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B06-Sustainable Development and Recycling of Materials

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B06. 可持续发展材料与循环利用

分会主席：王玉忠、柴立元、胡国华、Rodrigo Martins、Federico ROSEI、Paolo Colombo、Juan Morante

B06-01

Contribution of non-destructive testing in the development of sustainable materials

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Structural health monitoring (SHM) and non-destructive testing (NDT) of materials enable the assessment of the condition of a structure giving crucial information about the damage condition and necessity of repair. This contributes to the safe infrastructure management and prolongation of the operational life of the structure, thus saving valuable resources (cost, materials for new construction, person-hours). Definitely, the contribution of monitoring in laboratory cannot be underestimated; in fact it is equally important, where all new materials, systems and techniques are developed. In the present study advanced monitoring applications are discussed. They are all related to elastic waves, either in their active form, i.e. ultrasound (US) or passive form, i.e. acoustic emission (AE). In particular, assessment of self-healing and repair of cementitious media by ultrasonic mapping. Also, evaluation of durability loss in concrete by air-coupled ultrasound. In addition, fresh concrete curing monitoring based on AE. Finally, investigation of performance of natural fibre cementitious composites for structural applications. Elastic waves physically propagate through the material, being therefore sensitive to the elastic properties and in general the internal condition of the materials allowing a thorough and non-invasive assessment of their performance. Complementary, the sensitivity of AE to small-scale processes in the microstructure enables the prediction of the potential fracture mode much earlier than any form of damage (crack, delamination) becomes macroscopically measurable. Results show that proper application of passive and active elastic wave methodologies along with suitable interpretation can pave the way to reliable assessment of specific processes allowing maintenance decisions based on engineering criteria in addition to established but rough empirical correlations.

B06-02

Design and Preparation of Thermoplastic Elastomers with High Performance via Dynamic Covalent Bonds

Bo-Geng Li
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B06-03

How to tackle sustainability challenges for next generation specialty materials

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Syensqo

in the past 20 years, sustainability has totally transformed the requirements for develompnet of new materials. The health impact, environment impact, climate impact as well as resources availability are now key parameters to take into account for any new development of materials. all these new parameters on top of the more traditional attributes of a product needs to bee taken into account not only when developing the product but also during the full

life time of the material, in the usage part as well as at the end of life of the product. In this presentation we will describe how Syensqo, a leading company in the field of specialty materials is embracing the topic when it comes to research and development of new products. a few examples of complete new development of products for aerospace, electronics and energy industry, taking into account these elements will be presented.

B06-04

高分子材料的可持续发展

王玉忠
四川大学

B06-05

废塑料的生物降解与高值转化

姜岷
南京工业大学

B06-06

Tire Rolls on Sustainable Tire Road

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Tire road gradually emerged in China since 2022. Different from the traditional road paved by concrete or bitumen, the tire road was paved with rubber paste highly reclaimed through autocatalytic accelerated oxidation under reactive stirring and extrusion. The rubber paste consists of liquid rubber and core-shell carbon black with super adhesive performance (PG 88-34) and self-healing behavior. As a bitumen alternative, the rubber paste had easy processing ability to pave the durable road with all-rubber structural layers reinforcing with fiber or steel, just like tire structure. In the meantime, more roads and bridges are repaired with this structure and materials. Efficient, green and controllable reactive extrusion are further developed for various used tire and roads.

B06-07

可降解环氧树脂的结构设计、制造及应用

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B06-08

Raw lacquer-derived flame retardants toward multifunctional polymeric materials

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Bio-based flame retardants nowadays have attracted more and more attention owing to the environmental friendliness and easy availability. Herein, urushiol, extracted from raw lacquer, was developed to afford a new bio-based flame retardant (U-DC), which was found effective in addressing the dilemma between the expected flame retardancy and high mechanical strength of epoxy resins (EP). Impressively, EP with 9 wt% U-DC succeeded to meet the UL-94 V-0 rating, and acquired a quite high limiting oxygen index (LOI) up to 37.1%. In addition, by comparison with neat EP, the peak heat release rate (pHRR) and total heat release (THR) decreased by 40.5% and 26.6%, respectively. The optimized flame retardancy of EP was contributed to the flame-retardant activities of U-DC in the gaseous phase and condensed phase, confirmed by analyzing the volatile products and char residues. Besides the ascending flame retardancy, the mechanical properties of EP with U-DC were superior to neat EP, especially in terms of tensile strength, which increased from 64.4 MPa of EP to 81.6 MPa of EP/7 wt% U-DC, due to the incorporation of abundant rigid benzene rings in U-DC and the chain entanglement between the long side chain of U-DC and the epoxy macromolecular chain. Generally, this work paves the way for fire-new utilization of urushiol, which shows potential in constructing flame-retardant and high-performance EP.

B06-9

Isolation of cellulose, hemicellulose and lignin from rice straw and their application in polymer composite materials

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Lignocellulose is the most abundant renewable biomass resource, mainly including hardwood, softwood, gramineae, etc. Its main components, cellulose, hemicellulose and lignin, can be used as important energy and chemical raw materials. High-value utilization of lignocellulose can reduce dependence on non-renewable fossil resources. Although a lot of research has been done on lignocellulose, the specific structure of lignocellulose makes it difficult to separate its components efficiently. The pretreatment of straw can be divided into biological treatment, physical treatment, chemical treatment and physical-chemical treatment. This study uses the "low-temperature phase transition" method, one of chemical treatment methods, to simply and efficiently separate cellulose (40 wt.%), hemicellulose (32 wt.%) and lignin (19.5 wt.%) in rice straw. Only NaOH and sulfuric acid are used as reagents in this separation process, and there is no need to use high-temperature or high-pressure equipment, which is green and environmentally friendly. After modification, the isolated cellulose can be used to prepare fiber-reinforced PVA composite films, fiber-reinforced PLA fibers, cellulose-based conductive hydrogels, etc. The obtained hemicellulose and lignin have excellent solubility in organic solvents such as DMF and DMSO. The process of preparing bio-based polyurethane using hemicellulose and lignin as the chain extender are further studied.

