



Polymers 2026: Trends, Innovation and Future

25–28 June 2026 | Nanjing, China



Program and Abstract Book

Notice

Delegates will receive a name badge at the Information Desk upon registration. The badge must be worn prominently in order to gain access to the conference lecture halls and meals during the event. Admission will be refused to anyone not in possession of a valid conference badge.

Wi-Fi

A dedicated Wi-Fi network has been arranged for conference participants:

Network (SSID): Marriott Bonvoy

Connection Steps:

- Choose In House Guest
- Room Number: nkgnj
- Last Name: 1234
- Click Continue to access the internet

Please note that Wi-Fi performance may vary depending on network usage.

If you plan to use mobile data, please ensure your device and data plan are prepared in advance.

Conference Photo



Please scan the QR code to view live conference photos.

Latest Program



Please scan the QR code to check the latest program.

Conference Secretariat

Email: polymers2026@mdpi.com

Phone Number:

- +86 19908610085 (Luna Wang)
- +86 18742504979 (Katrina Zhang)

Social Event Schedule

Date: 26 June 2026, for all participants

We will arrange shuttle buses to transport the participants between the hotel and the Qinhuai River.

Time	Activity
17:40	Depart from Conference Hotel for Qinhuai River
18:10	Qinhuai River Night Cruise
19:30	Free Time & Dinner
21:00	Depart from Qinhuai River for Conference Hotel

If you prefer to return on your own:

Walk 10 mins to Fuzimiao Station (Metro Line3) → **Take Metro Line 3** to Nanjing South Railway Station → Transfer to **Metro Line 1** towards China Pharmaceutical University → **Get off at Hedingqiao Station** → **Walk 5mins** to Conference Hotel, Courtyard by Marriott Nanjing Jiangning.
Total time: approx. 40 mins

Organizers



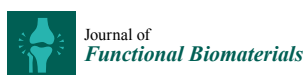
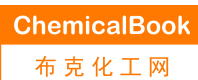
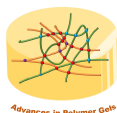
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polymers

an Open Access Journal by MDPI

Polymers (ISSN 2073-4360) is an international, open access journal of polymer science. It publishes research papers, communications and review articles. *Polymers* provides an interdisciplinary forum for publishing papers which advance the fields of (i) polymerization methods, (ii) theory, simulation, and modeling, (iii) understanding of new physical phenomena, (iv) advances in characterization techniques, and (v) harnessing of self-assembly and biological strategies for producing complex multifunctional structures. Scientists are encouraged to publish their experimental and theoretical results in as much detail as possible. There is no restriction on the maximum length of the papers. The full experimental and computational details must be provided so that the results can be reproduced.

Impact Factor: 5.8 (2025); **5-Year Impact Factor:** 6.1 (2025)

General Information

Conference Venue

Courtyard by Marriott Nanjing Jiangning, Nanjing

Address: No. 1101 Shuanglong Avenue, Jiangning District, Nanjing



The conference will be held at Courtyard by Marriott Nanjing Jiangning, conveniently located just 10 minutes from Nanjing South Railway Station and directly connected to Metro Line 1. The hotel provides easy access to popular local attractions, including Baijia Lake Park, Niushoushan Cultural Park, and Grand Baoen Temple.

Registration & Dining

Registration: 4th Floor, Courtyard Ballroom Foyer, June 25

Lunch: 4th Floor, Pavilion Restaurant, June 26–28

Banquet Dinner: 4th Floor, Courtyard Ballroom A, June 27

Certificate of Attendance

Participants will be able to download their electronic Certificate of Attendance from their dashboard on [Sciforum.net](https://www.sciforum.net) after the conference. The certificate will be found under the “My certificates” category.

Insurance

The organizers shall not be liable for any personal accidents or property loss.

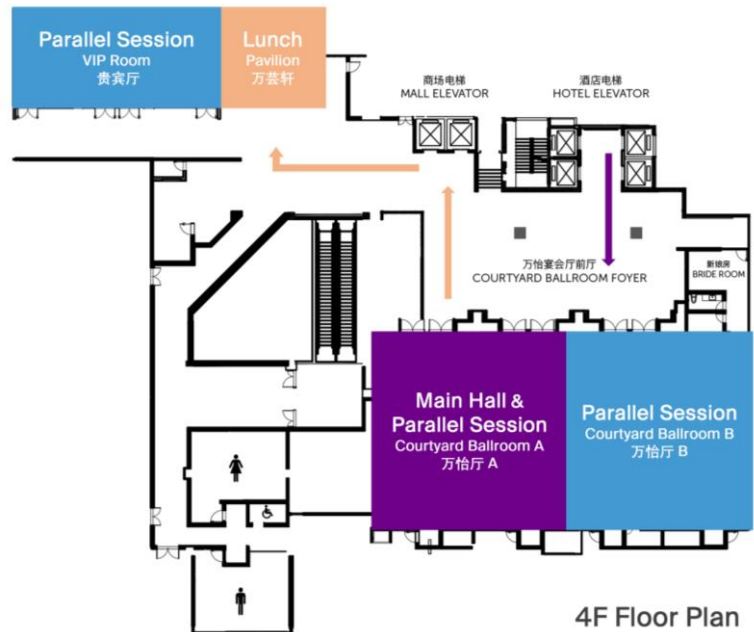
Main Conference Hall

4th Floor, Courtyard Ballroom A

Parallel Session

4th Floor, Courtyard Ballroom A & B

4th Floor, VIP Room



Route to the Venue

By Plane: Nanjing Lukou International Airport (NKG)

By taxi

Duration: approx. 35 mins

Estimated Fare: CNY 45

By metro

S1 Line S1 (towards Nanjing South Railway Station) from Lukou Airport Station

↓

S1 Alight at Nanjing South Railway Station

↓

1 Transfer within Line 1 (towards China Pharmaceutical University) get off Hedingqiao Station Exit 2A

↓

Walk about 340 meters to the conference hotel

By High-Speed Rail

1. Nanjing South Railway Station

By taxi

Duration: approx. 15 mins

Estimated Fare: CNY 20

By metro

1 Line 1 (towards China Pharmaceutical University) from Nanjing South Railway Station

↓

1 Get off Hedingqiao Station Exit 2A

↓

Walk about 340 meters to the conference hotel

2. Nanjing Railway Station

By taxi

Duration: approx. 30 mins

Estimated Fare: CNY 25

By metro

1 Line 1 (towards China Pharmaceutical University) from Nanjing Railway Station

↓

1 Get off Hedingqiao Station Exit 2A

↓

Walk about 340 meters to the conference hotel

Social Event

Date: 26 June 2026

Time: 17:40–21:00

Participants are invited to join a **night cruise along the Qinhuai River**, the “Mother River of Nanjing” and one of the city's most famous cultural landmarks. During the cruise, participants will enjoy the beautiful night views of the historic Ten-Li Qinhuai scenic area, featuring traditional architecture, colorful lanterns, and riverside attractions that reflect the rich history and charm of Nanjing.



Recommended Nearby Restaurants (after the cruise):

Please note that the conference will not provide dinner for regular attendees on 26 June following the Qinhuai River Night Cruise. If you are looking for a place to dine after the cruise, we are pleased to recommend the following local restaurants near the Qinhuai River and Confucius Temple.

1. Confucius Temple Food Street

Address: Confucius Temple Scenic Area
Pedestrian Street (Fuzimiao Area), Qinhuai
District, Nanjing
Distance: approx. 1–5 minutes' walk from
Qinhuai River
Opening hours: 10:00–22:00



A lively food street featuring a wide variety of local snacks and traditional Nanjing specialties.

2. Nanjing Dapaidang (Fuzimiao Pingjiangfu Store)

Address: No. 48 Dashiba Street, Qinhuai District, Nanjing
Distance: approx. 5–10 minutes' walk from Qinhuai River
Opening hours: 11:00–23:00



A well-known local restaurant chain specializing in traditional Nanjing-style cuisine. It is popular for its nostalgic dining atmosphere and a wide range of classic dishes.

3. Li Bai Xie (Zhuangyuanlou Store)

Address: Zhuangyuan Building, Fuzimiao Scenic Area, Qinhuai District, Nanjing
Distance: approx. 8 minutes' walk from Qinhuai River
Opening hours: 11:00–22:00



A popular local restaurant brand focusing on crab-based dishes and Jiangnan-style cuisine. Signature items include crab noodles and seasonal crab dishes.

Polymers 2026: Trends, Innovation and Future

25–28 June 2026 | Nanjing, China



Organizing Committee

Conference Chairs

Prof. Dr. Sixun Zheng
Prof. Dr. Xuming Xie
Prof. Dr. Dimitrios Bikiaris

Scientific Committee

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Prof. Dr. Changtong Mei
Prof. Dr. Daoyong Chen
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Prof. Dr. Zhaobin Qiu
Prof. Dr. Zhengwei You

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Conference Secretariat

Email: polymers2026@mdpi.com

Table of Contents

Welcome from the Chairs.....	1
Keynote Speakers.....	2
Invited Speakers	4
Polymers 2026 Abridged Program.....	7
Polymers 2026 Program.....	8
Poster List	15
Session 1. Polymer Synthesis	18
Session 2. Green Sustainable Polymers.....	29
Session 3. Polymer Processing.....	53
Session 4. Polymer Networks and Gels.....	62
Session 5. Polymer Composites.....	72
Session 6. Polymer Applications.....	105
Session 7. Polymers and the Environment	142

Welcome from the Chairs

Dear colleagues and friends,

We are very proud and honored to announce the international conference **Polymers 2026: Trends, Innovation and Future**, organized in collaboration with the MDPI open access journal *Polymers* (ISSN 2073-4360, Impact Factor 5.8, CiteScore 11). The conference will be held in **Nanjing, China**, on **25–28 June 2026**.

Polymers 2026 is one of the most significant international congresses in the field of polymer science, technology, and engineering, aiming to bring together all scientists working in polymers.

Polymer science was born of the establishment of the concepts of polymers and/or macromolecules. Nowadays, polymers are the materials required for modern society in every aspect. Over the past few decades, tremendous advances have been made in polymer science and engineering, from methodology of synthesis, correlations of structures with properties, application of a variety of processing technologies to development of new materials. Currently, polymer science and engineering are continuing the development of the past 60 years. There have been new trends such as green and sustainable chemistry and processing, bio and medical polymers, optoelectronic and other functional polymers. The combination of computers with internets is playing increasingly important roles; machine learning as well as artificial intelligence is being applied in the fields of polymer science and technology.

There are several issues concerning the synthesis of polymers by safe and sustainable by design (SSbD) approaches, their applications, recyclability and biodegradability of polymers. Biobased monomers and additives with lower toxicity to replace many harmful toxic fossil fuel-derived monomers should be produced using biomass treatment to avoid the production of polymers that cause several environmental and human health problems. Microplastics (MPs) represent significant challenges for the next few decades and the scientific community should take action to reduce their negative effects. Also, due to serious environmental concerns, new, green and lower energy approaches (less CO₂ emission) to the synthesis of polymers and final products should be investigated. Polymer synthesis should contribute to the transition to climate neutrality and the zero-pollution ambition.

The goal of the meeting is to bring together scientists and engineers from academia and industry to communicate on trends, innovation and future of polymer science and technology. Both oral and poster contributions of all aspects are welcome. The broad themes include synthesis, characterization, modification, polymer composites, bio-based and biodegradable polymers, smart and functional polymers, polymers from green and sustainable chemistry, polymers for the environment, and polymers in energy, among others.

Building on the strong foundation laid by Polymers 2018 in Barcelona, Polymers 2022 in Turin, and Polymers 2024 in Athens, the Polymers 2026 conference will continue to explore cutting-edge developments in the field.

We look forward to welcoming you at the meeting in Nanjing!



Prof. Dr. Sixun Zheng
Conference Chair

Shanghai Jiao Tong University,
Shanghai, China



Prof. Dr. Xuming Xie
Conference Chair

Tsinghua University, Beijing,
China



Prof. Dr. Dimitrios Bikiaris
Conference Chair

Aristotle University of
Thessaloniki, Thessaloniki,
Greece

Keynote Speakers



**Prof. Dr. Amadeo Rodriguez
Fernandez-Alba**

University of Almería, Almería,
Spain

Dr. Amadeo Rodriguez Fernandez-Alba is a Full Professor of Analytical Chemistry at the University of Almería, Spain. He is Director of the EU Reference Laboratory for Pesticide Residues in Fruits & Vegetables (EURL-FV) and founder of the research group “AGR-159 Pesticide Residues” of the Junta de Andalucía. His research over many years has focused on the development and validation of methods for analysing pesticide residues and other chemical contaminants in food and the environment, using advanced mass spectrometry and chromatography techniques. He has authored well over 300 peer-reviewed articles, supervised many PhD theses, and contributed to numerous national and international research projects and quality control panels.



Prof. Dr. Katja Loos

University of Groningen,
Groningen, The Netherlands

Dr. Katja Loos is a Professor at the Zernike Institute for Advanced Materials, University of Groningen, holding the chair in Macromolecular Chemistry and New Polymeric Materials. She currently serves as President of the European Polymer Federation (2023–2025). Her research focuses on the design, synthesis, and characterization of novel macromolecules and sustainable polymer production methods, including biocatalysis and controlled polymerization techniques.



Dr. Maria Nerantzaki

University of Strasbourg,
Strasbourg, France

Dr. Maria Nerantzaki is a Junior Group Leader at the Laboratory of Chemistry of Informational Macromolecules (LCIM), Supramolecular Science and Engineering Institute (ISIS), Université de Strasbourg, France. She leads an independent research group focusing on the development of sequence-defined polymers and bio-hybrid materials, combining precision polymer synthesis with DNA nanotechnology. Her team is currently working on the “MolecularArXiv” project, which aims to store large-scale data in DNA and artificial polymers.



Dr. Sing Swee Leong

National University of Singapore,
Singapore, Singapore

Dr. Sing Swee Leong is an Assistant Professor at the Department of Mechanical Engineering, National University of Singapore (NUS), Singapore. Swee Leong has been in the field of advanced manufacturing for more than 14 years. His research interests are enabling material development while creating strategic and sustainable values for Industry 4.0 and beyond through the use and integration of advanced manufacturing. His research team is currently focusing on the integration of artificial intelligence with additive manufacturing in both material design and process control.



Prof. Dr. Wei Yu
Shanghai Jiao Tong University,
Shanghai, China

Dr. Wei Yu is a professor at the School of Chemistry and Chemical Engineering, Shanghai Jiao Tong University, P. R. China. He is the vice director of the Chinese Society of Rheology. His research focuses on the structures, dynamics, and rheology of complex fluids, including polymers, gels, emulsions, and suspensions. He also works on the physics and processing of polymeric materials.



Prof. Dr. Yen Wei
Tsinghua University, Beijing, China

Dr. Yen Wei is Chair Professor of Chemistry at Tsinghua University. He received his undergraduate diploma and MS from Peking University, PhD from City University of New York, and postdoc at MIT. He became Full Prof. in 1995 and Herman B. Wagner Prof. of Chemistry in 2004 at Drexel University. He joined Tsinghua full-time in 2009 as a national highest level talent. His research focuses on polymers and nanomaterials for biomedicine, energy, water-treatment, intelligent device and 3D-printing technologies. He has co-authored 1444 articles with 86,850 SCI citations. He was listed as a highest cited scientist every year from 2014 to 2025.



Prof. Dr. Zhengwei You
Donghua University, Shanghai,
China

Dr. Zhengwei You is a Deputy Director of the State Key Laboratory of Advanced Fiber Materials and the Head of the Department of Composite Materials at Donghua University. He received his degrees of B.S. (2000) from Shanghai Jiao Tong University and Ph.D. (2007) from Shanghai Institute of Organic Chemistry, CAS. From 2007 to 2012, he conducted his postdoctoral research on biomaterials at Georgia Institute of Technology and University of Pittsburgh. Prior to joining Donghua University in 2013, he was an innovation manager in Bayer MaterialScience. His current research involves smart polymers, elastomers, 3D printing, biomaterials, and elastic electronics. He has published more than 100 peer-reviewed papers (55 papers with $IF \geq 10$) as the corresponding author in the journals such as Nature Medicine, Nature Communication (4), Science Advances (2), Advanced Materials (13), PNAS, Angewandte Chemie International Edition, Account Chemical Research, and been granted more than 60 patents, and contributed 2 book chapters. He won First Prize of Natural Science Award of China National Textile and Apparel Council (Ranking 1/6) and First Prize of Science and Technology Award of Chinese Materials Research Society (Basic Research Category, Ranking 1/7) at 2025, Gold Medal of the 12th Macau International Innovation and Invention Exhibition (Ranking 1/3) at 2024, Shanghai Top Ten Youth Science and Technology Outstanding Contribution Award at 2023, and was selected in the 2022 Shanghai Leading Talent Program. He currently serves as the director of Research Base of Textile Materials for Flexible Electronics and Biomedical Applications, China Textile Engineering Society, the vice chairman of Biomaterials Advanced Manufacturing Branch of Chinese Society of Biomaterials, associate editor of the journal Smart Materials in Medicine (CiteScore: 14.8), editorial board member of the journal Bioactive Materials (IF: 20.3) and Chinese Journal of Polymer Sciences (IF: 4.1), youth editorial committee member of the journals Materials China and Advanced Fiber Materials (IF: 21.3).

Invited Speakers



Prof. Dr. Alexey V. Lyulin
Eindhoven University of
Technology, Eindhoven, The
Netherlands



Prof. Dr. Chuangqi Zhao
University of Science and
Technology of China Suzhou
Institute for Advanced Research,
Suzhou, China



Prof. Dr. Daoyong Chen
Anhui Normal University, Wuhu,
China



Prof. Dr. Farzad Seidi
Nanjing Forestry University,
Nanjing, China



Prof. Dr. Ganji Zhong
Sichuan University, Chengdu,
China



Prof. Dr. Guozhong Wu
Shanghai Institute of Applied
Physics, Chinese Academy of
Sciences, Shanghai, China



Prof. Dr. Hong Yang
Southeast University, Nanjing,
China



Prof. Dr. Huining Xiao
University of New Brunswick,
Fredericton, NB, Canada



**Prof. Dr. Leonard Ionut
Atanase**
Apollonia University of Iasi, Iasi,
Romania



Prof. Dr. Liang Yuan
Anhui Agricultural University,
Hefei, China



Prof. Dr. Longcheng Tang
Hangzhou Normal University,
Hangzhou, China



Prof. Dr. Mingming Guo
Jiangsu University of Science
and Technology, Zhenjiang,
China



Prof. Dr. Pengjian Gong
Sichuan University, Chengdu,
China



Dr. Rentong Yu
Hainan University, Haikou, China



Prof. Dr. Wei Chen
University of Science and
Technology of China, Hefei,
China



Prof. Dr. Wei Zhang
Zhengzhou University,
Zhengzhou, China



Prof. Dr. Xiao Chen
Wuhan University of Technology,
Wuhan, China



Prof. Dr. Xiao Hu
Rowan University, Glassboro,
United States



Prof. Dr. Xiaomin Zhu
Zhejiang Sci-Tech University,
Hangzhou, China



Prof. Dr. Zhanhua Wang
Sichuan University, Chengdu,
China



Prof. Dr. Zhaobin Qiu
Beijing University of Chemical
Technology, Beijing, China

Polymers 2026 Abridged Program

	25 June 2026 Thursday	26 June 2026 Friday	27 June 2026 Saturday	28 June 2026 Sunday			
Morning		Onsite Registration & Morning Coffee (8:30–9:30)	Onsite Registration (8:30–9:00)	Onsite Registration (8:30–9:00)			
		Courtyard Ballroom A	Courtyard Ballroom A	Courtyard Ballroom A	VIP Room		
		Opening Ceremony	Keynote Talks	Session 5	Session 6		
		Keynote Talks		Tea Break	Tea Break		
				Keynote Talks	Session 5	Session 6	
		Lunch Break	Lunch Break				
		Afternoon	Registration (15:00–17:30)	Poster Session *		Poster Session *	
Courtyard Ballroom A	VIP Room			Courtyard Ballroom A	Courtyard Ballroom B	Courtyard Ballroom A	VIP Room
Session 7	Session 4			Session 3	Session 2	Session 5	Session 6
Tea Break				Tea Break		Courtyard Ballroom A	
Session 7	Session 4			Session 1	Session 2	Closing Ceremony	
	Session 2						
Social Activity				Courtyard Ballroom A			
				Banquet Dinner			

* Please note that all posters will be on display throughout both designated poster sessions on 26 and 27 June. The poster presentations will not be divided by sessions.

