中国材料大会 2024
暨第二届世界材料大会
CMC 2024 & WMC 2024

July 8-11, 2024
Guangzhou, China

FC07-粤港澳大湾区新材料论坛
FC07-New Materials Forum of the Guangdong-Hong Kong-Macao Greater Bay Area

Organized by

Chinese Materials Research Society

Website: https://cmc2024.scimeeting.cn

FC07 粤港澳大湾区新材料论坛（国际）

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科技进展与新质生产力

徐坚*

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邀请报告

FC07-I1

高性能胶黏材料的设计与应用

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香港中文大学（深圳）

胶黏剂作为五大合成材料之一，在现代工业发展和人类生活水平提高中扮演着不可或缺的角色。新能源、消费电子、智能制造和绿色包装等战略新兴产业和高端领域用胶需求增长势头强劲，对胶黏剂产品性能的提升提出了迫切需求。粘接强度作为最重要的性能指标，其关键设计原则在于对粘附力和内聚力的精细调控。与共价键相比，动态的非共价相互作用在机械力作用下更易被破坏但可重建，因此，可有效地调控与平衡内部和界面能量。鉴于此，我们团队近年来致力于通过调控动态非共价相互作用开发高性能胶黏材料，包括：

（1）通过引入离子-偶极相互作用，无需表面预处理，即可在低表面能材料上实现极高的粘接强度；

（2）通过引入丰富的氢键，开发了超高粘接强度且可通过温水浸泡快速解离脱粘的高性能水解胶；

（3）通过引入阳离子-π 和 π-π 相互作用，开发了极具商业化潜力的超强水下胶黏剂。

FC07-I2

高迁高稳养护无薄膜晶体管材料研究

彭俊彪*

华南理工大学

FC07-I3

中国新能源材料研发展望

康飞宇*

清华大学

FC07-I4

化工新材料产业发展方向

卜新平*

中国石化联合会

FC07-I5

Machine-learning interatomicpotential approach for modelingcomplex materials

张文清*

深圳大学

FC07-I6

高性能纤维创新研发与超高性能工程化进展

朱才镇*

南方科技大学

FC07-I7

Design and characterisation of CFRP metamaterials of high thermal-dimensional-stability

Yuan Chen*

Southern University of Science and Technology

High thermal-dimensional stability is crucial for high-precision applications, e.g., unmanned monitoring of Moon surface environment, etc. This study designs a novel 3D carbon fiber reinforced plastic (CFRP) metamaterial with high thermal-dimensional stability. First, the planar CFRP metamaterial was designed with a continuous carbon fiber reinforced polyamide (PA) central cross-lattice interlocked with four short carbon fiber reinforced PA outer-strips, fabricated via fused filament fabrication. The results show that the CFRP metamaterial can achieve an effective CTE of 4.6×10−6/℃ from the direct experimental measurements and of 4.9×10−6/℃ from the numerical simulation. Second, a novel three-dimensional (3D) metamaterial was developed and calculated, exhibiting a negative effective CTE at −0.18×10−6/℃, based on the planar composite metamaterial. After lightweight optimization under the constraint of CTE to zero for the 3D metamaterial, the optimal 3D composite lattice structure can possess an effective density of 0.0266 g/cm3 and an effective CTE of 0.0173×10−6/℃, which are 15.3% and 90.39% enhanced, respectively, as compared to those of the initial one, demonstrating the high thermal-dimensional-stability.

FC07-I8

高效等离激元增强光热纳米新材料及智能应用

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2. 北京理工大学

聚焦于粤港澳大湾区新材料发展，助力大湾区产业升级，我们在等离激元增强光热新材料应用研究方面：1）实现了等离激元金属/单晶半导体异质界面实现了 Plasmon 增强的高效光生电荷分离、热电子注入效率突破（达到 48%），获得其在高效光催化/光电催化等光/化学能转换方面的应用；2）绿色合成了原子厚度的的二维硫化铜(AT-CuS)新材料，发现其在第二近红外(NIR-II)窗口的光热转换效率(PCE)高达 94.3%，二维新结构带来的强烈载流子-声子耦合(7.18 × 1017 J K^{-1} $s^{-1}\cdot m^{-3}$)效应增强了光热转换，并实现了其在 PDMS、PMMA 等聚合物基质中的宏观智能新材料应用。

