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FC04. C-MRS & MRS-J Bilateral Symposium: Future Development Based on the Current State of Functional Materials

Symposium Organizers: Sun Zhengming, Yu Yanlei, Dai Bing, Madoka Takai, Nobuhiro Matsushita

最终交流类型：墙报

FC04-P01

Effect of M-site element on the interaction of M2AlC and Ag and the induced properties of Ag/M2AlC composites

Dandan Wang*[1],ZhengHui Xia[1],JianXiang Ding[2],ChengJie Lu[3],Zhengming Sun[3]
1. Changzhou University
2. Anhui University of Technology
3. Southeast University

The deintercalation of weakly bonded A element affects the microstructure and properties of MAX phases and their reinforced composites. In this work, the effect of M-site element on the interaction of Al-containing M2AlC (M=V, Cr) phase and Ag, and the induced properties of Ag/M2AlC electrical contact materials (ECMs) were investigated. Though Ag and Al are soluble to each other and can form intermetallics, the variation of M element significantly affected the vacancy formation of Al, and thereby the interfacial reaction of Ag/M2AlC. The difficult formation of Al vacancy in V2AlC contributed to no obvious interfacial reaction in Ag/V2AlC. But the easy deintercalation of Al atoms in Cr2AlC led to their massive replacement by Ag, which generated Ag nano-twins and Cr3C2 with the same crystallographic relationship in one original Cr2AlC, and Cr7C3 and Ag3Al as well. Due to the distinct interactions, the resistivities of Ag/V2AlC and Ag/Cr2AlC increased by roughly 1 and 5 times after sintering, respectively. The low resistivity and proper hardness of the sintered Ag/V2AlC, which were very close to those of the “all-purpose” commercial Ag/CdO, contributed to its superior arc erosion resistance.

最终交流类型：主题报告

Super-wettability and Beyond——Quantum-confined Superfluid Chemical Reaction

Lei Jiang*
Technical Institute of Physics and Chemistry , CAS, China

Life system presents an ultralow energy consumption in high-efficiency bio-synthesis. The total energy intake of human body is about 2000 kcal/day to maintain all our activities, which is comparable to a power of ~ 100 W. The energy required for brain to work is equivalent to ~ 20 W, while the rest energy (~ 80 W) is used for other activities. All in vivo bio-syntheses take place only at body temperature, which is much lower than that of in vitro reactions. To achieve these ultralow energy-consumption processes, there should be a kind of ultralow-resistivity matter transport in nanochannels (e.g.,molecular channels), in which the directional collective motion of molecules is a necessary condition, rather than the traditional Newton diffusion. Directional collective motion of molecules are considered as molecular superfluid. The research of molecular superfluid will construct future chemical reactors with high flux, high selectivity and low energy consumption, and produce a series of disruptive technologies.

最终交流类型：主题报告

Colloidal Quantum Dots and Solution-processed Photovoltaics

Takaya Kubo*,Hiroshi Segawa
Research Center for Advanced Science and Technology, The University of Tokyo

Colloidal quantum dots (CQDs) exhibit unique features such as size-dependent optical and electrical properties, and solution process compatibility. Because of these properties, they are widely recognized as important building blocks for functional materials and opto- and electro devices. Dense quantum dot solid films formed by solution processes, such as the dip-coating method, exhibit semiconductor properties. Therefore, CQDs are being studied as important components of solar cells and photodetectors. Additionally, since CQDs are compatible with solution processes, devices based on them can be mass-produced at low cost. Colloidal quantum dots can be readily incorporated into various types of solution-processed solar cells, including hybrid, Schottky, p-i-n, homojunction, and heterojunction solar cells. Among CQD-based solar cells, heterojunction solar cells made by combining Pb chalcogenide CQDs with wide bandgap oxides such as ZnO have shown excellent solar cell performance.

One important direction for increasing the efficiency of solar cells is the development of high-quality quantum dot solid-state films. Another direction is to build new solar cell structures that can improve carrier collection efficiency and effective carrier diffusion length. From the latter perspective, bulk heterojunction structures of PbS QDs and ZnO nanowires (NWs) are useful for simultaneously improving carrier transport and collection efficiency. Unlike the PbS QD/ZnO planar structures, PbS QD/ZnO NW composite structures forming bulk heterojunction layers (active layers) allow most of the photogenerated carriers to reach the PbS QD/ZnO NW interface even when the active layer is thicker than the carrier diffusion length. Recent studies have shown that PbS QD/ZnO NW composite structures give effective carrier diffusion lengths of more than 1 μm.