Polymers 2026 Program

25 June 2026 (Thursday)

Time: 15:00 (CST, China) | Foyer, 1st Floor

CST Time	Speaker	Title
15:00–17:30		Check-In & Onsite Registration

26 June 2026 (Friday)

Keynote Talks

Time: 8:30 (CST, China) | Foyer, 4th Floor

CST Time	Speaker	Title
8:30–9:30		Onsite Registration & Morning Coffee

Time: 9:30 (CST, China) | Courtyard Ballroom A, 4th Floor

CST Time	Speaker	Title
9:30–9:50		Opening Ceremony

Session Chair: Prof. Dr. Yen Wei

9:50–10:30	Katja Loos Keynote Speaker	Green Pathways to Functional and Renewable Polymeric Materials
10:30–11:10	Amadeo Rodriguez Fernandez-Alba Keynote Speaker	Micro- and Nanoplastics in Agricultural Crops: Plant Responses to Plastic Particles, Additives and Aged Polymers
11:10–11:50	Sing Swee Leong Keynote Speaker	Additive Manufacturing - A Sustainable Approach to Polymers Processing
11:50–13:00		Lunch
13:00–14:00		Poster Session

Session 7. Polymers and the Environment

Time: 14:00 (CST, China) | Courtyard Ballroom A, 4th Floor

CST Time	Speaker	Title
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Session Chair: Prof. Dr. Xiao Chen

14:00–14:05		Session Introduction
14:05–14:20	Haolin Liu Oral Presenter	Design, preparation and application of monodisperse polymer microspheres in ion chromatography-mass spectrometry
14:20–14:35	Alexandra L. Nikolaeva Oral Presenter	UV-aging of model undyed and dyed polystyrene microparticles
14:35–14:50	Patrick Navard Oral Presenter	Migration of Organic Additives from Low-Density Polyethylene into Human Skin: An Ex Vivo Study
14:50–15:05	Domenico Riccardi Oral Presenter	Pollutant removal from wastewater throughout a functionalized membrane based on poly(2,6-dimethyl-1,4-phenylene)oxide (PPO)
15:05–15:20	Tingting Yun Oral Presenter	Asymmetric Surface Photothermal Hydrogel Membrane: Balancing Water Transport and Evaporation for Stable Seawater Desalination
15:20–15:50		Tea Break

Session Chair: Prof. Dr. Amadeo R. Fernandez-Alba

15:50-16:05	Leonid Iliasov Oral Presenter	Network polyanions as multifunctional soil amendments
16:05-16:20	Paola Rizzo Oral Presenter	A New Generation of Micro and Macroporous Polymer Films: From Structural Design to High-Impact Environmental Applications
16:20-16:35	Alireza Ranjbari Oral Presenter	Mechanistic Evaluation of POP-Based Visible-Light Photocatalysis for Tracking Thiabendazole Removal Pathways
16:35-16:50	Angela Erbaggio Oral Presenter	Uniplanar crystalline phase orientation in PBS films
17:40-21:00	Social Activity	

Session 4. Polymer Networks and Gels
Session 2. Green Sustainable Polymers - Part I

Time: 14:00 (CST, China) | VIP Room, 4th Floor

CST Time	Speaker	Title
Session 4. Polymer Networks and Gels		
Session Chair: Prof. Dr. Wei Zhang		
14:00-14:05	Session Introduction	
14:05-14:30	Hong Yang Invited Speaker	Syntheses and Applications of Liquid Crystal Polymeric Materials
14:30-14:45	Gianluca Vidali Oral Presenter	Single-step grafting of a thermoresponsive RAFT polymer from nanocellulose by radical decarboxylation
14:45-15:00	Hong Liu Oral Presenter	The Gelation Transition of Olympic Gel
15:00-15:15	Zhaoming Zhang Oral Presenter	Modulation of the Mechanical Properties of Supramolecular Crosslinked Networks
15:15-15:45	Tea Break	
15:45-16:10	Farzad Seidi Invited Speaker	Crosslinkable Polysaccharides for Developing Functional Injectable Hydrogels for Wound Healing
16:10-16:25	Linglin Cheng Oral Presenter	Tuning aromatic affinity in PMHS through phenyl functionalization for efficient hydrocarbon separation
Session 2. Green Sustainable Polymers - Part I		
Session Chair: Dr. Maria Nerantzaki		
16:25-16:30	Session Introduction	
16:30-16:55	Liang Yuan Invited Speaker	Recyclable Polymer Networks from Renewable Raw Materials via Thiol-X Chemistries
16:55-17:10	Mukhamed Khavpachev Oral Presenter	Mechanochemical Preparation of Solid Dispersions of Poorly Soluble Bioactive Compounds with Functional Carriers
17:10-17:25	Vladislav Potselev Oral Presenter	Solvent-free Modification of Chitosan with Sorbic Acid for Tunable Stabilization of ZnS Quantum Dots
17:40-21:00	Social Activity	

27 June 2026 (Saturday)**Time: 8:30 (CST, China) | Foyer, 4th Floor**

CST Time	Speaker	Title
8:30–9:00	Onsite Registration	

Keynote Talks**Time: 9:00 (CST, China) | Courtyard Ballroom A, 4th Floor**

CST Time	Speaker	Title
Session Chair: Prof. Dr. Katja Loos		
9:00–9:40	Yen Wei Keynote Speaker	Photoactive Materials for Water Treatment, Soft Robots and Tumor Theragnosis
9:40–10:20	Zhengwei You Keynote Speaker	The dynamic cross-linking strategies simultaneously enhance the mechanical and processing properties of polyurethanes
10:20–10:50	Tea Break	
Session Chair: Prof. Dr. Leonard Ionut Atanase		
10:50–11:30	Wei Yu Keynote Speaker	Jamming in Polymer Nanocomposites
11:30–12:10	Maria Nerantzaki Keynote Speaker	Precision Polymer Synthesis and DNA Nanotechnology: A New Land for the Design of High-Performance Hybrid Materials
12:10–13:20	Lunch	
13:20–14:00	Poster Session	

**Session 3. Polymer Processing
Session 1. Polymer Synthesis****Time: 14:00 (CST, China) | Courtyard Ballroom A, 4th Floor**

CST Time	Speaker	Title
Session 3. Polymer Processing		
Session Chair: Prof. Dr. Guozhong Wu		
14:00–14:05	Session Introduction	
14:05–14:30	Ganji Zhong Invited Speaker	Characterization and Design of Hierarchically Oriented Structures in Polymer Processing
14:30–14:55	Wei Chen Invited Speaker	In-situ NMR Reveals the Microscopic Deformation Mechanism of Polymer
14:55–15:10	Hao Feng Oral Presenter	Combining CFD Simulation and Experimental Investigation for the Development of Adaptable Single-Screw Extruder Mixing Elements
15:10–15:35	Guozhong Wu Invited Speaker	Challenging and Opportunities of Radiation Processing for Polymers
15:35–16:00	Xiao Chen Invited Speaker	Microfluidic-based Technology for Tailoring the Structure of Nanofiber membranes
16:00–16:30	Tea Break	
Session 1. Polymer Synthesis		
Session Chair: Prof. Dr. Wei Chen		
16:30–16:35	Session Introduction	
16:35–17:00	Wei Zhang Invited Speaker	Polymerization-induced Chiral Self-assembly: In-situ Construction of Hierarchical Chirality in Polymer System
17:00–17:15	Zixiang He Oral Presenter	In situ Construction and Regulation of Supramolecular Chirality in Racemic Polymer Systems

17:15–17:30	Liting He Oral Presenter	Clickable Dialdehyde-Amine Polymerization (cDAP)
18:30–20:00	Banquet Dinner (Courtyard Ballroom A, 4th Floor)	
Session 2. Green Sustainable Polymers - Part II		
Time: 14:00 (CST, China) Courtyard Ballroom B, 4th Floor		
CST Time	Speaker	Title
Session Chair: Prof. Dr. Wei Yu		
14:00–14:05	Session Introduction	
14:05–14:30	Zhaobin Qiu Invited Speaker	Structure and properties of biobased and biodegradable polymers
14:30–14:45	Minseong Chae Oral Presenter	Eco-Degradable Polymer Platforms with Transient Sensing for Reliable Surgical Soft Robots
14:45–15:10	Xiao Hu Invited Speaker	Engineering 1D and 2D Shape-Morphing Biomaterials from Protein–polysaccharide Composites via Agarose Layering: Toward Programmable, Sustainable, and Stimuli-Responsive Platforms
15:10–15:25	Qiannan Liu Oral Presenter	Effect of amylose/amylopectin ratio on the molecular orientation and performance of three-dimensional-printed thermoplastic starch/polylactic acid intestinal stents
15:25–15:50	Zhanhua Wang Invited Speaker	Hydrogen-Bonding Synergistic Covalent Adaptable Networks: Towards Recycled Elastomers with Excellent Creep-Resistant Performance
15:50–16:05	Marco Zanetti Oral Presenter	Recycling Thermoset Polyurethanes via Covalent Adaptable Networks: The Role of Crosslink Density in Performance Retention
16:05–16:30	Tea Break	
Session Chair: Prof. Dr. Alexey V. Lyulin		
16:30–16:55	Mingming Guo Invited Speaker	Smart Water-Soluble Polymeric Materials – Molecular Design, Preparation, Intelligent Assembly and Novel Applications
16:55–17:10	Weixing Xu Oral Presenter	Cellulose Fiber Vitriimer: Dynamic Network Construction Mediated by Transesterification
17:10–17:35	Rentong Yu Invited Speaker	Mechanistic Insights into the Colloidal Stability of Synthetic Polyisoprene Latices Mediated by Protein
17:35–17:50	Nikolaos Bikiaris Oral Presenter	Eco-friendly synthesis of biodegradable PLA-based exfoliant microbeads via droplet microfluidics for sustainable cosmetics
17:50–18:15	Huining Xiao Invited Speaker	Synergistic Integration of Natural and Synthetic Polymers in Cellulosic Fibrous Interfaces for Multifunctional Wearable Systems
18:15–18:30	Hui Li Oral Presenter	Nucleotide Coordination Polymer: Supramolecular Self-assembly, Crystal Structure and Functional Properties
18:30–20:00	Banquet Dinner (Courtyard Ballroom A, 4th Floor)	

28 June 2026 (Sunday)

Time: 8:30 (CST, China) | Foyer, 4th Floor

CST Time	Speaker	Title
8:30–9:00	Onsite Registration	

Session 5. Polymer Composites - Part I

Time: 9:00 (CST, China) | Courtyard Ballroom A, 4th Floor

CST Time	Speaker	Title
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Session Chair: Prof. Dr. Longcheng Tang

9:00–9:05	Session Introduction	
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9:05–9:30	Alexey V. Lyulin Invited Speaker	Designing Fast Thermal Energy Storage: Interfacial Heat Transfer in Paraffin–Graphene Composites
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9:30–9:45	Leonor Calado Pequeneza Oral Presenter	RECYCLABILITY AND PROCESSING PERFORMANCE OF A BIOCOMPOSITE FILAMENT FOR CIRCULAR ADDITIVE MANUFACTURING
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9:45–10:00	MingHao Yan Oral Presenter	Preparation and Performance of SIS-Based Hot Melt Pressure-Sensitive Adhesive with Multiphase-Composite Bond Dynamic Interpenetrating Network
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10:00–10:15	Kristine V. Aleksanyan Oral Presenter	Characterization of PLA-polysaccharide biocomposites with AgNPs
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10:15–10:30	Pengchao Zhang Oral Presenter	Superspreading-based Fabrication of Nanoporous Polymer Membranes for Stable MD Desalination
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10:30–11:00	Tea Break	
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Session Chair: Prof. Dr. Dimitra Lambropoulou

11:00–11:25	Daoyong Chen Invited Speaker	Complexly and Regularly Structured Multicomponent Polymers for Unique Applications
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11:25–11:40	Pavel Vorontsov Oral Presenter	Multifactorial optimization of PVDF–CoFe ₂ O ₄ magnetoelectric multiferroic composite synthesis by controlling the thickness, stretching, and distribution of nanoparticles in the polymer matrix to improve magnetoelectric response
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11:40–11:55	Vitalii Salnikov Oral Presenter	FROM LIGAND TO LINEAGE: HOW NANOPARTICLE COATINGS CONTROL MAGNETOELECTRIC STIMULATION OF MESENCHYMAL STEM CELLS IN PVDF FILMS?
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11:55–12:10	Igor Volgin Oral Presenter	Assessing Gas Transport Properties of a Polysulfone/Asphaltene Nanocomposite Membrane via Molecular Dynamics Simulations Supported by Theoretical Analysis
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12:10–12:25	Daoxing Si Oral Presenter	Research on a Controllable Interface Thermoplastic Processing New Technique
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12:25–12:40	Yue Xu Oral Presenter	Highly thermal conductive and rechargeable 3D liquid metal network-based phase change composite enabling photothermal pad
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12:40–14:00	Lunch	
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Session 6. Polymer Applications - Part I

Time: 9:00 (CST, China) | VIP Room, 4th Floor

CST Time	Speaker	Title
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Session Chair: Prof. Dr. Farzad Seidi

9:00–9:05	Session Introduction	
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9:05–9:30	Xiaomin Zhu Invited Speaker	Hyperbranched polyethoxysiloxane – a unique silica precursor polymer for preparation of nanostructured silica materials
9:30–9:45	Yunfu Ou Oral Presenter	Synergistic Hierarchical Toughening of FRP Laminates via CNT Powder and Ultrathin Fiber Veils
9:45–10:00	Sibusiso Alven Oral Presenter	Formulation and Evaluation of Polymer-based Sponges for Wound Dressing Applications
10:00–10:15	Alexandra Mocanu Oral Presenter	Bacterial Cellulose as a Versatile Polymer Platform for Advanced Wound Dressing Applications
10:15–10:30	Jun Xu Oral Presenter	Design super-strong and biomedical polyurethane materials with molecular “Lego bricks”
10:30–11:00	Tea Break	

Session Chair: Prof. Dr. Xiaomin Zhu

11:00–11:25	Leonard Ionut Atanase Invited Speaker	Drug-loaded polymer particles based on polyester copolymers
11:25–11:40	Livia Alexandra Dinu Oral Presenter	Molecularly Imprinted Biopolymer Integrated on Silicon Electrochemical Sensors for Pesticide Detection
11:40–12:05	Pengjian Gong Invited Speaker	Low Dielectric and High Electromagnetic Transmitting Polymeric Foams Made from Supercritical Fluid Foaming
12:05–12:20	Elizaveta Akoulina Oral Presenter	Polymer Organized Surface Microstructure Effect on Eukaryotic Cells Growth and Differentiation
12:20–12:35	Jingbo Wang Oral Presenter	Electret Melt-Blown Nonwovens with Long-lasting Efficiency Based on Novel Charging Concept and Polymer Design
12:35–14:00	Lunch	

Session 5. Polymer Composites - Part II

Time: 14:00 (CST, China) | Courtyard Ballroom A, 4th Floor

CST Time	Speaker	Title
Session Chair: Prof. Dr. Zhanhua Wang		
14:00–14:25	Longcheng Tang Invited Speaker	Silicone polymers and porous composites: from fundamental research to engineering application
14:25–14:40	M.L. Atabekyan Oral Presenter	Novel Silicone-Based Transdermal Films for Gangleron Delivery: Synthesis, Characterization, and Release Profiles
14:40–14:55	Aday Romero Oral Presenter	Revalorization of agricultural waste in the manufacture of HDPE composites
14:55–15:10	Mario D. Monzón Oral Presenter	STUDY OF THE FORMULATION AND PROCESS PARAMETERS OF PLA WITH NATURAL BANANA RACHIS FIBER IN ADDITIVE MANUFACTURING
15:25–15:45	Closing Remarks and Award Ceremony (Courtyard Ballroom A, 4th Floor)	

Session 6. Polymer Applications - Part II

Time: 14:00 (CST, China) | VIP Room, 4th Floor

CST Time	Speaker	Title
Session Chair: Prof. Dr. Pengjian Gong		
14:00–14:25	Sergey Ponomarenko Invited Speaker	Organosilicon [1]benzothieno[3,2-b]benzothiophene-containing oligomers and polymers for solution processible organic electronics
14:25–14:40	Anna Senchukova Oral Presenter	Hydrophobically Modified Comb-Like Polyelectrolytes as Efficient Nanoreactors in Aqueous Media

14:40–14:55	Petr Fetin Oral Presenter	Hydrophobicity overcoming, comb-like polyelectrolytes for micellar catalysis
14:55–15:10	Han-Jui Chang Oral Presenter	Research on Optimization of Fresnel Lens Molding Process by Combining Rapid Heat Cycle Molding Technology with the Principle of Rupert's Tears
15:10–15:25	Massimo Lazzari Oral Presenter	From traditional techniques to surface-enhanced Raman spectroscopy for monitoring industrial polymer aging
15:25–15:45	Closing Remarks and Award Ceremony (Courtyard Ballroom A, 4th Floor)	

Poster List

No.	Name	Title
Session 1. Polymer Synthesis		
1	Nikolaos Bikiaris	Biobased azelate polyesters as macroinitiators for sustainable copolymers
2	Dimitrios Bikiaris	Ring-opening Copolymerization of L-lactide with poly(mandelic acid) for the development of biobased polyesters
3	Zixian Li	Organic-Inorganic Polyhydroxyurethanes with Double Decker Silsesquioxanes in the Main Chains
4	Yawei Zhang	Toughening of Epoxies through the Generation of Polydimethylsiloxane Nanophases
5	Fan Gui	Electronic Effects in Monoindenyl-Ketimide Titanium Catalysts for Ethylene (Co)polymerization
Session 2. Green Sustainable Polymers		
7	Evangelia Balla	Bio-based NIPU nanocarriers for the encapsulation and long-acting delivery of Paliperidone Palmitate
8	Jianglu Teng	Polydimethylsiloxane Crosslinked with Benzyl Hindered Urea Bonds: Reinforcement with Lignin, Reprocessing and Functional Properties
9	Aday Romero	Valorization of textile waste for the manufacture of panels with new sustainable materials
10	Xiaohui Wang	Fabrication of Degradable Poly(olefin-ester) via Cross Metathesis Reaction From Unsaturated Polyester and Polydiene
11	Evangelia Balla	Novel NIPU Sponge-Derived Nanoemulsions as Sustained Chloramphenicol Carriers for Wound Therapy: In Vitro Cytotoxicity (MTT), Antimicrobial Performance and Franz Cell Permeation Studies
Session 3. Polymer Processing		
12	Mario D. Monzón	Specific Study of the Application of ISO/ASTM 52924 Standard in the Classification of Finished Parts Manufactured by Laser-Based Powder Bed Fusion with PA12
13	Lanji Wen	Achieving Concurrent Transparency and Stability Improvements in Quantum-Dot Films via Polymer Encapsulation
Session 4. Polymer Networks and Gels		
14	Eleonora Kim	Metal-Coordination Polysiloxanes Based on Dibenzoylmethane: Synthesis, Structure and Properties
15	Rizos-Evangelos Bikiaris	A Bioactive Nanocomposite Hydrogel Modulates the Wound Microenvironment and Accelerates Healing with Niosome-Loaded Delivery
16	Yingxiang Li	Modulation of the Mechanical Properties of Supramolecular Crosslinked Networks
Session 5. Polymer Composites		
17	Wenhan Fu	Study on the evolution relationship between microstructure and electrical properties of dielectric elastomer composites under strain
18	Rizos-Evangelos Bikiaris	Sustainable Modification of High-Density Polyethylene via Hybrid Lignin-Calcium Pimelate Additives
19	Xinyang Liu	The relationship between the dielectric properties of dielectric elastic composites and the three-dimensional dispersion structure of fillers
20	Dimitrios Bikiaris	Reactive Processing of Recycled Polyethylene Blends Modified with Lignin Additive for 3D Printing Filament Applications

