

吴超群

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政治面貌	群众	学 院	化学学院
年 级	2022 级	专 业	材料科学与工程



奋斗历程

当我提笔撰写这份陈述时，目光不禁落在电脑屏幕上，“诤实扬华”四个字，如同精神的灯塔，自我踏入这所百年学府之日起，便照亮了我前行的每一步。今天，我郑重地申请“诤实扬华奖章”，这不仅是一份至高的荣誉，更是对我过去数年秉持校训精神、奋力拼搏的青春的一次总结与汇报。我的奋斗历程，是一条在“诤实”中积淀，在“扬华”中求索的追光之路。

我来自化学学院材料科学与工程专业。自踏入交大校门起，“诤实扬华”的校训便深深烙印在我的心中。我深知，“扬华”是远大的理想与报国的志向，而“诤实”则是实现这一切的唯一根基——它要求我们沉心静气，在追求真知的道路上脚踏实地。对我而言，这份“实”学，首先就体现在对专业知识的扎实掌握与精湛的实验技能上。因此，我的“诤实”之路，与 J3408 实验室里测试仪器的规律轰鸣声相伴，与 J3554 实验室深夜不灭的灯火为伍。我将学校“严谨治学、严格要求”的“双严”传统奉为圭臬，贯彻于每一次实验探索中：从精准把控每一个实验细节，到反复优化制备路径；从耐心分析失败数据，到追本溯源解决根本问题。3 号教学楼的合成与测试实验室已成为我的常驻地，我对各类复杂的仪器设备了如指掌，并因能迅速诊断并协助排除故障，被师弟师妹们亲切地称为“课题组的编外工程师”。这一过程不仅锤炼了我的动手能力，更培养了我作为一名科研工作者必备的严谨、坚韧与责任心。凭借这份持之以恒的努力与对“诤实”精神的坚守，我在学业与科研上取得了扎实的成果，并荣获国家奖学金、校级一等奖学金及“优秀研究生”等多项荣誉。然而，我深知，这些成绩并非终点，它们是我在“诤实”道路上，用汗水浇灌出的、一颗颗饱满的知识果实。我坚信，唯有将根基扎得更深，方能茁壮成长，最终积蓄足够的力量，托举起创新与突破的梦想。

我深刻认识到，“诤实扬华”的精神品格，其价值不仅闪耀于学术殿堂，更需要在广阔的社会实践与服务奉献中得以检验、升华与彰显。为此，我积极投身于多项学生工作，努力践行一名交大学子的责任与担当。在担任 2020 级高分子 1-2 班《高分子物理》课程助教期间，我不仅为同学们系统梳理专业知识，更坚持“有问必答、有疑必解”的原则，通过组织专题辅导、个别答疑等方式，最终助力全体同学以优异成绩通过课程考核，将知识的火炬传递给更多同窗。同时，作为化学学院合成实验室（J3554）的管理员，我肩负起安全保障的重任。通过定期、严格的设备巡检，我有效杜绝了多项安全隐患，实验室在迎接省、校、院各级安全检查中均获得高度评价。我还主动协调处理了包括下水道堵塞、空调故障在内的各类突发问题，确保了科研工作的顺畅运行，成为师生们信赖的“安全卫士”。此外，在担任学院分析测试仪器管理员期间，我以高度的责任心与专业素养，高效完成了大量样品的整理、测试与数据初步分析工作，为同学们的科研攻关提供了有力支撑。这些宝贵

的实践经历，让我褪去了书斋中的稚气，锤炼了我在沟通协调、责任担当和解决复杂实际问题上的综合能力，使我变得更加成熟、坚韧。更重要的是，它们让我深刻体会到个人价值在服务集体中的实现，从而对将来投身于国家需要的事业，怀抱更为坚定的信念与更为澎湃的动力。

回首在西南交大的求学岁月，我的成长体系清晰地构建于“诶实扬华”的校训之上：以**学术上的“诶实”**为根基，以**创新上的“扬华”**为追求，以**实践中的“力行”**为担当。这三者相互促进，共同塑造了今日的我。“诶实扬华奖章”是对这一体系最崇高的认可。我申请此奖章，是希望以此为新起点，将这份荣誉转化为一份具体的责任。我承诺：在未来的工作中，我将继续秉持“诶实”精神，深耕专业领域；勇担“扬华”使命，力争创新突破；并积极投身集体，主动传承服务精神，以实际行动诠释奖章的内涵。若能获奖，我定当不负期望，成为连接母校精神与未来事业的一座桥梁，让“诶实扬华”的旗帜在更广阔的天地中高高飘扬。

成绩列表

荣誉及获奖情况：

1. 2023 年 10 月，获“全国高分子学术论文报告会”优秀墙报将奖；
2. 2025 年 07 月，获“全国高分子创新创业大赛”金奖；
3. 2025 年 09 月，拟推荐获国家奖学金；
4. 2025 年 09 月，拟推荐获西南交通大学一等学业奖学金；
5. 2025 年 09 月，拟推荐获西南交通大学“优秀研究生”荣誉称号；
6. 2025 年 09 月，拟推荐获西南交通大学“优秀毕业生”荣誉称号。

论文、专利、著作情况：

1. 第一作者发表论文 3 篇：1 篇 SCI/A 类/中科院一区，2 篇 SCI/A 类/中科院二区；
2. 第二作者发表论文 7 篇：2 篇 SCI/A 类/中科院一区，2 篇 SCI/A 类/中科院二区，2 篇 SCI/B 类/中科院二区，1 篇 SCI/中科院二区；
3. 第三作者发表论文 1 篇：1 篇 SCI/中科院二区；
4. 学生第二作者发表论文 1 篇：1 篇 SCI/B 类/中科院二区；
5. 学生第一发明人（物理第二发明人）的身份发表授权专利 5 篇；
6. 学生第一发明人（物理第二发明人）的身份发表公开专利 1 篇；

以学生身份参与课题情况：

1. 学生第一主研 1 项：A 类（国家自然科学基金）1 项；

社会工作情况：

1. 2022 年 09 月至 12 月，担任 2020 级高分子 1-2 班《高分子物理》课程的助教；
2. 2022 年 12 月至 2025 年 08 月，化学学院合成实验室（J3554）的管理员。
3. 2022 年 10 月至 2025 年 08 月，化学学院分析测试仪器（FTIR、DMA、COMSOL 仿真模拟设备等）的管理员

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项目负责人：龙骐越

指导老师：王勇

申报院校：西南交通大学

特发此证，以兹鼓励！

第五届全国高分子材料创新创业大赛组织委员会
(厦门大学代章)
二零二五年七月

Biom mineralization-Inspired Ultra-tough and Robust Self-healing Waterborne Polyurethane Elastomers

