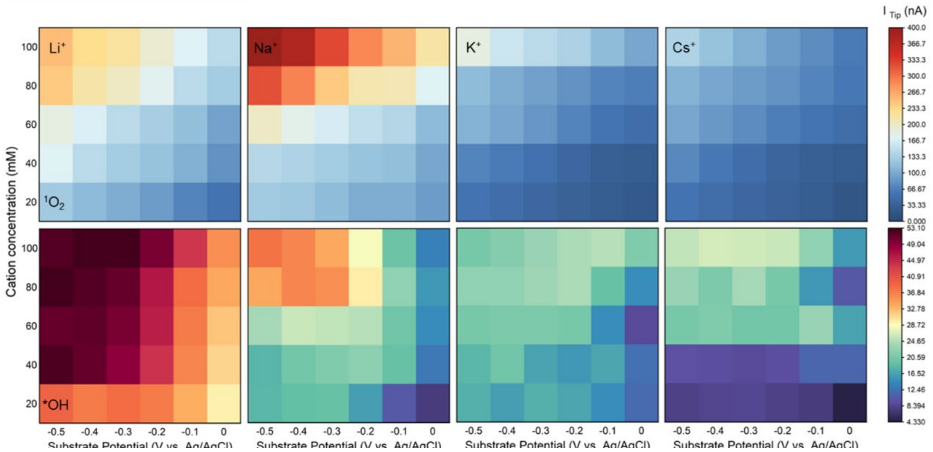
1. Kim, J.; Usama, M.; Exner, K. S.; Joo, S. H., Renaissance of Chlorine Evolution Reaction: Emerging Theory and Catalytic Materials. *Angew. Chem. Int. Edit.* **64**, e202417293 (2024).
2. Guo, K.; Wu, Z.; Chen, C.; Fang, J., UV/Chlorine Process: An Efficient Advanced Oxidation Process with Multiple Radicals and Functions in Water Treatment. *Acc. Chem. Res.* **55**, 286−297 (2022).
3. Xiao, M.; Wu, Q.; Ku, R.; Zhou, L.; Long, C.; Liang, J.; Mavrič, A.; Li, L.; Zhu, J.; Valant, M.; Li, J.; Zeng, Z.; Cui, C., Self-adaptive amorphous CoOxCly electrocatalyst for sustainable chlorine evolution in acidic brine. *Nat. Commun.* **14**, 5356(2023).
4. Moreno-Hernandez, I. A.; Brunschwig, B. S.; Lewis, N. S., Crystalline nickel, cobalt, and manganese antimonates as electrocatalysts for the chlorine evolution reaction. *Energ. Environ. Sci.* **12**, 1241-1248 (2019).
5. Mefford, J. T.; Akbashev, A. R.; Kang, M.; Bentley, C. L.; Gent, W. E.; Deng, H. D.; Alsem, D. H.; Yu, Y.-S.; Salmon, N. J.; Shapiro, D. A.; Unwin, P. R.; and Chueh, W. C., *Nature*, **593**, 67-73 (2021).
6. Jin, Z.; Li, P.; Meng, Y.; Fang, Z.; Xiao, D.; and Yu G., *Nat. Catal.* **4**, 615-622 (2021).

SECM-Based Detection of ORR-Generated Reactive Oxygen Species for Electrolyte Screening

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The electro-Fenton technology represents a class of electrochemical advanced oxidation processes that efficiently treats organic wastewater via oxygen reduction reaction generating various reactive oxygen species (ROS) with strong oxidative capabilities, demonstrating broad application prospects.[1,2] However, most researchers predominantly focus on enhancing ROS generation and activation which dominated by material intrinsic activity in catalytic reactions, while neglecting the crucial influence of cations in electrolyte mass transport processes on the electric double layer at catalytic microinterfaces. Preliminary experiments have revealed that different cationic electrolytes lead to variations in ROS generation and reaction pathways, consequently affecting pollutant degradation performance. To elucidate the underlying reaction mechanisms, this work employs scanning electrochemical microscopy (SECM) in substrate generation/tip collection mode to detect electrochemical signals of $^1O_2$ and ⁎OH at catalytic microinterfaces under varying cation types and concentrations in electrolytes.[3,4] This research not only presents a convenient and efficient analytical screening method but also provides a new avenue for further improving electrocatalytic material performance and optimizing organic wastewater treatment processes.

Fig.1 Correlation heatmap of current signal intensities for $^1O_2$ and ⁎OH in different electrolytes.



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References

1. J. Ji, Q. Yan, P. Yin, S. Mine, M. Matsuoka, and M. Xing, *Angew. Chem. Int. Ed.*, **60**, 2903–2908 (2021).
2. G. Zhu, X. Fan, Y. Yu, Y. Liu, and X. Quan, *Environ. Sci. Technol.*, **58**, 19545–19554 (2024).
3. M. C. O. Monteiro, F. Dattila, B. Hagedoorn, R. García-Muelas, N. López, and M. T. M. Koper, *Nat. Catal.*, **4**, 654–662 (2021).
4. J. S. Barroso-Martínez, A. I. B. Romo, S. Pudar, S. T. Putnam, E. Bustos, and J. Rodríguez-López, *J. Am. Chem. Soc.*, **144**, 18896–18907 (2022).

cally interlocked hydrogel bidirectional interfaces for adaptive neuromodulation in epilepsy management

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Timely intervention during early seizure activity represents a crucial therapeutic strategy for refractory temporal lobe epilepsy. While optogenetic neuromodulation has demonstrated effective seizure inhibition capabilities, the subtle behavioral manifestations during early epileptogenesis often fail to accurately reflect aberrant neuronal activity and therapeutic efficacy. Here, we present a mechanically interlocked hydrogel bidirectional interface featuring conformal tissue-adaptive, robust bioadhesion, and efficient interconnected conductive networks for high-fidelity neural signal acquisition and adaptive optogenetic neuromodulation. This bioinspired interface achieves robust seamless tissue-device integration through synergistic topological compliance and quadruple hydrogen bonding interactions, demonstrating stable chronic neural recording capabilities for about 12 weeks in awake-behaving rodents. In epilepsy management, this bidirectional interface with superior signal transduction fidelity simultaneously realizes precise detection of incipient epileptiform activities and adaptive optogenetic modulation triggered by epileptiform activity, while not interfering with the neural homeostasis during the interictal period.

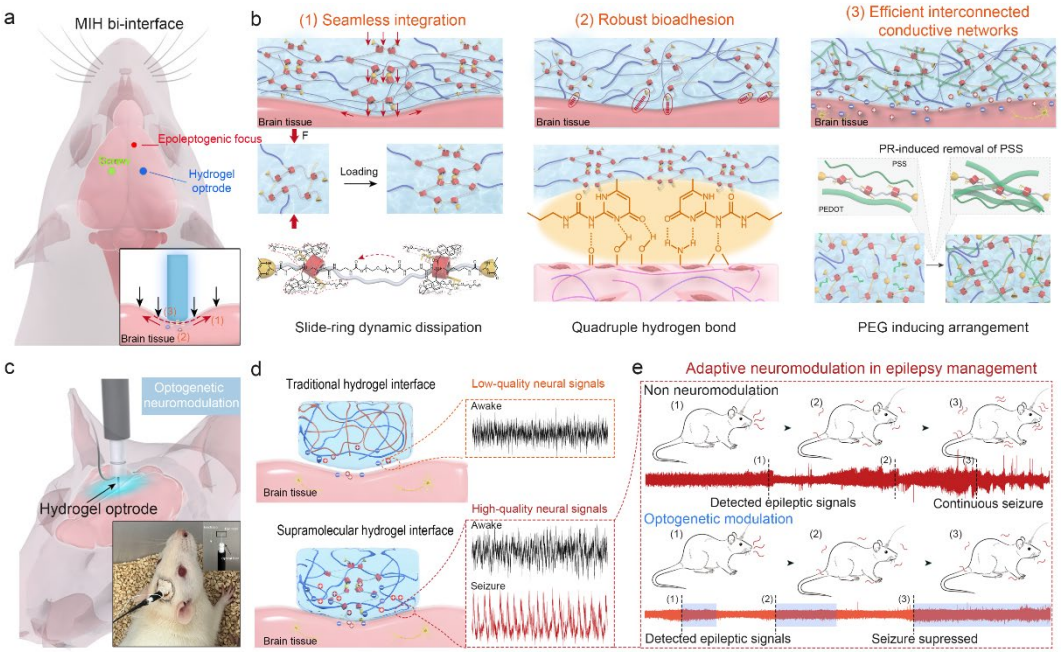


Fig.1 Mechanically interlocked hydrogel bi-interface enables adaptive epilepsy treatment.