21	Yijie Zhou	Engineering the Interface and Phase Morphology of PC/ASA Blends for Enhanced Low-Temperature Toughness and Processability
22	Ritsuki Wada	Development of Thermally Conductive Polyimide Hybrid Films Using Novel Composite Particles
23	Jiawei Sheng	Composite particles and Microencapsulated APP for Enhancing Flame Retardancy Thermal Insulation, and Ceramifiable Properties of EVA Composites
25	Anran Fu	Comparative study of chemically grafted vs. physically coated CNTs on fracture toughness of BMI/CF laminates
26	Leonard Ionut Atanase	Biocomposite microparticles loaded with Ibuprofen with antimicrobial activity
27	Yiting Weng	Tailoring thermomechanical performance of carbon fiber/polyimide composites via carbon nanotube interface engineering
Session 6. Polymer Applications		
29	Dejia Chen	Diradicaloid-loaded polypeptide nanoparticles for two-photon NIR phototheranostics
30	Yihuizi Li	The influence of divalent metal cation contamination (Ca ²⁺ , Mg ²⁺ , Fe ²⁺ , Cu ²⁺) on the degradation of Nafion membrane transport performance for proton exchange membrane fuel cells: A molecular dynamics study
31	Androniki Rapti	Biopolymer-graphene aerogels as green sorbents for β -blocker detection in environmental water matrices
32	Yadong Li	Regulation of Nanoimprint UV Resists and Device Performance in Liquid Crystal Lenses
33	Jinsong Wang	Lignin self-healing coatings based on thermo-reversible Diels-Alder reaction for anticorrosion applications
34	Dimitra Lambropoulou	Iron-based MOF-embedded polymeric monoliths for sustainable PFAS determination with high-resolution mass spectrometry
35	Wenquan Xie	Highly Interconnected Uniform Nanoporous Polyimide Separators: Controllable Fabrication and Electrochemical Performance
36	Yi-Fan Rao	Coupling of Electrostatic Interactions and Electroosmotic Flow in the Translocation of a Single-stranded RNA through Charged Nanopores
37	Matvei Kadnikov	Copolymers based on nonionic and cationic surfactant monomers as co-catalysts for the Suzuki reaction
38	Guojie Xu	Sustainable and Mass-producible Epoxy Vitrimers-Based Gel Polymer Electrolytes
39	Hejia Yue	Alginate-chitosan microbeads encapsulated bacteriophage phiKZ as model of bacteriophage delivery polymer system
40	Chrystalla Protopapa	Probing Melatonin's Release Pattern Using Synthetic Biopolymers
41	Xufeng Liu	Effects of mineralized alginate hydrogel microspheres on the growth and differentiation of MG63 cell line
42	Polina Zefirova	Comb-like polyelectrolytes as co-catalysts of water performed Suzuki reaction
43	Yuan Gao	Controlled Preparation and Mechanical Properties of Stretchable Polyurethane Films Based on Super-Spreadable Droplets
Session 7. Polymers and the Environment		
45	Androniki Rapti	TiO ₂ -Decorated Nanolignin hybrids as Functional Fillers in Poly(lactic acid) (PLA) Membranes for Photocatalytic Applications
46	Dimitra Lambropoulou	Photoaging-Induced Chemical Leaching from Poly(lactic acid) Micro- and Nanoplastics: A Suspect and Non-Target LC-HRMS Study

Poster List

47	Zhengyun Xie	A Redox-Responsive Nanoplatfrom for Heavy Metal Complexation and Plant Growth Promotion
48	Igor Volgin	Molecular Dynamics Simulations of Chain Detachment and Additive Leaching in Aged Micro- and Nanoplastics in Aqueous Environment
49	Anastasia Burmistrova	Polystyrene Foam Degradation by Zophobas Morio Larvae
50	Jingwei Xu	Preparation of highly nitrogen-doped graphene aerogel via catalytically accelerated ammonia generation for efficient and stable formaldehyde removal

Session 1. Polymer Synthesis

sciforum-171315: Ring-opening Copolymerization of L-lactide with poly(mandelic acid) for the development of biobased polyesters

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Aromatic polyesters derived from mandelic acid (MA) have garnered significant interest owing to their biodegradability, elevated glass transition temperature, and intrinsic chirality—features that enable advanced functional materials design. In the present work, copolymers of L-lactide with isotactic poly(mandelic acid) synthesized via Steglich Esterification are explored as a method to obtain amorphous polyesters with a glass transition temperature exceeding 50 °C. L-lactide and poly(mandelic acid) were successfully copolymerized and the resulting copolymers revealed rising T_g values upon increasing poly(mandelic acid) content. We confirmed the chemical structure of the synthesized materials using Nuclear Magnetic Resonance (NMR) and Fourier Transform Infrared (FT-IR) spectroscopy. Thermal properties were assessed via Differential Scanning Calorimetry (DSC) and Thermogravimetric Analysis (TGA), while molecular weight distributions ($M_n \approx 20\text{--}60$ kDa) were determined by means of Gel Permeation Chromatography (GPC), varying with poly(mandelic acid) feed, which was found to act like a co-initiator, as higher poly(mandelic acid) content resulted in lower molecular weights. This study demonstrates that the incorporation of aromatic and chiral MA units unlocks pathways toward high-performance, biobased polyesters suited for biomedical, packaging, and specialty engineering applications.

Keywords

Poly(mandelic acid); L-lactide; ring-opening polymerization; copolymers

References

1. Wang, Y., Jia, Z., Jiang, J., Mao, X., Pan, X., & Wu, J. (2019). Highly regioselective ring-opening polymerization of cyclic diester for alternating sequence-controlled copolymer synthesis of mandelic acid and glycolic acid. *Macromolecules*, 52(20), 7564–7571.
2. Fukuzaki, H., Aiba, Y., Yoshida, M., Asano, M., & Kumakura, M. (1989). Synthesis of biodegradable poly (l-lactic acid-co-d, l-mandelic acid) with relatively low molecular weight. *Die Makromolekulare Chemie: Macromolecular Chemistry and Physics*, 190(10), 2407–2415.
3. Graulus, G. J., Van Herck, N., Van Heck, K., Van Driessche, G., Devreese, B., Thienpont, H., ... & Dubruel, P. (2018). Ring opening copolymerisation of lactide and mandelide for the development of environmentally degradable polyesters with controllable glass transition temperatures. *Reactive and Functional Polymers*, 128, 16–23.



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sciforum-176116: Biobased azelate polyesters as macroinitiators for sustainable copolymers

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The environmental impact of conventional synthetic plastics derived from fossil fuels, including waste accumulation, microplastics, and CO₂ emissions, combined with the low efficiency of current recycling practices, has intensified the need for sustainable alternatives. In response, significant efforts have been directed toward the development of biobased and biodegradable polymers as part of a transition to a circular plastics economy. Poly(lactic acid) (PLA) is one of the most widely used due to its biocompatibility, compostability, and ease of processing. However, its inherent brittleness and slow degradation under natural conditions limit its range of applications. To address these issues, flexible biobased aliphatic polyesters such as poly(propylene azelate) and poly(butylene azelate) are explored as macroinitiators to tailor material properties. These polyesters were synthesized via two-stage melt polycondensation (esterification and polycondensation). Systematic sampling during polycondensation was performed and samples were characterized using FTIR, Intrinsic Viscosity measurements, GPC-SEC, DSC, and XRD to monitor structural, molecular, and thermal evolution.

The results indicate a progressive increase in intrinsic viscosity with reaction time, while GPC analysis shows a steady molecular weight increase with relatively controlled distributions, confirming effective chain growth. FTIR spectra reveal the gradual formation of ester bonds, supporting the advancement of the reaction. Thermal analysis via DSC highlights the evolution of melting and crystallization behavior throughout the process, while XRD patterns confirm a semicrystalline structure with only minor changes during polymerization. Overall, the polycondensation proceeds efficiently, yielding well defined biobased polyesters with tunable structural and thermal properties.

Acknowledgements

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sciforum-165006: Clickable Dialdehyde-Amine Polymerization (cDAP)

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Synthetic polymers are important components of modern functional materials. Developing efficient polymerization processes with ‘clickable’ features will enhance the diversity of available structures and facilitate exploration of new properties. In this work, we developed a new mode of step-growth alternating copolymerization based on the click-like organic phase OPA-amine two-component reaction. This clickable dialdehyde-amine polymerization (cDAP) affords isoindolin-1-one-based copolymers through the polycondensation of functionalized bis-OPA and bis-aniline monomers. The reaction was performed in DMF and catalyzed by pyridine/AcOH at room temperature, affording linear copolymers with high molecular weights. This reaction enabled the production of alternating copolymers in a modular manner, where different functional units could be simply incorporated by varying the linker units in monomer structures. This approach was further expanded to synthesize branched and crosslinked 2D polymeric networks by introducing triamine brancher and dithiol crosslinker into the polymerization system. Some of the synthesized isoindolin-1-one-based copolymers behaved as thermoplastic elastomers, demonstrating the potential of this polymerization in material sciences.



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sciforum-180307: Electronic Effects in Monoindenyl-Ketimide Titanium Catalysts for Ethylene (Co)polymerization

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A series of half-titanocene catalysts bearing ketimine ligands with the general formula IndTiYCl_2 (Ind = indenyl) were rationally designed and synthesized. By systematically varying the electronic properties of the substituents on the ketimine ligand, their influences on ethylene homopolymerization as well as ethylene/1-octene and ethylene/norbornene (NB) copolymerizations were comprehensively investigated. In ethylene homopolymerization, the catalytic activity follows the order: $\text{Ti3} [\text{N}=\text{C}(\text{tBu})(4\text{-NMe}_2\text{Ph})] > \text{Ti2} [\text{Y} = \text{N}=\text{C}(\text{tBu})(4\text{-tBuPh})] > \text{Ti4} [\text{Y} = \text{N}=\text{C}(\text{tBuPh})] > \text{Ti1} [\text{Y} = \text{N}=\text{C}(\text{tBu})(4\text{-FPh})]$, clearly indicating that electron-donating substituents play a crucial role in enhancing catalytic performance. This can be attributed to the increased electron density at the titanium center, which facilitates olefin coordination and insertion, thereby accelerating chain propagation.

A similar trend was observed in ethylene/1-octene copolymerization, where electron-rich substituents significantly improve both catalytic activity and copolymerization efficiency. In contrast, a distinct behavior was found in ethylene/norbornene copolymerization. Catalysts bearing electron-withdrawing substituents exhibited superior performance, affording polymers with higher catalytic activity, higher molecular weights, and increased norbornene incorporation. This difference is likely associated with the bulky structure and strained nature of norbornene, as well as its sensitivity to the electronic environment of the active center. Overall, this study highlights the critical role of ligand electronic effects in modulating catalytic behavior across different polymerization systems, providing valuable insights for the rational design of high-performance half-titanocene catalysts.



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sciforum-180169: In situ Construction and Regulation of Supramolecular Chirality in Racemic Polymer Systems

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Chirality, a fundamental attribute of nature, plays a pivotal role in understanding biological homochirality origins. There is a preconceived notion in chiral polymer systems holds that any polymers composed of racemic segments are optically inactive and lack any chiroptical applications. To address this issue, we present a methodology combining stepwise polymerization-induced chiral self-assembly (PICSA) with chiral conflict effects. This integrated approach not only facilitates the efficient in situ construction of supramolecular asymmetric structures but also enables precise hierarchical chirality regulation. By strategically manipulating the “late-comer lives above” and “first come, first served” effects between enantiomeric building units, we achieve dynamic switching of left-/right-handed supramolecular chirality in racemic copolymer assemblies. Furthermore, amplification of asymmetry in complex supramolecular/polymer system results from the delicate interplay of chiral and achiral structures. Building on this foundation, we further demonstrate a novel approach to the racemic sergeants and soldiers (S&S) effect, using enantiomeric sergeants and achiral soldiers, achieving dual control over both intensity and sign of global chirality, thus enabling precise global supramolecular chirality construction in racemic polymer systems without any external asymmetrical intervention.



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sciforum-180398: Organic-Inorganic Polyhydroxyurethanes with Double Decker Silsesquioxanes in the Main Chains

Zixian Li *, Yawei Zhang, Xibin Shen, Jianglu Teng, Guohua Hang, Lei Li and Sixun Zheng

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Polyurethanes (PUs) have wide-spread applications due to their thermal and mechanical properties such as high elasticity, abrasion resistance, excellent tunability of mechanical properties, favorable low-temperature tolerance, as well as its adhesive and sound-damping characteristics. However, the synthesis of traditional PUs involves the use of toxic isocyanates and phosgene, raising concerns about human health and environmental safety. In this contribution, we reported a synthesis of polyhydroxyurethanes (PHUs) *via* a non-isocyanate route. In the meantime, we introduced double-decker silsesquioxane (DDSQ) into the main chains to synthesize a series of organic-inorganic hydroxy polyurethanes containing DDSQ units. It was found that the linear organic-inorganic PHUs exhibited excellent thermal and mechanical properties. More importantly, the PHUs had shape memory properties, attributable to the physical crosslinking *via* the aggregation of DDSQ-DDSQ cages. Albeit physically crosslinked, the organic-inorganic PHUs were reprocessable through the transcarbamoylation (or transurethanization). This work demonstrates a strategy for developing environmentally friendly, sustainable, high-performance PUs.



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sciforum-180476: Precise Construction of Hierarchical Chiral Structures in Polymer System

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Achieving efficient and precise construction of multilevel chiral structures in polymer aggregates is crucial not only for understanding the formation, specific recognition, and biochemical activity of biomacromolecular multilevel chiral structures, but also for significantly influencing the performance of polymeric materials. Nevertheless, the intrinsic complexity of polymer aggregate systems makes the precise construction and functional implementation of multilevel chiral structures highly challenging. In contrast to the well-studied small-molecule systems, research on multilevel chirality in polymer aggregates has progressed relatively slowly, and the mechanisms of chiral transfer as well as the correlations between chiral effects and material properties remain insufficiently understood. To address these scientific challenges, our research has focused on the following aspects: (1) Developing a precise chiral assembly strategy for polymers. By integrating polymer chemistry, supramolecular chemistry, and chiral assembly, we established polymerization-induced chiral self-assembly, and more specifically polymerization-induced helix-sense selective self-assembly (PIHSSA), enabling the controllable construction of multilevel chiral structures in polymer aggregates. (2) Creating a chiral self-recovery strategy based on cross-linked structures. Utilizing the synergy of covalent and non-covalent bonds, we developed a “cross-linked structure”-guided chiral self-recovery approach, offering a novel concept for stabilizing multilevel chiral structures in polymer aggregates. (3) Designing multi-domain chiral liquid-crystalline actuators and color-tunable circularly polarized luminescence (CPL) materials. Leveraging the synergistic effects of multilevel chiral transfer and polymer liquid crystals, we engineered multi-domain chiral liquid crystal actuators and color-tunable CPL materials.



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sciforum-192735: Precision Polymer Synthesis and DNA Nanotechnology: A New Land for the Design of High-Performance Hybrid Materials

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It has been shown lately that the principles of structural and dynamic DNA nanotechnology can be applied to the engineering of programmable materials, bringing the abilities of synthetic polymers closer to their biological counterparts. Here, we describe our research group's work to explore the synergy between DNA nanotechnology and precision polymer synthesis. First, the design principles enabling researchers to construct complex supramolecular architectures with predictable and dynamically adjustable material properties—using uniform ($\Phi=1$) nucleic acid-functionalized bio-hybrid polymers—are discussed. The exact chain length and perfectly defined monomer sequences of these bio-hybrids are rigorously confirmed through polyacrylamide gel electrophoresis (PAGE), ion exchange high-performance liquid chromatography (IE-HPLC), and electrospray ionization mass spectrometry (ESI-MS). Finally, two key application areas where this biologically inspired material class offers particularly promising opportunities are presented. More specifically, their potential is highlighted in two key areas: (1) as a unique toolbox for molecular information processing in bio-hybrid digital polymers, and (2) as smart aptamer-enabled bio-hybrid materials for therapeutics, drug targeting, and imaging.



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sciforum-179236: Preparation of toughened bimodal ultra-high molecular weight polyethylene by co-anchoring strategy

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Ultra-high molecular weight polyethylene (UHMWPE) is an important engineering plastic widely used in many areas such as artificial joint pads, bulletproof vests, and high-performance fibers. However, the easily disordered entanglement of its molecular chain makes it difficult to process using traditional thermoplastic processing techniques. Traditional strategies to improve its processing fluidity are usually complex and detrimental to its mechanical properties. In this contribution, salicylaldehyde Ti catalyst capable of generating UHMWPE and pyridine (diimine) Iron catalyst capable of generating low molecular weight polyethylene are co-anchored on solid supports (SiO_2 , MgO , TiO_2). The co-anchored heterogeneous catalysts are highly active in ethylene polymerization, producing toughened-bimodal UHMWPE bearing improved tensile toughness and excellent rheological properties. The molecular level entanglement of the high molecular weight and low molecular weight components enable great balance between mechanical strength and processing rheological properties. Most importantly, this type of UHMWPE material exhibited excellent gas barrier performance, extrusion performance, thermal conductivity and photodegradation performance.



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sciforum-180397: Toughening of Epoxies through the Generation of Polydimethylsiloxane Nanophases

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Epoxies have been widely applied due to their excellent thermomechanical properties, electrical insulation, and chemical stability. However, epoxies are inherently of low toughness due to their high crosslinking densities, which significantly limits the application in high-tech fields like packaging and integrated circuits. In this contribution, we reported a new approach of improving fracture toughness through the generation of nanostructures. Toward this end, we synthesized brush-like polydimethylsiloxanes (PDMS) carrying poly(ethylene oxide) (PEO) side chains through hydrosilylation reaction and fluoride-initiated ring-opening polymerization methods, and selected the linear polymer PDMS-PEO-50 with a PEO content of 50% to toughen the commonly used epoxy which type is E51. Notably, the nanostructures can be generated while the brush-like PDMS-PEO copolymers were incorporated into epoxy networks. Benefiting from the generation of PDMS nanophases, the epoxy networks significantly displayed improved fracture toughness. This work provides a new method for toughening epoxy, that is, by adding linear polymers to the epoxy.



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Session 2. Green Sustainable Polymers

sciforum-176129: Bio-based NIPU nanocarriers for the encapsulation and long-acting delivery of Paliperidone Palmitate

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Schizophrenia is classified as a chronic psychiatric disorder requiring treatment via long-acting formulations, in order to reduce the risk of patient nonadherence and subsequent relapse. In the present study, the second-generation antipsychotic Paliperidone Palmitate (PP) was encapsulated in bio-based non-isocyanate polyurethane (NIPU) nanoemulsions, targeting on its sustained release. NIPU synthesis was achieved through the isocyanate-free polyaddition route, mitigating the safety and environmental risks associated with conventional polyurethanes. The drug-loaded nanoparticles were produced via oil-in-water (O/W) emulsions and subsequent solvent evaporation and lyophilization. NIPU concentrations of 0.3% and 0.5% w/v were combined with 0.5% w/v poly(vinyl alcohol) (PVA) and various drug ratios. The neat NIPU was characterized by GPC and NMR analyses, while FTIR, DSC, XRD and DLS were employed for the characterization of the nanoemulsions. Furthermore, the nanoparticles' drug loading, as well as the in vitro dissolution of PP were evaluated. Lastly, the resulting release profiles were fitted to kinetic models. The PP-loaded NIPU nanoparticles demonstrated controlled particle size and notably elevated drug loading values. Examination of the in vitro dissolution behavior demonstrated that the formulations exhibited a system-specific burst release, followed by a controlled and sustained drug release for majority of the samples. The aforementioned findings highlight the potential of NIPU nanocarriers as drug delivery systems, particularly for applications requiring long-acting/sustained treatment efficacy.



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sciforum-163853: Cellulose Fiber Vitrimer: Dynamic Network Construction Mediated by Transesterification

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Vitrimers integrate the high mechanical strength of thermosets with the reprocessability of thermoplastics via dynamic covalent transesterification, exhibiting substantial promise for sustainable polymer technologies. Amid dwindling fossil reserves and mounting alarm over the carbon emissions tied to their extraction and use, shifting from petroleum-based vitrimer feedstocks to renewable, bio-derived counterparts has become a central frontier in sustainable materials research. However, existing bio-based vitrimers typically require full depolymerization of biomass to low-molecular-mass monomers followed by repolymerization, which suffers from complex process routes, high energy intensity, and unfavorable economic metrics. An in-situ route is presented in which rice-husk fibers are directly converted into vitrimeric materials while part of their native supramolecular architecture is preserved. Controlled carboxylation yields a biphasic system composed of high-molecular-weight rigid scaffolds and high-reactivity oligo cellulose. A dynamic covalent network is subsequently constructed with a two-component curing package comprising succinic anhydride (SA) and bisphenol A diglycidyl ether (DGEBA), affording a vitrimer (ERH-Vitrimer) that exhibits excellent thermal stability, dimensional stability, and reprocessability. The influence of the DGEBA/ERH mass ratio on thermal stability, viscoelastic behavior, and reprocessing performance was systematically investigated. Under optimized conditions, ERH-Vitrimer exhibited an onset temperature of 320 °C, and a glass-transition temperature of 112 °C, manifesting pronounced vitrimer-like behavior. ERH-Vitrimer also retained ≥ 99 % of its original tensile strength after three reprocessing cycles. Compared with a control vitrimer prepared from conventional cellulose-derived small-molecule chemicals (CAP-Vitrimer), ERH-Vitrimer displayed an 18.75% increase in tensile strength while reducing chemical usage by 22.12%. By avoiding the energy-intensive depolymerization–repolymerization cycle, the strategy has enabled the low-energy, high-value conversion of agricultural waste into strong, tough, and closed-loop reprocessable bio-based vitrimers, serving as a demonstration model for advancing the circular bio-economy.