Chao-qun Wu, De-xiang Sun, Xiao-dong Qi, Jing-hui Yang, Sheng Dai,* and Yong Wang*



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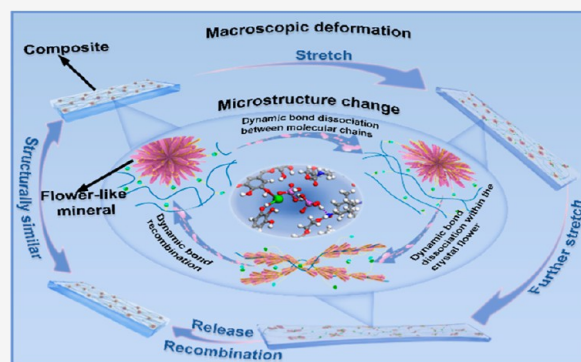


Article Recommendations



Supporting Information

ABSTRACT: Creating materials that exhibit properties analogous to biological muscles, such as toughness, strength, elasticity, and self-healing capabilities, presents a significant challenge. Here, inspired by the biom mineralization process in which macromolecules regulate mineral crystal assembly, we propose a strategy to induce in situ crystallization and assembly of minerals using ice-controlled media. This approach enables the fabrication of waterborne polyurethane (WPU) elastomers with exceptional mechanical performance (including an unprecedented toughness of approximately 1.9 GJ m^{-3} , remarkably high fracture stress of around 65 MPa, and extraordinary elongation at break reaching 6215%), as well as rapid self-healing capability (with matrix recovery and mineral reconstruction occurring within only 4 min). During the crystallization and assembly of minerals, the steric hindrance provided by WPU and tannic acid (TA) effectively regulates mineral crystal growth, while the cross-linking interaction between WPU and TA facilitates the in situ assembly of inorganic mineral nanocrystals into flower-like architectures. This synergistic process ultimately results in the formation of an organic–inorganic embedded structure within the WPU matrix. Moreover, this unique structural design establishes a novel theoretical framework for understanding the stress dissipation mechanisms of WPU elastomers under external forces. In summary, this work presents an innovative strategy for fabricating WPU elastomers with high mechanical performance and offers in-depth insights into the structural principles that underpin their exceptional mechanical performance.



INTRODUCTION

Polyurethane (PU) elastomer finds extensive applications in sectors such as electronics,¹ electrical engineering,² artificial intelligence,³ medical devices,⁴ and transportation.⁵ Further expansion of applications puts forward higher requirements for the mechanical properties and functionality of PU elastomers. Self-healable PU elastomers, designed to emulate the regenerative properties of human skin, hold the potential to mitigate environmental pollution and economic waste associated with PU elastomer disposal.⁶ However, balancing the mechanical properties and self-healing ability of PU elastomers is greatly challenging. Mechanical strength is often increased through the addition of inorganic fillers such as graphene nanoplatelets,^{7–9} graphene oxide,^{10–12} and cellulose nanocrystals.¹³ For example, Fu et al. developed a solvent-exchange-induced self-assembly strategy to embed layered boron nitride nanosheets (BNNS) skeletons into a room-temperature self-healing PU matrix, thereby preparing biomimetic self-healing composites with a 35.7-fold enhancement in mechanical toughness.¹⁴ Luo et al. introduced reversible noncovalent bonds and covalent cross-linking networks into PU chains, and designed carbon nanotubes (CNTs)//PU fiber architecture to fabricate PU elastomers and fiber-based strain sensors with improved mechanical properties and self-healing performance.¹⁵ Wang et al. incorporated

highly crystalline polyols with chain folding, stored chain length, and coordination bonds into PU, achieving an excellent balance of high tensile strength ($47.18 \pm 2.35 \text{ MPa}$), elongation at break ($5952.72 \pm 254.20\%$), outstanding toughness ($1396.39 \pm 90.05 \text{ MJ m}^{-3}$), and high hardness (Shore D 43.8 ± 0.8), while retaining intrinsic self-healing properties.¹⁶ Nonetheless, inorganic fillers are often inflexible and rigid and cannot be reconstructed once the internal microstructure is destroyed. In contrast, self-healing requires dynamic structures that are more stretchable and elastic.¹⁷ Furthermore, the intrinsic incompatibility between inorganic fillers and PU elastomers leads to a limitation in enhancing mechanical properties.

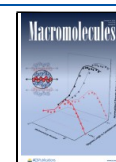
Biom mineralization is a natural phenomenon that enables organisms to possess remarkable hierarchical structures. It mainly relies on utilizing the interaction between organic macromolecules and inorganic ions at the interface to control

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Healable, Recyclable, and Ultra-Tough Waterborne Polyurethane Elastomer Achieved through High-Density Hydrogen Bonding Cross-Linking Strategy

Chao-qun Wu, Jie Chen, Qi-yue Long, De-xiang Sun, Xiao-dong Qi, Jing-hui Yang, and Yong Wang*



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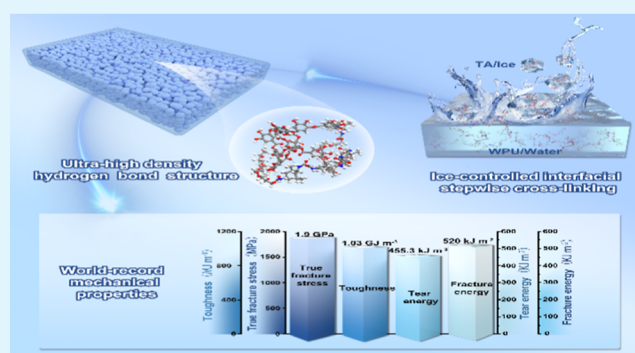
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Supporting Information

ABSTRACT: With the increasing popularity of elastomers in industry and daily life, their high performance and functionality have attracted widespread attention. However, it is a great challenge for them to possess both high mechanical properties and excellent healing and recovery capabilities due to the limitations of the preparation methods and the intrinsic microstructure of the elastomers. In this study, a strategy of ice-controlled interfacial stepwise cross-linking was proposed to prepare the waterborne polyurethane-based elastomers with ultrahigh-density hydrogen bonding interaction achieved by enhancing the utilization rate of phenol hydroxyl groups of tannic acid to the maximum extent. The elastomers have incredible mechanical properties, including ultrahigh toughness of 1.03 GJ m^{-3} (which represents the highest level among polyurethane elastomers prepared through common processing techniques to date), extremely high true fracture stress of $\sim 1.9 \text{ GPa}$, world-record fracture energy of 520 kJ m^{-2} , and exciting multiple functional characteristics, such as highly efficient self-healing ability of 10 min, high resistance to physical damage and chemical corrosion, broad temperature and frequency damping effects, good shape memory effect, and excellent melt-processing recyclability and solvent recyclability. These robust multifunctional elastomers represent considerable potential in various fields, from defense and military industry and civil transportation to precision manufacturing, etc.