FC07-I9

新型过度金属硫属化合物纳米光热材料的研制及其在癌症诊疗上的应用探索

胡俊青*
深圳技术大学

FC07-I10

近红外二区生物医用光功能纳米材料

王东*
深圳大学

FC07-I11

光电功能聚酰亚胺研究进展

张艺*
中山大学

FC07-I12

超低介电损耗热固性复合材料的结构与性能研究

王珂，叶林*
南方科技大学

FC07-I13

Material design and actuation programming of space charge-driven dielectric elastomers

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1. South China University of Technology
2. Zhejiang University

Dielectric elastomers (DEs) can perform rapid and large in-plane actuation (expansion/contraction) due to electric field-induced Maxwell stress. For robotic applications, converting this in-plane actuation into out-of-plane motion typically requires mechanical frames. Meanwhile, the high driving electric fields required (20-100 V/μm) necessitate bulky power accessories and significantly reduce the durability of DEs. Here, we report a type of dielectric polymer driven by the space charge mechanism, which offers several advantages over traditional DEs. Firstly, it can be actuated at a significantly lower driving voltage (2-10 V/μm), enhancing the safety and durability of DE-based devices. Secondly, it achieves out-of-plane bending actuation without the need for frames, leading to improved power density and simplified device fabrication. Lastly, its actuation behavior is highly dependent on the sample geometry, namely geometric effect. This allows us to directly regulate the actuation mode through shape (re)programming and enable multimodal actuation in a single device with dynamic shape-changing behavior. In summary, the unique features of space charge driven DEs provide versatile design opportunities for practical soft robotic applications.

口头报告

FC07-O1

高性能铁电聚合物的制备及多模传感应用研究

李波*、刘玮书、李江宇
南方科技大学

铁电聚合物由于其化学稳定性、柔韧性、生物相容性等在传感器、致动器和能量采集等领域有广泛应用。然而其低压电系数、热释电系数等限制了铁电聚合物的进一步应用范围。基于此，我们通过界面工程、辐照等提升铁电聚合物灵敏度的技术路线。聚 3，4-乙烯二氧噻吩/聚苯乙烯磺酸盐(PEDOT:PSS)为铁电聚合物(P(VDF-TrFE))的电极，利用二甲基亚砜等通过扩散在 P(VDF-TrFE)和 PEDOT:PSS 间形成互连界面结构，该界面结构增强了复合膜的电荷收集能力、改善电极与聚合物的界面结合性。所制备 PEDOT:PSS/P(VDF-TrFE)复合膜的压电系数(d33=-86 pC N−1)和热释电系数(p=95 μC m−2 K−1)比复合前提升了 3-4 倍。

FC07-O2

Proof of principle of scaling up of cluster beam technology for mass production of nanocluster

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We introduce a nanocluster mass production equipment based on the cluster beam technology. The new technology achieves by the scaling up of cluster beam flux through engineering linear amplification of various key components such as magnetron sputtering cathode and power supply, expansion nozzle and skimmer, ion optics, quadruple bend, differential deposition etc. We demonstrate the mass production (grams per hour) of Ag, Cu and Ni nanoclusters with narrow size distribution and decent sphericity distribution. This new approach can be applied to 65 elements, also compatible with alloys and compounds, which offers a new route for general synthesis of ligand free nanoclusters in large quantity for applications such as scientific research, chemical, energy, semiconductor, and biomedical industries.

FC07-O3

Application of Technology Readiness Assessment in the manufacture of high strength forging alloy of GH 4169

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This article introduces the concept, process, and method of Technology Readiness Level. Taking high strength forging alloy of GH4169 as an example, technical readiness assessment was conducted and provided reference for other complex systems and technology, promoting the enterprise technology readiness level and forming practical application.