B06-10

Role of hydrogen bond network in modulating the thermoplasticity of cellulose and its derivatives

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The difficulty of melt processing cellulose greatly limits its widespread and high-value applications. The fundamental reason lies in the abundant hydrogen bonds in cellulose, as well as its highly oriented, highly crystalline, and tightly packed aggregate structure. Therefore, deeply understanding the relationship between intra- and inter-molecular hydrogen bonds in cellulose materials and their thermoplasticity is fundamental and crucial for solving the issues related to its melt processing and balancing processability and mechanical properties. Existing research

indicates that controlling hydrogen bonds can aid in the dissolution and melting of cellulose, establishing a quantitative relationship between hydrogen-bond binding energy[1-3] or hydrogen-bond basicity[4] and cellulose solubility. However, the relationship between hydrogen bonds and their thermoplasticity remains unclear. This study proposes using chemical modification methods to randomly or selectively substitute the hydroxyl groups on cellulose molecular chains, preparing cellulose esters with different substituent structures to regulate the hydrogen bond network. It systematically explores the impact of the hydrogen bond network on material thermoplasticity. The results show that when flexible side groups are introduced into the cellulose, the remaining hydroxyl groups mainly exist in the form of intramolecular hydrogen bonds and free hydroxyl groups not forming hydrogen bonds. Introducing large and rigid side groups results in a significant presence of free hydroxyl groups in the corresponding cellulose esters that cannot form hydrogen bonds, with only a small amount of hydroxyl groups forming intramolecular hydrogen bonds. The rest of the hydroxyl groups mainly exist as intermolecular hydrogen bonds, restricting the movement of molecular chains and leading to the highest complete melt flow temperature. Additionally, whether they melt seems to be judged by a critical content of hydrogen bonds, and there is a certain linear relationship between their initial melting temperature, complete melting temperature, and the content of intramolecular hydrogen bonds.

B06-11

New Approaches of Upcycling Thermosetting Resins

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Polymeric materials are difficult to recycle and show low value-added in recycled products, which leads to a recovery rate of less than 15%. At present, researchers have made many efforts to recycle polymeric materials, but their main attentions are on thermoplastic that can be melted by heating and cured by cooling, i.e., they can be utilized again by reshaping. Thermosetting resins play an essential role in plastic industry due to their good physical and chemical resistance, but they cannot be remelted or reshaped for the stable cross-linked structure and thus their recycling ways are more complex and less accessible. Among the existing recycling approaches for thermosetting resins, physical recovery is simple, efficient and easy to promote industrialization, but the performance of recycled products is poor and the added-value is low. Chemical recovery can recover monomers, oligomers or value-added chemicals from wastes, showing great potential for upcycling. However, some problems such as harsh reaction conditions, complex post-treatment processes and low performance/value of recycled products, are still exist. Therefore, the authors developed several new oxidative degradation routes and established new models of in-situ separation and upcycling of degraded products based on supramolecular chemistry, which provides new ideas for promoting the resource utilization of waste polymeric materials.

B06-12

基于动态非共价键的可重构液晶高分子(Reconfigurable Liquid Crystal Polymers Based on Dynamic Noncovalent Bonds)

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Liquid crystal polymers are one of the most promising intelligent polymer materials. In recent years, the recycling and performance reconstruction of liquid crystal polymer materials through dynamic covalent bonding have been the focus of research in this field. Compared with dynamic covalent bonds, dynamic non-covalent bonds have lower bonding energy, so the recycling of liquid crystal polymer materials under a mild condition can be realized via incorporating dynamic non-covalent bonds. In the past five years, based on the design concept of dynamic non-covalent bonds to prepare reconfigurable liquid crystal polymers, we have successfully combined various dynamic non-covalent bonds such as dynamic polyphenol bonds, dynamic ionic bonds and dynamic hydrogen bonds with liquid crystal polymers, realized the preparation and performance optimization of recyclable liquid crystal polymer materials at room temperature, and explored the potential applications of related materials in the fields of intelligent bionics, light-driven vibrators, information encryption and anti-counterfeiting.

B06-13

废弃聚乙烯氧化升级回收制长链二元酸

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塑料自 19 世纪 60 年代问世以来得到了广泛使用，其产量在 2019 年达到 3.68 亿吨，预计到 2050 年将超过 11 亿吨，约占全球石油用量的 20%，然而大多数塑料在使用后被遗弃、简单填埋或焚烧，带来了系列环境问题。利用化学方法将塑料升级回收为小分子、单体或者更有价值的其它化学品，使废弃塑料“重获新生”，成为塑料回收利用的热点方向。

最近，我们开发了一种催化氧化工艺，可在温和条件下将废聚乙烯（PE）塑料转化为长链二元酸，相继开发了贵金属催化剂和非贵金属催化剂体系，可在 1.5 MPa 的压力和 160 ℃的温度下，将 PE 塑料升级回收为长链二元酸（Mw, 558 g/mol）；对不同的 PE 原料和回收塑料，也表现出优异的性能。该工作为聚乙烯废塑料的回收提供了一条新的路径，并有望扩展到其他高价值化学品和 PE 以外的其他塑料。

B06-14

Facile Construction of Bio-based High Fire-safety Lyocell Fabrics with Well Wearing Performance

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B06-15

聚合物乳液改性混凝土再生集料

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混凝土再生集料(Recycled Concrete Aggregate, RCA)是建筑废弃物经分选、破碎和筛分得到的一种可利用的材料。但 RCA 表面存在砂浆，吸水率大且强度低，无法在沥青路面等承重结构中应用。提升 RCA 表面致密性并提高其强度是解决该难题的关键点。为此，本研究拟采用水性聚合物改性 RCA 并探究改性效果与机理，研究改性 RCA 制备沥青混合料的路用性能，为 RCA 在沥青混合料中的高值高质资源化提供技术支撑。

研究发现 RCA 砂浆内部存在较多的孔洞和微裂纹，RCA 的物理性能低于天然集料。聚合物对 RCA 的吸水率和压碎值的降低均较好的处理效果。同时，聚合物能显著降低 RCA 对沥青混合料体积性能的影响，进而提高了 RCA 沥青混合料的路用性能。丙烯酸聚合物对 RCA 的改性机理也有相应研究。

B06-16

Highly selective catalytic depolymerization of polycaprolactone and repolymerization of the recycled compounds

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Polycaprolactone (PCL) fabricated by catalyzed ring-opening polymerization from ε-CL monomer possesses good mechanical and biocompatible performance and is widely utilized in the medical field. Differed with the traditional biodegradation treatments, the new strategy of catalytic depolymerization of waste PCL plastics to recover ε-CL monomers and their ring-opening re-polymerization, can reduce carbon emissions and make full use of this high-value biodegradable plastic. In this study, the effects of five different catalysts on the efficiency and products of PCL from chemical depolymerization were investigated, and the results demonstrated that stannous isooctanoate achieved the best chemical depolymerization for PCL when both the catalyzed efficiently and selectivity were considered. Then, we investigated the regulation mechanism of PCL thermal depolymerization by varying the parameters of stannous isooctanoate content, temperature and reaction time. Meanwhile, the composition of the depolymerization products were characterized by liquid chromatography, MS and NMR, respectively. Moreover, the activation energy of depolymerization were evaluated by thermogravimetric analysis to explore the mechanism of the highly selective catalytic depolymerization of PCL to ε-CL monomer. Interestingly, by the optimized reaction parameters, the recovery rate of ε-CL monomer was more than 91%. Furthermore, PCL was prepared by ring-opening polymerization of ε-CL monomer recovered from depolymerization, and the structure and properties of the product were characterized by 1H NMR, GPC, DMA, DSC, XRD, and tensile test, respectively. The results showed that the molecular weight, tensile strength, and the elongation at break of the recycled PCL were more than 50 Kda, 31 MPa, and 1200%, respectively, which were comparable to those of the raw material of PCL. Strikingly, the stannous octanoate can simultaneously achieve recycled ε-CL monomer with highly efficient and selective thermal depolymerization of PCL and the re-polymerized PCL from the recycled ε-CL monomer possesses high comprehensive performance. Eventually, the study opens up a new way of closed-loop recovery of PCL, and realizes the purpose of green, efficient and repeated utilization of biodegradable polyester.