By setting the size of PbS QDs to approximately 6 nm, the onset wavelength of the external quantum efficiency (EQE) spectrum can be matched to that of the Ge solar cell, which is one of the typical bottom cells of ultra-high-efficiency multi-junction solar cells. This indicates that PbS QD solar cells are potential candidates for bottom subcells in multi-junction solar cells. To conduct a proof-of-concept study, series-connected quasi-triple-junction solar cells were constructed by combining III-V 2J solar cells (InGaP top subcell/GaAs middle subcell) with PbS QD/ZnO NW solar cells (as a bottom subcell). The series-connected solar cell achieved a power conversion efficiency in excess of 30% under one-sun illumination. Additionally, we have confirmed that PbS QD/ZnO NW solar cells exhibited long-term air stability of more than 6 years and more-than-3000-hour light soaking stability.

Equally, the exploration of environmentally benign quantum dot/nanocrystal materials that do not contain lead in their composition is becoming increasingly important. Recent progress in AgBiS2 nanocrystal (NC) -based solar cells is noteworthy. It has been demonstrated that the same strategy used for PbS QD/ZnO NW bulk heterojunctions can also improve the carrier collection efficiency of AgBiS2 NC-based solar cells.

Solar cells fabricated by combining CQDs (or NCs) and wide-bandgap semiconductors have steadily achieved higher performance, and further progress is expected.

最终交流类型：主题报告

Manipulate the flow of light and heat through hierarchical designs

Jia Zhu*
Nanjing University

Light and heat are the two most common and widely used energy in the society. Nanostructures with carefully tailored properties can be used to manipulate the flow of light and heat, to enable novel devices and functionalities in an unconventional manner. In this talk, I will present two examples.

The first example is about passive cooling. Radiative cooling which sends heat to space through atmospheric transparency window without any energy consumption, is attracting significant attention. For radiative cooling to achieve high cooling performance, it is ideal to have a selective emitter, with an emissivity dominant in the atmospheric transparency window. However, so far scalable production of radiative cooling materials with selective emissivity has not been realized. Here I will present a hierarchical design for a selective thermal emitter to achieve high performing all-day radiative cooling. Moreover, it is revealed that this hierarchically designed selective thermal emitter shows significant advantage if being applied to alleviate Global Warming or to regulate temperature of the Earth-like planet.

The second example is about interfacial solar evaporation. We report that efficient and broad-band plasmonic absorber can be fabricated through a three dimensional self-assembly process. Because of its efficient light absorption and strong field enhancement, it can enable very efficient (>90%) solar vapor generations. Inspired by the transpiration process in plants, we report an artificial transpiration device with a unique design of two dimensional water path. The energy transfer efficiency of this artificial transpiration device is independent of water quantity and can be achieved without extra optical or thermal supporting systems, therefore significantly improve the scalability and feasibility of this technology. At the end, we would like to demonstrate that this type of interfacial solar vapor generations can have direct implications in various fields such as solar desalination, zero liquid discharge, sterilization and power generations.

最终交流类型：主题报告

Perovskite Photodetectors

Liang Li*
Soochow University

As a flexible and versatile semiconductor material, perovskite possesses various optoelectronic properties, such as high light absorption coefficient, micrometer level carrier diffusion length, high mobility, and defect tolerance characteristics. These excellent semiconductor properties make perovskite materials no longer limited to traditional photovoltaic applications. My research group has extensively carried out material preparation, device structure design, and functional system construction related to light-sensing application scenarios. This talk presents the preparation of perovskite thin films towards high-performance photodetectors with fast response time and high detectivity, which are also used as basic functional units for micro spectrometers, multimodal hyperspectral imaging, and anti-noise spatially coupled optical communication, etc.