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References

1. S. Lee and J. Kum, *et al. Nat. Electron.,* **7**, 800–814 (2024).
2. J. Qu and X. Kai, et al. *Sci. Adv.*, **10**, eadq9207 (2024).
3. J. Jin and X. Yang, et al. *Angew. Chem. Int. Ed.,* **62**, e202218313 (2023).
4. H. Ke and L. Yang, et al. *Nat. Chem.,* **11**, 470–477 (2019).

A fully integrated wearable sweat sensing patch for online analysis of multiple Parkinson's disease-related biomarkers

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Parkinson's disease (PD) is marked by a prolonged asymptomatic "window period" (several years). Early prediction and diagnosis during this window are crucial, as timely interventions can slow disease progression. In this study, we developed a fully integrated wearable sweat-sensing patch capable of real-time detection of three key PD biomarkers: L-Dopa, ascorbic acid, and glucose. The system includes a biomimetic microfluidic module for sedentary sweat collection, an advanced electrochemical sensing platform for biomarker analysis, on-site signal processing circuitry for data management, and custom software for real-time data visualization. A universal strategy was proposed to significantly extend the stability of oxidase enzymes without activity loss, achieved through the design of Cu-oxidase hybrid nanoflowers. The patch was successfully tested on dozens of volunteers (healthy and PD patients in various stages), demonstrating its capability to monitor biomarkers in real time, assess PD progression, and optimize medication management.

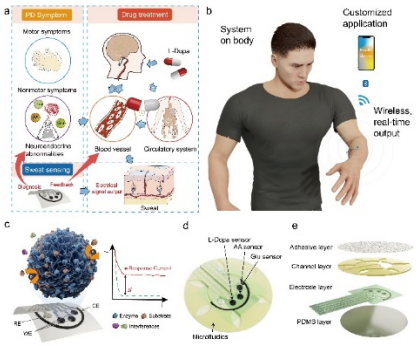


Fig.1 Schematic illustration and images of the integrated wearable sweat sensing patch. (a) Diagram of the principle of sweat detection in the diagnosis and drug treatment of PD. (b) Schematic of the wearable sensing patch that enables on-body, wireless, and real-time sweat monitoring. (c) The in-situ quantification of analytes using biosensors coupled with enzyme-induced NFs. WE, working electrode; RE, reference electrode; CE, counter electrode. Schematic (d) and layer assembly (e) of the microfluidic module for sweat induction, sampling, and biosensing.

Acknowledgements

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References

1. H. Zhao, J. Bai, X. Zhang, D. Li, Q. Chang, Y. Xia, Y. Liu, S. M. Mugo, H. Wang, Q. Zhang, *Adv. Mater.* 2025, 2504534.

Ultrathin Light Emitting Electrochemical Cells From Photo and Redox Active Molecular Layers

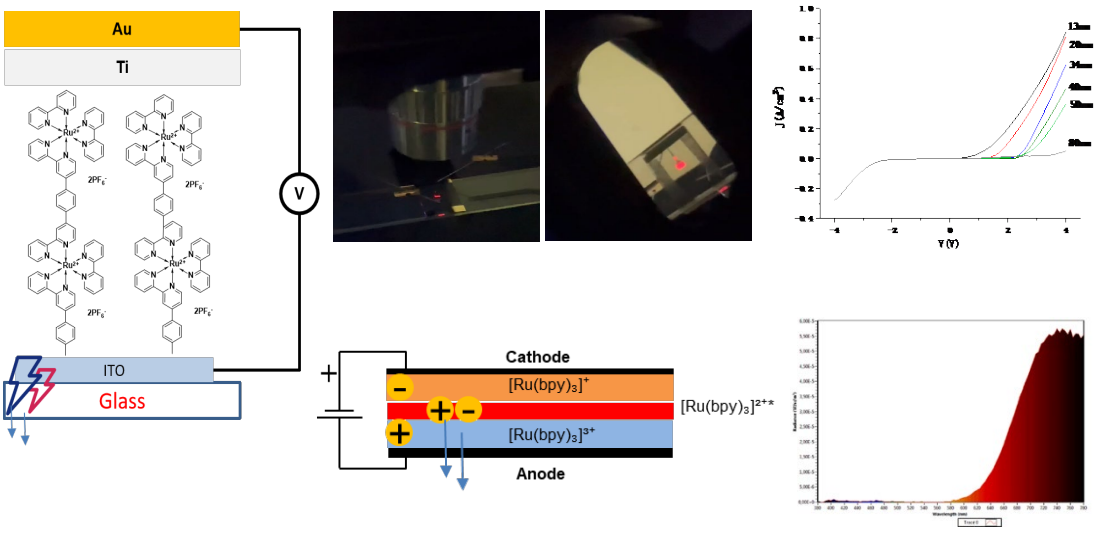
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Molecular electronics (ME) is a scientific domain, aiming at developing devices for information technologies. The initial motivation of ME was to mimic conventional silicon-based electronic devices with molecules, which was also driven by the dream of extending Moore's law beyond the current miniaturization limits of complementary metal oxide semiconductor (CMOS) technology.[1] Molecular junctions (MJs) are the key building blocks of ME, which could be created at the single molecule level or in large area systems. Compared to single molecular, the large-area molecular junctions (via self-assembly, Langmuir–Blodgett, or other methods) allows the massive fabrication of high-quality and reproducible MJs, they are much more appealing for industrial processes. The large-area MJs incorporating Ru(bpy)3 has already shown light emission in eC/Ru(by3)/e-C with semi-transparent electrode.[2,3] In this talk, the fabrication of the devices will be made on ITO, which could be made by lithography and wet etching, making it possible to generate 500 , 1000 or 3000µm wide and fully transparent electrodes which are used for electrochemical grafting. They would be used in the development of ultrathin layers (thickness between 5 and 20 nm) and eITO/Ru(bpy)3/Au-Tie molecular junctions. Transport properties and light emission was investigated in these ultrathin solid-state MJs, A threshold of 2.7 V was evidenced to trigger light emission and is coherent with a mechanism based of redox events occurring within the junction showing that these MJs can be seen as the thinnest light emitting electrochemical cell developed.[4,5]



References

1. Nguyen, Q. V.; Martin, P.; Lacroix, J.-C. *J. Am. Chem. Soc.* **2018**, 140 (32), 10131–10134.
2. U. M. Tefashe, Q. V. Nguyen, F. Lafolet, J.-C. Lacroix, R. L. McCreery. *J. Am. Chem. Soc.* **2017**, 139, 7436-7439.
3. U. M. Tefashe, C. V. Dyck, S.K. Saxena, J.-C. Lacroix, R. L. McCreery. *J. Phys. Chem. C* **2019**, 123, 29162−29172
4. T. Li, V. K. Bandari, O. G. Schmidt. *Adv. Mater.* **2023**, 35, 2209088
5. I. Hnid, A. Yassin, I. Arbouch, D. Guérin, C. Dyck, L. Sanguinet, S. Lenfant, J. Cornil, P. Blanchard, D. Vuillaume. *Nano Lett.* **2024**, 24, 2553−2560.