KEYWORDS: waterborne polyurethane (WPU), tannic acid (TA), hydrogen bond, multiple functions, recycling



INTRODUCTION

Their high entropic elasticity enables elastomers to dissipate mechanical energy, allowing them to return to their initial shape and regain their mechanical properties even after repeated shape alterations.^{1–3} This unique property of elastomers has led them to gain great interest and show great promise in various fields such as actuators, soft robots, shock absorbers, and flexible electronics.^{4–7} However, the quantities of elastomer-based materials are increasing year by year with the expansion of their applications, which also results in an explosive increase in elastomer waste. Currently, most commercial elastomers, particularly those known for their substantial toughness, are structurally bonded through irreversible covalent bonds and usually have limited self-healing (SH) and recyclable capabilities. Therefore, the waste elastomers can only be disposed of by scrapping, burying, or incinerating them, resulting in significant environmental pollution and resource wastage.^{8–10} The concept of environmental and economic sustainability requires a new generation of elastomers that have physical damage and chemical corrosion tolerance, excellent SH capability, and recycling capability to reduce elastomer maintenance costs, raw material

consumption, and environmental pollution,^{11–13} as well as extend the elastomer service life.^{14–17} However, the achievement of these functional attributes often entails a trade-off with mechanical properties, particularly by reducing the toughness.

Cross-linking and decross-linking of elastomers can be achieved through the dissociation and recombination of dynamic noncovalent interactions as well as covalent interactions, which provides a practical method for SH and recyclability of elastomers.^{16,18,19} The dissociation and recombination of dynamic covalent interactions usually require more energy, making it less likely to achieve efficient SH at room temperature.²⁰ In contrast, elastomers with dynamic noncovalent interactions that have low dissociation and recombination energy are more likely to achieve SH at room

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Self-Healable, Considerably Stretchable, and Wide-Temperature-Range-Damping Waterborne Polyurethane Elastomers by Constructing the Spider-Silk-Like Structures

Chao-qun Wu, Zhi-xuan Zhang, De-xiang Sun, Xiao-dong Qi, Jing-hui Yang, Hong Tan,* and Yong Wang*



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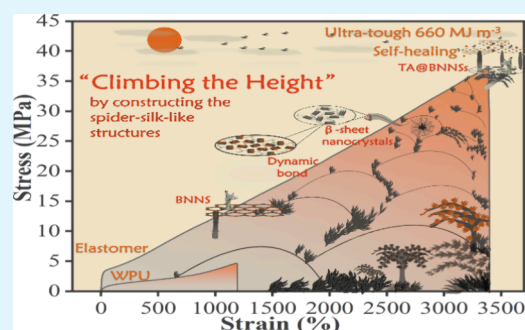
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Supporting Information

ABSTRACT: Waterborne polyurethane (WPU) has garnered considerable attention, owing to its environmentally friendly characteristics and diverse application potentials. However, its limited mechanical strength and toughness restrict its practical applications in demanding long-term loading scenarios. Herein, we propose a biomimetic microstructure strategy to address these limitations by preparing tannic acid-functionalized boron nitride nanosheets (TA@BNNs) through π - π stacking interactions, thereby structurally substituting the β -sheet nanocrystals in spider silk. Upon incorporation into WPU via solution processing, robust interfacial hydrogen bonds are formed between TA@BNNs and WPU, establishing a hierarchical architecture that mimics the β -sheet/amorphous matrix organization of natural spider silk. This bioinspired microstructure facilitates effective stress distribution and energy absorption, resulting in elastomers with exceptional mechanical characteristics, such as an ultrahigh toughness (660 MJ m^{-3} , which is about 4 and 24 times higher than those of spider silk and pure WPU, respectively), high tensile strength (37.4 MPa), and considerable stretchability (3433%). Additionally, the remarkable self-healing efficiency (75–100%) and broad damping temperature range ($>100^\circ\text{C}$) can further extend the elastomers' service life in harsh environments. This study not only advances the design of high-performance elastomers through biomimetic microstructure strategy but also demonstrates their potential for critical applications in advanced damping systems and wearable technologies.

KEYWORDS: waterborne polyurethane, tannic acid, toughness, self-healing, damping



INTRODUCTION

Polyurethane (PU) is extensively utilized owing to its superior elasticity, fatigue resistance, wear resistance, tear resistance, and vibration damping properties.¹ However, its relatively low strength and insufficient toughness restrict its application in advanced domains. Strategies for enhancing PU performance include regulating microphase separation or constructing cross-linked structures.² Nevertheless, these approaches often involve complex operations and reaction control challenges. Additionally, incorporating nanoparticles into PU matrices, such as silica,³ microfibrillated cellulose (MFC),⁴ cellulose nanocrystals,⁵ carbon nanotubes,⁶ and graphene oxide (GO),⁷ can effectively enhance the strength of PU, yet this often comes at the expense of its toughness. Moreover, the surface inertness of nanoparticles poses significant challenges for their dispersion within PU and their bonding with PU. In recent years, a strategy has been proposed to integrate nanoparticle incorporation with the construction of dynamic cross-linking structures. This approach not only facilitates the development of elastomers with superior strength and toughness but also confers them with self-healing ability, thereby enhancing their

service life in harsh environments.^{8–11} Integrating the nanoparticles and dynamic cross-linked structures to design a unique material microstructure plays a critical role in effectively enhancing the strength, toughness, and self-healing ability of PU.