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sciforum-191756: Nucleotide Coordination Polymer: Supramolecular Self-assembly, Crystal Structure and Functional Properties

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Nucleotides are the fundamental building blocks of RNA and DNA, participating in the storage and transmission of genetic information. They also play a crucial role in cellular energy metabolism, such as adenosine triphosphate (ATP). They participate in various biosynthetic processes, such as serving as coenzyme components. In this work, nucleotide as functional ligand with the coordination interactions of transition metal ion such as Cu(II), Ni(II), Zn(II), to form coordination polymers have been studied. A various 1D to 3D coordination polymer have been characterized by single crystal X-ray diffraction and spectroscopies comprehensively. Their structural diversity, pH- and ligand-dependent structural dimensions, supramolecular interactions, chiral induction, and their functional applications have been investigated by experimental and theoretical methods, for example, stereospecific drug binding and antimicrobial peptides. The results shown that the designing of nucleotide coordination polymers is a strategy to develop green sustainable polymers with wide applications, especially in drug delivery, amino acid recognition, biosensor and so on.



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sciforum-174931: Dimethyl 2-methylterephthalate (DMMT): a versatile building block in polyester synthesis with intriguing gas barrier properties

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This article describes the potential of using a “methyl-branched dimethyl terephthalate,” i.e., Dimethyl 2-methylterephthalate (DMMT), in the synthesis of polyalkylene methyl terephthalate. Here we propose three distinct strategies, all starting from lignocellulosic feedstock, to synthesise biobased DMMT under efficient reaction conditions. Among these three strategies, we have successfully validated two routes and will explain them in detail during the presentation. By employing linear diols with varying carbon chain lengths, three different polyesters were synthesised via the classical melt-polycondensation procedure using DMMT, respectively. All polymers exhibited high molecular weights and thermal stabilities similar to Poly(ethylene-terephthalate) (PET). The newly synthesised polyesters, Poly(ethylene-methyl-terephthalate) (PEmT) and Poly(propylene-methyl-terephthalate) (PPmT) are obtained as amorphous materials, whereas Poly(butylene-methyl-terephthalate) (PBmT) is semi-crystalline. In comparison to commercial PET, the branched methyl group is attributed with superior gas barrier properties as well as very similar tensile strength and elongation at break for PEmT. The combination of comparable mechanical properties and enhanced gas barrier performance of PEmT suggests substantial potential to replace petroleum-based polyesters in many application areas.



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sciforum-172599: Eco-Degradable Polymer Platforms with Transient Sensing for Reliable Surgical Soft Robots

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The rapid expansion of single-use medical devices has intensified concerns over medical waste, highlighting the need for eco-degradable polymer platforms that combine clinical reliability with controlled end-of-life behavior. Mechanically compliant polymers are central to soft surgical systems due to their low modulus, conformal contact capability, and processability. However, biodegradable polymers designed for surgical environments must withstand sterilization, physiological moisture, and repeated deformation without significant drift in mechanical or electrical performance. In this study, we present an eco-degradable elastomeric polymer platform integrated with transient conductive elements and systematically evaluate its stability under clinically relevant conditions, establishing its suitability for mechanically demanding, soft robotic surgical environments. We first investigate the influence of sterilization and moisture exposure on polymer network integrity through tensile characterization, focusing on modulus evolution, elongation at break, and hysteresis behavior. Moisture-induced plasticization and its impact on cyclic mechanical stability are quantified to elucidate structure–property–environment correlations. Electrical stability of transient electrodes embedded within the polymer matrix is assessed under hydrated conditions, revealing the interplay between polymer swelling, interfacial integrity, and conductive pathway retention. At the system level, cyclic pneumatic deformation is applied to probe fatigue resistance and deformation reproducibility, linking macroscopic actuation stability to underlying polymer mechanics. Integrated sensing performance is monitored throughout environmental exposure to evaluate signal robustness under concurrent mechanical and chemical stress. Finally, compost-based degradation and soil ecotoxicity analyses are conducted to assess environmental compatibility after disposal. By correlating sterilization tolerance, moisture stability, mechanical fatigue resistance, and degradability, this work establishes a materials-centered validation framework for eco-degradable polymer platforms in surgical soft systems. The results provide design guidelines for polymer architectures that balance clinical durability with programmed environmental transience.



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sciforum-171571: Eco-friendly synthesis of biodegradable PLA-based exfoliant microbeads *via* droplet microfluidics for sustainable cosmetics

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The growing concern of microplastic pollution from nonbiodegradable microbeads (MBs) used in personal care and cosmetic products (PCCPs) has become a major environmental issue due to their persistence and strong tendency to absorb persistent organic pollutants (POPs) in marine systems. This study focuses on developing environmentally friendly exfoliating agents by replacing traditional synthetic MBs with biodegradable counterparts made from aliphatic polyesters, such as poly(lactic acid) (PLA), and newly synthesized PLA-poly(ethylene glycol)-PLA (PLA-PEG-PLA) triblock copolymers. The production of these novel MBs utilized droplet microfluidics—a sustainable method that allows precise control over particle size and properties while reducing energy use and material waste. Degradation testing under various aqueous conditions showed that the microfluidically generated PLA and PLA-PEG-PLA MBs degraded more rapidly through hydrolysis and in soil compared to conventional MBs. Additionally, adsorption studies using phenanthrene as a model POP indicated a lower adsorption capacity for the new biodegradable MBs, attributed to their decreased surface area resulting from the microfluidic fabrication process. Sensory evaluations conducted with 13 trained panelists confirmed the suitability of these MBs for cosmetic use. Overall, the findings demonstrate that combining droplet microfluidics with newly developed PLA-based copolymers offers a promising, sustainable alternative to traditional MBs in personal care formulations.



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sciforum-180305: Effect of amylose/amylopectin ratio on the molecular orientation and performance of three-dimensional-printed thermoplastic starch/polylactic acid intestinal stents

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Starch, as a natural polymer, is regarded as the most promising bio-based, biodegradable raw material owing to its abundant and diverse natural sources, low cost, and inherent biodegradability. In this study, we developed three-dimensional (3D)-printed intestinal stents composed of thermoplastic starch (TPS) and polylactic acid (PLA), intended as biodegradable alternatives to conventional metallic stents. However, the influence of starch's structural features—including its molecular conformation and composition—on the performance of 3D-printed TPS/PLA stents remains insufficiently understood. Accordingly, TPS/PLA filaments were fabricated and subsequently employed in fused deposition modeling (FDM)-based 3D printing to produce intestinal stents. We systematically investigated how the amylose/amylopectin (AM/AP) ratio in the starch component affects molecular orientation, intermolecular interactions, crystallization behavior, microstructure, thermodynamic properties, mechanical performance, and hydrolytic degradation resistance. Molecular orientation was enhanced during both filament extrusion and the subsequent 3D printing process. This increased orientation promoted short-range molecular order and overall crystallinity within the starch phase. Reducing the AM/AP ratio enhanced short-range order predominantly by improving molecular orientation, thereby increasing circumferential compressive strength. Conversely, lowering the AM/AP ratio also reduced the number and size of plasticized starch domains while improving the continuity and dispersion of the PLA phase. These morphological improvements collectively enhanced both circumferential and axial compressive strength, as well as resistance to hydrolytic degradation. Collectively, these results underscore starch's strong potential—not merely as a cost-effective supplement—but as a viable primary constituent for engineering high-performance, fully biodegradable 3D-printed intestinal stents.



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sciforum-152684: Engineering 1D and 2D Shape-Morphing Biomaterials from Protein-polysaccharide Composites via Agarose Layering: Toward Programmable, Sustainable, and Stimuli-Responsive Platforms

Xiao Hu * and Nagireddy Poluri

Rowan University

Advancing the frontier of intelligent biomaterials requires convergence across materials science, bioengineering, and nature-inspired design. Here, we present a novel strategy to engineer one-dimensional (1D) rods and two-dimensional (2D) films from silk fibroin-methylcellulose (MC) composites layered with agarose, yielding environmentally adaptive, shape-morphing structures. These biopolymer materials leverage the synergistic properties of silk's hierarchical β -sheet nanostructure and MC's thermoresponsive gelation to achieve stimuli-responsive, programmable actuation—laying the groundwork for next-generation soft robotics, sustainable manufacturing, and biomedical devices. Composite systems were fabricated using formic acid solutions with varying concentrations of silk fibroin and MC, followed by surface agarose layering to induce anisotropic swelling. Thermal (TGA, DSC), morphological (SEM), and mechanical analyses confirmed tunable stiffness, porosity, and flexibility, with high elongation observed in low-silk blends and enhanced modulus in high-silk formulations. Notably, agarose-induced folding enabled programmed bending in both 1D and 2D configurations, exhibiting consistent self-actuation under ambient conditions.

This approach reveals how biopolymer composition and asymmetric layering govern structural anisotropy and actuation behavior. The one-dimensional constructs, in particular, demonstrated material-efficient transformation with greater mechanical coherence than their 2D counterparts—opening scalable pathways for low-cost, sustainable, and precision-controlled shape-shifting systems. By integrating renewable protein-polysaccharide composites with stimuli-responsive design, this platform provides a sustainable alternative to synthetic shape-memory polymers and enables dynamic, programmable structures for applications such as 4D-printed scaffolds, drug delivery systems, self-folding electronics, and eco-responsive packaging.



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sciforum-190231: Fabrication of Degradable Poly(olefin-ester) via Cross Metathesis Reaction From Unsaturated Polyester and Polydiene

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Using bio-based *cis*-2-butene-1,4-diol (cB) as a key monomer, combined with 1,4-butanediol and dicarboxylic acids of varying chain lengths (C6, C10, C12), a series of bio-based polyesters with tunable olefin content were prepared via melt polycondensation. The resulting unsaturated polyesters exhibited controlled molecular weights ($M_n = 21,245\sim58,410\text{ g}\cdot\text{mol}^{-1}$) and narrow distributions ($\mathcal{D} = 2.0\sim2.4$). Mechanical testing showed outstanding performance, particularly for the **P10**₄₋₁₀ sample, which exhibited high strength (36.7~39.3 MPa) and exceptional ductility (1070.1~1414.5% elongation at break), surpassing conventional biodegradable polyesters (e.g., PBS, PBAT).

Molecular-level recombination of unsaturated polyesters with waste polyolefin rubbers (BR, BIR, IR) was achieved via CM reactions, constructing block copolymers with tunable hard-soft segment ratios. After optimizing reaction conditions (catalyst selection: **G1/G2**; polymer concentration: 0.2~1.0 M), CM efficiency significantly improved. The resulting hybrid materials exhibited well-defined structures, with polyester segment contents ranging from 52.2 to 88.1 mol-%, uniform molecular weight distributions ($\mathcal{D} \approx 2.0$), but relatively low molecular weights ($M_n = 12,543\sim23,372\text{ g}\cdot\text{mol}^{-1}$). These materials demonstrated controllable degradation under mild alkaline conditions (1 M NaOH, 35°C), offering a novel approach for the high-value recycling of waste rubber.



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sciforum-179562: Green Pathways to Functional and Renewable Polymeric Materials

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Recent advances in polymer chemistry are opening genuinely green routes toward functional, renewable and recyclable polymeric materials. One major avenue is the use of biocatalysis (enzymes) for polymerization of monomers derived from renewable feedstocks. For example, enzymatic polycondensation of biobased diacids (e.g., furan-based) and diols or diamines affords polyesters and polyamides under mild, solvent-efficient conditions, enabling tunable architectures, controlled end-groups and enhanced degradability. These approaches demonstrate how enzymatic polymerizations can replace harsher conventional catalysis, align with renewability goals and facilitate downstream recycling.

In parallel, strategies for chemical or physical recyclability have been explored. Designing polymer backbones (and architectures) with end-of-life pathways in mind—including depolymerisation, enzymatic degradation or selective recovery of monomers—enables “circular” material lifecycles without sacrificing performance. Additionally, the integration of dynamic covalent networks or vitrimer-type behaviour has emerged as a key element: reprocessable, self-healing and adaptable polymer systems derived from biobased monomers or segments enable functional materials that combine renewability and reusability.

- (1) Silvianti, F.; Maniar, D.; Agostinho, B.; de Leeuw, T. C.; Woortman, A. J. J.; van Dijken, J.; Thiagarajan, S.; Sousa, A. F.; Loos, K. Enzymatic Synthesis of Copolyesters with the Heteroaromatic Diol 3,4-Bis(hydroxymethyl)furan and Isomeric Dimethyl Furandicarboxylate Substitutions. *Biomacromolecules* **2024**, *25* (5), 2792-2802.
- (2) Benninga, J.; Gebben, B.; Folkersma, R.; Voet, V. S. D.; Loos, K. Rapid Microwave-Assisted Chemical Recycling of Poly(p-Phenylene Terephthalamide). *Journal of the American Chemical Society* **2025**, *147* (9), 7191-7195.
- (3) Benninga, J.; Lima, G. M. R.; Ersek, G.; Portale, G.; Folkersma, R.; Voet, V. S. D.; Loos, K. Enzymatic Degradation of Poly(Butylene Adipate-co-Terephthalate)/Poly(Lactic Acid) Blends. *Journal of Polymer Science* **2025**, *63* (21), 4537-4545..
- (4) Morandi, P.; Folkersma, R.; Loos, K.; Voet, V. S. D. Dynamic Covalent Polymer Networks Based on Renewable Feedstocks: A Perspective on the Role of Vitrimers in a Closed-Loop Economy. *Biomacromolecules* **2026**, *27* (2), 1008-1023.



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sciforum-178204: Hydrogen-Bonding Synergistic Covalent Adaptable Networks: Towards Recycled Elastomers with Excellent Creep-Resistant Performance

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Chemical cross-linking is capable of improving the mechanical performance and creep-resistance of elastomers, but faces challenges in recycling and repair, leading to environmental concerns. Recent developments in covalent adaptive networks (CANs) have provided solutions for reprocessing and recycling. Although many different categories of CANs via various dynamic covalent bonds have been reported, developing strategies to overcome the dilemma between easy reprocessing and creep-resistance still deserves to be explored. This study focuses on the design and synthesis of polyurethane (PU) materials with targeted properties through the manipulation of stereochemistry in diamine chain extenders. By utilizing different cis- and trans-configurations of diamine extenders, we developed a range of PU materials with varying mechanical properties, thermal stability, and creep resistance. The trans-configured materials exhibited superior creep resistance and mechanical strength, attributed to dense hydrogen bonding arrays. Cis-configured materials displayed enhanced processability and elasticity. Both the trans- and cis-configured materials can be recycled through hot pressing or solvothermal approach via exchange reaction among urea bonds. This work demonstrates the critical role of stereochemistry in designing high-performance, recyclable elastomers with tailored properties for specific applications.



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sciforum-172587: Lignin-Containing Microfibrillated Cellulose as a Sustainable Platform Material for Energy Storage and Conversion Applications

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The transition toward sustainable energy systems demands renewable functional materials capable of replacing synthetic polymer components in energy devices. Lignocellulosic biomass, the most abundant biopolymer system on Earth, remains largely underexplored in this context. The key challenge lies not in the material itself, but in understanding how processing governs its functional properties and, in turn, its suitability for specific device applications.

In this work, lignin-containing microfibrillated cellulose (LMFC) was produced from unbleached softwood and hardwood kraft pulps carrying approximately 11% and 14% Klason lignin, respectively, via purely mechanical fibrillation - without the chemical pretreatments conventionally applied prior to fibrillation in nanocellulose production. LMFC materials were comprehensively characterized from raw pulp to final film, including fiber morphology, chemical composition, total fiber and surface charge, lignin structure by Py-GC/MS, thermal stability, and hydrophobicity. Two drying temperatures were selected relative to lignin's softening point in the wet state: one below (40°C) and one above (93°C), applied during the drying step itself rather than as a post-treatment - making property enhancement an intrinsic part of the film formation process.

LMFC films dried above lignin's softening temperature exhibited tensile strength up to 283 MPa and Young's modulus exceeding 15 GPa - superior to both lower-temperature-dried films and lignin-free MFC counterparts. Retained lignin simultaneously contributed to enhanced hydrophobicity, thermal stability, and doubled proton conductivity compared to lignin-free MFC, driven by higher total fiber charge inherited from kraft pulping. High gas pair selectivity ($\alpha(\text{H}_2/\text{N}_2) \approx 210$) confirmed excellent barrier performance. These properties were explored in two proof-of-concept energy device contexts: as separators in aqueous Zn-ion batteries (energy storage) and as proton exchange membranes in fuel cell applications (energy conversion).

The results demonstrate that LMFC, produced and processed via a simple, scalable, chemistry-lean route, constitutes a promising platform material for energy applications, with each device pathway requiring further targeted optimization.



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sciforum-180818: Mechanistic Insights into the Colloidal Stability of Synthetic Polyisoprene Latices Mediated by Protein

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Natural rubber latex (NRL) is a complex colloidal dispersion whose stability is governed by intricate interactions between hydrocarbons and non-rubber components. To isolate these effects, this study developed a biomimetic natural latex (BNL) system based on end-functionalized polyisoprene and a globular model protein. This model platform enables a systematic investigation into how the local protein environment modulates colloidal stability in ammonia-free systems.

Our findings reveal that the BNL particles possess a distinct core-shell architecture, with the protein creating a hydrophilic protective layer. We identified a concentration-dependent structural transition within this interfacial layer: at optimal concentrations, the protein corona provides robust steric stabilization and hydration; however, exceeding a critical threshold triggers interfacial compaction and dehydration, leading to a decline in stability. Rheological characterization further demonstrates that the mechanical integrity of the interface is highly sensitive to the protein dosage, evolving from a swollen, hydration-dominated state to a condensed film. This work clarifies the fundamental mechanisms by which proteins govern latex stability, providing a scientific basis for the design of sustainable, bio-inspired latex preservation strategies.



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sciforum-175027: Mechanochemical Preparation of Solid Dispersions of Poorly Soluble Bioactive Compounds with Functional Carriers

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Introduction: Poor aqueous solubility of many bioactive compounds limits their dissolution and bioavailability, necessitating the development of efficient and sustainable enhancement strategies. Solid dispersions (SD) with functional carriers are widely used to improve dissolution behavior by modifying intermolecular interactions and inhibiting aggregation or crystallization. Mechanochemical methods, such as solvent-free extrusion and milling, offer a scalable and environmentally friendly approach to the preparation of such systems. In this work, mechanochemical techniques were applied to obtain solid dispersions of poorly soluble bioactive compounds (benzocaine, resveratrol, and quercetin) using carboxymethyl cellulose and β -cyclodextrin as carriers.

Methods: Solid mixtures of poorly soluble bioactive compounds and carriers (weight ratio 9:1) were subjected to mechanochemical treatment at room temperature (25°C) using twin-screw extruder (Berstorff, Germany) and a SPEX-8000 vibrational mill.

Results: FTIR spectroscopy confirmed the formation of intermolecular interactions between the carriers and the bioactive compounds. XRD analysis revealed a decrease in the crystallinity of the active substances upon mechanochemical treatment, indicating partial amorphization accompanied by molecular dispersion of the bioactive compounds within the carrier matrix. These findings are in good agreement with DSC data, which likewise confirm the amorphization of the initially crystalline compounds after processing. SEM showed that mechanochemical treatment leads to a reduction in particle size of both the carrier and the drug, resulting in the formation of a homogeneous solid dispersion. UV spectroscopy demonstrated that the obtained solid dispersions exhibit increased apparent solubility and enhanced dissolution rates compared to the initial pharmaceutical substances.

Conclusions: Mechanochemical methods, including extrusion and milling, represent a promising approach for the preparation of solid dispersions of poorly soluble bioactive compounds with enhanced aqueous solubility and dissolution rate.

Acknowledgments:

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sciforum-172140: Novel NIPU Sponge-Derived Nanoemulsions as Sustained Chloramphenicol Carriers for Wound Therapy: In Vitro Cytotoxicity (MTT), Antimicrobial Performance and Franz Cell Permeation Studies

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The increasing demand for sustainable polymeric materials has accelerated research toward greener alternatives to conventional polyurethanes. Non-isocyanate polyurethanes (NIPUs) have emerged as promising candidates, as they eliminate toxic isocyanates and can be synthesized from bio-based precursors through the reaction of cyclic carbonates with amines. This approach aligns with green chemistry principles by reducing environmental impact while improving safety during synthesis and application.

In this study, bio-based NIPU polymeric sponges were developed as platforms for the sustained topical delivery of chloramphenicol (CHL), a broad-spectrum antibiotic for wound treatment. The NIPUs were synthesized via polyaddition of glycerol carbonate with 1,6-hexamethylenediamine and bio-derived di-acids (adipic, succinic, azelaic, and malonic). Structural characterization by FTIR confirmed urethane bond formation, while SEM analysis revealed a highly porous morphology favorable for drug loading and controlled release. Swelling studies demonstrated significant moisture retention, supporting a suitable wound-healing microenvironment, and enzymatic hydrolysis indicated a degradation profile compatible with biomedical use.

Biological evaluation showed satisfactory cytocompatibility, as assessed by MTT assays, confirming the suitability of the NIPU matrices for topical applications. Furthermore, antimicrobial studies verified the effective antibacterial activity of CHL-loaded sponges against representative pathogenic strains. Overall, the developed NIPU-based sponges represent a sustainable and biocompatible drug-delivery system with potential for prolonged antibiotic release and improved wound care performance.