Polymerization of bispyridylbutadiyne on surface evidenced by STM and application in photocatalysis

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PDPB belongs to the family of poly(diacetylenes), which are one of the interesting research targets among π-conjugated polymers, having fascinating physicochemical properties with tailorable pendant side groups and terminal functionalities. Scanning tunneling microscope (STM) is a powerful technique to investigate topographic as well as electronic properties on functional organic molecules down to sub-molecular level. BPBPy molecules, with a length of approximately 1.2 nm (as shown in Figure 1), self-assemble into highly ordered 2D nanostructures at the 1-heptanoic acid/HOPG interface under dark conditions. These nanostructures form differently oriented domains characterized by supramolecular stripes with a close-packed arrangement. High-resolution STM imaging shows a zig-zag organization stabilized by intermolecular N···H-N hydrogen bonds and weak van der Waals interactions with the HOPG substrate. Upon UV irradiation (365 nm) for varying durations, significant morphological transformations occur. After 15 minutes of exposure, the self-assembled patterns evolve into 1D polymeric wires with lengths ranging from tens to hundreds of nanometers (as shown in Figure 2). High-resolution STM images reveal sub-molecular details, including the cis orientation of pyridine moieties extending outward from the main axes. These findings demonstrate the potential of BPBPy molecules for photo-induced surface patterns.

These observations demonstrate on-surface polymerization reaction at a sub-molecular level.

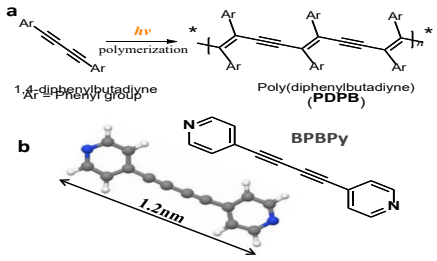


Fig.1 Molecular structure of BPBPy monomer and PDPB polymer

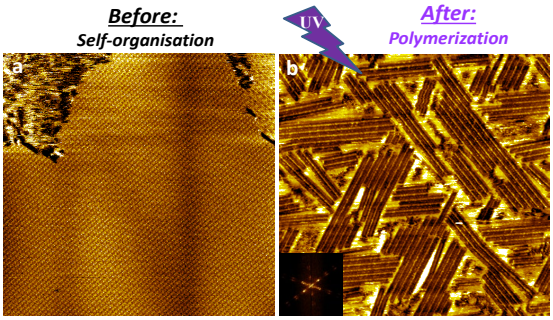


Fig.2 Molecular structure of BPBPy monomer and PDPB polymer

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References

1. Ghosh, Srabanti, et al. "Conducting polymer nanostructures for photocatalysis under visible light." Nature materials 14.5 (2015): 505-511.
2. L. Guan, F. Palmino, J. C. Lacroix*, F. Chérioux, X. Sun*, Nanomaterials, 2022, 12, 1334 (2022).
3. X. Sun*, X. Yao, G. Trippé-Allard, J. C. Lacroix*, J. Phys. Chem. C, 2021, 125, 1, 957–963.
4. X. Sun*, F. Lafolet*, G. Lemercier, F. Maurel, J. C. Lacroix, J. Phys. Chem. C, 2017, 121, 20925−20930.
5. X. Sun*, X. L. Yao, D. Frath, F. Lafolet, G. Lemercier, J. C. Lacroix*, J. Phys. Chem. Lett. 2019, 10, 15, 4164.
6. I. Hnid, L. Guan, E. Chatir, S. Cobo, F. Lafolet, F. Maurel, J. C. Lacroix*, X. Sun*, Nanomaterials, 2022, 12, 1318.

Photo-thermal Mediated Li-ion Transport for Solid-state Lithium Metal Batteries

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The development of lithium-based solid-state batteries (SSBs) has to date been hindered by the limited ionic conductivity of solid polymer electrolytes (SPEs)[1], where nonsolvated Li ions is difficult to migrate in a polymer framework at room temperature[2]. Here, we report an innovative strategy of light mediated energy conversion to build photothermal-based SPEs (PT-SPEs). Our results suggest that the nanostructured photothermal materials acting as a powerful light-to-heat converter enable heating within a submicron space, leading to a decreased Li^+ migration barrier and a stronger solid electrolyte interface. Via in situ X-ray diffraction analysis and molecular dynamics simulation, we show that the generated heating effectively triggers the structural transition of SPEs from a highly crystalline to an amorphous state, that help mediate lithium-ion transport. Using the assembled SSBs for exemplification, PT-SPEs function as efficient ion-transport media, providing outstanding capacity retention (96% after 150 cycles) and a stable charge/discharge capacity (140 mA g^{-1} at 1.0 C).

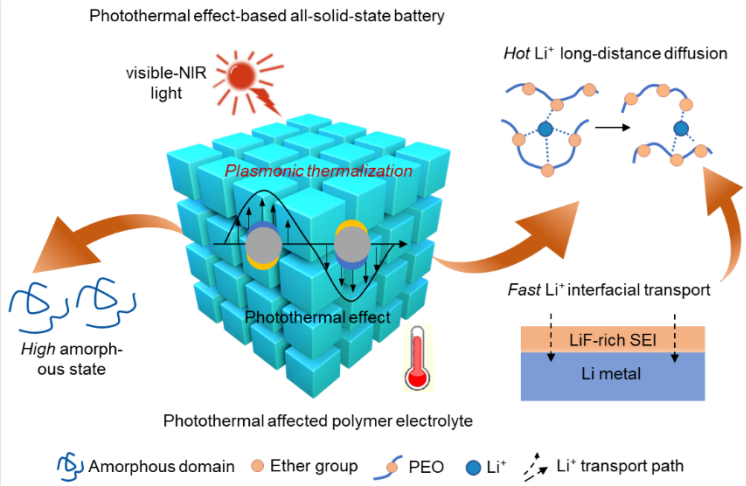


Fig.1 Multifunctionality of photothermal effect including an amorphous transition of PT-SPE, hot-assisted Li^+ long-distance diffusion, and the formation of a LiF-rich SEI.

References

1. Chi, X., Li, M., Di, J. *et al. Nature* **592**, 551–557 (2021).

2. Wang, Y., Zanelotti, C.J., Wang, X. *et al. Nat. Mater.* **20**, 1255–1263 (2021).

Advanced Photocatalytic Materials and systems for Solar water splitting

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The use of solar energy to drive the chemical and energy processes, along with the chemical storage of solar energy, are imperative for the transition to a low-carbon economy, sustainable and clean society. Solar hydrogen generation through water splitting processes has been developing as an important energy storage alternative. In this context, several approaches involving photocatalytic, photoelectrochemical (PEC) or, coupled photovoltaics, and electrolysis solutions have been widely studied. [1] Photocatalytic hydrogen production for transforming and storing inexhaustible solar energy to green and clean sustainable chemical energy (H_2) has been considered as an ideal way to relieve the growing global energy crisis. Although great achievements have been obtained, most of the photocatalysts still suffer unfavorable obstacles, such as weak photocatalytic stability, low efficiency, or toxicity, all of which critically restrict the practical application of the photocatalysis technology. Therefore, developing appropriate photocatalysts that can overcome the above problems is always an essential strategy for the ultimate goal of high-efficiency photocatalytic H_2 and O_2 production. [2,3]

In the present work, oxide semiconductor/metallic core-shell and heterostructures with carbon nitride were prepared and studied the photocatalytic hydrogen production under solar illumination. Furthermore, $SrTiO_3$ was successfully synthesized followed by surface decoration with Pt particles using the photodeposition method.