最终交流类型：主题报告

Material design through first-principles and related calculations for electronic and phononic structures

Masato Yoshiya*
Division of Materials and Manufacturing Science, Graduate School of Engineering, Osaka University

Data-driven materials exploration for diverse applications has acquired its momentum to meet with increasing demands toward our sustainable societies. As both are based on quantum waves, electronic and thermal properties had been intensively studied together until 1950’ [1] before electronics in various sectors have leaped, owing to the rise of semiconductor transistors. On the other hand, thermal properties have attracted increasing attention since the turn of the century due to further downsizing of electronic devices and modules which are essential in our contemporary life. Our understanding for further controlling thermal properties remains premature even for perfect crystals as compared to its electronic counterpart. Even though phonon properties are similar to electronic properties from the viewpoint of quantum waves, there exist substantial differences between them. This impedes the concurrent data-driven materials explorations which essentially require data and understanding of the materials properties for predictions.

What are missing in the aforementioned data-driven materials explorations today include something missing in perfect crystals of compounds: lattice imperfections, or lattice defects in other words. Point defects including vacancies or impurity atoms, dislocations and grain boundaries are ubiquitous in real materials, which drastically changes materials properties as it has been well known. It is therefore essential to extend the materials explorations toward the materials with lattice imperfections to further accelerate materials discoveries. For that, our basic understanding on lattice imperfections needs to be further deepened and widened than ever, to the extent it would facilitate the next-generation data-driven materials explorations.

In this light, we have intensively studied lattice imperfections, with special attention to grain boundaries [2-8] and dislocations [9,10], to uncover the roles they play upon changing electronic and thermal properties. In addition, we also shed light on crystals with unfamiliar atomic arrangements [11,12] to reveal mechanisms behind the microscopic conduction of electrons and phonons. Although significance may seem to us against our intuitive understanding, detailed roles that the lattice defects play will be discussed in this talk.

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最终交流类型：邀请报告

Three-Dimensional Network Graphene for Electrochemical Energy Storage

Xuebin Wang*
Nanjing University

Graphene is popularly used in electrochemistry for its high conductivity and specific surface area. The graphene bulk suffers from poor electrical conductivity and low surface area. 3D graphene is an advanced porous carbon, which is the key to bring the extraordinary nanoscaled properties of individual graphene flakes, such as high surface area, conductivity and stability, to the macroscopic assemblies. Yet, the scalable high-quality 3D graphenes remain difficult. We have developed several new syntheses based on the carbonization of organics, for producing the advanced 3D graphenes, which routes include the tiering pyrolysis, the oxidation-aminolysis method, and the blowing route. Our 3D graphenes possess dually interconnected pathways: the electron transport via solid framework and the mass exchange via pore channel network. It also has the excellent surface area owing to the avoiding of re-stacking. Their supercapacitors achieve the high specific capacitance and energy density. The 3D graphene can also load Fe3O4 for lithium ion battery, and can load NiFeP for bifunctional water splitting. It can equip diverse electrodes for electrochemical energy storage and conversion.

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最终交流类型: 邀请报告

Thermal properties of Ga_2O_3 materials and electronic devices

Huarui Sun[a], Yinfei Xie[a], Wenhui Xu[b], Yang He[a], Zhenghao Shen[b], Zhenyu Qu[b], Xiaonan Wang[a], Jinfeng Yang[a], Tiangui You[b], Xin Ou[b]

[a] School of Science and Ministry of Industry and Information Technology Key Laboratory of Micro-Nano Optoelectronic Information System, Harbin Institute of Technology, Shenzhen, China
[b] National Key Laboratory of Materials for Integrated Circuits, Shanghai Institute of Microsystem and Information Technology, Chinese Academy of Sciences, 865 Changning Road, Shanghai, China