FC07-O4

基于双水相微流控技术的多级体外模型构建

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深圳大学

在活细胞中，生物凝聚体，即相分离形成的无膜区室，在调节生化反应和协调细胞功能方面起着至关重要的作用。受这些自然系统的启发，合成凝聚体利用液-液相分离的原理，选择性地浓缩或排除各种生物分子，如肽、蛋白质、核酸，甚至细菌。通过将多重水相体系与允许精确控制流动和形成独特界面的微流控技术结合起来，创建了多功能的分级体外模型：例如，通过结合分离型和缔合型液液相分离体系，生成分级区室化结构，并控制微流体动力学形成“停滞环”，以维持核心-壳层区室进行包括蛋白质和核酸分离、富集和扩增在内的生化反应；设计了的能富集、浓缩生物分子的凝聚液滴体系，并在凝聚微液滴中进行核酸扩增反应，量化了核酸拷贝数与荧光液滴计数之间的强相关性；受悬滴法的启发，使用微流控技术将基于巨大囊泡（GUV）的原型细胞组装成由脂双层连接的阵列，促进细胞间和细胞-环境的通信，并能够创建用于新型生物材料和体外模型的混合细胞/原型细胞球体；利用双水相界面，支持兼容活细胞的液-液结构的自由形态三维打印。

墙报

FC07-P01

Physical Entanglement Supported Polymeric Form Stable Phase Change Materials with Ultra-high Melting Enthalpy

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Nowadays, the improved overall performance of electronic devices means a higher demand for heat management to achieve stable operation. The thermal storage of phase change materials (PCMs) can absorb or store the heat generated during the working process of electronic devices by phase transition, to control its internal thermal energy. However, conventional PCMs usually suffers from the difficulties of low enthalpy of phase change and leakage from melting during the phase change process. In this work, based on the basic polymer viscoelastic and crystallization theories, a simple and novel PEG-based PCMs with stable structure, high enthalpy of phase change, and low modulus was prepared by simply dissolving long-chain UHMWPEO in its chemical identical oligomers. Rheological and leakage-proof experiments confirmed that our PCMs could maintain form stability due to long relaxation times with a small amount of UHMWPEO, showing the potential for the long-term application without flow and leakage. A phase change enthalpy of up to 185 J/g could be achieved with our designed PCMs due to thinner amorphous layer thickness, which was higher than any reported PEG-based form stable PCMs in literatures. Furthermore, by simulating the application environment, our PCMs demonstrated excellent thermal energy storage capabilities and showed great potential to protect the electronic devices. We believe that this work will provide not only a kind of high performance PCMs but also the theoretical mechanism for designing physical entanglements network for form stable polymeric materials.

FC07-P02

Patterning of large area nanoscale domains in as-grown epitaxial ferroelectric PbTiO3 films

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Effective tuning of nanoscale domain structures provides fundamental basis for controlling and engineering of various functionalities in ferroelectric materials. In this work, we demonstrate the precise patterning of nanoscopic domain structures in as-grown epitaxial PbTiO3 (PTO) films by merely introducing an ultrathin pre-patterned doping layer (e.g., Fe-doped PTO). The doping layer can effectively reverse the interfacial built-in bias, consequent to a reversed initial polarization reorientation in the as-grown film, which makes it possible to transfer the nano-patterns in the doping layer into the domain structure of ferroelectric films. For instance, we have successfully fabricated large area ordered array of nanoscale cylindrical domains (downward polarization) embedded in the matrix domain with opposite polarization (upward polarization) in PTO film. These nanoscale cylinder domains also allow deterministic and reversible erasure and creation induced by biased tip scanning. The results provide an effective pathway for on-demand patterning of large area nanoscale domains in the as-grown films, which may find applications in a wide range of nanoelectronics devices.

FC07-P03

Interfacial Structure and Mechanical Properties of UHMWPE/EVA Co-Blended Fibers Prepared by Gel-Spinning