B06-17

资源化利用壳聚糖的绿色阻燃技术

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甲壳素是一种多糖类生物高分子，在自然界中广泛存在于低等生物菌类，藻类的细胞，节支动物虾、蟹、昆虫的外壳，软体动物的内壳和软骨，高等植物的细胞壁等。经过脱乙酰作用后，可得到含有胺基、羟基等特征官能团的壳聚糖大分子。其自身 pKa 约为 6.5。本工作根据其结构特点，利用静电作用和配位作用原理，开发了绿色高阻燃涂层技术，膨胀阻燃技术，纳米阻燃技术等。在软质聚氨酯泡沫、硬质聚氨酯泡沫、织物、环氧树脂等高分子材料中实现了高阻燃，赋予了多种高分子材料火安全性，实现了壳聚糖的资源化利用，为基于壳聚糖开发绿色阻燃技术提供了新思路和新方法。

B06-18

废旧棉纺织品制浆及废旧再生纤维素膜性能研究 （Research on Pulping of Waste Cotton Textile and Performance of waste regenerated cellulose membrane））

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Cotton fabric contains a large amount of cellulose, and is the world's largest renewable resource, accounting for the largest proportion of textilesViscose fiber production has a high degree of industrialization, large production capacity, mature technical route, and high market share. Viscose is made of raw wood pulp. Using waste cotton fiber instead of wood pulp to produce viscose fiber can save forest resources and reduce the dependence on imported wood pulp. The million-ton capacity of viscose fiber matches the million-ton volume of waste cotton fiber, which can truly realize the chemical closed-loop cycle of waste cotton fiber to textile, and improve the upcycling of waste cotton textile.

In this study, waste cotton pulp was prepared from waste cotton fabric by decolorization and impurity removal. The influence of pulping conditions on polymerization, reactivity, iodine equilibrium adsorption value, and crystallinity was investigated. The effects of different proportions of waste cotton pulp on the properties of regenerated cellulose fibers were investigated. It was found that the cotton pulp had the highest content of methylcellulose and the best swelling performance. Still, the ash content and polymerization degree were the highest, and the crystallinity was lower than that of the commercial pulp. After mixing waste cotton pulp and primary wood pulp, the cellulose sulfonate was prepared by mixing carbon disulfide and sodium hydroxide at 6% solid content, and the cellulose sulfonate membrane was successfully dissolved. With the content of waste, cotton pulp increased from 20% to 80%, the breaking strength of regenerated cellulose film decreased by 80%, and the crystallinity of the film decreased by 90% compared with that of pulp. This study provides a new and feasible recycling idea for waste cotton fabrics, an important breakthrough in recycling waste cotton textiles.

B06-19

一次性包装塑料合金：制备及应用

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塑料在使用后以高度混合的状态使用和收集，这限制了它们的经济机械回收。一次性包装塑料，主要是聚乙烯（PE）、聚丙烯（PP）和聚对苯二甲酸乙二醇酯（PET），占所有塑料的 2/3 以上。它们的使用寿命最短，因此给环境带来了最紧迫的压力。本文介绍了三方面工作：(1) 将聚烯烃（PO）与聚磷酸铵（APP）共混物的热化学发泡应用于将 PE 和 PP 混合物直接转化为潜在的阻燃泡沫。PP/APP 共混物孔隙率的演变遵循指数增长规律。相反，POs/APP 共混物的孔隙率遵循对数增长规律。对其结构、结构和力学性能进行的研究分析揭示了这一差异产生的原因。(2) 合成了一种新型接枝共聚物，并对其进行了表征，使三元塑料合金（PE、PP 和 PET）的断裂伸长率提高了 7000%以上，显示出大规模加工混合塑料的巨大潜力。(3) 将马来酸酐接枝聚丙烯（PP-g-MAH）和有机改性蒙脱土（OMMT）用于三元塑料，研究了复合材料通过增材制造加工方式所得材料的力学性能表现，分析了导致力学性能变化的内在因素。

B06-20

一种结构色可控且机械性能可调的自生长光子晶体复合材料

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Structural color has a wide range of application prospects in the fields of mechanical sensing, flexible display, optical coating and anti-counterfeiting materials. At present, two types of techniques, top-down and bottom-up, are available to prepare considerable ordered periodic nanostructures. In practical applications (cosmetics, apparel, security, etc.), multicolor patterning is essential. In order to achieve multicolor patterning, restricted deposition/swelling, regioselective polymerization, etc., are commonly methods recently. Overall, the above strategies usually involve sophisticated techniques and a high level of synthesis methods. Growth is an effective post-processing method to change material properties, which is based on the principle of introducing a dynamic mechanism into the cross-linked polymer network, thus systematically changing the size, composition, mechanical properties and shape of the existing materials. However, currently growth systems possess only simple polymer matrices, which are far from the fine, ordered, and complex composite structures observed in nature. Therefore, it is of great importance to develop versatile strategy to fabricate polychromatic patterned materials with vibrant colors and controllable properties. Here, we proposed a photo-induced polymerization-growing strategy based on the coupled reaction of photopolymerization and ester-exchange, and applied it to the “living” photonic crystal system, and realized the fabrication of photonic crystals with controllable structural colors, patterning capabilities and tunable mechanical properties under the growth procedure of the composites. Based on the reversibility of the ester exchange reaction, shape remodeling can be achieved by growing the sample. Since this facile approach can be applied to the common polymer systems and yields excellent properties, we can foresee its great potential for application in addressing many new challenges of structural color materials.

B06-21

Liquid-like Brush Surface with Anti-scaling Property and Its Application in Spraying Cooling

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Salt-scaling on evaporation surface is a leading problem for normal operation of various seawater-related systerms including heat exchang, solar evaporation, coastal building and facility. Crystal can not detach from the substrate under gravity due to strong adhesion between crystal-substrate. Surface engineering is a promising strategy for regulating salt crystalization process and eliminating salt deposition, which can be applied to various materials. Fo instance, lubricant layer and superhydrophobic surface have been introduced to fabricate low salt-adhesion evaporation surface. Nevertherless, external force (air flow) should be applied to remove salt crystal from evaporation surface due to the relatively high crystal-substrate adhesion. In this study, we introduce the liquid-like polydimethylsiloxane brush to evaporation surface, We demonstrate that polydimethylsiloxane brush grafting glass slide (PBGG) with lower hysteresis and higher temperature is favorable to columnar structure formation (Figure 1A). The lifting crystal detached from tilted evaporation surface under gravity. Moreover, a layer of silica was deposited onto aluminum alloy substrates substrate via chemical vapor-deposition method, and then the polydimethylsiloxane brush was grafted onto the aluminum alloy (PBGAA). In long-term 3.5 wt% saline spraying (spraying 5 s, terminal 10 s, 3 bar) on 100 ℃ substrate, few salt crystal is observed on the modified surface, while the original metal surface is covered by salt crystal (Figure 1B). We envision that this PBGAA together with successive droplet addtion strategy will offer potential possibility for spray cooling with saline water.