Gallium oxide (Ga_2O_3) has become a material of extensive attention in semiconductor research due to its ultra-wide bandgap and ultra-high Baliga figure of merit. However, the inherently low thermal conductivity of Ga_2O_3 severely hinders the development of Ga_2O_3 power devices towards higher power densities. Effective measurement of the junction temperature in Ga_2O_3 power devices is crucial for assessing device thermal resistance and thermal reliability. Traditional infrared (IR) thermal imaging may introduce measurement errors due to the transparency of ultra-wide bandgap Ga_2O_3. In this work, we employ three-dimensional micro-Raman thermography to systematically measure the thermal properties of β-Ga_2O_3 Schottky barrier diodes (SBDs). We investigate both β-Ga_2O_3 bulk SBDs and β-Ga_2O_3 SBDs heterogeneously integrated with high thermal conductivity SiC substrate. The ultra-thin heteroepitaxy of β-Ga_2O_3 allows Raman thermography to directly extract the junction temperature. By combining the use of TiO_2 nanoparticles as Raman thermometers, we achieve three-dimensional characterization of the lateral and vertical temperature distribution in the devices. We find that the thermal resistance of heterogeneously integrated β-Ga_2O_3 SBDs is only about one-third of that ofβ-Ga_2O_3 bulk SBDs. We employ TCAD-based electrothermal coupling simulations to calculate the electric field and temperature field distribution in β-Ga_2O_3 SBDs, which verify the accuracy and reliability of Raman thermography measurements and demonstrate the effectiveness of high thermal conductivity substrate integration in reducing the junction temperature and thermal resistance of β-Ga_2O_3 devices. We conduct systematic thermal measurements and simulation calculations on devices with different electrode layouts, proposing electrode structures that achieve an optimized balance between electrical performance and thermal performance.

Additionally, we use first-principles calculations and machine-learning molecular dynamics methods to study the thermal transport and phonon properties of different phases (β-, α-, κ-) of Ga_2O_3 crystals, providing guidance for the thermal management of devices based on different Ga_2O_3 phases.

最终交流类型：主题报告

Interface regulation strategies of Na metal anodes

Yan Yu*

University of Science and Technology of China, China

Sodium (Na) metal batteries have been considered as the most promising energy storage systems because of their high theoretical capacity and low cost of Na resource. However, the practical application of Na metal anodes faces several challenges in terms of unstable SEI structure, dendrite growth and huge volume expansion during the plating and stripping process, which may cause the structure damage of electrode and poor electrochemical performance of Na metal batteries. To address the above key problems, we have developed some effective strategies to regulate the interface of Na metal anodes: 1) designing three-dimensional conductive skeleton can reduce local current density and induce uniform interface deposition of alkali metal ions. 2) constructing the artificial interface protective layer on the surface of alkali metal anode could not only improve the mechanical toughness and ion diffusion ability, but effectively reduce the nucleation overpotential of metal ions. 3) modifying the electrolyte and separator can induce uniform metal ions deposition process and suppress the dendrite growth. Our research may provide scientific guidance to promote the commercial development and application of Na metal batteries.

最终交流类型：邀请报告

Low-dimensional wide-bandgap semiconductors for UV photodetectors

Xiaosheng Fang*

Fudan University

Benefitting from the continuous innovations in semiconductor materials and device fabricating techniques, ultraviolet (UV) photodetectors have been successfully used in advanced communications, flame detection, air purification, and ozone sensing and leak detection in the past few decades. Up to now, various sophisticated techniques, such as metal-organic chemical vapor deposition (MOCVD), molecular beam epitaxy (MBE), pulsed laser deposition (PLD) and atomic layer deposition (ALD), have been developing rapidly, which has provided vast opportunities for thin-film based materials, especially Si, GaN and GaAs based photodetectors, to be successfully commercialized. However, fabricating photodetectors focusing on the aforementioned techniques usually requires high operating costs, which will hamper further scale-up production of such photo electric devices. Therefore, it is of great importance to explore novel and facile techniques for fabricating high-performance photodetectors. Nowadays, nanoscience, nanofabrication technologies and versatile materials have sparked a new vision of UV photodetectors, which move toward higher precision, lower energy consumption and greater miniaturization. Recently, our group developed several novel photodetectors based on various low-dimensional nanostructure materials by using several simple and low cost bottom-up approaches [1-8]. It is expected that this novel kind of

UV photodetectors with smart, intelligent and multifunctional design will benefit daily life and the well-being of society in the near future.