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Ethylene-vinyl acetate copolymer (EVA) with different mass fractions was used as a modifier to dissolve in ultra-high molecular weight polyethylene spinning solution, and a blend-modified UHMWPE/EVA fiber was prepared by gel spinning method. ATR-FTIR and XPS tests confirmed the presence of EVA on the fiber surface. In addition, ATR-FTIR was used to study the mixed fiber filaments at different stretching stages during the spinning process, such as the drying stage and the super-draw stage. The results showed that the content of polar functional groups on the surface of EVA increased with the progress of stretching. Non-isothermal DSC tests showed that when the mass fraction of EVA was less than 15%, it hindered the crystallization of ultra-high molecular weight polyethylene. However, when the mass fraction of EVA was 25%, the small molecules of EVA might agglomerate and act as a heterogeneous nucleating agent to promote crystallization. The tensile performance and elastic modulus of the blend fibers decreased with the increase of EVA content. The transverse fiber bundle tensile results showed that the interfacial performance of the modified fibers was improved. WAXS and SAXS were used to study the microstructure changes in the blend fibers. WAXS results indicated that the addition of EVA disrupted the monoclinic crystal phase of ultra-high molecular weight polyethylene but did not affect the orientation of the orthorhombic crystal phase. SAXS results showed that the addition of EVA had little effect on the length and misorientation angle of shish crystals. The study of the microstructure and macroscopic properties of the blend fibers is conducive to the regulation and modification of the polar functional groups on the fiber surface, to prepare blend fibers with excellent mechanical and interfacial properties.

FC07-P04

Fluorinated polyimide with triphenyl pyridine structure for 5G communications: low dielectric, highly hydrophobic and highly transparent

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Polyimide (PI) is aclass of high-performance polymers with an imide ring (-CO-NR-CO-) structure in the main chain and has a wide range of applications in the aerospace, microelectronics and optoelectronics industries. At present, PI in the microelectronics industry, especially in the field of 5G high-frequency communication applications demand attention. With the rapid development of 5Gcommunications, there is an increasing demand for the development of PI with excellent performance and low dielectric constant (Dk) (≤3.0) and low dielectric loss (Df) in order to improve communication quality.

In response to the problem that traditional PI can hardly meet the requirements of high-frequency communication due to high Dk, high Df and high hygroscopicity, this paper combines three modifications of triphenyl pyridine, trifluoromethyl and long chain anhydride to prepare PI with low Dk, low Df and low hygroscopicity and excellent overall performance, and systematically investigates the relationship between PI molecular structure and macroscopic performance. Among them, PI-2CF3 has the best overall performance, showing the advantages of low dielectric constant (Dk=2.72@10GHz), low dielectric loss (Df=0.00233@10GHz) and low hygroscopicity (Ma=0.246%, Ca=111°). In addition, PI-2CF3 is highly transparent (λ0=389nm, Tvia=89%) and prove outstanding solubility, being soluble in NMP, DMAc, DMF, THF, etc. at room temperature. Therefore, the PI prepared by this strategy has shown great value in the field of high- frequency communication.

FC07-P05

An in-situ encapsulation strategy for enhancing the stability of hydrogels in both air and water through surface-confined copolymerization

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Air-drying and water-swelling are significant limitations of conventional hydrogels, hindering their potential applications. In this study, we present a facile, versatile and in situ encapsulation strategy aimed at overcoming these drawbacks and enhancing the stability of hydrogels in both air and water. Our method involves creating a flexible and hydrophobic polymer coating through surface-confined copolymerization of triethoxyvinylsilane (VETS) and 2, 2, 3, 4, 4, 4-hexafluorobutyl methacrylate (HFMA), along with the infusion of a hydrophobic oil layer through hydrophobic interactions. By adjusting the monomer ratio, polymerization time, and oil viscosity, we successfully anchored a flexible double-hydrophobic-coating to the hydrogel surface without compromising its mechanical properties. This double-layer-coating acts as an effective barrier, significantly reducing water evaporation within the hydrogel and preventing water diffusion and penetration from the external environment. Remarkably, the encapsulated hydrogel retains over 75.0 % of its weight after a 7-day air-drying test and exhibits non-swelling behavior in diverse aqueous environments for 150 days. Moreover, our strategy is applicable to various hydrogel types and shapes, demonstrating its universality in enhancing resistance against both drying and swelling. Therefore, the proposed approach offers valuable insights into the surface functionalization of hydrogel and broadens the application of next-generation hydrogels in real-world settings, spanning wet and dry environments.