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sciforum-180392: Polydimethylsiloxane Crosslinked with Benzyl Hindered Urea Bonds: Reinforcement with Lignin, Reprocessing and Functional Properties

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Polydimethylsiloxane (PDMS) networks possess excellent chemical and thermal stability, biocompatibility, and intrinsic hydrophobicity. However, their application is limited by low mechanical strength; their static crosslinked structures hinders reprocessing and recycling properties. Hindered urea bonds (HUBs) have recently gained attention for their catalyst-free dynamic exchange under mild conditions, offering a promising route to recyclable polymer networks. In this contribution, we reported the integration of dynamic benzyl hindered urea bonds into PDMS networks. In the meantime, lignin was incorporated into the networks. It was found that the resulting PDMS networks exhibit excellent reprocessing properties and excellent shape memory properties. Benefiting from the incorporation of lignin, the PDMS networks displayed improved thermal and mechanical properties. Moreover, the PDMS networks had remarkable photothermal properties. Furthermore, the photothermal effect can be utilized to trigger shape recovery of the materials in a non-contact fashion. This work demonstrates a strategy of developing sustainable, high-performance PDMS materials with functional properties.



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sciforum-174706: Recyclable Polymer Networks from Renewable Raw Materials via Thiol-X Chemistries

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Transforming traditional thermosetting materials into sustainable and recyclable is attracting significant attention. Thiol-X chemistry has presented itself as an invaluable toolkit to achieve polymeric materials from renewable raw materials. Starting from sustainable phenolic compounds (vanillin, eugenol, guaiacol, etc.), we advanced the thiol-aldehyde, thiol-oxazoline and thiol-benzoxazine chemistries for the fabrication of crosslinked polymer networks. Polymer networks containing dithioacetal groups from thiol-aldehyde condensation are thermally processable and degradable under oxidative conditions. Particularly, the mechanical strength of the polydithioacetal polymers can be enhanced through creating nanocomposites with cellulose fibers through Pickering emulsion polymers, or by controlled oxidation of dithioacetal groups without breaking the mainchain. Crosslinked polyamide networks from thiol-oxazoline addition were reshapable with the assistance of water. Phenolic networks from thiol-benzoxazine addition were found to be readily soluble in organic solvents, such as THF, DCM and toluene, and regenerate the structure after drying. These methods provide promising opportunities to renewable materials with enhanced performances and sustainability.



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sciforum-168828: Recycling Thermoset Polyurethanes via Covalent Adaptable Networks: The Role of Crosslink Density in Performance Retention

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Introduction

Thermoset polyurethanes (PUs) are widely used thanks to their excellent mechanical and chemical resistance, but their permanent crosslinked structure severely limits recyclability. Covalent Adaptable Networks (CANs), enabled by dynamic covalent chemistry of urethane bonds, offer a promising route for the reprocessing of thermoset PUs without complete depolymerisation. However, a clear understanding of how network parameters affect reprocessability and property retention is still lacking.

Methods

In this work, the recyclability of thermoset polyurethanes was investigated through two complementary approaches. First, an industrially available, partially biobased thermoset PU was reprocessed multiple times by mechanical grinding and hot pressing. Second, model PU networks with comparable chemistry but different crosslink densities were synthesised to isolate the role of network architecture. Pristine and reprocessed materials were characterised by FTIR, DSC, TGA, DMA, swelling tests and tensile measurements. Stress relaxation experiments and Kohlrausch–Williams–Watts (KWW) analysis were used to investigate relaxation mechanisms and define reprocessing conditions.

Results

The biobased commercial PU could be successfully reprocessed up to three times, maintaining thermal stability and showing improved tensile strength and elongation at break despite a moderate decrease in crosslink density. In contrast, model systems revealed that effective property recovery strongly depends on crosslink density. Highly crosslinked networks retained mechanical performance after reprocessing, while loosely crosslinked systems exhibited poor cohesion and significant property loss. KWW analysis indicated that dynamic bond exchange dominates relaxation only in sufficiently crosslinked networks.

Conclusions

These results demonstrate that urethane-based CANs can enable effective recycling of industrially relevant thermoset polyurethanes. Crosslink density emerges as a key design parameter governing reprocessability and mechanical performance retention, providing clear guidelines for the development of recyclable thermoset PU materials.



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sciforum-175024: Solvent-free Modification of Chitosan with Sorbic Acid for Tunable Stabilization of ZnS Quantum Dots

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Introduction: Efficient stabilization of quantum dots (QDs) in aqueous media is essential for controlling their size and colloidal properties. Polymeric matrices are widely used to regulate nanoparticle formation and aggregation. Chitosan (CS) is a promising stabilizer whose behavior depends on its macromolecular structure and intermolecular interactions. Chemical modification by introducing hydrophobic moieties enables tuning of these properties. In this work, chitosan derivatives with different degrees of substitution (DS) were synthesized via solid-state modification with sorbic acid (SA) using twin-screw extrusion and evaluated as stabilizing matrices for ZnS QDs.

Methods: Hydrophobically modified chitosan derivatives (CS-SA) were prepared by reactive extrusion at 80°C and 60 rpm. Chemical interaction between CS and SA was confirmed by FTIR spectroscopy. Elemental (CHN) analysis revealed DS values of 0.08 and 0.14 for CS/SA molar ratios of 1:0.5 and 1:1, respectively. ZnS QDs were synthesized in the presence of native and modified matrices. Hydrodynamic diameter and size distribution were determined by dynamic light scattering using a Malvern Zetasizer.

Results: A 0.2% solution of native CS exhibited a mean hydrodynamic diameter of 472 nm, indicating polymer aggregation. ZnS QDs stabilized with unmodified CS showed a bimodal distribution (~50 nm and ~400 nm). The CS-SA derivative with DS=0.08 demonstrated a predominantly unimodal distribution with a main peak at ~60 nm and a reduced contribution of large aggregates. Increasing the DS to 0.14 shifted the main peak to ~100 nm and increased polydispersity, indicating tunable nanoparticle assembly depending on the modification degree.

Conclusions: Solid-state extrusion enabled the preparation of CS-SA derivatives with controlled DS (0.08–0.14). The degree of substitution influences ZnS QD aggregation behavior and allows regulation of particle size. This solvent-free approach offers a sustainable strategy for designing functional chitosan-based polymer nanomaterials.

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sciforum-173684: Structure and properties of biobased and biodegradable polymers

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From both fundamental research and practical application perspectives, biobased and/or biodegradable polymers have recently attracted considerable attention. Actually, biobased and biodegradable are two different items. Some polymers are only biobased but not biodegradable, such as furan based polymers, while some polymers are biodegradable but not biobased, such as PBAT, PBST, and PCL. Some polymers are both biobased and biodegradable, such as PES, PBS, PHA, and PLLA. In our lab, we synthesized many different kinds of biobased and biodegradable polyesters, such as PES, PBS, PEA, PLLA, PBF, PPF, PHF, PNF and so on, and these polymers based copolymers, polymer blends, polymer composites. We have been modifying the chemical and physical structures and adjusting the physical properties of biobased and/or biodegradable polymers using different methods, including copolymerization, polymer blending, and polymer nanocomposite. In this topic, we will briefly introduce the recent progress of the structure and properties of biobased and/or biodegradable polymers of our lab.



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sciforum-179598: Synergistic Integration of Natural and Synthetic Polymers in Cellulosic Fibrous Interfaces for Multifunctional Wearable Systems

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Cellulose fibers are typical natural polymeric materials with advantages such as renewability, flexible porous structures, and good biocompatibility. However, their intrinsic functionality is limited and their interfacial responsiveness is insufficient, making them difficult to meet the requirements of smart materials for multifunctional integration and stable signal output. Synthetic polymers possess advantages of tunable structures and controllable functionalities, making them one of the ideal materials for overcoming the functional limitations of natural polymers. To address this issue, this work adopts a “natural polymer-synthetic polymer” synergistic construction strategy by introducing multifunctional polymers onto cellulose fiber substrates to build multiscale interfacial functional layers, thereby achieving performance complementarity and functional coupling. To overcome the smooth surface of regenerated cellulose fibers that hinders stable loading of nano-functional materials, an interfacial polydopamine (PDA) layer is constructed via in situ polymerization to achieve stable MXene immobilization, and poly(glycidyl methacrylate) (PGMA) is introduced as a reactive interfacial layer to provide active sites for grafting antibacterial polymers, thereby constructing a composite system with high-sensitivity pressure sensing, electromagnetic interference shielding, and antibacterial performance. Subsequently, a metal-organic framework-carbon dot system with antibacterial and bacterial detection functions is stably immobilized on the fiber surface using poly(vinyl alcohol) (PVA), resulting in a smart dressing that integrates antibacterial activity and bacterial monitoring. Meanwhile, through a Janus structural design, a PEDOT:PSS thermosensitive conductive layer and a thermochromic polymer microcapsule layer are constructed on the two sides of the fibers, enabling synergistic electrical temperature sensing and visual temperature feedback. In summary, through interfacial modification strategies, PDA, PGMA, PVA, and antibacterial polymers are stably introduced onto the fiber surface, significantly enhancing interfacial binding and long-term stability of functional components, thereby providing a feasible pathway for the design of multifunctional fiber-based smart materials.



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sciforum-188711: The dynamic cross-linking strategies simultaneously enhance the mechanical and processing properties of polyurethanes

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Our team has long pursued the research of elastomers. To address the ubiquitous trade-off between mechanical properties and processability in elastomers, this work proposes new molecular design strategies based on the temperature-responsive behavior of dynamic covalent bonds, and constructs two types of dynamically cross-linked polyurethane systems with promising industrial application potential.

(1) Short-chain dynamic cross-linking achieves synergistic plasticization and reinforcement: we have proposed and verified the effectiveness of small molecule crosslinking agents in simultaneously strengthening and plasticizing polyurethanes, achieving a 100-fold increase in strength and toughness while reducing processing viscosity by 50% and solid-liquid transition temperature by 31 °C. This molecular design was further applied to the melt-spinning preparation of elastic conductive fibers. Furthermore, a plasticizing reinforcing agent featuring dynamic cross-linking was designed based on the above mechanism. It possessed a stable cross-linked structure at 25 °C, effectively reinforcing matrix material, and dissociated oligomers and small molecules at high temperatures, exerting a plasticizing effect. This strategy not only increased the strength of thermoplastic polyurethane to 75.8 MPa, but reduced viscosity during processing by 70%. Its versatility has been confirmed by the reinforcement and plasticization of other polymers such as poly(lactic acid) and polyvinyl chloride.

(2) Multi-arm dynamic covalent cross-linked polyurethane: we have designed a four-arm dynamic polymer crosslinking site with chemical coupling effect. This topological structure strategy not only increased the crosslinking density of network, effectively enhancing the mechanical and solvent resistance properties of the material in usage environment; but endowed the network with more thermally responsive dynamic bonds, improving thermoplastic processing performance. As the temperature increased from 30 °C to 150 °C, the ratio of dynamic storage modulus $G'_{\max}$ to $G'_{\min}$ reached 153.3, which is the highest value among those of reported cross-linked polyurethanes to date.

These works resolve the long standing contradiction between mechanical and processing properties, providing a new strategy for the development of high-performance and easy-to-process polymers, and offering a new perspective for the practical application of dynamic covalent bonds. The molecular design strategies have significant theoretical significance and practical value.



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sciforum-174826: Valorization of textile waste for the manufacture of panels with new sustainable materials

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Introduction

Textile industry generates 10% of global CO₂ and approximately 92 million tons of textile waste per year.

One of the simplest and most robust ways to address this problem is mechanical recycling to obtain panels (downcycling). This work presents three mechanical recycling solutions (downcycling) using shredded cotton from used clothing combined with different binders of natural origin to, subsequently, evaluating their compressive strength, acoustic properties and resistance to environmental humidity accumulation.

Methods

Three types of panels composed of cotton fibers from textile waste (105 g per specimen) were developed using three variants of biodegradable binder solutions: starch-glycerol, starch-glycerol-casein and sodium carboxymethylcellulose (CMC).

The specimens were manufactured by compression molding in molds of 100 mm diameter and 40 mm thickness. After thermal curing at 60 °C for 24 h, the compressive Young's modulus and relative humidity were evaluated as well as sound absorption coefficient at normal incidence according to ISO 105334-2.

Results

The best result in acoustic absorption was obtained for CMC, being also the group that obtained the lowest elastic modulus and lowest capacity to retain environmental humidity. These results reveal that a less rigid structure and reduced water absorption capacity are a key factor to improve insulation.

Table 1. Young's modulus, humidity and absorption coefficient values of specimens

Specimen;Young's modulus (MPa);Max Absorption Coefficient (σ);Humidity %

Starch/glycerol;8.96;0.64;3.58

Starch/glycerol/casein;3.99;0.52;9.95

CMC 3.92;0.77;6.07

Conclusions

In conclusion, this study demonstrates a potential downcycling solution of textile waste using natural binders such as CMC, with a low environmental impact and with possible applications in different sectors such as the construction sector.

Acknowledgements

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Session 3. Polymer Processing

sciforum-180100: Investigation of Polymer Deformation Mechanisms by Rheo-NMR

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Nuclear Magnetic Resonance (NMR) spectroscopy stands as one of the most vital analytical characterization techniques in materials science, playing an irreplaceable role in elucidating chemical structures and dynamics. During processing and service, materials are often subjected to external fields, leading to alterations in their internal structure and dynamics. In the laboratory, mechanical properties are typically characterized via uniaxial tension or shear. However, rheometers themselves struggle to directly capture structural and dynamic information.

In this work, we employ the recently developed in situ tensile NMR apparatus, Rheo-Spin NMR, which enables the simultaneous acquisition of macroscopic stress-strain curves and microscopic chain dynamics. In this presentation, we will discuss the applications of Rheo-Spin NMR in the following area: Deformation mechanisms of polymer networks under small and large strains. The combined macroscopic stress-strain data with microscopic insights into chain relaxation and orientation provide a solid experimental foundation for ultimately achieving a coupling of multi-scale structure and dynamics.



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sciforum-180315: Achieving Concurrent Transparency and Stability Improvements in Quantum-Dot Films via Polymer Encapsulation

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Quantum dots (QDs) feature narrow emission spectra, high color purity, and strong photoluminescence, with size-dependent tunability that enables a wide range of optoelectronic applications. However, their sensitivity to oxygen, moisture, light, and heat can cause defect formation and structural degradation, significantly reducing device reliability. This issue has increased interest in protection strategies, with polymer encapsulation emerging as a simple, device-friendly method that has gained widespread attention. In this work, a multilayer spin-coated barrier structure is fabricated based on a styrene–methyl methacrylate copolymer (SMMA) matrix containing nano-glass flakes (MGF). The glass flakes help match the refractive index and improve optical transparency. In the multilayer architecture, micro- and nanoscale MGF are incorporated to control their orientation distribution. This orientation-controlled arrangement increases the tortuosity of moisture and oxygen diffusion pathways, thereby enhancing barrier performance. As a result, the multilayer SMMA–MGF barrier film remains highly transparent while providing effective protection for QDs against environmental damage. By integrating MGF and managing refractive index within the multilayer structure, the resulting QD films demonstrate high transparency, excellent barrier properties, and compatibility with large-scale manufacturing. This multilayer polymer–glass packaging combines improved transparency and stability, allowing the films to achieve a color gamut of 112% NTSC. It also exhibits strong environmental and photostability, with fluorescence intensity staying near 100% and a photoluminescence quantum yield (PLQY) around 85% after 720 hours of humid-oxygen aging. Additionally, it retains about 80% and 60%, respectively, after 360 hours of blue-light exposure. These results demonstrate the material's resistance to light, moisture, and oxygen, highlighting the effectiveness of this packaging strategy for durable QD-film protection in practical applications.



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sciforum-182463: Challenging and Opportunities of Radiation Processing for Polymers

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Radiation technology has been employed in polymer processing for a long time to achieve high performance, although it seems not widely recognized in the scope of polymer scientists and engineers, this technology has an irreplaceable advantage over conventional polymer processing methods. Radiation crosslinking is the mostly applied route to fabricate thermal resistant or heat-shrinkable polyethylene/EVA and many other polymer materials. By applying electron beam irradiation processing, the cost of radiation crosslinking could be competitive. To meet industrial needs, much higher thermally resistant nylon or PBT are recently also commercialized via radiation crosslinking. This type of crosslinked PA/PBT components can withstand short-term high temperatures (much higher than melting point) without melting or failure. PTFE is a typical radiation degradable polymer, it micropowder has been produced commercially by a combination of irradiation and grinding, however, a substantial amount of PFOA or PFAS is formed during the irradiation in air, and such PFOA need to be removed 25 ppb under the current EU regulation. In this talk, the challenges and opportunities of radiation processing will be introduced, with several well-known polymer materials cited as case studies.



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sciforum-180707: Combining CFD Simulation and Experimental Investigation for the Development of Adaptable Single-Screw Extruder Mixing Elements

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Plastics can be tailored to specific properties by blending with other polymers or fillers, where the mixing process has a decisive impact on the final product properties. In extrusion, screws are typically designed for a specific material-throughput combination. Under varying operating conditions, however, this often results in overdimensioned mixing performance and unnecessary energy input, leading to higher energy consumption than required. With rising energy costs, this is not economically advantageous.

To address this issue, an adaptable mixing element has been developed that can adjust its mixing performance during operation without retooling to meet material requirements. In this study, several pre-defined mixing geometries were first evaluated using computational fluid dynamics (CFD) simulations based on pressure profiles and distributive mixing performance, and the most promising configuration was selected for manufacturing and experimental investigation.

The results demonstrate the potential of the proposed design to provide adjustable mixing performance and controllable energy input. The combination of simulation and experimentation provides a foundation for the further development and optimization of adaptable extruder mixing elements.



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sciforum-180472: Design and Characterization of Hierarchical Structures in Polymer Processing

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Polymer materials can only achieve valuable products through processing and molding. Designing specific oriented structures during processing is a crucial approach to achieving high performance and functionalization of polymer materials, playing a vital role in the national economy and major demand sectors. However, the formation of these oriented structures is closely related to external fields such as flow field, temperature field, and pressure field. These fields are often characterized by high intensity, short duration, and strong coupling, making it difficult to precisely resolve the formation mechanisms of oriented structures under their combined influence. Furthermore, oriented structures exhibit typical multi-scale characteristics and diversity, with nonlinear relationships to product's performance. Consequently, achieving precise control over the generation of oriented structures and elucidating their structure-property relationships presents a significant challenge. Therefore, this report will introduce recent research progress in efficient design of multi-scale structures and high-throughput in-situ characterization, specifically including: (1) Establishing high-throughput in-situ characterization methods to address the research challenge of tracking rapid evolution of oriented structures, visualizing millisecond-scale formation kinetics of multi-scale structures under strong external field coupling; (2) Efficiently designing oriented structures through multi-field coupling effects, establishing orientation methods for multi-scale structures including amorphous, crystalline, and dispersed phases, breaking through material performance limitations, and achieving excellent comprehensive properties that cannot be obtained through conventional processing.



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sciforum-180628: Microfluidic-based Technology for Tailoring the Structure of Nanofiber membranes

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Nanofiber membranes, known for their excellent mechanical properties and unique fibrous structure, have attracted considerable interest for applications in flexible wearable devices, electronic skin, energy storage, and separation. However, traditional fabrication methods often suffer from pore defects and limited control over fiber orientation, which compromise mechanical performance and hinder large-scale application. In this work, we employ a microfluidics-based approach to precisely manipulate fluids at the micrometer scale. Stable laminar flow within microchannels enables controlled membrane formation with precise thickness regulation, symmetric structure, and highly oriented assembly of two-dimensional nanosheets. By tuning flow velocity, residence time, channel aspect ratio, and solvent exchange dynamics during coagulation (including nanofiber protonation), we convert liquid laminar flow into continuous nanofiber membranes. Microfluidics-based aramid nanofiber (ANF) membranes achieve a thickness of 140 ± 25 nm with symmetric surface morphology, resulting in a high tensile strength of 667 ± 40 MPa compared to membranes prepared by casting or vacuum filtration [1]. Similarly, regenerated cellulose and diacetate cellulose membranes show 42% and 94% improvements in tensile strength, respectively. Moreover, the pore structure of these membranes can be controlled via coagulation bath composition or pore formers such as polyethylene oxide [2]. Under laminar flow, graphene oxide nanosheets achieve an orientation degree as high as 0.93 and high mechanical strength [3]. Overall, this microfluidic strategy offers a new route for tailoring the microstructure of nanofiber membranes, advancing their applications in flexible electronics, intelligent sensing, and renewable energy.