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交流类型：邀请报告

Nano-structured Cu_2O films fabricated by mist-spin spray method for glucose sensor with high sensitivity and selectivity

Nobuhiro Matsushita[1), Yuta Kubota[1), Atsuko Yamasaki[1), Yuta Katayanagi[2)

1) Dept of Mater. Sci and Eng, School of Mater. and Chem. Tech., Tokyo Tech
2-12-1 Ookayama, Meguro, Tokyo 152-8550, Japan

2) Dept of Tech. Education, Cooperative Faculty of Education, Gunma Univ.,
4-2 Aramaki-machi, Maebashi, Gunma 371-8510, Japan

Cuprous oxide (Cu_2O) is a p-type semiconductor that is abundant in nature, non-toxic, and has excellent optical properties, and is therefore used in fields such as photoelectron optics, catalytic chemistry, and biomedicine [1]. Cu_2O decomposes easily at low and medium temperatures, so impurity layers are easily formed when forming films using the gas-phase method. In the liquid-phase method, Cu_2O film could be fabricated at lower temperatures and there is no need to consider the decomposition reaction of the Cu_2O film. However, since Cu^{2+} is stable in solution, it is difficult to prevent the oxidation of copper ions, especially in the alkaline environment in which Cu_2O precipitates, and as a result, impurity phases such as CuO and $Cu(OH)_2$ are easily formed.

In this study, a new Cu_2O fabrication process called the mist spin spray (MSS) method was proposed. The MSS method is a process for fabricating thin films by mixing two types of solutions, a raw material solution and a reaction solution, into mist using ultrasound, and spraying them with a nitrogen carrier gas so that the two mist are alternately supplied to a substrate on a rotating table kept at a constant temperature. It was thought that a single-phase Cu_2O film could be produced by quickly precipitating a solution in which copper ions had been sufficiently reduced onto a substrate using a strong alkaline solution as a reaction solution.

The raw material solution in which copper sulfate pentahydrate and ascorbic acid were dissolved in deionized water, and a reaction solution in which sodium hydroxide and aqueous ammonia were added to deionized water. The Cu_2O film was fabricated by spraying mist from the two solutions onto a glass substrate with a surface temperature of 90°C fixed on a table rotating at 150 rpm. The film did not peel off even after ultrasonic cleaning, indicating that it had strong adhesion to the substrate. The XRD diagram shows that the sample produced was composed of a crystalline phase of Cu_2O. In addition, the SEM image showed that a dense film without cracks was formed on the surface. The cross-sectional SEM image confirmed that the film thickness was several tens nm.

As described above, the Cu_2O film produced by the MSS method was a very thin and dense single-phase film, and is therefore expected to be used in flexible chemical sensors. In the invited talk at the conference site, the glucose sensor performances of MSS prepared Cu_2O film in several tens nm thick would be presented.

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最终交流类型：主题报告

Application of vanadate glasses containing different metal oxides to rechargeable batteries

Nobuto Oka*
Kindai University

Cathode materials with high charge-discharge capacity are expected for Li-ion battery and metal-air battery to be applied to hybrid and electric cars. We have developed new cathode materials using vanadate glasses containing different metal oxides for these types of rechargeable batteries. Conductivity of barium iron vanadate glass, $20BaO \cdot 10Fe_2O_3 \cdot 70V_2O_5$ and its analogs, could be "tunable" over a wide range (10^{-7} - 10^{-1} S·cm-1) by isothermal annealing [1].

In this abstract, we present the results of air-electrode (cathode) catalysts containing vanadate glasses for metal-air rechargeable battery. Metal-air battery has a very high energy density because it could use atmospheric oxygen as the electrode active material. This rechargeable battery needs bifunctional catalytic materials, which involve effective oxygen reduction/evolution at the air electrode in the discharge/charge process.

New catalytic materials have been developed using vanadate glasses containing MnO_2 and NiO, $20BaO \cdot 5MnO_2 \cdot 5NiO \cdot 70V_2O_5$ glass. For the preparation of the air electrode, pulverized vanadate glass was mixed with poly (tetrafluoroethylene), which was hot-pressed on the gas diffusion layer over a Ni metal mesh. 8M KOH aqueous solution and a Pt mesh were placed inside the Teflon cell as the electrolyte and the counter electrode, respectively. Temperature of the Teflon cell was kept constant at 60 °C. Discharge and charge polarization curves were recorded in a potentiostat. The prepared vanadate glass electrode showed an excellent bifunctional oxygen reduction/evolution activity, being more than that of the materials reported in the literature, such as polycrystalline $LaNiO_3$. This vanadate glass proved to be a highly potential candidate for the bifunctional catalytic material for the rechargeable metal-air battery.

We will also present the application of the conductive vanadate glass to Li-ion battery [2].