FC07-P06

Study on structure and properties of PAN filament based on internal and external collaborative plasticizing melt spinning

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Carbon fiber has many advantages and is widely used in different fields. Among them, PAN-based carbon fiber dominates the carbon fiber market. The advantages of melt spinning are that there is no need to use a large amount of solvent, spinning speed is fast, equipment requirements are not high, and the prepared PAN raw silk core structure is small, which improves the heat transfer uniformity in the subsequent heat treatment process. However, the melting point of PAN needs to be reduced to realize melt spinning because the PAN homopolymer will decompose first and melt later during the heating process. The internal plasticization method is to polymerize AN by adding a copolymer and use the copolymer to act as a steric hindrance on the PAN molecular chain, to reduce the interaction force between cyanide groups on the PAN molecular chain. The introduction of the copolymer helps to moderate the heat release behavior of PAN filament in the pre-oxidation temperature range and avoid the defect structure caused by the concentration of heat release. The external plasticizer method is to melt spinning by adding an external plasticizer and mixing PAN. In this method, small molecules of external plasticizer are chemically bonded with cyanogen group to reduce the interaction force between cyanogen groups, to achieve the purpose of reducing the melting point of PAN. Melt spinning PAN fiber will be prepared by internal and external collaborative plasticizing method. P(An-co-AMPS) copolymer was prepared by adding appropriate amount of new copolymer AMPS and AN polymerization as melt spinning material, which not only reduced the molecular force between PAN, but also ensured that the mechanical properties of PAN filament would not decrease significantly. The feasibility of melt spinning by mixing EC as external plasticizer with P(AN-co-AMPS) was investigated by means of simulation calculation and DSC. The results showed that EC had plasticizing effect on P(AN-co-AMPS), which provided a feasible guidance for the preparation of melt spinning PAN fiber.

FC07-P07

Construction of Multifunctional Borophene Hybrid Aerogel Based on A Fast Gelation Method

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As an emerging two-dimensional material with high theoretical carrier density, electrical conductivity, magnetism, and high aspect ratio, borophene has great potential for building lightweight and multifunctional wearable electromagnetic interference (EMI) shields for various applications. However, despite the low density, low thickness, high mechanical flexibility, and high EMI SE of 3D porous structures, there has been no relevant research on the development of 3D macrostructures of borophene to date. Here, we have prepared cellulose nanofiber (CNF)/MXene/borophene foam (CMB-foam) with a porous three-dimensional structure using KOH by fast gelation and freeze-drying methods. This foam consists of uniformly distributed pores exposing abundant heterogeneous interfaces. As the combined effect of CNF, MXene and borophene provides more channels for multiple reflections of electromagnetic waves, excellent EMI shielding performance can be produced with electromagnetic shielding up to 90 dB. In addition, this foam has multifunctional properties such as electrochemical energy storage, Joule heating and thermal insulation. These studies demonstrate the potential use of borophene-based materials for functional applications and inform the exploration of borophene properties.

FC07-P08

Study on the structure and properties during the thermo-oxidative stabilization process of a PAN copolymer precursor fiber

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Polyacrylonitrile (PAN) is currently the most widely used precursor material for carbon fibers. The overall properties of carbon fibers can be enhanced to some extent by the addition of suitable copolymer monomers, such as itaconic acid (IA). In this study, we developed the use of a novel copolymer monomer, 2-acryloylamino-2-methyl-1-propanesulfonic acid (AMPS), in the preparation of PAN fibers. This was characterized by Fourier transform infrared spectroscopy (FT-IR), X-ray diffraction (XRD), two-dimensional wide-angle X-ray diffraction (2D-WAXD), small-angle X-ray scattering (SAXS) and Mechanical property tests were conducted to investigate the changes in the structure and mechanical properties of the two types of PAN fibers in the wet-spinning and stabilization processes. The structure and mechanical properties of the two types of PAN fibers were established by comparing the two PAN fibers. This study aimed to establish the connection between the structure, mechanical properties and process of PAN fibers. The results demonstrate that when the stabilization temperature is below 205°C, the stabilization reaction predominantly occurs in the amorphous region. Conversely, the cyclization reaction is primarily observed during the stabilization period, spanning from 205 to 265°C. The oxidation cross-linking reaction is primarily observed in the late stabilization period (265-285°C), which facilitates the formation of a novel sequential structure of the graphite-like and enhances the mechanical properties of the fibers. Additionally, the degree of orientation of the micropores exhibits a decreasing trend with the cyclization reaction and subsequently increases with the emergence of the graphite-like lamellar structure. Furthermore, the degree of orientation of the micropores increased with the appearance of the graphite-like lamellar structure.