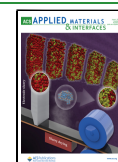
In nature, organisms undergo long-term evolution, during which a variety of optimized structures have emerged, enhancing survival capabilities and endowing biological structures with superior mechanical properties.¹² For instance, mussel feet exhibit strong adhesive capabilities,^{13,14} nacre layers possess extremely high fracture toughness,^{15,16} and spider silk demonstrates remarkable strength, extensibility, and toughness.^{17,18} Among them, the unique structure of spider silk, consisting of semiamorphous regions and β -sheet

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Microstructure and Performance Evolution of Poly(L-Lactic Acid) during Physical Aging: Effect of Molecular Weight

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Zhi-xuan Zhang, Chao-qun Wu, Yi-fan Zha, De-xiang Sun,* Xiao-dong Qi, Jing-hui Yang, and Yong Wang*



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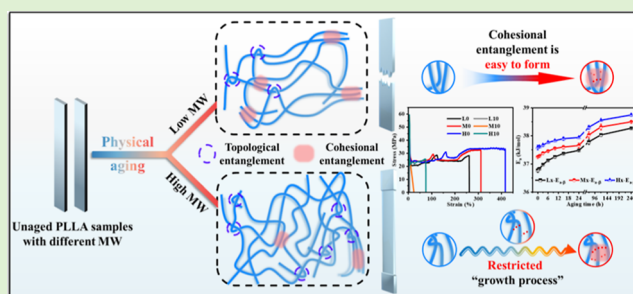


Article Recommendations



Supporting Information

ABSTRACT: With the growing public awareness of environmental protection, poly(L-lactic acid) (PLLA) has started to establish a presence across various industries. However, the inevitable physical aging of PLLA products leads to substantial alterations in both microstructural evolution and macroscopic properties. Therefore, it is essential to conduct an in-depth discussion of the underlying mechanism associated with physical aging. As an intrinsic parameter of PLLA, the mechanism by which molecular weight influences physical aging remains to be clarified. In this article, the regulatory mechanism of molecular weight over the physical aging timeline in PLLA is elucidated according to the cohesive entanglement theory. The "growth process" of cohesive entanglements within the high-molecular-weight sample system is inhibited, leading to a decrease in the effective number of such structures, which is manifested as a delay in physical aging behavior. Moreover, the effect of molecular weight on the physical aging exhibits a nonlinear increase, and a "saturation effect" is observed. This work provides a theoretical basis for elucidating the regulatory mechanism of molecular weight on the physical aging behavior of PLLA.



1. INTRODUCTION

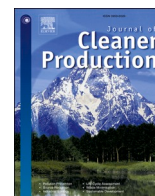
The development of human society and the advancement of science and technology over the past few decades have been evident to all. However, it is undeniable that the volume of waste generated by humans each year has also been increasing rapidly.¹ Plastic pollution is not merely confined to visible waste, and the presence of tiny fragments of different plastics, known as microplastics, which are widely dispersed in the environment, also exerts adverse effects on various aspects of human life.^{2,3} In accordance with the environmental protection policies proposed by the government, it is advisable to prioritize the utilization of biodegradable materials derived from natural sources over conventional petroleum-based materials.^{4,5} Poly(L-lactic acid) (PLLA) is a well-established compostable biobased polyester that has garnered significant attention in recent decades, attributed to its favorable physical properties, processability, sustainability, and cost-effectiveness.^{6,7} Owing to the broad application prospects, PLLA materials have been utilized in diverse forms across various fields, including biomedicine, bioelectronics, water treatment, and textiles.^{8–12} However, the inherent brittleness of PLLA has remained a significant challenge for the researchers, thereby considerably restricting its application and development.^{13,14}

It has been suggested that the brittleness of PLLA material is likely attributed to the physical aging behavior occurring spontaneously at room temperature.^{15,16} When products are cooled from the molten state above the glass transition temperature (T_g) to room temperature, the motion units, such as chain segments within the system, are "frozen in", which results in the system being in a nonequilibrium thermodynamic state with excess thermodynamic quantities. And during the service of products at room temperature, the excess thermodynamic quantities will tend to decrease, thus bringing the system closer to thermodynamic equilibrium.¹⁷ The phenomenon wherein the properties of a polymer change over time at a constant temperature and in the absence of other external influences is referred to as "physical aging". The physical aging is dependent on the motion units within the material system and is typically reversible.^{17,18} From an alternative perspective, the occurrence of physical aging can

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Synthesis of magnetically recyclable FeCeO nanocrystals with heterojunction between Fe₂O₃ and CeO₂ via one-step method toward efficient organic dyes degradation by activating peroxymonosulfate

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Dynamic polyvalent metal

ABSTRACT

Azo dye wastewater poses a serious threat to environment and human health due to steady structures make them resistant to biodegradation or chemical degradation. The coupling of photocatalysis and peroxymonosulfate (PMS) as an efficient strategy can achieve dye-contaminated water purification by inducing advance oxidation processes. In this study, magnetic FeCeO nanocrystals with heterojunction between Fe₂O₃ and CeO₂ by one-step method were successfully synthesized to efficiently degrade methyl orange (MO) and Congo red (CR) by activating PMS under visible light irradiation. PMS molecules could be adsorbed by Fe₂Ce₁O composite and generated •SO₄⁻ radicals during photocatalytic process. Free radical quenching experiments and electron paramagnetic resonance (EPR) revealed that •SO₄⁻ radicals were the dominant species in photodegradation process. Fe₂Ce₁O catalyst could completely decompose dye molecules for waste solutions with low dye concentration. Increasing MO and CR concentrations to 100 mg L⁻¹, the removal efficiencies of MO and CR by Fe₂Ce₁O were still up to 85.2% and 77.9% in sequence. And liquid chromatography mass spectrometry (LC-MS) was used to confirm the intermediates and degradation pathways during MO and CR degradation processes. Cyclic experiments demonstrated that Fe₂Ce₁O composite had good durability and reusability. Moreover, degradation mechanisms were investigated. This study provides new insight into the synthesis of heterogeneous metal oxide catalyst to solve the organic pollution issues.

1. Introduction

Water pollution and energy crisis have become the primary issues in an era of rapid economic development (Mohammadi et al., 2023). Therefore, the prerequisites for improving the living quality are to obtain clean freshwater and abundant energy. So far, a large number of nondegradable dyes have been discharged into nature, and caused a series of serious organic pollution (Rasool et al., 2023; Mousavi et al., 2022). Non-biodegradable dyes have carcinogenic, mutagenic and teratogenic properties to human and other living creatures (Yadav et al., 2023; Zhou et al., 2023). Hence it is imperative to remove pollution sources in sewage, and untreated wastewater should be strictly prohibited from being discharged into nature. Many researchers are working to develop more efficient strategies and novel materials to purify sewage (Manikandan et al., 2023).