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最终交流类型：邀请报告

Low-Dimensional WBG Semiconductor Nanostructures for Renewable Fuels Production

Yongjie Wang*[1],Xiaowu Gao[1,2],Ziwei Zhao[1,2],Hansong Zhang[1],Bing Dai[2],Jiaqi Zhu[2]
1. Harbin Institute of Technology, Shenzhen
2. Harbin Institute of Technology

An essential step of artificial photosynthesis is solar water splitting, which can be achieved by either photocatalytic or photoelectrochemical approach. To date, however, there has been no demonstration of such efficient and stable device, which has been largely limited by the lack of a semiconductor photoelectrode that can operate efficiently and stably under visible light and can be directly integrated onto Si wafers. Here, we investigate the growth, electronic and optical properties, and photocatalytic and photoelectrochemical performance of low-dimensional III-nitride and transition metal dichalcogenide nanostructures. Relatively high solar-to-hydrogen efficiency >5% photocatalytic water splitting has been demonstrated on monolithically integrated multi-band InGaN nanowires. We also report on the demonstration of an InGaN nanowire photocathode for efficient unbiased photoelectrochemical water splitting and CO2 reduction. In addition, nanodiamond has also been reported as potentially low-cost and multi-functional photocatalyst for renewable fuels production. Based on above achievements, different novel catalysts have been investigated to achieve photocatalytic carbon dioxide reduction or nitrogen fixation with controlled selectivity. Work presented here provides a new approach for achieving high efficiency and highly stable production of newable fuels on the WGB semiconductors, e.g. diamond and gallium nitride.

最终交流类型: 主题报告

The current status and future of China's lithium battery industry technology

Xiaoqiang Wang*
CALB Group Co., Ltd

The current status and future of China's lithium battery industry technology
The global target on carbon neutralization drives the rapid development of electrical vehicles. In addition, new energies such as wind and solar also require highly efficient energy storage technologies. Lithium-ion batteries have become the most important approach among the existing feasible technologies to address these problems. After several decades of development, China's lithium-ion battery industry has achieved global leadership. In this talk, I will introduce the current status and development trends of China's lithium-ion batteries, specifically covering topics such as cathode materials, anode materials, electrolytes, as well as solid-state batteries.

最终交流类型: 邀请报告

Emerging Thermal Switching Materials

Junjun JIA*[1],Yuzo SHIGESATO[2]
1. Waseda University
2. Aoyama Gakuin University

Growing global concerns about energy shortages and carbon emissions have driven the energy-efficient utilization and the reuse of wasted thermal energy as 60% of the energy in the world is wasted as heat [1]. Customizing the storage, transfer, and conversion of thermal energy as needed to manipulate heat flow with electronic analogs has been a long-term dream of thermodynamic engineering, which facilitates the advancement of various thermal devices [2]. Recent advances have demonstrated that significant improvements for thermal switching materials can be achieved by utilizing those novel phase transition material driven by external stimulus, such as Mg-Ni alloy under dehydro-/hydro-generation reactions [3, 4, 5]. These phase transition materials undergo structural phase transition accompanying with metal--insulator transition. This enables simultaneous tuning of both electronic and phonon contributions, resulting in a giant switching ratio along with large ON-state thermal conductivity. Noteworthily, manipulating magnetic excitation also shows promising due to its energy-less loss nature and large switching ratio. Herein, we reshape the understanding for discovering thermal switching materials under external controls from the aspect of heat conduction mechanisms, and provide new and emerging directions for materials discovery in this continuously evolving field.

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最终交流类型：邀请报告

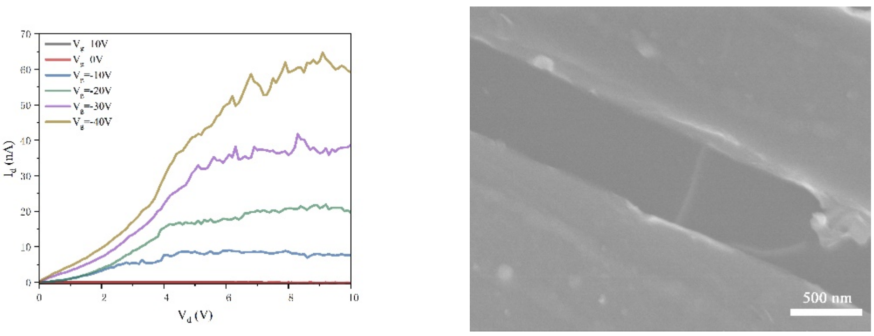
Laser Treating CNTs for Fabricating Field Effect Transistor