B06-22

Utilizing Nanocellulose in Engineering Porous Materials for Energy and Environmental Applications

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Nanocellulose, a sustainable and renewable material, possesses unique advantages such as a nanofibrous structure, high surface area, ease of modification, and good flexibility, making it an ideal template or substrate for engineering various functional materials. Recently, we have developed nanoengineering approaches, including interfacial synthesis and interweaving techniques, to fabricate various porous materials such as metal-organic frameworks (MOFs), covalent organic frameworks (COFs), and porous carbons into freestanding nanopapers or aerogels with the assistance of nanocellulose. The resulting nanocomposites exhibit hierarchical porosity, good flexibility, and high mechanical strength, making them suitable for applications in energy harvesting and storage, separation and purification, E-waste recycling, thermal insulation, fire retardancy, etc.

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B06-23

不饱和聚酯树脂的溶剂促回收方法研究

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B06-24

热致变色纤维素光子晶体的制备及其信息加密研究

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仿生动态结构色在传感、显示、信息加密和安全等领域有着广泛的应用。然而，结构色的转变通常取决于材料变形引起的晶格变化，导致结构色的控制不足、响应速率低以及可逆性差。本工作研究发现，一种胆甾型光子晶体可通过热诱导相分离调节螺距大小，实现了快速、线性和稳定的结构颜色调制。胆甾型光子晶体对温度变化表现出快速而灵敏的响应，可逆和稳定的颜色切换（至少 100 个周期，显示出优于当前报道的性能）。通过调控光子晶体的热致相分离行为，实现了其响应温度范围和响应速度的可定制。基于这些响应特征，结合多通道编码技术，实现了温度/时间依赖性的多维信息加密，为开发先进的智能响应结构彩色材料提供了新的平台。

B06-25

Lignin-First Integrated Steam Explosion Process for Green Wood Adhesive Application "木质素优先"策略下结合蒸汽爆炸处理的绿色胶黏剂制备与应用

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Steam explosion (SE) is one of the most advanced pretreatment processes currently used for the production of biofuel from lignocellulose. However, SE lignin is generally recovered as a secondary impure coproduct and mainly used for energy production. In this work, the beech wood sawdust was first exploded at 180 or 200 °C for 5 min after water or dilute acid impregnation. The recovery of the lignin from the exploded wood was studied using an

alkali process at 80 °C or an ethanol organosolv process at 200 °C. The impact of the SE parameters and of the delignification step on the lignin structure was examined by size exclusion and ionic chromatography and ^{31}P and heteronuclear single quantum coherence NMR spectroscopic. The different lignin fractions have been evaluated for the production of the adhesive without the addition of any synthetic resin, composed of 50% glyoxalated lignin and 50% tannins. It was demonstrated by the thermomechanical analysis that the parameters of the process greatly impact the performance of the resulting resin. The SE lignin produced from the acid SE (a-SE) treatment at 200 °C followed by alkaline delignification led to an adhesive formulation displaying a very good performance with MOEmax ≈ 6000 MPa.

摘要：蒸汽爆炸（SE）是目前生产木质纤维素生物燃料的最先进的预处理工艺之一。然而，SE 木质素通常作为二次不纯的副产物被回收，主要用于能源生产。在这项研究工作中，山毛榉木屑首先在 180 或 200°C 下用水或稀酸浸渍后蒸汽爆破处理 5 分钟，再使用 80°C 的碱工艺或 200°C 的乙醇-有机溶剂法提取木质素。通过离子色谱、31P 和核磁共振光谱研究了脱木质素步骤对 SE 木质素结构的影响，同时对不同的木质素组分进行了评估，在不添加任何合成树脂的情况下生产绿色木质素胶黏剂，该胶黏剂由 50%乙二醛化木质素和 50%单宁组成。热机械分析表明，工艺参数对树脂的性能影响很大。在 200°C 蒸汽爆破处理的碱性木素制得的胶黏剂表现出非常好的性能，最大动态弹性模量≈6000 MPa。

B06-26

Multifunction of recycled carbon fibre in composite materials for damage sensing

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Materials often experience small structural damage before catastrophic failure occurs, so if this small structural damage is used as an indicator, then the long-term safe service of the material will be ensured. However, identifying these warning signs presents a significant challenge due to the intricate composition of composite structures. Recycled carbon fibres, a waste material, exhibit the ability of electric conductivity which can be developed not only for their structural strength but also as a sensing mechanism within composite materials. The subtle damages, such as fibre breakage, delamination, or interlayer/intra-layer crack propagation, could be monitored in real-time by incorporating recycled carbon fibres into the composite. To validate this concept, glass fibres were combined with recycled carbon fibres into hybrid composite materials. Additionally, artificially created holes (2.4mm, 3.2mm, 4.1mm, and 5.95mm) were introduced in the center of specimens to investigate the role of recycled carbon fibres in influencing the sensitivity of the whole hybrid composites. The relative resistance change ($\Delta R/R$) shows an exponential trend with three indexes 0.025, 0.05, and 0.1, indicating three material states: safe, caution, and failure, respectively. The sensitivity performance of hybrid composites has been improved from 60% to 80% of the relative strength of notched/un-notched compared to pure recycled carbon fibre composites. In conclusion, the dual purpose of recycled carbon fibres for enhancing structural integrity and damage sensing has been presented, highlighting the potential application in composite material across various industries.