Reference

- [1] Xiao Chen[#], Jiaqing Su[#], Sha Cheng, Cheng Huang, Chunxia Zhao, Chao Teng*, Pengchao Zhang*, *Mater. Horiz.* 2024, 11, 5103
- [2] Shaopeng Liu, Sha Cheng, Cheng Huang, Jin Han, Jingjing Xie*, Pengchao Zhang*, Ya You, Wen Chen, Zhengyi Fu, *Small* 2024, 20, 2404639.
- [3] Xiao Cheng, Sha Cheng, Runyu Duan, Cheng Huang, Ming Liu, Ruiqi Che, Xiao Chen*, Chao Teng, Pengchao Zhang*, *Small* 2025, 21, 2500151.



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sciforum-190996: Research Progress on the Principles of Polymer Processing and Equipment Innovation

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The academic report mainly includes the following contents:

In the field of precision plastic molding, the lab deciphered the core principles of mold accuracy control. Through collaboration with Ningbo Haitian Plastics Machinery, it further enhanced the precision of injection molding machines, achieving industrial-scale application and winning the Second Prize of the National Science and Technology Progress Award. Based on this, the team originally proposed a new concept of "polymer 3D copying" for intelligent manufacturing;

In the field of molten nanofibers, the lab pioneered a green intelligent manufacturing technology—differential electrostatic spinning of polymer melt nanofibers. The resulting high-end filtration materials have been successfully applied in critical fields such as China's space station, earning the Second Prize of the National Technology Invention Award;

In low-carbon intelligent manufacturing of high-end tires, the lab proposed a new theoretical framework for tire rolling resistance and invented novel tire structures along with electromagnetic induction vulcanization equipment for precise shaping.

Furthermore, through interdisciplinary innovation at the intersection of new materials and clean energy, the lab has developed technologies such as the "Clean Energy Core" for enhanced heat transfer and a "Firecracker-Style" controllable nuclear fusion clean energy technology based on radiative cooling. Leveraging its scientific innovations and industry collaborations, the team has led the establishment of the "China Plastics Machinery Innovation Talent Training Base," advancing engineering education from traditional "metalworking practice" to advanced "high-end engineering practice." This initiative has cultivated a large number of high-level talents, effectively supporting the high-quality development of the industry.



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sciforum-174813: Specific Study of the Application of ISO/ASTM 52924 Standard in the Classification of Finished Parts Manufactured by Laser-Based Powder Bed Fusion with PA12

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In the context of the manufacturing industry, the relevance of classifying properties of parts made by additive manufacturing (AM) is because it helps engineers, designers, and manufacturers predict performance, ensure quality, and choose the right process and materials. This is the reason why the new standard ISO/ASTM 52924 [published in 2023] was developed by the international bodies for standardization in Additive Manufacturing (ISO TC261, ASTM F42 and CEN TC438). This standard, for classification of AM plastic part properties defines the categories of properties for polymer parts produced by AM, with the goal of establishing a shared understanding of part quality. This standard focuses on AM technologies for plastics, in particular Powder Bed Fusion (PBF) and Material Extrusion (MEX). The classification indicated by the standard is based on the mechanical, physical, and geometric properties of the final part, in particular tensile property (Tensile modulus, Tensile strength, Elongation at break), relative density (%) and dimensional accuracy. A total of 11 classes are established (from class 0 to class 10), grouping each parameter within a minimum and maximum range.

This work shows how the classification level (ISO/ASTM 52924) of the final part is affected by the percentage of reused powder and the use of nitrogen gas, in the process of laser-based Powder Bed Fusion (PBF-LB) of polyamide PA12. The modified process conditions were the use or not of nitrogen gas inside the chamber, and the use of 100% virgin PA12 powder versus 75% of reused PA12 powder.



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Session 4. Polymer Networks and Gels

sciforum-179819: Crosslinkable Polysaccharides for Developing Functional Injectable Hydrogels for Wound Healing

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The healing of chronic and infected wounds demands multifunctional dressing that combine adaptability, infection control, oxidative stress regulation, and tissue regeneration. Polysaccharides such as chitosan and cellulose are highly values in wound healing due to their inherent biocompatibility, biodegradability, and bioactivity. Injectable hydrogels, in particular, offer unique advantages for covering irregular wounds, enabling minimally invasive delivery, and facilitating in situ gelation. In this work, we present a versatile platform based on chemically modified chitosan and cellulose to construct injectable hydrogels via three distinct crosslinking strategies: reversible boronate ester bonds, supramolecular host-guest interactions, and Diels-Alder cycloaddition. By functionalization of polysaccharides with catechol/phenylboronic acid, adamantane/cyclodextrin, or furan/maleimide moieties, we achieved rapid and tunable gelation, shear-thinning injectability, and in most cases self-healing properties that enable conformal coverage of irregular wounds. Dual functionalization of polysaccharides with antimicrobial groups (such as quaternary ammonium moieties), antioxidant groups (such as catechol moieties) or physical encapsulation of antimicrobial/antioxidant agents (such as epigallocatechin gallate, berberine, neomycin) or loading of probiotics could render the hydrogels strong antimicrobial and antioxidant functionality. The hydrogels could slowly release the therapeutic agents to prevent the wound infection and inflammation. These natural-based hydrogels showed excellent biocompatibility against NIH3T3 fibroblast cells and potent antimicrobial activity against *S. aureus* and *E. coli*. In vivo full-thickness skin defect models demonstrated that these hydrogels significantly accelerate wound closure, promote collagen deposition and enhance tissue remodeling compared to commercial dressings.



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sciforum-174736: Tuning aromatic affinity in PMHS through phenyl functionalization for efficient hydrocarbon separation

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The removal of aromatic compounds from naphtha is a critical yet challenging step in olefin production, as these species do not effectively participate in cracking reactions but instead promote coke formation in the furnace. Consequently, the separation of aromatic and aliphatic fractions is essential for molecular refining and process optimization. Their similar physicochemical properties make the separation of aromatics and aliphatics highly difficult, demanding more efficient separation technologies. Among the available approaches, pervaporation has attracted considerable attention owing to its relatively low energy consumption. Polymeric membranes, in particular, are the most extensively investigated because of their good film-forming ability and cost-effectiveness; nevertheless, their separation performance still requires further improvement. To date, most studies on aromatic–aliphatic pervaporation separation have focused on aromatic-affinity membranes. These membranes exploit the polarization of aromatic molecules with delocalized π electrons induced by polar functional groups, which leads to distinct diffusion behaviors of aromatic and aliphatic molecules within the membrane and thus enables selective separation. In this study, various functional groups were introduced into poly (methylhydrosiloxane) (PMHS) materials via side-chain modification, and their performance in the separation of toluene/n-heptane mixtures was evaluated. The results demonstrate that incorporating phenyl side chains enhances membrane separation performance via the π – π interactions with toluene. Notably, in the one-step preparation method employed in this study, side-chain modification and membrane crosslinking both proceeded via hydrosilylation and thus competed with each other. The phenyl-modified membrane (PPhMS) exhibits optimal separation performance at a PMHS-to-styrene mass ratio of 1:0.3. At 40 °C, the permeation flux and separation factor for a 50/50 wt% toluene/n-heptane mixture are 1.23 kg m^{−2} h^{−1} and 6.1, respectively. This study is expected to provide valuable insight into the application of phenyl-modified silicone rubber membranes for aromatic/aliphatic hydrocarbon separation.



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sciforum-171861: A Bioactive Nanocomposite Hydrogel Modulates the Wound Microenvironment and Accelerates Healing with Niosome-Loaded Delivery

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Advanced wound dressings that modulate the wound microenvironment, allow for sustained therapeutic delivery and limit pathological scarring are an ongoing challenge in regenerative medicine. A multifunctional nanocomposite hydrogel was prepared using iota and lambda carrageenan, gelatin and glycerin and crosslinked with CaCl₂. This hydrogel was next functionalized with hyaluronic acid grafted with L-arginine (HA-Arg) for enhanced cellular response. Niosomes that were packed with asiaticoside were additionally included in the hydrogel for therapeutic biochemical signalling at the nanoscale level. The niosomes which were formed showed they were nanometric in size (± 160 nm), low polydispersity (0.30 ± 0.04), stable negative surface charge, high encapsulation efficiency (up to 82%) and sustained release of loaded drugs for a period of 72 h. As determined by various structural and physiochemical characterizations, stable hydrogel formation with favourable porous architecture, swelling behaviour, thermal stability and homogeneous distribution of nanovesicles was well established. The produced hydrogel when assessed in vitro showed excellent biocompatibility, hemocompatibility and anti-bacterial activity along with improved cell and blood-material interaction. In vivo evaluation of designed hydrogel in full-thickness wound model of rats indicates faster healing kinetics. The final hydrogel containing niosomes promoted wound closure up to ~80% at day 14 as compared to ~70% in untreated control group with faster contraction of. Thus, this system will be able to offer scarless healing by providing a suitable microenvironment.



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sciforum-173323: Metal-Coordination Polysiloxanes Based on Dibenzoylmethane: Synthesis, Structure and Properties

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The development of modern materials science requires the functionalization of polymer matrices to impart specific properties, such as enhanced mechanical strength and controlled curing kinetics. This research focuses on the development of hybrid macromolecular systems by integrating dibenzoylmethane (DBM) fragments into polysiloxane matrices. While traditional siloxanes often lack sufficient intermolecular interactions, the introduction of chelating β -diketone groups allows for the creation of coordination-crosslinked networks. These systems are designed to address the needs of modern technologies by providing high-speed curing kinetics, sensitivity and tunable mechanical properties.

The synthesis strategy involved the functionalization of siloxanes using hydrosilylation reactions with an allyl derivative of DBM. The structure and composition of the obtained compounds were characterized using IR and NMR spectroscopy, mass spectrometry, X-ray diffraction analysis, and gel permeation chromatography. Thermal stability was assessed via TGA and DSC, mechanical and rheological properties were studied using dynamometry and rheometry, and optical properties were studied by UV-Vis and luminescent spectroscopy.

A series of monomeric, oligomeric, and polymeric siloxanes containing DBM fragments were synthesized, including coordination-crosslinked polymers synthesized by reacting DBM-containing polysiloxanes with metal acetates, boron trichloride, or organometallosiloxanes. The study demonstrated that the architecture of the resulting systems is directly influenced by the structure of the siloxane spacer between ligand fragments. Furthermore, coordination-crosslinked polymers demonstrated a significant increase in viscosity and improved mechanical characteristics compared to non-modified siloxanes, as well as self-healing, recyclability and sensing properties.

The research established a systematic approach to creating hybrid metal-organosilicon systems. The synthesized coordination-crosslinked polymers exhibit high vulcanization rates and tunable mechanical and optical properties, making them promising for additive technologies and luminescent composite materials. The findings expand the fundamental understanding of siloxane polymer chemistry and offer new pathways for designing smart materials with programmable characteristics.



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sciforum-179880: Modulation of the Mechanical Properties of Supramolecular Crosslinked Networks

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Supramolecular crosslinked networks formed via non-covalent interactions have emerged as a vital complement to traditional chemically crosslinked polymers, owing to their remarkable dynamic properties such as self-healing, stimulus-responsiveness, and reprocessability. To date, although a variety of supramolecular crosslinked networks with diverse structures and properties have been constructed based on different supramolecular motifs, their insufficient mechanical performance remains a bottleneck hindering further development. To address this, we have developed a series of strategies to enhance the mechanical properties of these networks by multi-scale structural modulation of cross-link dissociation: 1) Through molecular design, interlocked and woven cross-links were created, establishing a novel mechanism of topological confinement to suppress supramolecular dissociation, thereby improving material strength, stability, and strain recovery; 2) By linearly connecting cross-links, continuous supramolecular cross-link chains were constructed, where cooperative dissociation amplified energy dissipation, resolving the classic strength–toughness trade-off; 3) Based on phase separation, heterogeneously distributed cross-links were prepared, enabling precise construction of heterogeneous structures and achieving programmable regulation of mechanical properties.



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sciforum-170416: Single-step grafting of a thermoresponsive RAFT polymer from nanocellulose by radical decarboxylation

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Nanocellulose-polymer composites are emerging as advanced materials with outstanding mechanical, thermal, and chemical properties, driving innovation across biomedical, environmental, and industrial applications. This work introduces a novel, efficient method for synthesizing thermoresponsive TEMPO-oxidized cellulose nanofiber (TOCNF) and poly(N-isopropylacrylamide) (PNIPAM) conjugates via silver-mediated RAFT polymerization. In contrast to traditional techniques requiring prior modification of nanocellulose with RAFT agents, this approach enables surface-initiated polymerization through Ag-mediated radical decarboxylation of TOCNF. The radicals generated on TOCNF act as active sites for the polymerization of NIPAM, forming robust C–C bonds between the cellulose nanofibers and the grafted polymer.

This green, one-step, one-pot reaction, performed primarily in aqueous conditions and under mild temperatures, yields thermoresponsive PNIPAM-g-CNF hydrogels with tunable molecular weights, high grafting density, and quite narrow polydispersity. The presence of RAFT agents as polymer end-groups further allows for end-group modification, facilitating the synthesis of block copolymers and providing a versatile platform to customize material properties. SANS analysis of the materials provides a clear model to explain the effect of the polymer degree of polymerization on the thermoresponsive and gelation properties of PNIPAM-g-CNF, where a lower degree of polymerization results in an ordered assembly of bundled fibers above the gelation temperature.

This approach enables efficient polymer grafting without requiring extensive modifications to the nanocellulose, thus lowering chemical waste. The versatility of this method in tailoring material properties while adhering to green chemistry practices underscores its potential for developing sustainable, high-performance materials for addressing pressing industrial and environmental challenges.¹

Vidali, G.; Mendoza, D. J.; Bentley, C.; McKay, A. I.; Raghuwanshi, V. S.; Mata, J.; Garnier, G.; Hooper, J. F., Single-Step Grafting of a Thermoresponsive RAFT Polymer from Nanocellulose by Radical Decarboxylation. *ACS Polymers Au* 2025.



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sciforum-180415: Structural Heterogeneity in Tetra-arm Gels Revealed by Computer Simulation

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Designing homogeneous networks is considered to be one typical strategy for solving the problem of strength and toughness conflict of polymer network materials. Experimentalists have proposed a hypothesis of obtaining structurally homogeneous hydrogel by crosslinking tetra-armed polymers^{1,2}, which the homogeneity was claimed to be verified by scattering characterization and other method. Nevertheless, it is highly desirable to further evaluate this issue from other perspectives. In this study, a coarse-grained molecular dynamics simulation coupled with stochastic reaction model is applied to reveal the topological structure of polymer network synthesized by tetra-armed monomers as precursors. Two different scenarios, distinguished by whether internal cross-linking is allowed, are considered. We introduce the Dijkstra algorithm from graph theory³ to precisely characterize the network structure. The microscopic features of the network structure, e.g., loop size, dispersity and the size distribution are obtained via the Dijkstra algorithm. By comparing the two reaction scenarios, Scenario II exhibits an overall more idealized structure. Our results demonstrate the feasibility of the Dijkstra algorithm on precisely characterizing the polymer network structure. We expect this work will provide a new insight for the evaluation and description of gel networks, and further help to reveal the dynamic process of the network formation.

- [1] Y. Okaya, Y. Jochi, T. Seki et al., "Precise synthesis of a homogeneous thermoresponsive polymer network composed of four-branched star polymers with a narrow molecular weight distribution," *Macromolecules* **2020**, 53, 374–386.
- [2] M. B. Koo, J. H. Lee, G. W. Kim, H. Jang, S. Y. Kim, and K. T. Kim, "Structural homogeneity of macromolecular networks by end-to-end click chemistry between discrete tetrahedral star macromolecules," *ACS Macro Lett.* **2024**, 13, 75–81.
- [3] J. L. Gross, J. Yellen, and P. Zhang, *Handbook of Graph Theory* (CRC Press, 2013).



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sciforum-179590: Syntheses and Applications of Liquid Crystal Polymeric Materials

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Liquid crystal elastomers (LCEs) have garnered significant attention for their exceptional actuation capabilities, but their practical applications are hindered by insufficient mechanical strength and fatigue resistance.^[1-2] Here, we introduce our recent advancements in overcoming these limitations through the following design strategies. (1) Nanocomposite reinforcement for mechanical performance: Integrating high-aspect-ratio 2D metal-organic framework (MOF) nanosheets into LCE matrices *via* pore-confined crosslinking creates an interpenetrating network that preserves mesogenic alignment and significantly enhances mechanical performance. The composite demonstrates an enhanced tensile strength of 89 MPa at room temperature, and even at 200°C, maintains a high tensile strength of 4.2 MPa with excellent stability over 1000 stretching cycles at 15% strain. (2) Dynamic network design for enhanced fatigue resistance: Introducing partial dynamic sacrificial bonds (tetraarylsuccinonitrile, TASN) into LCE matrixes enables reversible dissociation and recombination of central C-C bonds, allowing the LCE-TASN materials to endure 3000 stretching cycles at 100% strain with rapid recovery within 5 min. Collectively, these strategies promote the development of high-performance LCE systems with enhanced mechanical strength and fatigue resistance, paving the way for their broader application in advanced actuation and impact-dissipating devices.

References

- [1] Physical Properties of Liquid Crystals Wiley-VCH, Weinheim, 1999.
- [2] *Nature Materials* 2015, 14, 1087-1098.



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sciforum-180467: The Gelation Transition of Olympic Gel

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One of the most topologically beautiful entities of polymers could be Olympic gels (or catenated polymer networks). Although Olympic gels was first proposed by de Gennes only decades ago, they have been possibly present in nature for million of years. Kinetoplast mitochondrial DNA (kDNA) manipulated by DNA Topoisomerase represents one of well-known examples of Olympic gels^[1]. A recent experiment demonstrated that DNA Topoisomerase works well also in vitro, and interestingly Olympic gels can be formed in a solution of DNA rings with active DNA Topoisomerase^[2]. The formation of Olympic gels is, in essence, a gelation process. In traditional polymer networks, gelation is commonly described by the classical Flory–Stockmayer mean-field theory and its extensions, under key assumptions such as equal reactivity of all functional groups and the absence of intramolecular cyclization^[3]. In sharp contrast, in Olympic gel, ring polymers possess no well-defined functionality, and their “reaction probability” varies dynamically due to entropic penalties. These features render the gelation process of Olympic gels both intriguing and fundamentally distinct from classical theories, yet it remains largely unexplored and poorly understood. In this work, we endeavor to explore physical feature of the gelation transition during DNA Topoisomerase mediated formation of DNA Olympic gels and establish a universal framework describing this gelation process.

Reference:

- [1] D. Michieletto, Kinetoplast dna: a polymer physicist’s topological olympic dream, *Nucleic Acids Res.* 53, gkae1206 (2024).
- [2] B. A. Krajina, A. Zhu, S. C. Heilshorn, and A. J. Spakowitz, Active dna olympic hydrogels driven by topoisomerase activity, *Phys. Rev. Lett.* 121, 148001 (2018).
- [3] M. Rubinstein and R. H. Colby, *Polymer Physics* (Oxford University Press, 2003).



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Session 5. Polymer Composites

sciforum-174996: Assessing Gas Transport Properties of a Polysulfone/Asphaltene Nanocomposite Membrane via Molecular Dynamics Simulations Supported by Theoretical Analysis

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In recent years, asphaltenes – by-products of deep petroleum refining – have attracted growing attention as a promising class of nanofillers for various applications. The effects of their incorporation into polymer matrices have received increasing interest. In this study, we assess the effectiveness of asphaltenes as a class of natural carbon-based nanoparticles for modifying the gas transport properties of commercially available polysulfone.

Particular attention is given to the development of the all-atom polysulfone model and its validation using a recently proposed theoretical approach (Macromolecules 2024, 57(2), 586–596), which enables direct comparison between molecular dynamics simulation results and experimental data. After validating the model, we estimate gases solubility and diffusivity in polysulfone nanocomposite membranes as a function of asphaltenes content.

Our results demonstrate the effectiveness of the proposed simulation methodology for parameterizing accurate all-atom models of polysulfone that are capable of reproducing experimental observations. Moreover, the observed changes in the gas transport properties of polysulfone upon the addition of asphaltenes indicate their potential as modifying nanofillers for the development of membranes with controlled properties.

Acknowledgements

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sciforum-174177: Cohering Particles *via* Weak Electromagnetic Waves for Highly Conductive Polymer Composites

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Highly conductive polymer composites are essential for modern electronics, yet their widespread use is constrained by the high cost of conductive fillers. This work reports a universal and rapid strategy to achieve highly conductive polymer composites by cohering microfillers using weak electromagnetic waves (EMWs). Inspired by the Branly effect underlying the earliest radio coherer, it is demonstrated that EMWs with power as low as 10^{-6} mW can induce insulator-to-conductor transitions in metal microfiber-polymer composites, reducing resistance from >50 M Ω to ~ 1 k Ω within 0.34 μ s. The effect arises from EMW-induced voltage breakdown of surface oxides and localized joule heating, which optimizes the conductive network. The transition is reversible under micro-force (29 mN) and stable over 10^4 cycles. By combining EMW treatment with a transient voltage, the conductive network can be permanently locked, lowering the percolation threshold from 45 wt% to 15 wt% for steel fibers. This strategy is broadly applicable to various conductors (metals, carbon) and polymers, and enables remotely programmable resistive memory devices. The findings offer a cost-effective, scalable approach to enhance the performance of conductive polymer composites for electronic applications.