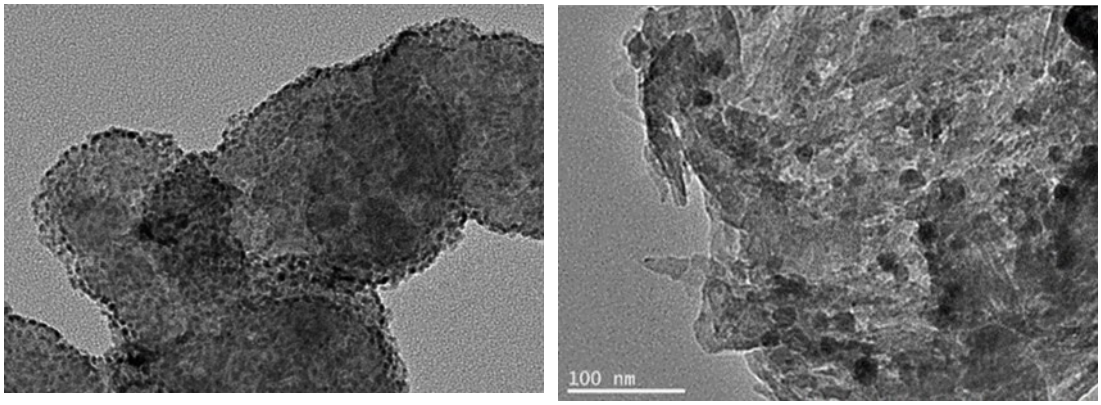


Fig. 1 TEM images of heterostructures TiO_2 with IrO_2 nanoparticles, and Carbon nitride with IrO_2.

KEYWORDS: solar driven H_2 production, oxide semiconductor, carbon nitride

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References

1. Shwetharani, M. Sakar, C. A. N. Fernando, Vassilis Binas and R. Geetha Balakrishna, Catalysis Science & Technology (2019) 9, 12-46.
2. Xing Kang, Jinwen Shi, Huaiyu Lu, Guiquan Zhang, Jiantao Yao, Lulu Hou, Feng Chen, Samuel S. Mao, Vassilios D. Binas, Shaohua Shen, Advanced Sustainable Systems (2021) 2100138
3. S. Murcia-López, M. Moschogiannaki, V. Binas, T. Andreu, P-Y. Tang, J. Arbiol, J. Jacas, G. Kiriakidis, J.R. Morante, ACS Applied Materials & Interfaces, 9 (2017) 40290-40297.

EHNHANCED ELECTROCHEMICAL DETECTION OF LEAD AND CADMIUM USING CROWN ETHER MODIFIED GEL-ELECTROMEMBRANE EXTRACTION

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This study presents a novel electrochemical method integrated with gel-electromembrane extraction (G-EME) for the simultaneous detection of cadmium (Cd^{2+}) and lead (Pb^{2+}) ions in environmental water samples. Differential pulse anodic stripping voltammetry (DPASV) was employed to quantify Cd^{2+} and Pb^{2+} in an acetate buffer, with metal ions initially deposited onto the electrode surface at -1.3 V. The highest current signal observed at pH 4 in acetate buffer following a 90 s deposition period. Once optimal electrochemical conditions were established, G-EME was implemented as a preconcentration step. An agarose-based gel membrane, modified with 1% (w/v) crown ether (18C6) to enhance ion transfer efficiency, facilitated the migration of positively charged Cd^{2+} and Pb^{2+} ions from the donor phase (pH 5.0) across the 18C6@gel membrane (pH 5.0) into the acceptor phase (pH 5.0) under an applied potential of 30 V for 10 minutes. The developed method yielded a linear detection range of 0.3–5 µg/L for Cd^{2+} and 0.5–5 µg/L for Pb^{2+}, with detection limits of 0.10 µg/L and 0.19 µg/L, respectively—demonstrating up to a 120-fold improvement in sensitivity over direct electrochemical measurements. Importantly, the developed method successfully detected Cd^{2+} and Pb^{2+} in environmental water samples, achieving %relative recoveries between 97.00% and 109.00%, indicating high accuracy and precision. Additionally, the method maintained selectivity for Cd^{2+} and Pb^{2+} ions, even in the presence of other potential heavy metal ions in the environment.

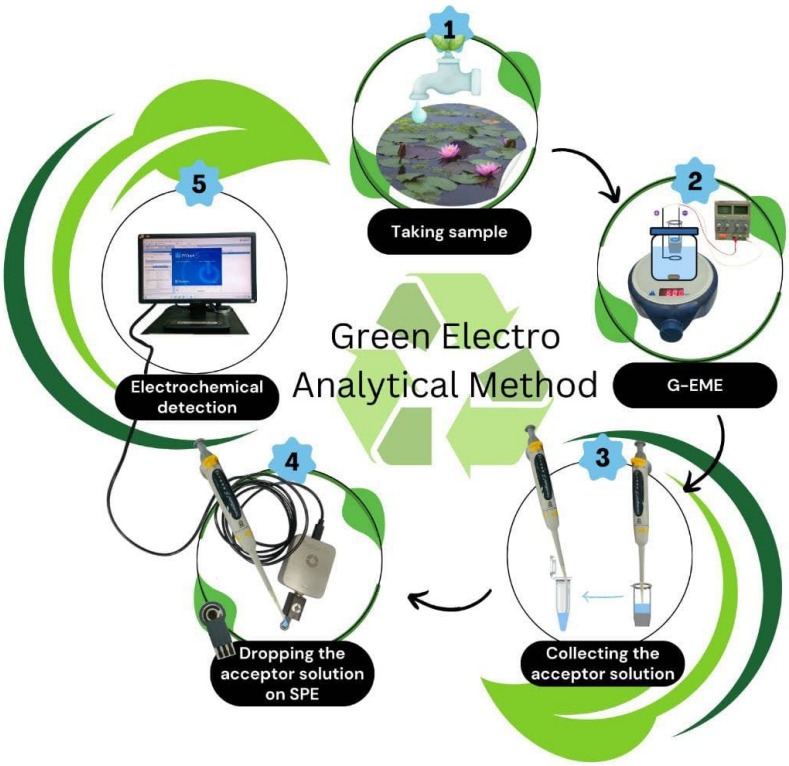


Fig 1. Visual summary of the research workflow

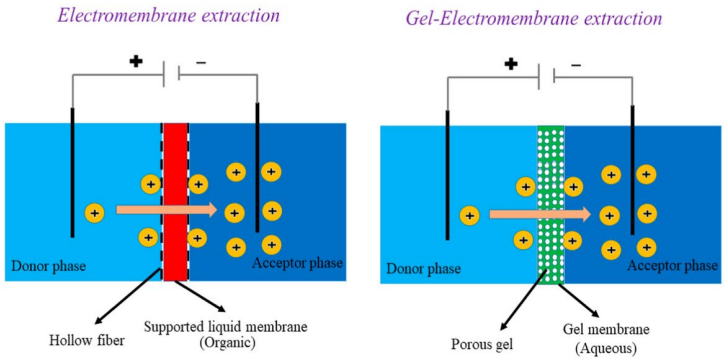


Fig 2. Schematic illustration of the Gel-Electromembrane Extraction mechanism[4]

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References

1. B. Leila, M. Rafatullah, A. Kerrouche, M. Qutob, A. M. Alosaimi, H. S. Alorfi, and M. A. Hussein. *Water,* **14**(21), 3432 (2022)
2. Güell, Raquel, G. Aragay, C. Fontàs, E. Anticó, and A. Merkoçi. *Analytica Chimica*

Acta, **627**(2), 219-224 (2008)
3. H. Tabani, K. Khodaei, P. Varanusupakul, and M. Alexovič. *Microchemical Journal,* **153**, 104520 (2020)
4. H. Tabani, F. Dorabadizare, and S. Pedersen-Bjergaard. *TrAC Trends in Analytical Chemistry,* **160**, 116990 (2023)
5. S. Yousefi, S. Makarem, W. Alahmad, F. D. Zare, and H. Tabani. *Talanta,* **238,** 123031 (2022)

An interfacial-intramolecular electron highway for accelerated electrocatalytic CO_2 reduction by an O_2-tolerant formate dehydrogenase