墙报

B06-P01

Improving PVA Films: A Study on Flame Retardancy, Antimicrobial Efficacy, Mechanical Properties, and Recyclability

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Poly(vinyl alcohol) (PVA) is widely used in packaging, wearable electronics, and flexible solar cells due to its water solubility, film-forming ability, degradability, and good mechanical properties at a low cost. However, PVA's macromolecular structure, composed of C, H, and O, makes it highly flammable, with a limiting oxygen index (LOI) of only 19%. Additionally, PVA's strong hydrophilicity, due to its polyhydroxy structure, makes it susceptible to bacterial growth, posing health risks and limiting its applications in biomedicine, clean production, and textiles. Therefore, enhancing PVA's flame retardancy and antibacterial properties is crucial to increase its value and expand its applications. Balancing these properties with mechanical strength, however, is challenging. In this work, hexa(1,2,4-triazol-3-ylamine) cyclotriphosphazene (HATA) was synthesized and incorporated into PVA via simple physical blending and solution film spreading, resulting in a multifunctional flame-retardant PVA film with a thickness of about 100 μm. Scanning electron microscopy and energy-dispersive X-ray spectroscopy demonstrated good dispersion of HATA in PVA, leading to high transparency of the PVA films. Transmission electron microscopy revealed nanostructured domains averaging 59.59 nm, indicating strong hydrogen bonding interactions between HATA and PVA. Flame retardancy tests showed that adding 0.5 wt% HATA endowed PVA/HATA films with self-extinguishing properties, achieving the UL94 VTM-0 rating, and increased the LOI from 19.6% to 31.0%. Microscale combustion calorimetry indicated an increase in char residue at 700°C from 3.8% to 33.6%, with peak heat release rate and total heat release values reduced by 60% and 55%, respectively. Additionally, incorporating HATA improved PVA’s elongation at break from 2.93% to 294.33%, nearly 100 times higher, indicating good ductility. However, tensile strength decreased, possibly due to disruption of the hydrogen bonds within the PVA molecular chain. The PVA/HATA composite films exhibited good self-healing properties under water-initiated conditions and were recyclable due to reversible hydrogen bonding. A cut PVA/HATA composite film could withstand about 4 kg after self-healing. After five recycling cycles, the mechanical properties and flame retardancy of the PVA films were maintained. Moreover, the PVA/HATA films displayed excellent antimicrobial properties, inhibiting E. coli and S. aureus by 99.99% and 96.67%, respectively. This work presents a novel strategy for designing multifunctional PVA films with good flame retardancy, antimicrobial properties, mechanical properties, self-healing, and recyclability.

B06-P03

基于三磷酸腺苷阻燃莱赛尔织物的制备与性能研究

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The design of flame-retardant lyocell fabrics suffered from deterioration on wearing performance and environmental issue. Here, we developed facile construction of bio-based high fire-safety lyocell fabrics that exploited a series bio-based flame-retardant multifunctional coatings (APD、APDP and LBL) based on adenosine triphosphate (ATP) derivatives. The rich phosphorus/nitrogen elements of ATPs enabled the excellent fire safety of treated lyocell fabrics. Specifically, the lyocell fabrics with add-on of 11.5 wt% LBL achieved the limiting oxygen index (LOI) of 32.0 %. Meanwhile, compared with the pure lyocell fabrics, the peak of heat release rate (PHRR), total heat release (THR), and fire growth rate (FIGRA) of LBL/Lyocell fabrics decreased by 75.2 %, 61.0 % and 69.8 % in cone calorimetric test (CCT), respectively. By characterizing the gaseous products and solid residues, the presence of the LBL coating could not only quickly form the dense expanded carbon layer by itself, but also promote the conversion of cellulose into thermal-stability residues, thus reducing the release of combustible substances during combustion and protecting the lyocell fabrics. In addition, LBL/Lyocell showed excellent antimicrobial properties with 99.99 % antibacterial rates against Staphylococcus aureus (S. aureus) and Escherichia coli (E. coli). More importantly, the wearing performance of LBL/Lyocell fabrics, such as handle, air permeability and tensile strength, etc. almost remained after treatment. The ease of operation and use of bio-based coating made it a promising option to obtain the practical and multifunctional lyocell fabrics with flame-retardancy.

B06-P05

A VOCs absorbing material based on waste epoxy resin

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The disposal of waste epoxy resin has become an urgent issue, but the stabilized cross-linking structures make the conversion of waste epoxy resin into high value-added chemicals or new materials is a key challenge. Herein, we use the economical hydrogen peroxide to degrade epoxy resins under mild conditions, and from this, we develop a new material with volatile organic compounds (VOCs) absorption. The degraded epoxy resin (DEP) shows excellent absorbing capabilities for various polar VOCs, for example, the saturated absorption capacity of acetone and dichloromethane is up to 600 mg/g and 650 mg/g, respectively. The reason is that functional groups which can form hydrogen bond donors and hydrogen bond acceptors are introduced into DEP during degradation, which are crucial for VOCs absorbing materials. Moreover, the appropriate strength of intermolecular force between DEP and VOCs allows VOCs to be effectively removed by heating, ensuring reuse of the material. The success of this work provides new ideas for the design of VOCs absorbers.

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B06-P06

Catalytic oxidative degradation of epoxy resin under mild conditions

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The dense three-dimensional cross-linked structure gives epoxy resin (EP) excellent mechanical properties and chemical stability, but its insoluble and non-melting properties make the recycling of EP very difficult. Chemical recovery of EP can destroy its stable structure and transform it into oligomers with different molecular weights, showing the potential for upcycling. However, there are still problems such as harsh reaction conditions and low value-added of degraded products [1]. In this work, the efficient degradation of EP under mild conditions and high value utilization of the degraded products of EP (DEP) were achieved with vanadium catalytic oxidative system. During the degradation, the vanadium selectively breaks the C-O bond in EP to obtain oligomers containing active functional groups such as hydroxyl and carbonyl groups. And thus, the DEP can be used as recyclable adhesive through supramolecular interactions, which shows excellent adhesion to a variety of substrates, with a maximum adhesive strength of 10 MPa. This work provides a new strategy for recycling EP, promoting a circular economy.

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B06-P07

Cellulose nanocrystals, which can be self-assembled into structural color, are extracted from straw and utilized in advanced anti-counterfeiting applications.

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Each year, a considerable quantity of straw is produced during the grain harvest. Currently, the disposal of straw is primarily by incineration and landfill, which results in considerable energy consumption and environmental problems. The conversion of waste crop straw into useful materials without the destruction of its biological components remains a challenge. Here， we demonstrate a method for extracting self-assemblable structural color Cellulose Nanocrystals (CNC) from agricultural waste straw. The impact of varying acid hydrolysis times on the formation of CNC structural colors was examined, along with the influence of CNC size and surface charge density on CNC self-assembly. Utilizing ultrasonic processing, the structural color of this straw CNC can achieve a wide wavelength range of color changes from blue to red, and when combined with the intricate transformations of the ' Klotski Puzzle' strategy, advanced multi-level encryption can be achieved. These discoveries open up possibilities for the effective utilization of waste biomass and the development of innovative advanced materials.

B06-P08

Design, Synthesis, and Performance Regulation of High-Performance Recyclable Furan Polyesters

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Bio-based furan polyesters are potential sustainable and renewable alternatives to current petrochemical-based semi-aromatic polyesters. However, their inherent flammability and insufficient thermal performance hinder further applications. Herein, we report a full bio-based furan copolyester (PDF) copolymerized by isoflavone-containing monomer (DDF-OH), 2,5-furandimethyl dicarboxylate, and 1,4-butanediol. The PDF copolyester exhibits exceptionally high tensile strength, high glass transition temperature (111 °C), and low fire risk (limiting oxygen index, 25.0%). Moreover, a rapid, solvent-free chemical depolymerization method is developed to efficiently recycle the polyester without introducing other organic solvents. This recyclable novel furan-based polyester shows promising potential for applications in engineering plastics, synthetic fibers, and packaging materials.