Fengqi Wei[1], Yang Cheng[1], Jianlei Cui[1]

1- State Key Laboratory for Manufacturing Systems Engineering, Xi’an Jiaotong University, Xi’an 710049, China
E-mail address: cjlxjtu@mail.xjtu.edu.cn

With unique electrical, mechanical, and thermal properties, carbon nanotubes (CNTs) possess the potential to be the ideal next-generation semiconductor in very large scale integration (VLSI). However, the considerable Schottky contact resistance generated by the interface between CNTs and metal electrodes has recently become a sticky constraint, which can significantly affect current transmission. In this paper, we used a femtosecond laser to join the CNTs and the metal electrodes. The interconnect quality was investigated under different laser power and scanning speed. Then, the carbon nanotube field effect transistor (CNFET) based on a single CNT was fabricated, and its electrical performance after laser-induced interconnect was characterized. It is shown that the operating current of CNFET after irradiation is approximately 1.5 times that of before irradiation.

Keywords: Carbon nanotubes, Femtosecond laser, Joining, Field effect transistor.



（a） （b）

Figure 1（a）CNFET output characteristics at varying gate voltages after laser irradiation.（b）Morphology of a single CNT in transistor channel after laser irradiation.

最终交流类型: 邀请报告

Composite Solid Electrolytes for Solid-State Lithium Metal Batteries

Long Pan, Xiong Xiong Liu, Pengcheng Yuan, Shengfa Feng, ZhengMing Sun
School of Materials Science and Engineering, Southeast University, Nanjing 211189, P. R. China

Solid electrolytes are essential for next-generation solid-state Li-metal batteries (SSLMBs), which promise high energy density and enhanced safety. While inorganic solid electrolytes (e.g., oxides, sulfides) offer fast ion conduction, they suffer from poor interfacial contact with electrodes due to their rigidity and brittleness. On the other hand, solid polymer electrolytes provide good interfacial compatibility and contact but generally exhibit lower ionic conductivity. In this sense, composite solid electrolytes (CSEs) are emerging as a promising solution for SSLMBs, combining the flexibility of polymers with the high ionic conductivity of inorganic materials. In this talk, I will present our recent advancements in CSEs. Firstly, I will discuss a sacrificial inhibitor strategy that effectively suppresses fluoropolymer/garnet interfacial reactions, achieving CSEs with ionic conductivities of up to 1 mS/cm and stability at 5V. Secondly, I will introduce a passive ceramic strategy that significantly enhances ionic conductivity while reducing the overall cost of CSEs. Lastly, I will provide an overview of our efforts towards the large-scale production of CSEs.

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最终交流类型: 主题报告

Laser displays using cutting-edge technology

Yoshihiro Oshima*[1],Junichi Osako[1],Akira Tashiro[1],Xianrong Liu[2],Qiang Zhong[2],Youliang Tian[2]
1. TVS REGZA Corporation
2. Hisense Laser Display Co., Ltd.

Ultra-short throw projectors that use a RGB laser as a light source, "Laser TVs" are attracting attention. Laser TVs can be easily replaced with LCDs, OLEDs because the projector can be installed close to the wall. In addition, wide color gamut by RGB Lasers, portability, and low power consumption are also attractive. Laser TVs are projector products and therefore requires a screen. There are various types of screens available, the most common being white matte screens. This type of screens are superior in terms of viewing angle characteristics and brightness uniformity, but have the issue of low contrast in bright environments. To solve this issue, we developed a screen that provides high contrast even in bright environments. By combining a special microstructure on the screen surface with an optical multilayer coating designed by Optical Thin Film Design Software “TF Calc” consisting of a metallic thin film and a dielectric thin film at the nanometer level, we have succeeded in developing a structure that can selectively reflects only RGB Laser light from the projector. This technology,

called Ultra Black Technology, improves light utilization from the projector by 50% and reduces ambient light by 94% by the internal standards. We have completed a 100” prototype screen using this technology. This achievement is the result of the fusion of Chinese and Japanese technologies, and further enhances the performance of laser TVs.