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Bioelectrocatalytic CO2 reduction, superior to thermocatalysis, photocatalysis and material electrocatalysis in energy utilization efficiency, offers a sustainable route for CO2 bioconversion. However, the reaction rate remains limited by the specific activity (intramolecular electron transfer) and interfacial electron transfer, as well as the trade-off between enzyme activity and oxygen tolerance. Here, we have mined a "super" formate dehydrogenase, from Shewanella oneidensis MR-1 (SoFdhAB), which possesses not only the inherent interfacial-intramolecular electron highway facilitating the direct electron transfer (DET)-type bioelectrocatalysis, but also the excellent oxygen tolerance. Cryo-electron microscopy analysis reveals that five [4Fe-4S] clusters contributes to the intramolecular electron highway, and the surrounding aromatic residues at the distal [4Fe-4S] facilitate the favorable orientation and the interfacial electron transfer. Thereon, a direct bioelectrocatalytic CO2 reduction system has been constructed and a total 912 ± 81.5 μmol formate has been produced with an average rate of 30.4 ± 2.7 μmol h-1 cm-2 and a Faradaic efficiency of 99.6%. The merits of extraordinary (electro)catalytic property and oxygen tolerance endow SoFdhAB a promising candidate for developing high-performance CO2 bioconversion system, and the inherent DET capability may inspire the interfacial engineering of other oxidoreductases to bring a widespread

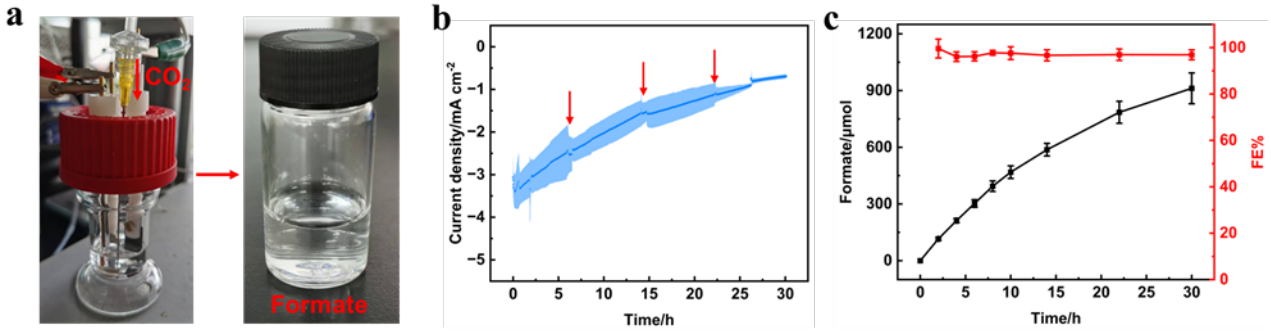


Fig.1 Electrosynthesis of formate from CO_2 catalyzed by *So*FdhAB-Y94S, (a) The electrochemical reaction device, (b) i-t curve of CO_2 reduction under a potential of -600 mV vs. SHE, the red arrow indicates the replacement of fresh electrolyte, (c) Time course of formate accumulation.

breakthrough to the long-pursed DET goal in bioelectrocatalysis.

Acknowledgements

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Direct Synthesis of Taurine from CO_2 via a Tandem Electro-Biosystem

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Transforming CO_2 into high-value chemicals through a sustainable approach remains a long-term goal for CO_2 conversion and utilization. Coupling electrocatalytic CO_2 reduction with low-carbon biosynthesis offers a highly promising strategy for the precise synthesis of high-value products from CO_2 [1-6]. However, poor compatibility, low energy conversion efficiency, and a limited product spectrum are significant challenges that hinder its practical application. In this work, we design a tandem electro-biosystem that enables the direct synthesis of taurine from CO_2. Soluble formate is selected as the bridging intermediate. Metal hydride is employed to accelerate formate formation via hydrogen transfer enhancement in a Bi-based catalyst, increasing the formate formation rate by 30%. Kinetic isotope effect studies validate the accelerated protonation process. *Ab initio* molecular dynamics simulations further reveal that the introduction of metal hydride facilitates the initial hydrogen transfer process, forming the key intermediate *OCHO. In the biosynthesis module, a *Saccharomyces cerevisiae* strain capable of utilizing formate is selected as the host cell. The glycine and taurine biosynthesis pathways are subsequently integrated, enabling the successful conversion of formate into taurine. Carbon-13 isotopic labeling confirms that both carbon atoms in the synthesized taurine are derived from formate. After 338 hours of shake-flask fermentation, the strain achieves an optical density (OD_{600}) of 8.66, with a taurine yield of 3 mg/L. No additional hydrogen is required, and the produced formate is directly used for biosynthesis without the need for further separation or purification. The elaborate design and integration of this electro-biosystem establish a novel paradigm for the green and precise synthesis of high-value biochemicals from CO_2, advancing the practical application of CO_2-based electro-bio manufacturing.

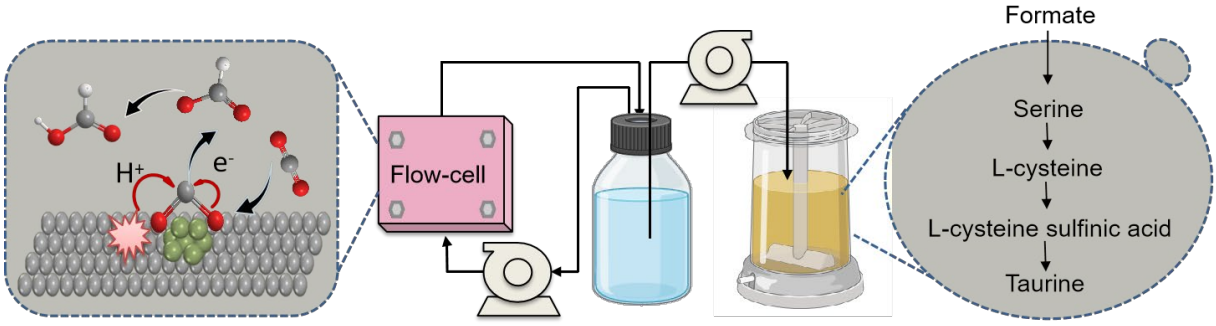


Fig.1 The schematic diagram of the tandem electro-biosystem for taurine synthesis from CO_2.

Acknowledgements

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References

1. T. Zheng, M. Zhang, L. Wu, S. Guo, X. Liu, J. Zhao, W. Xue, J. Li, C. Liu, X. Li, Q. Jiang, J. Bao, J. Zeng, T. Yu, and C. Xia. *Nat. Catal.*, **5**, 388-396 (2022).
2. P. Zhang, K. Chen, B. Xu, J. Li, C. Hu, J.S. Yuan, and S.Y. Dai. *Chem*, **8**, 3363-3381 (2022).
3. H. Cui, W. Liu, C. Ma, P. Shiri, Z. Zhu, H. Jiang, D. Li, and L. Zhang. *Appl. Catal. B-Environ. Energy*, **350**, 123946 (2024).
4. Z. Gong, W. Zhang, J. Chen, J. Li, and T. Tan. *Bioresour. Technol.*, **406**, 130956 (2024).
5. G. Liu, Y. Zhong, Z. Liu, G. Wang, F. Gao, C. Zhang, Y. Wang, H. Zhang, J. Ma, Y. Hu, A. Chen, J. Pan, Y. Min, Z. Tang, C. Gao, and Y. Xiong. *Nat. Commun.*, **15**, 2636 (2024).
6. K. Chen, P. Zhang, Y. Chen, C. Fei, J. Yu, J. Zhou, Y. Liang, W. Li, S. Xiang, S.Y. Dai, and J.S. Yuan. *Joule*, **9**, 101769 (2025)

Fe, Co co-implanted dendritic CeO_2/CeF_3 heterostructure@MXene nanocomposites as a Highly Efficient Coreaction Accelerator in the Luminol–Dissolved O_2 System for the Detection of Carcinoembryonic Antigen