FC07-P09

Ozone-Induced Rapid and Green Synthesis of Polydopamine Coatings with High Uniformity and Enhanced Stability

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The development of green, controllable, and simplified pathways for rapid dopamine polymerization holds significant importance in the field of polydopamine (PDA) surface chemistry. In this study, a green strategy is successfully devised to accelerate and control the polymerization of dopamine through the introduction of ozone (O_3). The findings reveal that ozone serves as an eco-friendly trigger, significantly accelerating the dopamine polymerization process across a broad pH range, spanning from 4.0 to 10.0. Notably, the deposition rate of PDA coatings on a silicon wafer reaches an impressive value of ≈64.8 nm h^{-1} (pH 8.5), which is 30 times higher than that of traditional air-assisted PDA and comparable to the fastest reported method. Furthermore, ozone exhibits the ability to accelerate dopamine polymerization even under low temperatures. It also enables control over the inhibition–initiation of the polymerization process by regulating the “ON/OFF” mode of the ozone gas. Moreover, the ozone-induced PDA coatings demonstrate exceptional characteristics, including high homogeneity, good hydrophilicity, and remarkable chemical and mechanical stability. Additionally, the ozone-induced PDA coatings can be rapidly and effectively deposited onto a wide range of substrates, particularly those that are adhesion-resistant, such as polytetrafluoroethylene (PTFE).

FC07-P10

Surface metallization and application of ultra-high molecular weight polyethylene fiber

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Ultra-high molecular weight polyethylene (UHMWPE) fibers and fabrics exhibit weak interfacial bonding with composite matrix due to their chemically inert surface and high crystallinity, which affects the performance of composite materials. To enhance the surface activity of UHMWPE fiber, the surface metallization modification (UHMWPE-Cu) of UHMWPE fiber was realized by electroless deposition of copper, and the effects of metal coating on the morphology, crystal structure, surface roughness and electrical conductivity of UHMWPE fibers were investigated. The interfacial bonding performance and puncture resistance of UHMWPE-Cu with polyurethane resin matrix were also studied. The results showed that metallization endowed the fiber with good electrical conductivity, with a conductivity of up to 660. 79 S/cm. At the same time, metallization increased the surface activity of the fiber, improving the interfacial adhesion between the fiber and the resin matrix. The peeling strength of UHMWPE fiber-reinforced polyurethane composites was increased by 108% compared to unmodified fiber samples.In addition, metallization of UHMWPE fibers significantly improved their puncture resistance in composite materials. Compared with unmodified samples, the modified samples showed a 35% improvement in puncture resistance. Metallization also greatly improved the electromagnetic shielding performance of composite materials,with an electromagnetic shielding performance of up to 53 dB, far superior to the qualified electromagnetic interference intensity value (20 dB) for shielding applications. Therefore, the surface metallization of UHMWPE fiber has a broad application prospect in electromagnetic shielding.

FC07-P11

Super strong and tough hydrogels constructed via network homogenization of macromolecular chains

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Load-bearing materials form animals such as tendons and muscles have a high-water content of nearly 70% but are still strong and tough. Synthetic hydrogels have been created by using numerous strategies such as hydrogen bonding, ion bonding, freeze and salting out, self-assembly and mechanical training to reach better mechanical performance. However, many hydrogels with the same high-water content do not show high strength, toughness or homogeneity. Herein, we present a strategy to produce a homogeneous hydrogel architecture using a freeze-drying and salting-out treatment. The produced poly(vinyl alcohol) and poly(ε-Caprolactone) hydrogels are highly homogeneous. These hydrogels have a water content of 60–95% and properties that compare favorably to those of other tough hydrogels and even natural tendons; for example, an ultimate stress of 24 MPa, strain levels of 3,000 %, toughness of 350 MJ/m3 and fracture energy of 178.4 kJ/m2. This strategy is particularly applicable for introducing non-aqueous polymer into hydrogels and constructing strong and tough hydrogels.