B06-P09

Smoke-suppressing wood-plastic composite based on the co-modification of SiO2 and ammonium octamolybdate

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Polyvinyl chloride-based wood-plastic composite (PVC-WPC) has been increasingly developed and utilized in recent years as a green and environmentally friendly material esteemed for its superior mechanical properties, exceptional corrosion resistance, and commendable dimensional stability . However, the combustion of PVC-WPC results in the release of significant quantities of smoke and toxic gases, such as HCl, which can pose serious risks to both the ecological environment and human health . Hence, enhancing the effectiveness of smoke suppressants in PVC-WPC while maintaining its mechanical properties is a significant challenge. In this work, $MSiO_2$ was obtained by modifying nano-silica with a silane coupling agent, and then $MSiO_2$ was reacted with ammonium octamolybdate through a simple ion exchange reaction to prepare modified smoke suppressant $MSiO_2$-AOM. The combined action of SiO_2 and ammonium octamolybdate was employed to impart flame retardant and smoke suppressant properties to WPC, while reducing the influence on the mechanical properties of composite materials. When the smoke suppressant prepared is applied to PVC wood plastic composite, it can maintain the mechanical properties of the composite material. With an addition amount is 15wt%, the bending strength is only reduced by 10wt%, while the bending modulus and hardness increase, thereby meeting the application requirements for daily use. Simultaneously, cone calorimetric tests demonstrated that the addition of the smoke suppressant had a significant smoke suppression effect. When 15wt%$MSiO_2$-AOM was added, the Peak Smoke Production Rate (PSPR) and Total Smoke Production (TSP) were reduced to $0.044m^2$ /s and $4.10m^2$, respectively, representing decreases of 41% and 62% compared to the pure sample. The mechanism analysis reveals that $MSiO_2$-AOM has effective smoke suppression in PVC-WPC composites mainly due to the synergistic effect of molybdenum-catalyzed carbon formation and the stabilization of the carbon layer by SiO_2.

B06-P10

Closed-loop recycling of biobased semi-aromatic polyester with high gas barrier performance and excellent mechanical properties

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Compared to traditional petroleum-based polymer materials, bio-based polyester synthesis from renewable resources offers advantages such as being green, low-carbon, and sustainable, playing a crucial role in reducing dependence on petrochemical resources and protecting the environment. However, these materials still present a trade-off dilemma between chemical closed-loop recycling and high performance. Based on this, a high-performance and recyclable bio-based polyester material (PBSVx) has been synthesized by introducing lignin-derived aromatic monomer (HEVA), succinic acid, and 1,4-butanediol. By adjusting the incorporation amount of HEVA, the polyester exhibits excellent mechanical properties (a 51.2% increase in tensile strength compared to PBS), barrier properties, and UV shielding performance. Furthermore, this work proposes a mild and efficient chemical depolymerization method to achieve recycling of polyesters, which can recover monomers with high purity (>98%) and high yield (>90%), providing a promising solution to address green and sustainable material development.

B06-P11

Fully Recyclable, flame-retardant and anti-dripping PLA composites with balanced performance based on a phosphorus/nitrogen-containing zwitterion

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Abstract

Polylactic acid (PLA) is a biodegradable polymer with excellent comprehensive properties, which has the advantages of high strength, easy processing, environmental protection and non-toxic, and has been widely used in medical materials, agricultural film, food packaging and textile fields. However, its inherent flammability necessitates the additions of substantial amounts of flame retardants in practical applications, often resulting in compromised performance and aesthetics, as well as increased complexity in recycling processes. To address this challenge effectively, we have developed a fully recyclable flame-retardant PLA systems (PLA-X) with balanced performance by incorporated a phosphorus/nitrogen-containing zwitterionic flame retardant (CPPIM) . Surprisingly, only a small loading of 3wt% loading of retardant CPPIM could increase the LOI value of PLA from 19.2% to 27.7% and achieve V-0 rating in UL-94 vertical burning test. Due to the absence of significant thermal degradation or side reactions during the melting process, the mechanical properties of PLA-X are well-preserved, while improving the appearance color with lower yellowing index, thereby conferring advantages for physical recycling. Moreover, PLA-X exhibits excellent compatibility with various chemical recycling methods. Regardless of acidic or alkaline conditions, hydrolysis or alcoholysis, it demonstrates remarkable tolerance towards depolymerization processes without affecting the chemical recycling of PLA. Furthermore, by leveraging its zwitterionic property, CPPIM can also be effectively recovered. This work offers a state-of-the-art solution for addressing the trade-off between chemical recycling, high-performance and functionality of PLA, thereby providing robust support for sustainable circular economy.

Keywords: Polylactide acid; Flame retardancy; Closed-Loop Recycling; zwitterion

B06-P12

Efficient Low-Temperature Depolymerization of Waste PET using Mixed Solvent Systems for Enhanced Recycling and Blended Textile Separation

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Efficient Low-Temperature Depolymerization of Waste PET using Mixed Solvent Systems for Enhanced Recycling and Blended Textile Separation

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Degradation of waste polyethylene terephthalate (PET) is challenging due to its molecular structure being difficult to fully break down at low temperature. This research aims to find an effective mixed solvent system that enables efficient chemical depolymerization of PET at low temperature by utilizing methods like solubility parameter and the principle of similarity and compatibility. The selected solvents can not only efficiently depolymerize PET, but also achieve simultaneous precipitation of the depolymerization products by adjusting the operating conditions. Additionally, depolymerization conditions, including solvent ratio, temperature, and time were optimized. The efficiency of depolymerization is evaluated based on indicators such as depolymerization rate, product purity, and re-polymerization capacity. Experimental results show that the mixed solvent system can promote the depolymerization of PET within a range of temperatures, while the products can be quickly recovered through filtration. Moreover, the mixed solvents generated in the PET depolymerization process can be recovered and reused, which significantly reduces the environmental burden and overall depolymerization cost. The research also explored the separation of various blended textiles, such as poly-cotton and poly-acrylic, and achieved the depolymerization of single PET through chemical means, providing a solution for separating and recycling polyester materials.

B06-P13

Manifold dynamic synergy mediated by cation-π interactions enables flame-retardant and hydrophobic coatings with strong adhesion and layer-by-layer recyclability

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Flame-retardant and hydrophobic coatings providing protections from water and burn injuries have garnered significant attention in textile industry; however, the current methods of end-of-life management for these multifunctional coatings, particularly those containing phosphorus-based substances, are unsustainable and pose substantial ecological risks. Consequently, there is a growing focus on sustainability-driven approaches to create eco-friendly flame-retardant and hydrophobic coatings used in textiles. Herein, we propose a novel layer-by-layer (LBL) recyclable strategy to facilitate the straightforward recycling of the multifunctional and multilayer flame-retardant coatings. By introducing multiple strong non-covalent interactions mediated by cation-π interactions, the obtained flame-retardant and hydrophobic coating presents an impressive adhesive strength of 7.96 MPa. In addition, such coating can offer high flame retardancy and self-extinguishing property to cotton fabric. By immersing the coated fabric in an effective solvent, the multifunctional coating can be successfully recovered through layered extraction with a recovery rate of 93%. This work opens new avenues for the layered recycling of multifunctional coatings, potentially forging new pathways within the circular economy.