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sciforum-174952: Development of Thermally Conductive Polyimide Hybrid Films Using Novel Composite Particles

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The continuous miniaturization of electronic devices have made efficient thermal management a critical issue, particularly as heat generation from high-performance semiconductor devices increases. Polyimide (PI) is widely used in microelectronics owing to its thermal and dimensional stability as well as electrical insulation properties; however, its inherently low thermal conductivity limits further device advancement. In this study, a novel composite particle composed of boron nitride and alumina (BN@Al₂O₃) was developed to enhance the thermal dissipation performance of PI-based materials. PI hybrid films were fabricated by homogeneously dispersing BN@Al₂O₃ into a PI matrix.

The composite particles and hybrid materials were prepared based on our previous work¹⁾. Poly(amic acid) (PAA) was synthesized as a PI precursor and converted into PI films via thermal imidization. The composite particle content was controlled at 0, 10, and 30 wt% relative to the PAA weight. In addition, a comparative sample containing the same amount of BN particles, but without alumina, was prepared.

The dispersion state of the hybrid films was evaluated by macroscopic observation, and their thermal transport was examined using thermographic analysis. All hybrid samples incorporating the composite particles exhibited a well-dispersed state. Furthermore, the heat transfer performance improved progressively with increasing composite particle content. In addition, the BN@Al₂O₃-based hybrid film exhibited smoother heat transfer behavior than the BN-only composite, indicating the effectiveness of the composite particle design. This enhancement is attributed to the formation of efficient thermal conduction pathways, enabling heat transfer from the BN phase to the Al₂O₃ phase within the PI matrix.

These findings indicate that BN@Al₂O₃ composite particles provide an effective strategy for improving the thermal dissipation performance of PI hybrid materials and offer a versatile design concept for thermally conductive polymer materials applicable to next-generation electronic devices.

References

- (1) Wada R. et al., *Polym. Prepr. Jpn.*, 2025, 74(2), 1Pc049.



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sciforum-174956: Highly thermal conductive and rechargeable 3D liquid metal network-based phase change composite enabling photothermal pad

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Thermal therapy alleviates pain and improves circulation but commercial pads face limitations in controllability and recyclability. Polymer based solar-rechargeable phase change material pads offer convenience and heat storage, yet low thermal conductivity, photothermal efficiency, and uneven temperature distribution hinder their clinical thermotherapy applications. This paper presents a liquid metal network-based phase change composite material (LM-PCM) with enhanced photothermal conversion and heat storage capability. In this work, the graphite flake@copper fillers are incorporated into LM to increase the thermal conductivity of metallic composite filler and increase the viscosity of LM-based composite. Hot-pressing method has been applied to construct highly thermal conductive LM network within PCM matrix. The surface of LM-PCM is spray-coated with graphite layer to collect solar energy and convert it into heat. The obtained LM-PCM exhibits thermal conductivity as high as ~ 7 W/m·K with 50 vol% metallic filler and light absorption efficiency of $\sim 90\%$. Moreover, such LM-PCMs have been demonstrated to be thermally rechargeable, producing less pollution than the other disposable thermal pads. The development of LM-PCM shows great prospect as thermal comforting material for clinical therapy, and also provides a new solution for the application of LM-based composites.



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sciforum-174759: Jamming in Polymer Nanocomposites

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While extensive experimental and theoretical research has explored the jamming transition in colloidal and granular suspensions, its presence and nature in nanoparticle-filled polymers remain unclear. Unlike the liquid-to-solid criteria for jamming in attractive colloidal gels, the liquid-to-solid transition in polymer nanocomposites is attributed to percolation, in which a system-spanning particle network forms while many agglomerates still retain the ability to roll or twist. In our study, we investigated silica-filled polymer nanocomposites and identified multiple key transitions in linear and nonlinear rheological features, including yield stress, equilibrium modulus, and recoverable strain. These correspond to the percolation threshold, the beginning of agglomerate jamming, and aggregate jamming, respectively. Structural characterizations support these findings. Additionally, particle-polymer interactions and particle shape significantly influence the jamming behavior. Decreasing attractive interactions and increasing nanoparticle aspect ratio tend to raise the transition concentration. We also observed that mechanical properties, such as crack propagation, are closely related to the particle packing state.



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sciforum-174985: Novel Silicone-Based Transdermal Films for Gangleron Delivery: Synthesis, Characterization, and Release Profiles

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Abstract. Gangleron, a pharmaceutical drug manufactured in the Republic of Armenia, exhibits spasmolytic activity and is used in the treatment of vascular spasms and smooth muscle spasms of abdominal organs, as well as in the prevention of hypertensive crises. As injectable administration of the drug is associated with significant discomfort, the development of Gangleron-containing transdermal films offers improved patient compliance and comfort. Furthermore, these systems provide prolonged drug release over a period of 1–3 days. The synthesized Gangleron-containing silicone films were characterized using a range of analytical techniques, including spectrophotometry, infrared (FTIR), and Raman spectroscopy. The study revealed that the nature of the crosslinking agent and catalyst employed in the silicone films significantly influences the release profile of Gangleron from the prepared films. Significant differences in drug release were observed when the hydrophobic silicone matrix was synthesized using a tetrafunctional crosslinking agent, tetraethoxysilane (TEOS), with DBTDL (dibutyltin dilaurate) or aminopropyl-terminated polydimethylsiloxane (PDMS-NH₂) as curing catalyst. Drug release from the PDMS-NH₂-catalyzed matrix reached only 1.7% after 72 hours, while the DBTDL-catalyzed matrix exhibited a markedly higher release of 81% over the same period. Overall, this work provides a versatile platform for the development of advanced transdermal delivery systems, combining patient comfort with prolonged and controlled drug release.



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sciforum-197292: Research on a Controllable Interface Thermoplastic Processing New Technique

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This report presents a controllable-interface thermoplastic processing technique for preparing polymer alloy materials with improved microstructural regulation and mechanical performance. Conventional twin-screw blending is widely used in polymer composite processing, but it usually produces random and uncontrollable phase boundaries, which limits further enhancement of material properties. Although chemical modification can improve compatibility through molecular design, it often involves complex procedures, high cost, and limited practical efficiency.

Based on micro–nano lamination technology, this study proposes a new thermoplastic processing route that enables controlled interface construction during melt processing. The technical route includes multi-unit thermoplastic extrusion, vertical stretching, twin-screw dispersion, and granule collection. A controllable-interface thermoplastic processing platform was successfully developed, and verification experiments were carried out using PE/PP/PE systems and color-masterbatch-assisted dispersion analysis.

Compared with conventional twin-screw blended PP/PE samples, the new process changes the typical incompatible sea-island morphology into a more ordered core–shell structure with an interfacial transition layer and clear layered features. Mechanical testing of PP/LDPE systems shows that PP-coated LDPE structures are more favorable for maintaining or improving tensile and flexural properties, while LDPE-coated PP structures significantly enhance impact toughness. Increasing the stretching ratio further refines the dispersed phase, enlarges the composite interface area, and promotes molecular chain orientation. Overall, this work demonstrates the potential of controllable-interface thermoplastic processing for precise microstructure regulation in incompatible polymer systems.



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sciforum-186584: Synergistic Hierarchical Toughening of FRP Laminates via CNT Powder and Ultrathin Fiber Veils

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Delamination remains a critical weakness of fiber-reinforced polymer (FRP) composites, limiting their structural applications. Here we introduce a hierarchical toughening strategy for carbon fiber/epoxy laminates that synergistically combines two carbon nanotube (CNT)-based reinforcements: (i) CNT powders (average length 2 μm) dispersed in the epoxy matrix, which overcome the "self-filtration" effect during vacuum-assisted resin transfer molding (VARTM) to achieve uniform CNT distribution; and (ii) an ultrathin CNT fiber veil (~100 nm thick) interleaved between plies, providing interlaminar toughening with minimal weight increase and no sacrifice of in-plane properties. Double cantilever beam (DCB) tests showed that the CNT veil alone increased G_{IC} from 636 J/m² to 840 J/m² (+32%), while 0.5 wt% CNT powders in the matrix raised G_{IC} to 1031 J/m² (+62%). Remarkably, the combination of both methods produced a synergistic effect, achieving G_{IC} of 1418 J/m²-a 123% improvement that surpasses the sum of individual contributions (94%). The figure of merit for interlaminar reinforcement, accounting for changes in interlaminar properties relative to interleaf and ply thickness, achieved a value of 2460, far exceeding current state-of-the-art values. This hierarchical approach offers a highly effective pathway to dramatically enhance delamination resistance in FRP laminates for demanding structural applications.



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sciforum-180324: Bio-inspired High-performance Nanocomposites

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Enhancing stress transfer capacity at the organic/inorganic interface remains a challenging problem in the field of high strength and toughness nanocomposites. Achieving ordered alignment of nanomaterials within the polymer matrix, improving interfacial interactions between organic and inorganic phases and regulating the crystallinity of the polymer matrix all contribute to the internal stress transfer, leading to improved mechanical properties of nanocomposites. However, challenges exist in controlling both the nanofiller orientation and polymer crystallinity. On the one hand, nanofiller agglomeration within the polymer matrix diminish their reinforcement effect. On the other, It still lacks of effective methods to regulate polymer crystallinity within nanocomposite systems, thus hindering the synergistic effect of organic-inorganic reinforcement. Consequently, how to achieve oriented assembly of nanofillers and effective regulation of polymer crystallinity constitute key scientific problems in developing high-strength and toughness nanocomposites. Our study proposed a universal strategy based on utilizing crystalline inorganic nanomaterial's confined dewetting effect to induce polymer crystallization. Here, our work includes utilizing superspreading shear-flow-induced alignment assembly of nanomaterials, followed by dewetting-induced nanomaterial crystallization to construct nano-confined spaces. And the confined dewetting effect of inorganic nanomaterials could help to regulate polymer crystallinity, thereby fabricating organic-inorganic co-crystalline structures. Moreover, continuous fabrication techniques are established for these nanocomposites enabling the large-scale production of various high-strength and toughness lamellar nanocomposites. Our work aims at achieving the scalable fabrication of nanocomposites with ultra-high mechanical properties, with potential applications in fields such as aerospace and military protection, while fostering a multidisciplinary research team to serve the needs of national strategic.



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sciforum-014972: Biocomposite microparticles loaded with Ibuprofen with antimicrobial activity

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Introduction: Respiratory tract infections are among the leading causes of mortality, morbidity, and disability worldwide and it is estimated that by 2050 more than 39 million deaths will be attributable to antibiotic-resistant infections. In this context, the purpose of this study aimed to obtain new polymer microparticles by a simple water/oil emulsion method, using carboxymethyl chitosan and polyvinyl alcohol.

Methods: The obtained microparticles were structurally characterized using FTIR analysis. Their mean diameter was determined by DLS, while their morphology was examined via transmission electron microscopy. SEM-EDAX analysis was used to quantify the amount of ZnO nanoparticles incorporated into the biocomposite microparticles. The stability of the obtained microparticles in an aqueous solution (PBS, pH 7.4) was evaluated by electrophoresis at 25 °C using a Malvern Zetasizer. Additionally, the swelling degree, drug loading, and release of Ibuprofen from the microparticles in PBS (pH 7.4) were determined. Finally, hemolysis, cytotoxicity and antimicrobial tests were performed.

Results: FTIR analysis confirmed the presence of ester bonds within the microparticle structure, as well as the incorporation of ZnO nanoparticles. The obtained microparticles were spherical in shape and had diameters ranging from 500 to 1100 nm. The swelling degree varied between 650% and 1550% and the release degree of Ibuprofen varied between 84% and 100%. The hemolysis results suggested a good compatibility with the blood environment, as they do not produce a degree of hemolysis greater than 2.5%. The obtained microparticles showed good antimicrobial activity against the *S. aureus* strain.

Conclusions: Polymeric microparticles obtained in this study show efficient drug loading and release, good biocompatibility, and potential as innovative carriers against respiratory infections in the context of antimicrobial resistance.

Acknowledgement

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sciforum-180099: Biomimetic construction of fiber-based nanocomposites and their applications

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High-performance layered polymer nanocomposite film materials have received extensive attention and research due to their lightweight, high-strength and multifunctional properties. It is difficult for traditional fabrication strategies to take into account the unity of mechanical and functional properties of the materials, and it remains a great challenge to enhance the mechanical properties and multifunctional characteristics of nanocomposites simultaneously. In order to solve the above problems, scientific researchers have turned their attention to nature to solve the problems. As we all know, the high content of inorganic calcium carbonate (95 V%) and a small amount of organic proteins (5 V%) in natural shells are arranged into a complex and ordered multi-scale structure, which combines the multiple interfacial interactions of the organic-inorganic layers, effectively compounds the strength of the inorganic phase and the toughness of the polymer, and realizes the perfect unity of the structural-interfacial and mechanical properties. Inspired by the microstructure and interface of shells, the high-performance biomimetic nanocomposites are obtained by designing and constructing the laminar structure, the fiber framework structure, and the interfacial interactions, to realize the effective enhancement of the mechanical properties and functional properties of the composites, and to provide a feasible path for the development of strong and tough composites.



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sciforum-180446: Characterization of PLA-polysaccharide biocomposites with AgNPs

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In order to solve existing ecological problems, researchers develop new functional materials. In this work the biocomposites based on plasticized poly(lactic acid) (PLA) was mixed in polysaccharides (starch and chitosan) with the introduction of silver nanoparticles (AgNPs). The composition proposed combines biodegradability and antibacterial activity. In order to characterize these biocomposites, the mass loss after exposure in soil was evaluated along with tests on fungus resistance and tests on antibacterial activity using test-cultures from the All-Russian Collection of Microorganisms (VKM). Integrated approach to investigation of the properties of these systems using modern methods (DSC, FTIR, microscopy) allowed one to conclude that the introduction of polysaccharides intensify the biodegradation processes in tests. Besides, it was demonstrated that the presence of AgNPs did not affect the degradation rate and intensity. Thus, considering different aspects of their ability to degrade and inhibit the bacterial growth, these biocomposites can be successfully used as multifunctional packaging materials.

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sciforum-189176: Comparative study of chemically grafted vs. physically coated CNTs on fracture toughness of BMI/CF laminates

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The interlaminar toughness and delamination resistance of these composites are relatively poor due to their laminated structure and intrinsic brittleness of the resin matrix. Therefore, this study investigates the interlaminar toughening of bismaleimide/carbon fiber (BMI/CF) composite laminates using modified carbon nanotubes (CNTs) deposited via spray coating technology. Pristine CNTs were functionalized through chemical modification (grafting 5-aminoisophthalic acid small molecules to yield CNT-COOH) and physical modification (coating with a layer of polydopamine to produce CNT@PDA) to enhance dispersion within the composite matrix. While both modification methods improved the dispersion of CNTs, their thermal stabilities during composite molding led to contrasting toughening outcomes. Chemically grafted CNT-COOH demonstrated superior performance, achieving a 20 % increase in mode I fracture toughness (G_{IC}) and a 32.37 % increase in mode II fracture toughness (G_{IIIC}). In contrast, physically coated CNT@PDA exhibited reduced toughening efficacy compared to the baseline in both mode I and mode II fracture toughness. This can be attributed to the poorer thermal stability of the physically coated CNT@PDA than that of chemically grafted CNT-COOH. On one hand, the coating material PDA itself has poor thermal stability which is highly prone to decomposition during high-temperature molding. On the other hand, it can be influenced by the methods of CNT modification. The bonding mechanisms of chemical grafting (covalent bonds) and physical coating (van der Waals forces and other physical interactions) differ, leading to varying thermal stability under high temperatures. The decomposition of the coating material and the high-temperature failure of van der Waals forces diminished surface functional groups and introduced defects around the CNTs, significantly compromising interlaminar fracture toughness. The findings underscore the critical role of thermal stability in determining the effectiveness of nanomodification strategies for advanced composite materials.



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sciforum-184865: Complexly and Regularly Structured Multicomponent Polymers for Unique Applications

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Precisely engineering complex yet ordered nanostructures in multicomponent polymer systems to enable strong intercomponent synergy and substantial functional enhancement is of critical importance, yet remains highly challenging. Here, we report the fabrication of intricately yet regularly structured multicomponent polymer systems with unique functionalities. In the first example, we prepared oppositely charged Janus nanoparticles (OC-JNPs) and achieved their individual dispersion at high concentrations and uniform orientation within a conventional polymer matrix. This combination of isolated dispersion and consistent alignment gives rise to a strong, long-range ordered built-in electric field throughout the matrix. We further demonstrate that these internal fields not only induce diode-like conductive anisotropy but also profoundly modulate the properties of embedded guest molecules. In the second example, we developed a preorganization strategy for the efficient fabrication of macroscopic polymer assemblies (MSPAs-PIBC) exhibiting a pure inverse bicontinuous cubic (IBC) mesostructure, derived from standard linear block copolymers (LBCPs). The key innovation lies in employing precipitates with pre-organized structures, formed via solution self-assembly of LBCPs with tailored structural parameters, as precursors. Owing to their ultrahigh polymer concentration and pre-organized architecture, these precipitates, when induced to evolve independently, transform directly into MSPAs-PIBC structures through a dramatically shortened kinetic pathway. Moreover, by spatially segregating two mutually incompatible catalysts into distinct continuous domains within the MSPAs-PIBC, we constructed a catalytic system that exhibits high activity in tandem reactions while also being exceptionally easy to recover.



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sciforum-185434: Composite particles and Microencapsulated APP for Enhancing Flame Retardancy Thermal Insulation, and Ceramifiable Properties of EVA Composites

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To address the issue of structural failure of Ethylene- vinyl acetate copolymer (EVA) plastic in a fire environment. This study utilized the hydrolysis condensation effect of a silane coupling agent to form covalent bonds with aluminum hypophosphite (AHP), and OMMT was fixed on the it. AHP@OMMT and microencapsulated Ammonium polyphosphate (APP) were used to synergistically improve the flame retardancy, thermally insulate, flexibility and ceramifiable properties of EVA composites. Results demonstrate that the composite containing 15% Triphenyl phosphate (TPP)@APP and 5% AHP@OMMT exhibits significantly improved fire retardancy. Its limiting oxygen index (LOI) reaches 29.6% and it achieves a UL- 94 V- 0 rating. After sintering at 1000°C the flexural strength of the sintered residue attains 15.17 MPa. The composite's peak heat release rate and total smoke production are reduced by 86.32% and 34.77% than pure EVA, respectively. Meanwhile, the elongation at break of the composite material reaches 601%. This work provides a promising approach for developing highperformance EVA composites with balanced flame retardancy and mechanical integrity.



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sciforum-153932: Designing Fast Thermal Energy Storage: Interfacial Heat Transfer in Paraffin–Graphene Composites

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Efficient thermal energy storage materials are essential for the energy transition, particularly for low-temperature heat management in buildings and industrial processes. Paraffin waxes are attractive phase change materials (PCMs) due to their high latent heat capacity and melting range near ambient temperatures. However, their inherently low thermal conductivity limits heat charging and discharging rates, restricting practical applications. Incorporation of graphene-based fillers is a promising strategy to enhance thermal transport, yet the molecular origins of thermal resistance in such composites remain poorly understood.

In this paper, we employ large-scale atomistic molecular-dynamics (MD) simulations to uncover the mechanisms governing thermal transport in paraffin–graphene nanocomposites. Four key findings emerge: (i) branching of alkane chains decreases crystallinity and suppresses thermal conductivity in bulk paraffin; (ii) near pristine graphene, paraffin molecules assemble into ordered lamellae parallel to the surface, which promotes in-plane but hinders cross-interface heat transfer; (iii) alkyl functionalization of graphene significantly reduces the interfacial thermal resistance (Kapitza resistance) by improving vibrational coupling; and (iv) in systems with multiple graphene flakes, the composite thermal conductivity is dominated by flake orientation, interfacial resistance, and structural alignment of solidified paraffin. Finally, we present preliminary results of a multiscale framework where MD-derived thermal conductivities and interfacial thermal resistance values could be passed as input to finite-volume heat transport simulations in the OpenFoam package. This approach enables prediction of effective thermal performance at device-relevant scales and bridges atomistic insight with macroscopic design. Our results lay the foundation for rational engineering of graphene-enhanced phase change materials for fast and efficient thermal energy storage.