FC07-P12

Preparation and properties of creep-resistant UHMWPE fibers

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Ultra-High Molecular Weight Polyethylene (UHMWPE) fiber has the advantages of ultra-high specific strength and smaller density than water and is widely used in the field of national defense and military industry and national economy. However, its creep resistance is relatively poor, which greatly limits its application range. In this paper, the creep resistance of UHMWPE fibers was realized by silane grafting and cross-linking, and the modified UHMWPE materials for silane grafting and crosslinking were prepared by twin-screw extrusion-gel molding, and the effects of important influencing factors of silane grafting crosslinking reaction, such as the type of silane coupling agent, the amount of silane coupling agent, the amount of initiator, the hydrolysis crosslinking temperature and the hydrolysis crosslinking time, on the creep resistance of UHMWPE fibers were studied. Infrared spectroscopy analysis showed that the four silane coupling agents selected in the experiment could be successfully grafted with UHMWPE. The gel rate test showed that the gel rate of the cross-linked UHMWPE gel prepared by silane coupling agent A172 and KH570 under the same addition amount was as high as 90%, which was nearly 100% higher than that before modification, while the silane coupling agent A151 had milder cross-linking conditions, low cross-linking reactivity, and the gel rate was about 85%. Finally, the optimal modification conditions were determined as follows: BPO initiator addition amount of 1phr (Parts per hundred parts of resin, phr); The hydrolysis crosslinking time is 4h; The hydrolytic crosslinking temperature is 80 °C. The creep test showed that the creep resistance of the fibers was increased by nearly 90% when the A151 addition amount was 1-4phr. When the addition of A151 is 4phr, the creep resistance of the fiber is the best, and when the addition amount is 1phr, the effect on the fiber strength is the lowest, and the tensile strength of the modified creep resistance fiber reaches 31.7cN/dtex, which is almost the same as that of pure UHMWPE fiber. Silane grafting crosslinking greatly improves the creep resistance of UHMWPE without affecting the fiber strength, which provides a simple modification strategy for the preparation of high-strength and creep-resistant UHMWWPE fibers, which is of great significance for the expansion of the application field of UHMWPE fibers.

FC07-P13

Simultaneously enhancing the EMI shielding performances and mechanical properties of structure-function integrated CF/PEEK composites via chopped ultra-thin carbon fiber tapes and interfacial engineering with MXene

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The functionalization of carbon fiber reinforced poly(ether ether ketone) (CF/PEEK) structural composites with high electromagnetic interference shielding efficiency (EMI SE) has important engineering application in the fields of aviation and aerospace. However, the poor interfacial adhesion between CF and PEEK matrix remains a major concern. To address this issue, we employed an integrated design approach that involved synthesizing PFEEK as a binder and then utilizing mechanical spreading technology to prepare chopped ultra-thin CF tapes. Subsequently, we employed a strategy for depositing two-dimensional MXene (Ti3C2Tx) on the CF tapes to enhance the interface properties of CF/PEEK composites, aiming to simultaneously improve both EMI SE and mechanical properties. As a result, when the dispersion concentration of MXene was 1.0 mg/ml, the flexural strength, flexural modulus, and interlaminar shear strength of the obtained CF/PEEK composites achieved 17.6%, 13.3% and 36.6% enhancement higher than that of the virgin CF/PEEK composites, respectively, which may be owing to the elevated interfacial properties via the π-π interactions, hydrogen bonds, electrostatic interaction, and mechanical interlocking with the incorporation of MXene. In addition, it is worth noting that the CF/PEEK composites modified with MXene at 3.0 mg/ml achieved an optimal EMI SE of 44.9 dB in the X-band, which was 129.1% higher than the unmodified CF/PEEK composites. The improvement in the EMI SE can be attributed to the heightened ohmic losses and multiple reflections of EM waves facilitated by the presence of MXene and ultra-thin CF tapes. The outstanding EMI SE and mechanical properties granted a structure-function integrated CF/PEEK composite, which has potential application prospects in various cutting-edge domains.