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Carcinoembryonic antigen (CEA) is a broad-spectrum tumor marker. Serum CEA levels are below 5 μg L^{-1} in healthy individuals, while high CEA concentrations (>20 μg L^{-1}) are associated with a high risk of cancer [1]. CEA is overexpressed in many cancer tissues, such as colon cancer, breast cancer, ovarian cancer, and gastric cancer. Therefore, it is urgent to develop a CEA detection method with high sensitivity and specificity for clinical diagnosis. With the Continuous development of immunological techniques, immunofluorescence, enzyme-linked immunosorbent assay, and Electrochemiluminescent (ECL) sensors have been gradually Applied to the efficient and sensitive detection of CEA[2]. In this study, we have synthesized a novel Fe, Co-CeO_2/CeF_3@MXene heterostructure, demonstrating efficient oxygen evolution reaction (OER) catalytic activity and abundant oxygen vacancies[3]. These oxygen vacancies, serving as intrinsic defects in the oxide matrix, function as active sites for O_2 adsorption and reaction. Furthermore, they facilitate the rapid generation of superoxide anion radicals ($O_2^{\bullet-}$), which subsequently react with luminol anion radicals ($L^{\bullet-}$) to enhance the catalytic process[4]. The synthesized heterostructure was employed for immobilizing the primary antibody (Ab_1), enabling a high ECL signal response. For further signal amplification, luminol-encapsulated MIL-53 was conjugated to the secondary antibody (Ab_2) as a signaling probe. The resulting ECL emission from both luminol and dissolved O_2 was simultaneously monitored using a photomultiplier tube (PMT) and a smartphone-based detection system. The developed biosensor demonstrated excellent selectivity and sensitivity, with a wide linear detection range of 0.005–400 ng mL^{-1} and an ultralow detection limit of 0.0039 ng mL^{-1}. When applied to CEA detection in real clinical samples, the sensor showed reliable performance, confirming its practical applicability for diagnostic testing.

Keywords: Co-reactant accelerator, Immunoassay, Carcinoembryonic antigen, Electrochemiluminescence, 2D nanomaterials

References

1. H.-L. Xie, Y.-Z. Gong, J.-A. Kuang, F. Gao, S.-Y. Tang and J.-L. Gan, *Cancer Management and Research*, 2019, 7499-7511.

2. W. Lai, J. Li, M. Jiang, P. Li, M. Wang, C. Ma, C. Zhao, Y. Qi and C. Hong, *Analytical Chemistry*, 2023, **95**, 7109-7117.

3. Y. Mao, X. Yang, K. Dong, T. Sheng and Q. Yuan, *Journal of Colloid and Interface Science*, 2024, **662**, 208-217.
4. Y. Tang, B. Zhang, Y. Wang, F. Zhao and B. Zeng, *ACS Applied Nano Materials*, 2021, **4**, 7264-7271.

Applications of single atoms doped transition metal chalcogenides in fast detections of fluoroquinolones

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Inspired by the excellent catalytic activities of transition metal single atom catalysts and low cost of two-demenstional MoS_2, single atoms doped MoS_2 are developed and mimick oxidase, peroxidase, and catalase (Fig. 1).[1] With glucose and glutathione as substates, the maximum velocities (v_{max}) are 9.14×10^{-4} and 3.11×10^{-6} $mol\cdot L^{-1}\cdot s^{-1}$ when micking oxidase, respectively. With H_2O_2 and 3,3',5,5'-tetramethylbenzidine as substrates, v_{max} are 2.67×10^{-7} and 3.88×10^{-7} $mol\cdot L^{-1}\cdot s^{-1}$ (Fig. 2), respectively. v_{max} for catalase-mimicking experiments are 1.39×10^{-4} $mol\cdot L^{-1}\cdot s^{-1}$. The coordinations of single atoms with Mo and S atoms of MoS_2 leads to the remarkable catalytic activities.[2] Compared with most transition metal catalysts, such as Au-Ni/g-C_3N_4, Fe-CDs, MoS_2@$MgFe_2O_4$, $SrRuO_3$, the signle atoms doped MoS_2 nanozymes process better catalytic activities.[3] ·OH, and $^1O_2$ reactive oxygen speices are produced during the decompostions of H_2O_2 catalyzed by the signle atoms doped MoS_2 nanozymes. Thanks to the inhibition effects of levofloxacin to the colrimentric reactions between H_2O_2 and TMB, 1.0–250 μM levofloxacin are detected (limit of detection, 0.5 μM). Ofloxacin, levofloxacin cycloester, L-α-aminoglutaric acid, uric acid, glucose, KCl has no interruptions to the detections of levofloxacin. This study realizes the fast and potable detections of levofloxacin and would be applied in practice.

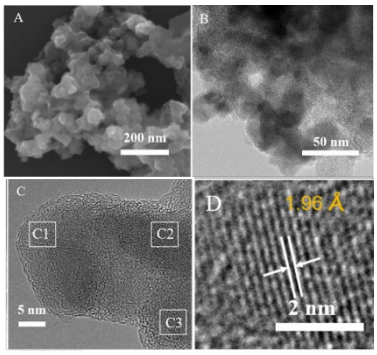


Fig.1 SEM and TEM characterizations of single atoms doped MoS_2 nanozymes.

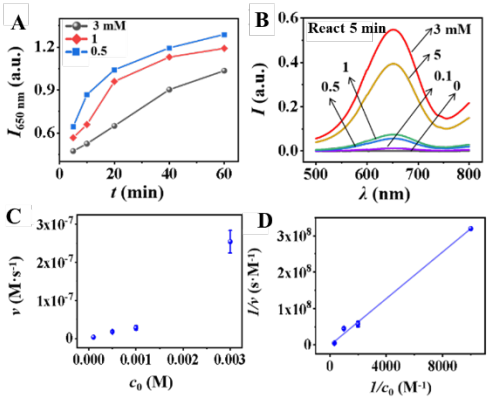


Fig.2 UV-visible absorptions (A and B) and reaction kinectics (C and D) of H_2O_2 and TMB catalyzed by single atom doped MoS_2 nanozymes.

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References

1. K. Wu, L. Cheng, *et al*, Nano Today, **43**, 101380 (2022).
2. Z. Wang, H. Hu, *et al*, Adv. Funct. Mater., **33**, 2210037 (2023).
3. L. Lin, L. Zhang, *et al*, Chem. Eng. J, **43**, 142176 (2023).

Flowing-SERS for High-Precision Analysis of Trace Aqueous Pollutants

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Despite the significant potential of Surface-Enhanced Raman Spectroscopy (SERS) for pollutant detection, its practical application is hindered by poor reproducibility and quantification challenges. This study addresses these critical limitations through methodological innovation and detector design, focusing on the unstable SERS signals. Two key factors for poor reproducibility in liquid-phase SERS are proposed: the extremely small effective excitation volume, which poorly represents heterogeneous bulk samples, and the laser-induced aggregation of thermodynamically unstable plasmonic nanoparticles (e.g., Au, Ag NPs). This uncontrolled aggregation disrupts electromagnetic hotspots and cause unpredictable signal fluctuations, which would be further exacerbated by the small sampling volume. Thus, ensuring sample stability during measurement is paramount. To overcome these issues, we developed a Flowing-SERS approach. This method simultaneously enhances sample representation by increasing analyte throughput and homogenizing the probed volume, and mitigates laser-induced effects by drastically reducing nanoparticle laser exposure time, thereby suppressing aggregation. Collectively, these improvements substantially enhance the accuracy and reproducibility of trace aqueous pollutant analysis by SERS technology.