In recent years, advanced oxidation processes (AOPs) as an eco-friendly and efficient method have been widely applied to decompose

recalcitrant pollutants (Bai et al., 2023). Sulfate radical-based advanced oxidation processes (SR-AOPs) can generate multiple reactive oxidizing species (ROS) such as sulfate radicals (•SO₄⁻), superoxide anions (•O₂⁻), hydroxyl radicals (•OH) and singlet oxygen (¹O₂) to efficiently decompose and mineralize organic pollutants due to SR-AOPs possess outstanding redox potential (2.5–3.1 eV), long activity lifetime and wide pH adaptability (Zhang et al., 2023). Song et al. (2020) used carbon anodes to compare electrochemically activated PMS and peroxydisulfate (PDS), and obtained that the electrochemically activated PMS molecule had higher reactivity and lower stability than PDS, which was conducive to quickly generate •SO₄⁻. In order to enhance PMS activation ability, many strategies have been proposed to improve the yield of active radicals, such as photocatalysis, thermal treatment, light irradiation, and electrical assistance (Ashraf et al., 2023). At present, the photocatalyst-mediated PMS activation system has been demonstrated to be a promising technique for removing organic pollutants due to PMS as electron acceptor can efficiently separate photogenerated carriers and

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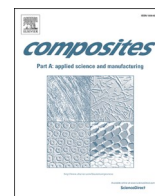
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Eco-friendly waterborne polyurethane-based coatings with spontaneously formed gradient distribution architectures achieved absorption-enhanced electromagnetic interference shielding and infrared stealth

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Waterborne polyurethane
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Infrared stealth

ABSTRACT

Electromagnetic interference (EMI) shielding and infrared (IR) stealth technologies play crucial role in modern industrial and military fields. However, the secondary pollution of electromagnetic waves (EMWs) generated by reflection-dominated EMI shielding materials is undesirable. Therefore, preparing eco-friendly coatings that integrate electromagnetic protection and thermal camouflage while reducing the EMWs reflectivity through simple methods is of great significance. This paper proposes a straightforward strategy: using tannic acid (TA)-modified MXene as the conductive fillers and waterborne polyurethane (WPU) as the matrix, gradient structure is spontaneously formed within the coatings via a one-step spraying method. The resulting composite coatings achieve excellent EMI shielding effectiveness (37.4 dB) and high absorption coefficient (0.41). Under the synergistic protection of WPU and TA, composite coatings maintain superb EMI shielding performance (retention rate exceeding 93 %) in harsh environments. Due to the low IR emissivity of MXene, composite coatings also exhibit satisfactory IR stealth performance under different temperature fields, which not only achieve ideal camouflage of human body and significant reduction of detection signal in the medium (60 °C) and high (120 °C) temperature environments. Finally, benefiting from the adhesive properties of WPU, composite coatings perform outstandingly in both qualitative and quantitative adhesion tests. This study provides important references for the design and fabrication of multifunctional protective coatings in commercial and military applications.

1. Introduction

The rapid development of science and technology and the continuous progress of society have greatly increased the usage frequency of electrical equipment in the modern world, and the resulting massive electromagnetic waves (EMWs) pollution not only seriously interferes with the stable operation of high-precision electronic devices but also poses a great threat to human life [1–3]. Therefore, the development of high-performance electromagnetic interference (EMI) shielding materials is imperative. Electrical conductivity is one of the key factors affecting the EMI shielding performance of materials. When EMWs contact the surfaces of objects with high electrical conductivity, severe impedance mismatch causes strong reflection that endows the materials with the ability to isolate EMWs [4,5]. To achieve this goal, metallic materials with intrinsic high electrical conductivity are typically used in the

preparation of EMI shielding materials [6–9]. However, in many application scenarios, metallic materials are limited by their high density and susceptibility to corrosion. As a result, composite materials incorporated with conductive fillers (such as carbon materials and conductive polymers) have become the focus of researches [10–13]. Apart from that, most EMI shielding materials possess sufficiently high EMI shielding effectiveness (EMI SE), but the serious secondary pollution of EMWs caused by the reflection-dominated shielding mechanism has become an urgent research issue [14]. Introducing magnetic materials (such as magnetic metals and their oxides [15–19]) and designing special macroscopic structure (such as constructing asymmetric or gradient structures [20–23]) are often adopted by researchers to reduce the reflectivity of EMWs. However, the above methods often suffer from complex preparation processes and limited scalability, making the development of simple and scalable technologies for preparing EMI

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Visible-light-driven peroxymonosulfate activation by multiphase $\text{Fe}_2\text{Cu}_1\text{Ce}_x\text{O}$ composite catalyst for efficient removal of organic pollutions

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Heterojunction
Visible-light photocatalysis
Polyvalent metal oxides
PMS activation
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ABSTRACT

The band structures of polyvalent metal oxides are well-suited for visible-light-induced catalysis. However, the lower charge carrier separation efficiency of single metal oxide as catalyst significantly limits its photocatalytic activity. In this work, a novel multi-heterojunction construction strategy was proposed. Based on the oxidation temperature differences between Ce^{3+} and $\text{Fe}^{3+}/\text{Cu}^{2+}$ ions, as well as their atomic radius mismatch, we innovatively developed a high-temperature gradient oxidation strategy by introducing Ce into the Fe-Cu-O spinel system, and successfully fabricating a multi-heterojunction $\text{Fe}_2\text{Cu}_1\text{Ce}_x\text{O}$ catalyst containing Fe_2O_3 , CuO, $\text{Cu}_{0.75}\text{Fe}_{2.25}\text{O}_4$, and CeO_2 components. $\text{Fe}_2\text{Cu}_1\text{Ce}_x\text{O}$ heterojunctions establish built-in electric fields at multiphase interfaces, efficiently facilitating electron-hole pairs separation and enhancing photocatalytic performance. Although $\text{Fe}_2\text{Cu}_1\text{O}$ matrix demonstrates strong visible-light absorption, strategic incorporation of Ce element further amplifies light harvesting capacity while improve photoelectrochemical properties. Notably, $\text{Fe}_2\text{Cu}_1\text{Ce}_{0.5}\text{O}$ achieves exceptional photocatalytic through synergistic effects between different semiconductors, exhibiting 92.0 % tetracycline hydrochloride (TCH) degradation efficiency in the $\text{Fe}_2\text{Cu}_1\text{Ce}_{0.5}\text{O}/\text{PMS}/\text{vis}$ system. The system also exhibits robust removal capabilities for organic dyes, eliminating 88.5 % methyl orange (MO, 120 mg L^{-1}) and 92.5 % Congo red (CR, 100 mg L^{-1}). The superior photodegradation performance is primarily attributed to the enhanced activation of peroxymonosulfate (PMS) by $\text{Fe}_2\text{Cu}_1\text{Ce}_{0.5}\text{O}$ composite under visible light irradiation. During the catalytic process, PMS not only serves as the precursor for sulfate radical ($\bullet\text{SO}_4^-$) generation but also facilitates the dynamic valence cycling of polyvalent metal ions ($\text{Ce}^{3+}/\text{Ce}^{4+}$ and $\text{Fe}^{2+}/\text{Fe}^{3+}$), thereby enabling a self-sustaining catalytic mechanism. This study proposes a novel strategy for designing heterogeneous metal oxide heterojunction catalysts, offering an effective solution to mitigate persistent organic pollution through advanced oxidation processes.