FC07-P14

含芳杂环结构聚芳醚酮树脂可纺性探究

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含二氮杂萘酮结构聚芳醚类聚合物是耐热等级较高的可溶性聚合物，其中含二氮杂萘酮结构聚芳醚砜酮（PPESK）玻璃化转变温度为 283℃，同时还具有良好的化学稳定性和机械强度，在航天、军工、电子等领域取得了广泛应用。为进一步扩大 PPESK 的应用领域，制备 PPESK 纤维势在必行。首先， PPESK 溶液属于假塑性流体，由流变实验确定纺丝的喷丝速率，纺丝液温度等条件。然后，采用传统的湿法纺丝工艺制备 PPESK 纤维，低浓度纺丝液纺丝所得纤维致密性较差，力学性能不高。最后，提高纺丝液浓度，并分别经由干喷湿纺以及湿纺两种纺丝技术制备 PPESK 纤维，对两种纺丝方式所得纤维的表观形貌、力学强度、热拉伸处理进行了初研究。结果表明，纤维具有较好的力学性能，拉伸强度为 150Mpa，热拉伸处理可显著提高纤维的拉伸强度，强度提高约 50％。通过 XRD 分析表明纤维于无定形结构，但纤维的取向度随热牵伸倍数的提高会有所提高，相对于膜来说有很大提高。

FC07-P15

High Refractive Index and High Abbe Number Polymer Based on Norbornadiene

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Optical polymers, as excellent potential candidates for inorganic materials, have great advantages in the development of high integration optical components with lightweight, easy processing, and tunable properties. This paper introduces a series of fresh sulfur-containing heterocyclic optical monomers with a high refractive index and a high Abbe number that were designed and synthesized by a one-pot Wittig reaction of norbornadiene, tri-nbutylphosphoniodithioformate (TBPD), and aldehydes. On this basis, high refractive index polymers (HRIPs) were synthesized from these monomers and polythiols via thiol−ene click reactions. The polymers possess good thermal stability (Tg > 107 °C and Td5% > 200 °C) and mechanical properties (tensile strength >57 MPa), excellent visible light transmittance (>85%), a tunable high refractive index (n = 1.6055−1.6274), and an extremely high Abbe number (v > 59). Combining the ring structure of norbornadiene and the sulfur-containing heterocycle, the prepared HRIPs achieve a high balance between the refractive index and the Abbe number, which provides a new idea for the preparation of high refractive index and high Abbe number polymer materials.

FC07-P16

PVDF-HFP 固态电解质成膜过程的原位 GIWAXS 研究

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固态电解质具有较高的安全性和稳定性，PVDF-HFP 固态电解质因其较好的介电常数、与锂金属界面稳定性高等优势而受到关注。聚合物固态电解的合成方法、离子传导机理等关键问题都得到了广泛的关注和研究，而聚合物固态电解质从液体到固体成膜过程中的结晶行为演变却很少被关注。本研究采用自行设计的原位 GIWAXS 装置在线表征了 PVDF-HFP 聚合物固态电解质从液体到固体成膜过程的结晶行为演变。结果表明，PVDF-HFP 固态电解质在成膜后的 1.5h - 2.0h 之间发生突变，q=14nm-1 (2θ=15.9°) 处峰强度迅速减弱，PVDF-HFP 的结晶度快速下降。通过对一维 GIWAXS 曲线分析表明：1.5h - 2.0h 之间，DMSO 和 LiTFSI 大量消耗晶区的 PVDF-HFP，形成稳定的夹层结构。 夹层结构尺寸较大，导致 PVDF-HFP 固态电解质 q=9.5nm-1(2θ=10.8°)的峰向左移至 q=8.8nm-1(2θ=10°)，对应的晶面间距由 0.32nm 增大到 0.36nm。成膜 6h 后，一维 GIWAXS 曲线不再变化，成膜过程完成。本研究通过表征 PVDF-HFP 聚合物固体电解质结晶行为，可以控制薄膜的结晶度，优化聚合物的微观结构，提高离子导电率；对指导生产高性能、高稳定的聚合物固态电解质具有重要意义。