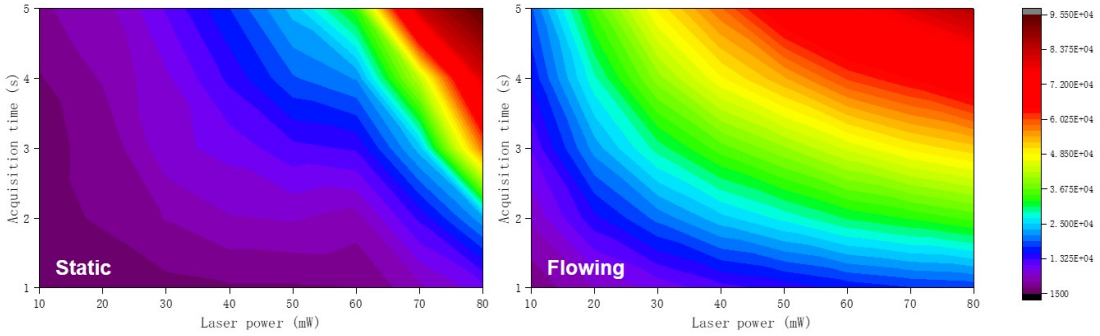


Fig.1 Improved signal stability against laser power and acquisition time by Flowing-SERS

References

1. Xu, X., Zhao, L., Xue, Q. *et al. Anal. Chem.* **91**, 7973-7979 (2019).
2. Bi, X., Czajkowsky, D., Shao, Z. *et al. Nature* **628**, 771-775 (2024).

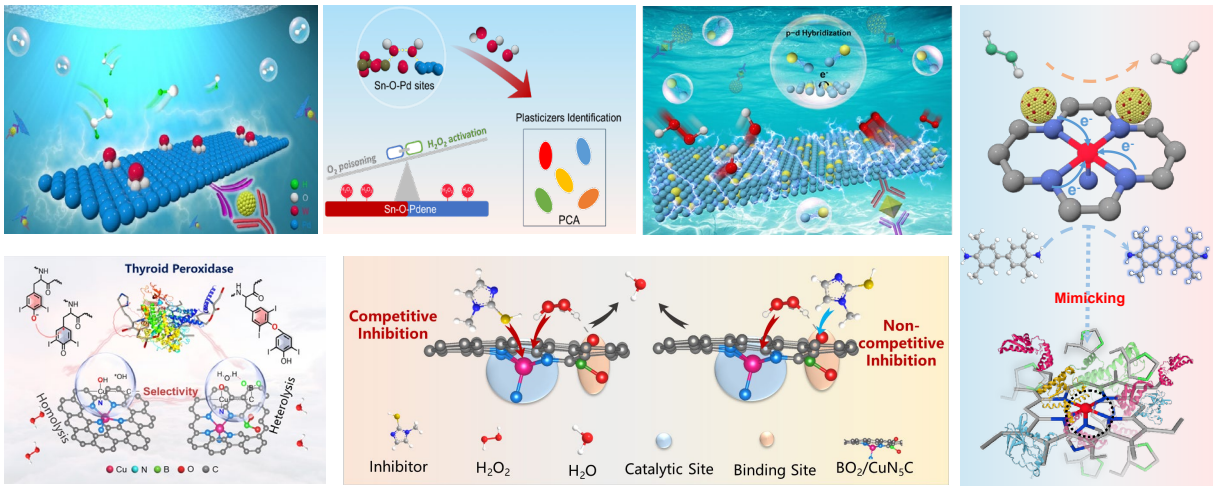
The Design of Biomimetic Sites for Application in the Sensing Field Mediated by H_2O_2 Activation

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Colorimetric sensing analysis technology is a simple and universal chemical sensing technique, featuring low cost, easy operation, and visualizability. Nanoezyme signal transduction and molecular measurement have become the research frontiers in the field of chemical measurement, and are widely applied in disease diagnosis, environmental monitoring, and biological therapy. Compared with natural enzymes, nanoenzymes have lower costs, recyclability, and superior stability, but their catalytic activity and specificity are still far below those of natural enzymes, seriously hindering the application of nanoenzymes in immunoanalysis. To address these issues, we innovatively proposed two solutions: Bionic three-dimensional catalytic pocket design and Orbital hybridization interface engineering. Based on the above strategies, we developed a high-performance nanoenzyme immuno-sensing platform for prostate-specific antigen (PSA) detection.



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Reference

1. G. Xie, W. Guo,* Z. Fang, Z. Duan, X. Lang, D. Liu, G. Mei, **Y. Zhai,*** X. Sun, and X. Lu*, *Angew. Chem. Int. Ed.*, **63**, e202412568(2024).

2. Hu, L.; Li, R.; Chen, C.; Jia, X.; Li, X.; Jiao, L.*; Zhu, C.; Lu, X.*, **Zhai, Y.***; Guo, S.*, *Sci. Bull.*, 70, 1611-1618(2025)
3. Jia, X.; Jiao, L.*; Li, R.; Chen, C.; Li, X.; Hu, L.; **Zhai, Y.***; Zhu, C.; Lu, X.*, *Adv. Funct. Mater.*, 2406380(2024)
4. Chen, C.; Yan, D.; Jia, X.; Li, R.; Hu, L.; Li, X.; Jiao, L.*; Zhu, C.; **Zhai, Y.***, Lu, X.*, *Chem. Sci.*, 15, 15440-15447(2024)
5. Chen, C.; Jiao, L.*; Yan, D.; Jia, X.; Li, R.; Hu, L.; Li, X.; Zong, P.; Zhu, C.; **Zhai, Y.***; Zhu, Z.; Lu, X. *, *Adv. Funct. Mater.,* DOI: 10.1002/adfm.202506250(2025)
6. Yan, D.; Jiao, L.*; Chen, C.; Jia, X.; Li, R.; Hu, L.; Li, X.; **Zhai, Y.***; Strizhak, P.; Zhu, Z.*; Tang, J.*; Lu, X.*,. *Nano Lett.*, **24** (9), 2912-2920(2024)
7. Hu, L., Jiao L.*, Chen C., Jia X., **Zhai, Y.***; Zhu, Z.; Lu, X. *, *Anal. Chem.*, **97** (3), 1767-1774(2025)
8. Li, R.; Guo, W.; Zhu, Z.; **Zhai, Y.***; Wang, G.; Liu, Z.; Jiao, L.*; Zhu, C.; Lu, X.*,. *Anal. Chem.*, **95**, 7195-7201(2023)
9. Sun X., Li X., Zong P., Yan D., Qin Z., Zhang Y., Jiao L., **Zhai, Y.***, Lu, X.* *Anal. Chem.*, **97** (1), 880-885(2025)

Multi-Site Tandem-Driven Electrocatalytic Conversion of Small Molecules

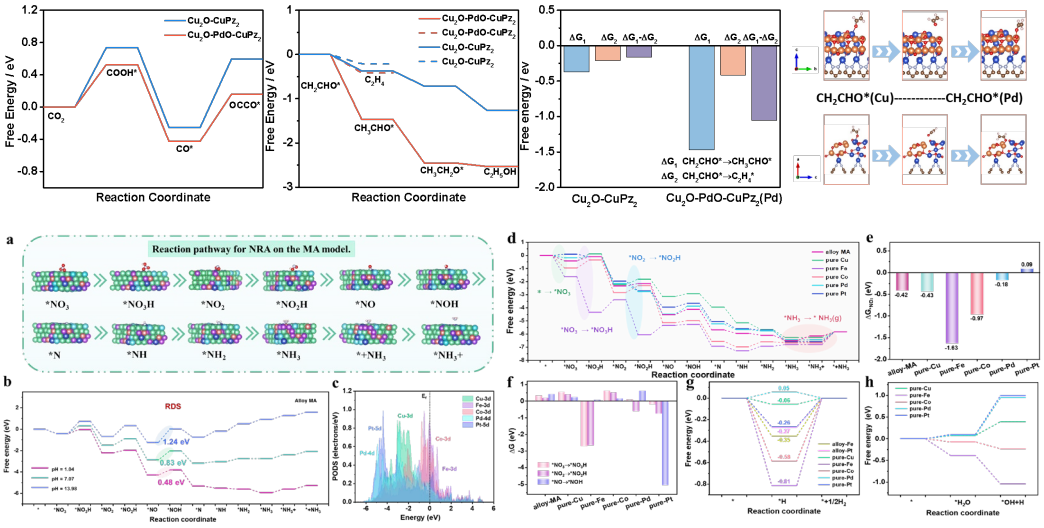
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Electrocatalytic carbon dioxide reduction reactions (CO_2RR) driven by renewable electricity can convert greenhouse gases into valuable chemicals, offering both environmental and economic benefits. Currently, the focus is on designing efficient catalysts, particularly multi-sites catalysts, which possess unique properties that decouple complex reaction steps and facilitate effective co-catalysis at the active site for enhanced CO_2 to C_{2+} products conversion efficiency. The synthesized 1.4%Pd-Cu@$CuPz_2$ shows outstanding electrocatalytic activity for the CO_2RR into C_{2+} products. Theoretical calculations have revealed that the enhanced interfacial electron transfer facilitates the adsorption of *CO intermediate and *CO-*CO dimerization on the Cu-Pd dual sites of Pd-Cu@$CuPz_2$. Additionally, the oxophilicity of Pd can stabilize the key intermediate *CH_2CHO and promote subsequent proton-coupled electron transfer more efficiently, improving the selectivity of alcohol.