1. Introduction

The rapid economic development has been accompanied by escalating environmental pollution, particularly through the discharge of persistent organic pollutants into ecosystems [1,2]. Among these contaminants, antibiotics and synthetic dyes have emerged as critical concerns due to their ubiquitous application and environmental persistence. Tetracycline (TC) antibiotics, representing the second most prevalent antibiotic class, constitute over one-third of global antibiotic production and utilization [3]. Their extensive use has led to concerning accumulation in aquatic and terrestrial environments, where their stable aromatic structure and low biodegradability enable long-term environmental persistence [4]. The ecological impacts of TC contamination are multifactorial. TC exposure inhibits microbial community

functions and pathogen suppression capacities in terrestrial systems [5]. In aquatic environments, it disrupts algal photosynthesis (particularly in *Microcystis aeruginosa*) and compromises antioxidant enzyme systems [6,7]. More critically, antibiotic misuse accelerates the proliferation of antimicrobial-resistant bacteria, facilitating horizontal gene transfer of resistance determinants within environmental matrices. These resistance genes potentially infiltrate human food chains and water supplies, posing significant threats to ecosystem integrity and public health [8,9]. Concurrent with antibiotic pollution, synthetic organic dyes present comparable environmental challenges. These chromatic pollutants not only induce water discoloration but also critically reduce dissolved oxygen levels through accelerated oxygen consumption, creating hypoxic conditions that impair aquatic biodiversity and hinder natural purification processes [10,11]. Of particular concern are dyes containing

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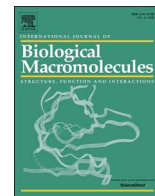
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Microstructure and performance evolution of poly (L-lactic acid) during physical aging: Determinable role of molding method on β -relaxation

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ARTICLE INFO

Keywords:

Poly (L-lactic acid)
Physical aging
Relaxation process

ABSTRACT

As one of the biodegradable materials, poly (L-lactic acid) (PLLA) attracts much attention and acquires fast development since it is crucial for alleviating the issue of microplastic pollution. During processing and service, polymers usually experience the physical aging process, leading to the microstructure and performance evolution. Such scenario is especially obvious for PLLA. However, the mechanisms involved remain unclear. Here, the relationship between ductility and relaxation behavior of PLLA during physical aging is investigated. The ductility is greatly dependent upon the molding method, and the quenched samples show higher tensile ductility compared with cold-pressed samples. The cohesional entanglement gradually forms with aging time, and it is closely related to molding methods. The cohesional entanglement has no impact on the α -relaxation process, nevertheless, it greatly restricts the β -relaxation of PLLA. The decrease in the mobility of molecular chains makes it unable to effectively absorb energy when subjected to external forces. Furthermore, physical aging is an irreversible process while quenching treatment can retard the physical aging behavior of PLLA for a certain period. This work provides new insight on the microstructure and performance evolution mechanisms of PLLA during physical aging, which can guide the microstructure design of PLLA-based articles with promising performances.

1. Introduction

As one of the major issues of great concern to the world, the concept of sustainable development has been deeply rooted in people's hearts. The increasingly severe microplastic pollution has driven attention of researchers from petroleum-based polymers to biodegradable polymers derived from nature [1,2]. Among those biodegradable polymers [3], poly (L-lactic acid) (PLLA) possesses the advantages of favorable biocompatibility, biodegradability [4], excellent transparency [5], and low cost [6]. As the most popular renewable and biodegradable aliphatic polyester material, PLLA is also regarded to be one of the most promising environmentally friendly biomaterials for replacing traditional petroleum-based materials [7]. In the past two decades, PLLA material has already been utilized in limited fields that have no additional requirement for mechanical properties, such as textiles, biomedicine, packaging and so on [4,8]. However, the further expansion of application is restricted by its relatively poor mechanical properties, especially toughness [9,10].

Physical aging is a common phenomenon experienced by the polymers, which is related to the gradual evolution from nonequilibrium state to equilibrium state via micro-Brownian motion in the glass state [11]. In other words, physical aging is a relaxation process of polymers. Generally, the relaxation behavior is greatly dependent upon the flexibility of molecular chains. Higher flexibility of molecular chains leads to lower relaxation time and therefore, polymers can achieve the equilibrium state in a shorter time. In this condition, the effect of physical aging on microstructure and performances of polymers is inconspicuous. Contrarily, polymers with rigid chains have larger relaxation time and therefore, physical aging inducing microstructure rearrangement and performance evolution become prominent [12]. Although PLLA is a typical semicrystalline polymer, the rigid chain feature leads to low mobility of chain segments. This indicates that the relaxation of PLLA molecular chains is difficult. During the melt processing of PLLA, the rapid cooling to room temperature that is much lower than the glass transition temperature (T_g) of PLLA ($\sim 60^\circ\text{C}$), there is not enough time for the relaxation of PLLA molecular chains and therefore, PLLA is

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Rational Design of CeO₂/CdSe Heterojunction Photocatalysts toward Enhanced Charge Separation for Efficient Photoreduction of Cr(VI) and Photodegradation of Tetracycline Hydrochloride

Liang Li, Chao-qun Wu, Zhi-xuan Zhang, Nan Zhang,* Ting Huang, and Yong Wang*



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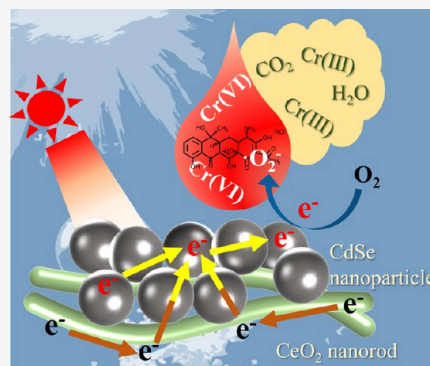