B06-P14

A Room-Temperature Self-Healing Glassy Thermosetting Polymer

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Glassy polymers are mechanically robust and have been used as hard plastics for a wide range of applications.However, even such hard plastics are gradually deteriorated and eventually discarded, thereby causing a catastrophic outcome to our living planet.Technologies for efficient recycling have been awaited.However, only

8% of plastic materials, mostly PET, are recycled.Self-healing polymers, which possibly lower the frequency of recycling and/or elongate the lifespan of plastic materials, can potentially overcome the issue of plastic waste.However, self-healable polymers are mostly rubbery, while hard plastic materials are non-healable unless they are melted.Namely, glassy polymers that self-heal at ambient temperatures below Tg were unprecedented before our recent report.In 2018, Aida et al.reported poly(ether-thiourea) TUEG3 as the first room-temperature self-healable glassy polymer.1)Thanks to a large number of nonlinear zigzag arrays of H-bonded thiourea units, this polymer is non-crystalline but amorphous over a wide temperature range, and shows a self-healing behavior even at 12 °C, which is definitely lower than its Tg (27 °C).This work swept away the preconception that mechanically robust polymers cannot self-heal at ambient temperatures.Although some new room-temperature self-healable glassy polymers have been reported more recently,2-3)all of them are thermoplastic polymers.Here we newly developed a room-temperature self-healable glassy thermosetting polymer with a disulfide group, which can be cleaved off reversibly to provide the polymer with a dynamic nature.We will report details of its interesting self-healing nature.

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B06-P15

Recastable assemblies of carbon dots into mechanically robust macroscopic materials

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Assembly of nanoparticles into macroscopic materials with mechanical robustness, green processability, and recastable ability is an important and challenging task in materials science and nanotechnology. As an emerging nanoparticle with superior properties, macroscopic materials assembled from carbon dots will inherit their properties and further offer collective properties; however, macroscopic materials assembled from carbon dots solely remain unexplored. Here we report macroscopic films assembled from carbon dots modified by ureido pyrimidinone. These films show tunable fluorescence inherited from carbon dots. More importantly, these films exhibit collective properties including self-healing, re-castability, and superior mechanical properties, with Young's modulus over 490 MPa and breaking strength over 30 MPa. The macroscopic films maintain original mechanical properties after several cycles of recasting. Through scratch healing and welding experiments, these films show good self-healing properties under mild conditions. Moreover, the molecular dynamics simulation reveals that the interplay of interparticle and intraparticle hydrogen bonding controls mechanical properties of macroscopic films. Notably, these films are processed into diverse shapes by an eco-friendly hydrosetting method. The methodology and results in this work shed light on the exploration of functional macroscopic materials assembled from nanoparticles and will accelerate innovative developments of nanomaterials in practical applications.

仅发表论文

B06-PO01

Improved microstructures and performance of public filler aggregate and recycled mortar with additional tannic acid

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This paper proposes the method of enhancing public filler (PF) with tannic acid (TA) to prepare modified fully recycled aggregate mortar (FRAM). The improvement effect of TA on the macroscopic physical properties of public fine aggregate (PFA) at different concentrations and immersion times was analyzed and the improvement effect of TA on the basic physical properties and durability of FRAM was investigated. Finally, the strengthening mechanism of TA on FRAM was analyzed by micro-technical methods. The results indicated that the modification effect of TA could remove the loose cement mortar on the surface of PFA, react with calcium hydroxide and calcite, generate nanoparticles in situ to fill the pores, significantly lower porosity, and promote cement hydration between PFA and cement mortar to improve the mechanical strength and durability of recycled mortar. Compared with the non-treated PFA, the compressive strength was increased by 24.62% at 28 d, and the capillary water absorption and electrical flux were reduced by 54.12% and 16.56%, respectively. Microscopic analysis further indicated that TA could improve the interfacial bonding effect of PFA, and enhance the cohesion of the hardened cementitious material, as well as that TA adsorbed on the surface of PFA could be dispersed to the freshly mixed cement mortar to improve the internal structure. The above results indicated that TA can significantly improve the performance of PFA, which has a positive effect on improving the mechanical strength and durability of FRAM and is conducive to saving natural aggregates (NA) and recycling construction resources.

B06-PO02

高炉渣制备高品质 4A 分子筛及其作为 CO2 捕收剂的研究

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高炉渣主要由 CaO、SiO2、Al2O3 等氧化物组成，高炉渣中的 SiO2、Al2O3 是组成沸石的重要成分，同时高炉渣中含有的稀土元素一直作为沸石高效改性剂之一，具有显著提升沸石吸附性能的潜力[1-2]。然而，CaO 含量过高会影响沸石的合成，并且 CaO 的去除会造成大量的资源浪费。因此，CaO 的分离和再利用对高炉渣资源化至关重要[3]。本研究利用酸浸方法将 CaO 与 SiO2、Al2O3 分离，将滤渣通过碱熔，水浴合成 4A 沸石。结果表明，利用该方法可制备纯净的 4A 型沸石，可应用于环境分离材料。此方法可以实现高炉渣的高值化利用，并对高炉渣的综合利用提供一种新思路。

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B06-PO03

Transparent, thermally stable, and water-stable films derived from cellulose nanocrystals synthesized using deep eutectic solvents

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Nanocellulose-based films, primarily composed of nanosized cellulose, represent a novel type of material that combines renewability with enhanced or unique properties. Significant efforts have been directed towards improving these intrinsic properties or developing new functionalities to broaden their applications, such as in food packaging, water treatment, and flexible electronics. In this study, two distinct types of deep eutectic solvents (guanidine sulfamate-glycerol and guanidine sulfamate-choline chloride) were formulated and used to produce cellulose nanocrystals (CNCs) with dialdehyde cellulose (DAC). The effects of various reaction conditions, including time, temperature, and cellulose-DES ratio, on the grafting degree and yield were investigated. Following ultrasonication, two types of CNCs with average diameters of 3-5 nm and lengths of 140.7-204.2 nm were obtained. These synthesized CNCs exhibited improved thermal stability compared to pristine cellulose. Additionally, highly transparent (with light transmittance over 90%) and water-stable nanocellulose-based films (with a wet tensile strength exceeding 30 MPa after 24 hours of water immersion) were produced. Furthermore, the resulting films demonstrated a low oxygen transmission rate, indicating their strong potential for use in food packaging applications.