最终交流类型: 邀请报告

Bottom-up Cu filling of high-aspect-ratio through-diamond vias for 3D integration in thermal management

Kechen Zhao [a], Jiwen Zhao [a], Xiaoyu Guan [a], Bing Dai [a], Jiaqi Zhu [a]

[a] *National Key Laboratory of Science and Technology on Advanced Composites in Special Environments, Harbin Institute of Technology, Harbin 150080, China*

Chip fabrication evolves to miniaturization, lightweight, and integration. Advanced packaging technologies from 2D to 3D are also developing rapidly. A three-dimensional integrated circuit (3D-IC) with through-silicon-vias (TSV) is a promising technology to improve performance without increasing power consumption because its vertical structure will shorten the signal path and reduce the chip interconnect area. But the increase in integration level is accompanied by higher power density. It will face more, in particular, serious internal heat storage, prominent local. Diamond shows excellent thermal conductivity, electrical insulation, and high-temperature resistance. It can efficiently transfer the heat concentrated in devices. Several techniques have used diamond as a hybrid heat spreader or combined with microfluidics for efficient thermal management. At present, the advanced 3D integration methods developed based on Si chips mainly include the preparation of TSV, the Cu filling process, and the hybrid bonding technologies. However, there are few reports on the consideration of diamonds in 3D-IC integration.

This study demonstrates a technique regarding the possible integration of diamond into 3D package heat dissipation. The through-vias arrays of diamond were prepared by a UV nanosecond laser. Then, both diamond and Cr/Au metalized surfaces were treated with Ar/O plasma to improve the wettability of the electrolyte. The Cu-filled TDV of a high aspect ratio (10:1) was achieved by the bottom-up Cu electroplating process. The low average single-via DC resistance of 47.5mohm means that this structure is promising for vertical interconnections of various electronic components or the development of diamond substrates. As well as in some advanced package technologies for heat dissipation, especially in high-power devices thermal management.

最终交流类型: 邀请报告

Crystallographic texture and mechanical function control via metal powder bed fusion

Takuya Ishimoto*

Universiy of Toyama

Osaka University

Although the attraction of metal additive manufacturing (AM) is often thought to lie in the fabrication of complex three-dimensional shapes, recent research has shown that it goes beyond that and can significantly improve the chemical and mechanical properties by controlling the microstructures of alloys. In this talk, I will present the latest findings on the control of the microstructural features of metallic materials, including crystallographic texture by powder bed fusion (PBF), which our research group (Anisotropic Design & Additive Manufacturing Research Center, Osaka University) has been working intensively in recent years. PBF is characterized by small melt-solidification units called melt pools, and therefore fast cooling rates of up to 10-7 K/s, resulting in the formation of various unique microstructures. My talk will outline the differences in crystallographic texture formation behavior, strengthening mechanisms, and corrosion properties that depend on the thermal properties and phase transformation behavior of different materials, such as titanium, iron, nickel alloys, and tungsten, as well as the influence of different heat sources on these properties. The unique microstructures formed only by the PBF method and their contributions to the mechanical properties are also presented.

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最终交流类型：邀请报告

Adaptive neural interface materials and devices

Du Xuemin*
Shenzhen Institutes of Advanced Technology (SIAT), Chinese Academy of Sciences (CAS)

Neural interface technologies have gained significant attention for their ability to address neurological conditions such as blindness, depression, and Parkinson’s disease. Despite extensive progress, they still face challenges in establishing seamless integration between the implanted devices and living tissues. These devices often have two-dimensional flat structures that fail to match the three-dimensional morphology of tissues, leading to ineffective information interaction. Moreover, the surfaces of these devices always lack cell affinity, thereby causing inflammation responses and the final loss of information transmission function. To overcome these challenges, we propose a new strategy that integrates shape-editable polymers with implanted neural electrodes to achieve unique bio-adaptivity. By adjusting the macro-geometry of the electrodes, we can ensure macro-morphological match with tissues. By rationally modulating the micro-geometry of the electrode surfaces, we can enhance the biocompatibility with tissues. Furthermore, we explore the potential applications of these bio-adaptive devices in the treatment of neurological diseases.