Article Recommendations



Supporting Information

ABSTRACT: The rapid development of modern industry has exacerbated water pollution, posing significant threats to environmental sustainability and human health. Semiconductor heterostructures have emerged as a promising strategy to enhance the photochemical properties and catalytic activity of heterogeneous catalysts, offering a viable solution to water pollution challenges. In this study, a series of CeO₂/CdSe catalysts was successfully synthesized via chemical deposition. The results demonstrate that CdSe nanoparticles could effectively modulate the band gap, enhance visible light absorption ability, and improve the photochemical performance of CeO₂/CdSe composites. The catalytic activity and practical application prospects of the as-synthesized samples were evaluated by reducing hexavalent chromium (Cr(VI)) and decomposing tetracycline hydrochloride (TCH). CeO₂/CdSe composites exhibited significantly higher photocatalytic activities compared to pure CdSe and CeO₂. Notably, CeO₂/0.6CdSe demonstrated the highest photocatalytic activity, achieving 93.6% removal of Cr(VI), which was 4.39 and 1.77 times as high as those of pure CeO₂ and CdSe in sequence. Furthermore, CeO₂/0.6CdSe achieved a remarkable TCH removal rate of 97.0%. The enhanced photocatalytic performance of CeO₂/0.6CdSe is attributed to the formation of heterojunction structures between CdSe and CeO₂, which facilitates efficient charge separation and transfer. Cyclic experiments confirmed the excellent anti-interference ability and sustainability of CeO₂/0.6CdSe. Reduction mechanisms of Cr(VI) and degradation mechanisms of TCH were thoroughly investigated, with DFT mechanistic analysis providing further insights into the superior catalytic activity of CeO₂/0.6CdSe. This work highlights the potential of CeO₂/0.6CdSe as a highly efficient photocatalyst with broad applications in wastewater treatment.



INTRODUCTION

The escalating severity of environmental pollution has posed significant threats to the safety of life and the sustainable development of ecosystems.¹ Among these, water pollution is particularly critical, as water is the fundamental source of life.² Heavy metal ions and antibiotics are among the primary contaminants contributing to water pollution. Developing effective methods to remediate wastewater pollution remains a formidable challenge. Currently, advanced oxidation–reduction strategies such as Fenton,³ ozone oxidation,⁴ piezo catalysis,^{5,6} and photocatalysis⁷ have been extensively investigated for applications in water treatment. Among them, photocatalysis demonstrates notable advantages over conventional advanced oxidation processes. Fenton reactions face limitations in catalytic applications due to their requirement for acidic pH conditions and the generation of iron sludge, while Ozone oxidation is constrained by its dependence on energy-intensive ozone generation. However, photocatalysis operates effectively under ambient conditions without chemical additives, minimizing the secondary pollution. Also, catalysts harness solar or UV light to generate reactive species (e.g., ·O₂[−], ·OH, and h⁺), enabling broad-spectrum degradation of

recalcitrant pollutants—a capability often limited in piezo catalysis due to its reliance on mechanical energy input.

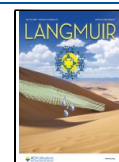
In recent years, solar-driven photocatalysis based on semiconductor materials has gained widespread recognition as a promising approach to address water pollution.^{8,9} However, the removal rate of contaminants using single semiconductor catalysts is often unsatisfactory due to poor light absorption and high recombination rate of photo-generated charges.¹⁰ At present, researchers have proposed various synergistic optimization strategies to address the limitations of wide band gap semiconductors (e.g., TiO₂, ZnO, and SrTiO₃) and low-carrier-mobility semiconductors (e.g., WO₃, Fe₂O₃, and BiVO₄), aiming to achieve efficient light absorption and charge separation. These strategies include the regulation of band gap width via doping,¹¹

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Largely enhanced damping performance of nitrile rubber/ethylene–vinyl acetate blends via phenolic resin-induced phase separation

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Phase separation
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Mechanical properties

ABSTRACT

The low glass transition temperature (T_g) and narrow effective damping temperature range (EDTR) greatly restrict the application of common vulcanized rubbers in fields relating to high temperature environmental condition due to the greatly reduced damping performances. In this work, phenolic resin (PR) was incorporated into nitrile rubber/ethylene–vinyl acetate (NBR/EVM) blends through melt-compounding processing, and the microstructure and damping performance changes induced by PR were comparatively investigated. The results show that PR induces the phase separation of the blends and most of PR particles selectively locate in the NBR component. Molecular dynamics simulation confirms that more hydrogen bonds form in the ternary blends, and reduced free volume fraction is also achieved. The ternary blends show good high-temperature damping performances, and apparently enhanced T_g (up to 17.7 °C) and EDTR (82.6 °C, from –2.6 to 80 °C) are also achieved. Additionally, the ternary blends exhibit good mechanical properties, including higher ductility and larger fracture energy, and better energy dissipation ability. This work provides an alternative resolution way to enhance the damping performances of the common vulcanized rubbers at high temperatures.

1. Introduction

As industry and modern life have rapidly advanced, the use of machinery and equipment has increased exponentially. Whether small electronic devices or heavy mechanical systems, their operation inevitably produces vibration. The long-term vibration may induce great negative effects, such as the reduced precision of electronic equipment, the failure of building structure, the generation of noise [1–3], etc. Damping materials, which can reduce the negative effect of mechanical vibration by adsorbing vibration energy and converting it to heat, attract much attention and gain explosive development. The damping performances can be evaluated using the parameter of loss factor ($\tan\delta$), including the intensity, temperature range, the integral area of the corresponding loss peak. $\tan\delta$ is the ratio of loss modulus to storage modulus, in which the former is related to the viscosity while the latter is related to the elasticity of the materials. Rubbers or elastomers are thought as the idea damping materials due to their special viscoelastic performances [4,5]. During the glass transition process, the great

internal friction originated from the high molecular weight, high crosslinking degree, and the possible molecular interaction leads to a large number energy absorption and consumption. However, it is important to note that the glass transition range of most of individual rubbers is relative narrow and consequently, they exhibit the efficacious damping range (with $\tan\delta > 0.3$) only about 20–30 °C surrounding glass transition temperature (T_g , °C) [6]. Furthermore, most of rubbers exhibit low T_g , much lower than room temperature. This indicates that the damping performances of rubbers may deteriorate greatly and possibly completely lose efficacy at temperatures much higher than room temperature [7]. Thus, enhancing the T_g of rubbers to fulfill damping requirements under a wide range of temperature conditions has garnered substantial interest.

The first widely used strategy is incorporating nanoparticles into rubbers to enhance the T_g of the rubber matrix [8]. First, the well-dispersed nanoparticles may restrict the mobility of rubber molecular chains once there is intense interfacial interaction between nanoparticles and rubber matrix, which promotes the enhancement of T_g .

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Glutaraldehyde-assisted crosslinking for the preparation of low dielectric loss and high energy density cellulose composites filled with poly (dopamine) modified MXene

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MXene
Polydopamine
Crosslinking
Dielectric properties

ABSTRACT

In today's electric power systems, biodegradable and environmentally benign dielectric materials with outstanding dielectric capabilities are essential. Here, a hybrid filler MXene@PDA (M@P) was acquired by coating MXene with polydopamine (PDA), and then it was added into cellulose matrix to manufacture regenerated cellulose/M@P (RC/M@P) composite films. Finally, a crosslinking strategy with glutaraldehyde (GA) assistance was developed to further modify the RC/M@P composite films. The crosslinked composite films (CRC/M@P) had a denser structure with fewer defects, considerably decreased dielectric loss, and significantly strengthened breakdown strength. The highest energy storage density of 3.37 J/cm^3 was obtained for CRC/M@P-1 composite film with only 1 wt% M@P at 361.07 MV/m , achieving significant enhancement compared with the original CRC film. Moreover, crosslinking also contributed to the CRC/M@P for achieving better mechanical properties. The excellent comprehensive performances endow CRC/M@P composite films with promising application for the next-generation dielectric capacitors.