B06-PO04

A Recyclable Superhydrophilic Cellulose Filter-Membrane for Efficient Treatment of Oily Wastewaters

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Filter-membranes with superwettability have been considered as one of the most effective candidates in oil/water separation for their easy operation and high efficiency. But the construction of superwettability often requires costly/complex processes and the absence of viable recycling options upon reaching the end of their service life. Low-cost, sustainable, and recyclable superwettable filter-membranes become promising candidates for the treatment of oily wastewaters. Here, a superhydrophilic CTA-HPC porous filtration membranes were prepared from cellulose acetate (CTA) and hydroxypropyl cellulose (HPC) by a simple water etching method. The superhydrophilic CTA-HPC porous membranes show excellent oil-water separation and high oil-in-water emulsion separation performance. Such porous membrane also shows high acid and alkali resistance, and could be used repeatedly. Furthermore, by adjusting the proportion of CTA and HPC, pores with different sizes could be obtained to meet different filtration requirements. Moreover, the superhydrophilic CTA-HPC porous membrane is recyclable for remake a new membrane when the surface is contaminated or blocked.

B06-PO05

Wrinkled cellulose nanocrystal photonic elastomer with a controlled mechanically stable structure for multi-iridescent/noniridescent structural coloration

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Cellulose nanocrystals (CNCs), typically extracted from cellulose fibers through controlled sulfuric acid hydrolysis, are an eco-friendly biopolymer that can self-assemble into chiral nematic liquid crystals during solvent evaporation, producing structural colors visible to the naked eye. Unfortunately, the current state of art in CNC films is still limited to iridescent structural colors, giving rise to serious judgment errors if using for optical sensing. Development of non-angle-dependent structural-color materials from CNC is therefore urgently required. Surface wrinkles are a common phenomenon in nature, ranging from nano-ridges in the epidermal cells of flower petals to rolling mountains. Surface wrinkles caused by unstable mechanical forces are commonly utilized on film surfaces, providing unique dynamic properties to the surface morphology and optical properties of the material. In this work, a CNC flexible photonic film is assembled on a planar stretched rubber substrate to fabricate a film/substrate double-layer elastomer. By releasing the stress of the substrate, buckling induces the formation of stable micro-wrinkled patterns on the elastomer's surface. Therefore, a new material development strategy based on micro-wrinkled structures to control the iridescent and non-iridescent characteristics of CNC structures is proposed. Here, two different stretching modes are designed to manipulate the wrinkle process, and the structural color angle optical behavior of the elastomer is investigated in the parallel wrinkle direction and vertical wrinkle direction is investigated. When the viewing angle is parallel to the wrinkle formation direction, the wrinkle structure has no obvious effect on the angle-dependence of the structural color of elastomers. When the viewing angle is vertical to the wrinkle direction, the wrinkle structure can induce the structural color from iridescence to low iridescence. In addition, order parameters are introduced to quantify the relationship between the directional order of wrinkles and the periodic changes of the CNC array structure. Finally, we propose the mechanism of color formation by microscale wrinkle structure and helical nanostructure.

B06-PO06

Znln2S4/PAM 水凝胶光催化除湿/产氢应用研究

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This study focuses on developing a novel $ZnIn_2S_4$ nanosheet-polyacrylamide (PAM) hydrogel composite photocatalyst for in-situ water adsorption and regeneration without energy consumption. The composite material is prepared via free radical polymerization, with 2D $ZnIn_2S_4$ serving as the photocatalyst for water decomposition and the hydrogel as the support matrix, suspension medium, and water collector.Experimental results demonstrate that the H_2 production rate of the ZIS/PAM hydrogel reaches 0.717 mmol/h/g, which is 1.29 times higher than that of bulk $ZnIn_2S_4$ (0.555 mmol/g/h). This improvement is due to the hydrogel matrix effectively suspending the $ZnIn_2S_4$ nanosheets and preventing their aggregation, thereby increasing the number of reactive sites.Furthermore, hygroscopic experiments show that adding 5% LiCl to the hydrogel significantly enhances its moisture absorption capacity, reducing the humidity from 99.9% to approximately 46% in ZIS/PAM-5%LiCl and maintaining stability over seven cycles. During this process, the hydrogel not only absorbs moisture but also decomposes it, ensuring stable performance over multiple cycles.DFT calculations indicate that the interaction between $ZnIn_2S_4$ and PAM molecules effectively modulates the material's electronic properties, lowering the Gibbs free energy of the hydrogen evolution reaction, thus enhancing photocatalytic performance.In summary, this study successfully develops a novel $ZnIn_2S_4$ nanosheet-PAM hydrogel composite photocatalyst, which shows excellent performance in photocatalytic hydrogen production and dehumidification applications. The composite material can perform efficient photocatalytic reactions under simulated sunlight and exhibits energy self-sufficient in-situ dehumidification potential under indoor lighting conditions. This research provides a significant reference for sustainable dehumidification technologies and highlights the potential of combining photocatalytic technology with hygroscopic materials.

B06-PO07

Highly efficient decolorization system and low-temperature glycol depolymerization recovery for waste PET textiles

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The recycling and high-value utilization of used polyester fibers hold significant scientific value and practical significance. Given the presence of diverse dyes, pigments, and additives, the recycling process poses considerable challenges, thereby emphasizing the importance of decolorization as a crucial step in the recycling of used polyester fibers [1]. In this study, we successfully addressed the discoloration issue of waste polyester and achieved low-temperature glycolysis using aromatic sulfone (AS), which exhibits excellent swelling properties for PET. The fabric underwent complete bleaching at 120 ℃, resulting in a decolorization rate of 99.9% . Following the decolorization process, PET was glycolyzed and reclaimed by introducing a 0.2 wt% Zn(OAc)2 catalyst at 153 ℃, with complete glycolysis accomplished within just 120 minutes. This represents a significant reduction of 45 ℃ in reaction temperature compared to conventional glycolysis systems. The yield of the depolymerized product, ethylene glycol phthalate (r-BHET), was 86.5% , and the whiteness (L * value) was as high as 98.1. R-BHET can be polycondensed to produce new polyester materials (rPET) and has comparable properties to PET from petroleum-based BHET .

B06-PO08

Reactive extrusion & flow-driven chemistry: Advancing high atom efficiency and achieving full circular economy for polymer materials.

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This presentation aims to elucidate the fundamental engineering principles underpinning the use of twin-screw extruders as a distinct type of mixer and/or reactor, with a focus on enhancing atom efficiency and contributing to a circular economy in the preparation, processing, and recycling of polymer materials. The emphasis lies in flow-driven chemistry, which seeks to create a specific flow field to control the dynamics of reactive molecules (stretching, alignment, diffusion, and collision). This approach is crucial for tuning reaction kinetics and/or selectivity, promoting desired chemical reactions while mitigating undesirable ones. Contrary to traditional efforts over decades that prioritized three-dimensional flow for chemical reactions involving viscous systems like polymers, flow-driven chemistry reveals that three-dimensional flow is not always the most favorable for achieving optimal chemical reaction kinetics and/or selectivity.