Ammonia (NH_3), as an important chemical and carbon-free energy carrier, has been widely used in industrial and agricultural production as well as in daily life. A multicomponent alloy catalyst PtPdFeCoCu-TiO_2 (named MA-TiO_2) with oxygen vacancies was employed in the electrocatalytic reduction of NO_3^- to synthesize NH_3. The study shows that the multicomponent alloy electrocatalyst MA-TiO_2 benefits from the synergistic effects of different metals and the SMSI between MA and the TiO_2 support, resulting in high catalytic activity and stability for NO_3^- reduction across acidic, neutral, and alkaline conditions. DFT theoretical calculations indicate that the synergistic effect of multiple active sites in MA optimizes the electronic structure of the material, reduces the free energy of adsorption for *NO_3 and *H on the catalyst surface, and accelerates the adsorption/desorption of intermediates, thus speeding up the kinetics of NO_3^- reduction.



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Reference

1. Z. Fang, W. Guo*, G. Xie, G. Mei, Y. Zhai*, **Z. Zhu***, X. Lu*, J. Tang, *Appl. Catal. B-Environ.*, **359**, 124473(2024)
2. D. Liu1, Y. Zhai1, W. Guo,* X. Lang, G. Xie, Z. Duan, G. Mei, **Z. Zhu***, X. Lu*, *Appl. Catal. B-Environ.*, DOI:10.1016/j.apcatb.2025.125678(2025)
3. Chen, C.; Jiao, L.*; Yan, D.; Jia, X.; Li, R.; Hu, L.; Li, X.; Zong, P.; Zhu, C.; Zhai, Y.*; **Zhu, Z.**; Lu, X. *, *Adv. Funct. Mater.,* DOI: 10.1002/adfm.202506250(2025)
4. Yan, D.; Jiao, L.*; Chen, C.; Jia, X.; Li, R.; Hu, L.; Li, X.; Zhai, Y.*; Strizhak, P.; **Zhu, Z.***; Tang, J.*; Lu, X.*, *Nano Lett.*, **24** (9), 2912-2920(2024)

Metal Aerogels for Electrochemical Energy Conversion and Sensing Applications

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The unique characteristics of conductive interconnected metallic nanowire network structure, large surface area and high porosity of metal aerogels have promoted them to be rising stars in electrochemical energy conversion and sensing applications. When comes to real applications, metal aerogels meet great challenges including high cost and insufficient activity and durability. The high cost is mainly ascribed to the high prices of the noble metals and the tedious synthetic process of metal aerogels. In addition, the huge 3D interconnected network structure makes the concise tailoring of the metal aerogel backbone structure and interfaces difficult, which blocks the further enhancement of their activity and durability. What's more, the poor mechanical property of metal aerogels limits their effective integration into the energy consversion and sensing devices and compromise the advantages of their unique structures. We have made great efforts to solve these issues [1-12]. Herein, we will present some facile strategies for the synthesis of metal aerogels, and routes to enhance both their electrocatalytic/sensing activity and durability from controlling their components, electronic structure, porous structure, interface engineering, and mechanical properties points of view. Based on these explorations, the high-performance applications of metal aerogels in proton exchange membrane fuel cell and pressure sensor have been realized.

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References

1. J. Yang, J. Wang, R. Hübner, X. Tao, Y. Ren, Z. Zheng and W. Liu *Adv. Energy Mater.* **15**, 2404684 (2025).
2. J. Mo, D. Lou, J. Li, X. Tao, Z. Zheng and W. Liu *J. Colloid Interf. Sci.* **697**, 137934 (2025).
3. Y. Y. Zheng, A. S. Petersen, J. Rossmeisl and W. Liu *Adv. Energy Mater.* **13**, 2204257 (2023).
4. J. Yang J., R. Hübner, Z. K. Zheng, J. Rossmeisl and W. Liu *Angew. Chem. Int. Ed.* **60**, 9590 (2021).
5. A. A. Dubale, Y. Y. Zheng, J. W. Zhang, Z. K. Zheng and W. Liu *Angew. Chem. Int. Ed.* **59**, 13891 (2020).
6. J. Li, N. Li, Z. C. Peng, Z. K. Zheng and W. Liu *Adv. Sci.* **9**, 2201912 (2022).
7. Y. Y. Zheng, J. Jang, Z. K. Zheng and W. Liu *Adv. Energy Mater.* **11**, 2002276 (2021).
8. Y. Li, K. Jiang, J. Yang, Z. K. Zheng and W. Liu *Small* **17**, 2102159 (2021).
9. W. Liu, A.-K. Herrmann, T. J. Schmidt, N. Gaponik and Eychmüller A. *Acc. Chem. Res.* **48**, 154 (2015).

10. W. Liu, D. Haubold, A. Czyrska-Filemonowicz and A. Eychmüller *Chem. Mater.* **28**, 6477 (2016).
11. W. Liu, P. Rodriguez, T. J. Schmidt and Eychmüller A. *Angew. Chem. Int. Ed.* **52**, 9849 (2013).
12. W. Liu, A.-K. Herrmann, N. Gaponik and Eychmüller A. *Angew. Chem. Int. Ed.* **51**, 5743 (2012).

Charge Transfer Complex Nanocrystals for NIR Photothermal Therapy, Ferroptosis, and Electrochemical Diagnosis of 4T1 Cancer Cells

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ABSTRACT: Due to the labor-intensive synthesis and suboptimal responsiveness of many agents within the tumor microenvironment, there is growing interest in the development of novel near-infrared (NIR) absorbing organic photothermal agents with enhanced therapeutic and diagnostic performance. In this study, charge transfer complex-based nanocrystals (CTNs) were synthesized using DBT as the electron donor with various acceptors, including F4TCNQ, TCNB, and DTTCNQ. Among the formulations, DBT–F4TCNQ (DBT-F4-CTN) was identified as the most effective, exhibiting strong NIR absorption and excellent photothermal conversion efficiency. Notably, DBT-F4-CTN demonstrated cysteine-triggered intracellular depletion of glutathione (GSH), promoting reactive oxygen species (ROS) accumulation and inducing ferroptosis. The in vivo antitumor efficacy was validated through NIR-triggered photothermal therapy and ROS-mediated ferroptosis. Additionally, the diagnostic capability of the CTNs was demonstrated through electrochemical detection of H_2O_2, generated from choline oxidation via choline oxidase, highlighting their potential for early cancer diagnosis. This study presents a promising strategy for the development of multifunctional nanotheranostic platforms with integrated therapeutic and diagnostic capabilities against aggressive cancers such as 4T1 breast

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References

1. Reengineering of Donor—Acceptor—Donor Structured Near-Infrared II Aggregation-Induced Emission Luminogens for Starving- Photothermal Antitumor and Inhibition of Lung Metastasis. *ACS Nano* 2024, 18, 30069−30083
2. Synergistic Cancer Photoimmunotherapy by Harnessing Near-Infrared-Activated Nanoparticles Containing Charge Transfer Complexes. Angew. Chem. Int. Ed. 2025, 64, e202423550.