1. Introduction

Due to the diverse compositions of dielectric materials, the dielectric capacitors can be categorized into ceramic capacitors, mica capacitors and polymer film capacitors, etc [1–2]. Polymers have several advantages over other dielectric materials, including low weight, cheap cost, ease of production, and excellent dependability. Therefore, they are popularly utilized as dielectric capacitors in various fields, such as new energy vehicles and high-power laser [3]. The energy density (U_e) is one of the main parameters for dielectric materials, which can be determined by the following equation, where E is the electric field, D is the electric displacement.

$$U_e = \int E \, dD \quad (1)$$

Therefore, the critical issue to enhance dielectric properties is to improve E . However, there is an inherent inverted relationship between dielectric constant (ϵ) and breakdown strength (E_b). Because an increase in ϵ is usually at the expense of a decrease in E_b . In addition, traditional petroleum-based polymers have an extremely fatal weakness. They are

non-biodegradable and non-renewable, and the wide application inevitably leads to inordinate environment problems. Therefore, how to maintain a high ϵ and E_b as much as possible while effectively reduce environmental pressure are the focus of research work about the fabrication of the polymeric-based dielectric materials.

Cellulose, which is one of the most plentiful materials in the world, shows numerous advantages, such as biodegradability, renewability, biocompatibility, and nontoxicity [4–8]. There are abundant hydroxyl groups connected by hydrogen bonds between and within the cellulose molecules, making for a highly sequential internal structure. Consequently, from the perspective of realizing high E_b , cellulose is a prospective expectant because of the high mechanical properties of the cellulose film originated from the powerful hydrogen bonding interactions. However, due to the fewer dipoles inside the cellulose molecules and strong water absorption ability, cellulose usually has a low inherent ϵ , making it disagreeable to meet actual industrial applications. The preparation of cellulose-based dielectric materials filled with various fillers has been extensively investigated. One kind of methods is incorporating carbon-based fillers. For example, Beeran et al. prepared the graphene oxide (GO)/nanofibrillated cellulose (NFC) dielectric composite with the ϵ of 46 at 1 MHz [9]. Zeng et al. confirmed that the

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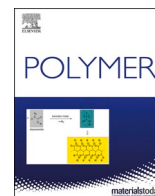
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Design of super-toughened, heat-resistant and antistatic polyethylene terephthalate-based blend composites by constructing a tenacious interface

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ARTICLE INFO

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Polymer-matrix composites (PMCs)
Electrical properties
Fracture toughness
Mechanical properties

ABSTRACT

It's a great challenge to achieve the synchronous enhancement of the fracture toughness and strength via designing the microstructures of blend composites. Herein, multi-walled carbon nanotubes (MWCNTs) were incorporated into polyethylene terephthalate/ethylene butyl acrylate-glycidyl methacrylate terpolymer (PET/PTW) blend. Effects of MWCNTs on the mechanical properties, phase morphology, crystallization behaviors, heat resistance and antistatic property of the blend were investigated. It is found that MWCNTs are selectively located at the two-phase interface of the blend and induce epitaxial crystallization of PET matrix, which better strengthens the interfacial adhesion of blend composites. Tenacious interface endows blend composites with superior fracture toughness and strength. The impact strength and tensile strength of the blend composite only containing 0.5 wt% MWCNTs are as high as 72.3 kJ/m² (without fracture) and 38.9 MPa, respectively. The toughening mechanisms are attributed to the role of MWCNTs in compatibilizing, stress transferring and hindering the rapid propagation of cracks at the interface of the blend. Moreover, MWCNTs endow the blend composites with outstanding heat resistance and antistatic property, which enlarges the application fields of PET. This work offers a dexterous and effective blueprint for manufacturing of high mechanical performances PET-based blend composites.

1. Introduction

In recent years, with the rapid development of the industry, polyethylene terephthalate (PET) as an engineering plastic, due to its high mechanical strength, excellent wear resistance, creep resistance, corrosion resistance, chemical stability and popularity prices, is widely used in packaging, automobile manufacturing, electronic and electrical appliances and some other fields [1,2]. Nevertheless, some disadvantages of PET seriously restrict its application in the industrial fields. Firstly, PET presents typical brittleness and notch sensitivity, resulting in its notch impact strength is only 2–3 kJ/m² and elongation at break is only 5–7% [3]. Secondly, the crystallization ability of PET is very weak, and

the rigid PET molecular chains are difficult to arrange into the crystal lattice in an orderly manner during melt processing, which will lead to the poor heat resistance of PET [4]. Thirdly, the surfaces of PET products are prone to accumulate a large amount of electric charge because PET has good electrical insulation, and the products are easy to release static electricity in a dry environment, which might bring safety risks to electrical equipment [5]. Hence, it is necessary to solve the above problems to develop high-performance PET materials, especially to improve the fracture toughness of PET resin.

The most common strategy for toughening polyester material is blending it with elastomers, such as ethylene-vinyl acetate-glycidyl methacrylate copolymer (EVMG) [6], acrylonitrile-butadiene-styrene

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发明专利证书

发明名称：一种超韧宽温域阻尼弹性体复合材料及其制备方法

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(54) 发明名称

一种高强韧宽温域阻尼自愈合导热弹性体
复合材料及其制备方法

(57) 摘要

本发明公开了一种高强韧宽温域阻尼自愈合导热弹性体复合材料及其制备方法。其制备方法具体包括以下步骤：(1) 取组分A和组分B加入去离子水，进行球磨，避光静置，取上清液，其中组分A为单宁酸或壳聚糖或多巴胺，组分B为氮化硼或石墨烯；(2) 取水性聚氨酯溶液，加水稀释，然后再加入过渡金属盐溶液，搅拌；(3) 将上述上清液加入到步骤(2) 最终所得溶液中，搅拌，然后真空抽滤，烘干，制得。本发明制备方法具有工艺简单、可控性强、稳定性好、反应条件温和成本低廉等优点，制得的高强韧宽温域阻尼自愈合导热弹性体复合材料同时具备超高的韧性、较宽的阻尼温度范围、良好的导热性和优异的自愈效率。