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sciforum-174543: Engineering the Interface and Phase Morphology of PC/ASA Blends for Enhanced Low-Temperature Toughness and Processability

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Polycarbonate/acrylonitrile-styrene-acrylate (PC/ASA) alloys are promising weather-resistant materials for applications such as new energy vehicles, outdoor communication equipment, and outdoor intelligent robots/tools. However, their advanced application is hindered by the inherent conflict between melt flowability—required for molding large or complex parts—and low-temperature toughness needed for harsh environments. To overcome this challenge, this study establishes a comprehensive experimental framework to systematically investigate the influence of multiphase interface design and phase structure on the melt flowability and low-temperature toughness of PC/ASA alloys. By integrating efficient surface tension measurements with direct transmission electron microscopy observations, we quantitatively characterize interfacial interactions and morphological evolution. Additionally, toughening agents and compatibilizers are employed to further tailor the interface and phase morphology, enabling precise control over the phase microstructure. Through tuning the microstructure, we elucidate processing-structure-property correlations that reveal how interfacial compatibility and phase morphology synergistically affect melt flowability and low-temperature toughening. The optimized phase structures significantly enhance low-temperature toughness without compromising melt flowability or mechanical integrity, achieving a melt flow index ≥ 30 g/10 min (260 °C/5kg), notched Izod impact strength ≥ 500 J/m at room temperature and ≥ 200 J/m at -30 °C, while maintaining excellent tensile and flexural properties. These results demonstrate that precise manipulation of rubber phase distribution and interfacial adhesion enables a favorable balance between processability and toughness. This work not only provides a robust experimental methodology for designing high-performance PC/ASA alloys but also offers insights applicable to other multiphase polymer systems requiring tailored interfacial properties for harsh-environment applications.



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sciforum-175069: From Ligand to Lineage: HOW Nanoparticle Coatings Control Magnetoelectric Stimulation of Mesenchymal Stem Cells in PVDF Films?

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Magnetoelectric (ME) polymer composites offer a promising platform for remote electrical stimulation of cells in bioelectronic and tissue engineering applications [1]. Here, we systematically investigate how surface ligands on CoFe_2O_4 (CFO) nanoparticles influence the magnetoelectric response of poly(vinylidene fluoride) (PVDF)-based multiferroic composites and the behavior of mesenchymal stem cells (MSCs) cultured on their surfaces. CFO nanoparticles coated with polyethylene glycol (PEG), oleylamine (OAm), oleic acid (OA), and citric acid (CA), as well as uncoated particles, were incorporated into PVDF films and analyzed in terms of nanoparticle dispersion, polymer-filler interfacial coupling, phase composition of the PVDF matrix, and local and bulk ME responses.

Bulk ME coefficients ranged from 10 to 38 $\text{mV}\cdot\text{cm}^{-1}\cdot\text{Oe}^{-1}$, with the highest values obtained for OAm-coated nanoparticles due to improved dispersion and stronger mechanical coupling with the PVDF matrix. In contrast, localized surface measurements revealed extremely high ME signals up to $\sim 6000 \text{ mV}\cdot\text{cm}^{-1}\cdot\text{Oe}^{-1}$ in OA-containing composites, which is attributed to nanoparticle aggregation and the formation of surface-localized piezoactive spherulites within the polymer matrix.

Biological experiments demonstrated that magnetoelectric stimulation induced mesenchymal stem cell condensation after 7 days of culture in the absence of exogenous growth factors. Composites containing OAm-coated nanoparticles additionally promoted higher cell adhesion and density without inducing localized cell death. These results demonstrate that nanoparticle surface chemistry controls polymer-filler interactions, ME output, and cellular responses, providing practical design guidelines for flexible magnetoelectric scaffolds for regenerative medicine.

[1] Omelyanchik A. et al. Boosting magnetoelectric effect in polymer-based nanocomposites // *Nanomaterials*. – 2021. – T. 11. – No. 5. – S. 1154.



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sciforum-175080: Multifactorial optimization of PVDF–CoFe₂O₄ magnetoelectric multiferroic composite synthesis by controlling the thickness, stretching, and distribution of nanoparticles in the polymer matrix to improve magnetoelectric response

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Polyvinylidene fluoride (PVDF) is a biocompatible polymer with thermal stability, chemical resistance, and piezoelectric properties [1, 2], enabling applications in sensors [3], energy harvesting devices [4], and biomedical technologies [5].

PVDF–cobalt ferrite (CoFe₂O₄, CFO) composites are promising magnetoelectric (ME) materials whose performance depends on phase composition, supramolecular structure, nanoparticle dispersion, and processing conditions. Systematic studies investigated the effects of film thickness, uniaxial stretching, and surface modification of CFO nanoparticles on structural, mechanical, dielectric, magnetic, and ME properties [6–8].

CFO nanoparticles (~5 nm) with cubic spinel structure were surface-modified with oleic acid to enhance compatibility and ensure uniform dispersion in PVDF. Composite films containing 10 wt% CFO were fabricated by the Doctor Blade method with thicknesses of 15–58 µm. Selected films were uniaxially stretched at 100 °C up to 300% elongation. Structural and phase analysis was performed using X-ray diffraction, FTIR, and Raman spectroscopy; morphology was examined by SEM and AFM; thermal, mechanical, magnetic, dielectric, and ME properties were characterized.

Thinner films exhibited smaller spherulites and pores, higher β-phase content (up to 42%), and improved dielectric performance. Surface modification ensured homogeneous nanoparticle distribution and a high ME coefficient of 24.5 mV/(cm Oe). Uniaxial stretching induced a controlled α/γ → β phase transformation, increasing β-phase content from 1% to 91% and tensile strength up to 85 MPa, with enhanced coercivity.

References

- [1] P. Saxena, P. Shukla, Adv. Compos. Hybrid Mater. 4, 8 (2021).
- [2] Y. P. Su, L. N. Sim, X. Li, et al., J. Memb. Sci. 620, 118818 (2021).
- [3] M. Bichurin, R. Petrov, O. Sokolov, et al., Sensors 21, 6232 (2021).
- [4] F. Narita, M. Fox, Adv. Eng. Mater. 20, 1700743 (2018).
- [5] H. Alibakhshi, H. Esfahani, E. Sharifi, Ceram. Int. 50, 8017 (2024).
- [6] P. A. Vorontsov, V. D. Salnikov, V. V. Savin, et al., Bull. Russ. Acad. Sci.: Phys. 89, 575 (2025).
- [7] P. A. Vorontsov, V. D. Salnikov, V. V. Savin, et al., Crystals 15, 47 (2024).
- [8] P. A. Vorontsov, V. D. Salnikov, V. V. Savin, et al., Crystallogr. Rep. 70, 24 (2025).



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sciforum-180038: Preparation and Performance of SIS-Based Hot Melt Pressure-Sensitive Adhesive with Multiphase-Composite Bond Dynamic Interpenetrating Network

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This study prepared a styrene-isoprene-styrene (SIS)-based hot melt pressure-sensitive adhesive (HMPSA) with a multiphase-composite bond dynamic interpenetrating network, aiming to achieve the conjugate regulation of three core indicators (initial tack, peel strength, and holding power) and meet the green and environmental protection application requirements in the medical and labeling fields. Through the melt blending method, a petroleum resin-rosin resin compound system that improves compatibility and cohesion, EAA-Surlyn composite ionomers that enhance ionic cross-linking and mechanical strength, and $\text{SiO}_2\text{-TiO}_2$ composite nanoparticles that increase interfacial interaction and cross-linking density were sequentially introduced, and the HMPSA with excellent bonding performance and low-temperature adaptability was prepared via stepwise synergistic modification. Low-field nuclear magnetic resonance (LF-NMR) analysis showed that the cross-linking degree of the material exceeded 90%, forming a multiphase composite structure containing van der Waals forces, hydrogen bonds, ionic bonds, and covalent bonds; mechanical property tests indicated that its initial tack reached 35.1 N, 180° peel strength was 41.2 N/cm, and the glass transition temperature (T_g) was as low as $-10.5\text{ }^\circ\text{C}$. Through the synergistic modification strategy of tackifying resins, ionomers, and nanoparticles, a highly adaptable SIS-based HMPSA was developed, solving the problems of weak cross-linking, unbalanced bonding performance, and poor low-temperature adaptability of traditional SIS-based HMPSAs.



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sciforum-176040: Reactive Processing of Recycled Polyethylene Blends Modified with Lignin Additive for 3D Printing Filament Applications

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The development of sustainable materials from post-consumer plastics is of increasing importance for circular economy strategies. In this work, recycled low-density polyethylene (rLDPE) and high-density polyethylene (rHDPE) were blended (80/20 wt%) and reinforced with kraft lignin as a bio-based additive, in the presence of polyethylene-graft-maleic anhydride (PE-g-MA) as a compatibilizer. Composites containing 1–10 wt% lignin were prepared via reactive melt mixing and a comprehensive characterization was performed to evaluate the structure–property relationships of the produced materials. Thermal properties were investigated using differential scanning calorimetry (DSC) and thermogravimetric analysis (TGA), while structural and chemical features were examined via infrared spectroscopy (IR), X-ray photoelectron spectroscopy (XPS), and X-ray diffraction (XRD). Pyrolysis–gas chromatography/mass spectrometry (Py-GC/MS) was employed to further probe compositional aspects, whereas scanning electron microscopy (SEM) provided insight into the morphology and dispersion of lignin within the polymer matrix. Mechanical performance was assessed through tensile testing, and molecular mobility was studied using dielectric relaxation spectroscopy (DRS). Thermal analysis showed that lignin addition did not significantly affect melting or crystallization behavior, while it led to improved thermal stability. Dielectric relaxation spectroscopy revealed a gradual increase in the glass transition temperature ($T_g \approx -35$ °C for the unfilled blend) with increasing lignin content, indicating restricted chain mobility. Mechanical testing demonstrated that low lignin loading (1 wt%) yielded the most favorable balance between tensile strength and ductility. In contrast, higher lignin contents led to particle agglomeration, as observed by SEM, which negatively affected mechanical performance. The optimized composite formulation was successfully extruded into continuous filaments suitable for 3D printing, exhibiting good processability and structural integrity. Overall, this study demonstrates that lignin can act as an effective bio-based modifier for recycled polyethylene blends, enabling the production of value-added materials and promoting the upcycling of plastic waste into functional products for additive manufacturing applications.

Acknowledgements

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sciforum-180685: RECYCLABILITY AND PROCESSING PERFORMANCE OF A BIOCOMPOSITE FILAMENT FOR CIRCULAR ADDITIVE MANUFACTURING

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Increasing interest in sustainable materials has led to greater attention on bio-based solutions that can also be recycled effectively. In additive manufacturing, particularly in fused filament fabrication (FFF), this is especially relevant, since the viability of circular approaches depends on the ability of materials to retain performance after repeated processing.

This work was carried out within the FF2F (From Fossil to Forest) project and focuses on a cellulose-reinforced biocomposite filament developed for FFF. The material combines a bio-based polymer matrix with micronised cellulosic fibres and a functional additive intended to improve fibre dispersion and processing behaviour. Filament production was performed by twin-screw extrusion under controlled conditions.

To investigate recyclability, the material underwent two consecutive mechanical reprocessing cycles. After each cycle, new filament was produced and assessed in terms of dimensional stability, processability and printability. An increase in melt flow rate (MFR) was observed, indicating some degree of chain scission during reprocessing. Nevertheless, the thermal and mechanical behaviour remained stable overall, and in some cases slight improvements were observed. The filament also preserved good surface quality, colour consistency and spoolability throughout the cycles.

Morphological analysis showed that fibre dispersion remained effective after reprocessing, with no relevant agglomeration or major structural defects. These results suggest that the material remains suitable for short-loop recycling in additive manufacturing.

A third reprocessing cycle is currently being carried out in order to identify possible degradation limits. In parallel, scale-up trials are underway using an industrially representative route based on compounding followed by filament extrusion, with the aim of assessing reproducibility under more realistic processing conditions.

Overall, the study shows that cellulose-based biocomposite filaments represent a promising recyclable feedstock for more circular FFF applications.



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sciforum-174930: Revalorization of agricultural waste in the manufacture of HDPE composites

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Introduction

Natural fibers are commonly used as reinforcement in composite materials, to reduce cost and improve sustainability. This work explores the valorization of high-volume vegetable fibers, those are Brewer's Spent Grain (BSG) and *Pennisetum Setaceum* (PS) harvested from invasive plants eradication campaigns programs, to develop HDPE composites.

Methods

In this study, HDPE matrix composites were developed with 40% w/w of both types of fibers (BSG and PS) by extrusion process. Subsequently, specimens of standardized dimensions for tensile and flexural tests were manufactured by injection molding according to the UNE-EN ISO 527-1:2020 and UNE-EN-ISO 178:2020 standards respectively. Measurement of the flow index of the three materials was also carried out.

Results

Mechanical properties and flow index results are shown in Table 1. Tensile and flexural properties showed an increase in modulus and yield strength in both composites, being greater in those with PS, highlighting the results obtained in the flexural assay.

Regarding the flow rates, a decrease was determined in both composites with respect to the HDPE matrix, not presenting a drawback for the processability of the material by means of injection manufacturing.

Table 1. Characterization of different composite formulations

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Conclusions

This work shows the potential use of discarded vegetable fibers in injection molding, obtaining different mechanical properties of the composites depending on the type of fiber used. Therefore, composites manufactured have different applications depending on the necessary performance requirements. Likewise, this approach reduces the consumption of fossil-based matrix by 40% by mass.



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sciforum-180870: Silicone polymers and porous composites: from fundamental research to engineering application

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This report will presents our recent advances in silicone polymers and their composite materials, with a special emphasis on porous silicone polymer composites. It briefly elaborates on the molecular design strategies and controllable synthesis methods of several typical functional silicone polymers, and conducts an in-depth and systematic study on regulating the pore structure and optimizing macroscopic properties of the corresponding silicone polymer composites. A variety of functional porous silicone polymer composites have been fabricated and fully characterized, and their critical performances including thermal insulation and thermal protection have been systematically evaluated. In addition, the structural evolution mechanism of these materials under high-temperature conditions is also revealed, providing theoretical support for material design. Based on the above fundamental research, a series of high-performance functional materials such as silicone rubbers, thermal protection silicone foam materials, and silicone aerogels have been successfully developed, which have been practically applied in the fields of new energy and aerospace fields, showing the promising developement and application of advanced silicone polymer composites.



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sciforum-171421: Silsesquioxanes-based Functional Materials for Sustainable Development

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Developing narrow-band gap and near-infrared absorbing materials is extremely desirable for significantly enhancing solar energy utilization and promoting artificial photosynthesis, but remains a formidable challenge. Here, we demonstrate a facile and general strategy for bonding silsesquioxane to various asymmetric D–A molecules to synthesize photocatalysts (PCS-DCIs) with broad and strong absorption bands spanning the 200 to over 1100 nm spectral range. We discovered that incorporating a thiophene group into the π -conjugated bridge of the asymmetric D–A molecule significantly improves both its NIR-light absorption capacity and facilitates the adsorption capacity and adsorption interactions with O_2 , greatly enhancing photocatalytic efficiency. PCS-DCI-4 exhibits exceptional performance, achieving H_2O_2 generation rate of $1033 \mu\text{mol g}^{-1} \text{h}^{-1}$ directly from pure water and air under NIR-light irradiation. Most importantly, by processing PCS-DCI-4 with polyacrylonitrile and electrospinning PAN/PCS-DCI-4 membranes, we developed a flow reactor capable of continuously producing H_2O_2 for over 100 h. Subsequently, a panel conversion system was fabricated to demonstrate the general utility of photocatalytic selective coupling for imine derivatives and achieving a conversion efficiency of $\sim 99\%$ under natural sunlight. This work not only provides a robust platform for solar energy conversion but also opens new avenues for practical applications in chemical synthesis.



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sciforum-174815: Study of the Formulation and Process Parameters of PLA with Natural Banana Rachis Fiber in Additive Manufacturing

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This study addresses the formulation, behavior during processing, and final performance of a composite material made from a bio-based polymer, PLA, reinforced with natural fiber from banana plant waste, specifically the rachis. The rachis is the central axis that supports the banana bunches and is usually discarded in the processing plants of the sector's cooperatives.

The rachis fiber was obtained through a combination of a retting process and subsequent mechanical extraction. Two methods for obtaining granules of the composite material were evaluated in this work—milling the fiber and processing using a thermomechanical system—employing different fiber contents, with the aim of feeding an additive manufacturing system based on material extrusion (MEX) technology with a screw feeding system.

The material's behavior during additive manufacturing was also analyzed, modifying various parameters of the MEX process to optimize the quality of the produced parts. Test specimens were manufactured with different formulations and processing strategies for subsequent physicochemical (TGA and FTIR), rheological, morphological, dimensional, and mechanical characterization.

Although the flow of material through the nozzle in the MEX process presents difficulties — mainly due to the risk of obstruction during deposition—, the results obtained demonstrate the viability of the process and the production of parts with acceptable quality under suitable operating conditions.

Acknowledgment

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sciforum-180452: Study on the evolution relationship between microstructure and electrical properties of dielectric elastomer composites under strain

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As a key material for the next generation of flexible actuators/generators, dielectric elastomers (DEs) are required to maintain excellent electrical performance under large strains. However, the electrical properties (dielectric constant, conductivity, breakdown strength, etc.) of DE materials exhibit complex strain dependence, which further affects the performance of the devices. Currently, the changes in material electrical properties and their correlation with microstructure evolution under strain load are not clear, and there are also significant errors in the methods used to characterize the electrical properties of elastomers under large strains. To address these problems, a pure shear tensile device of DE material and a high-precision electrical property test platform were built in this topic, and a scientific characterization method for the electrical properties of dielectric elastomers (electrical conductivity, electrical breakdown strength, dielectric constant, etc.) under strain was established. On this basis, EPDM and KH570 modified nano-silica (SiO₂) were selected as the research system to characterize the changes of microstructure and macroscopic electrical properties of DE materials under pure shear strain, and the response relationship between multi-scale microstructure and macroscopic electrical properties of DE materials was clarified.



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sciforum-179887: Superspreading-based Fabrication of Nanoporous Polymer Membranes for Stable MD Desalination

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Hydrophobic porous membrane is the key to the desalination performance of membrane distillation (MD). However, traditional MD membranes suffer from poor hydrophobicity of pore surfaces, leading to pore wetting and causing the loss of desalination stability. In this study, we present an ultrathin polyvinylidene fluoride (PVDF) nanocomposite membrane with robust anti-wetting properties and high permeability for stable MD desalination. The improved anti-wetting properties are achieved by enhancing the hydrophobicity of membrane pore surfaces via introducing hydrophobic silica nanoparticles to build nanostructures on the pore surfaces. The hydrophobic nanostructured pore surfaces induce the formation of the nano-Cassie state upon contact with water, thereby enhancing the specific liquid entry pressure of water (LEP_w) with 788% compared to commercial PVDF membranes. The resulted porous structure and 10 μm membrane thickness (i.e., 20 times thinner than commercial PVDF membranes) enable the stable desalination flux of 20.30 kg m⁻² h⁻¹ and high salt rejection of > 99.9% with 60°C seawater. Our ultrathin nanocomposite membranes provide a promising solution for long-term MD seawater desalination.



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sciforum-176238: Sustainable Modification of High-Density Polyethylene via Hybrid Lignin–Calcium Pimelate Additives

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Lignin, the second most abundant natural polymer following cellulose, is receiving considerable interest as a renewable resource capable of diminishing dependence on fossil fuels and improving the environmental sustainability of polymer composites [1]. While unmodified lignin offers inherent benefits like thermal stability, flame retardancy and antioxidant properties, its poor compatibility with hydrophobic matrices often limits its incorporation to only a small amount. As a result, a variety of chemical modification strategies are utilized to produce value-added lignin derivatives, hence enhancing their applicability in green polymeric materials [2]. In addition, calcium pimelate (CaPi) is widely used as a nucleating agent in polyolefin matrices, since it reduces the free surface energy of the growing crystals and the energy barrier during nucleation.

In the present study, a hybrid filler composed of lignin and calcium pimelate (containing 5 wt% CaPi with respect to the lignin fraction) was incorporated into the HDPE matrix at five different loadings: 1, 5, 10, 20, and 30 wt%. The composites were prepared via melt mixing at 190 °C, and the final samples were characterized in terms of their structure through Fourier-transform infrared spectroscopy (FTIR). Their thermal behavior was evaluated via Differential Scanning Calorimetry (DSC) and revealed no significant alteration of the HDPE properties, while tensile strength and Young's modulus of HDPE were maintained at high levels for up to 10 wt% of filler loading. Finally, the investigation of antioxidant properties through the DPPH method suggested enhanced antioxidant capacity compared to the neat polymer.



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sciforum-172830: Synthesis and properties of composite materials based on humic acids modified with reduced graphene oxide under ultrasonic treatment

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Introduction

The development of composite materials with carbon nanofillers is a pressing area of modern materials science and nanotechnology, as their introduction into a matrix system enables significant modification of the physicochemical, structural, and thermal properties of materials. Of particular interest are composites based on humic acids (HA), obtained from coal waste as an accessible and renewable raw material. The aim of this study was to synthesize composite materials based on humic acids modified with reduced graphene oxide and to investigate the effect of ultrasonic treatment on their structure and properties.

Methods

Composites were synthesized using ultrasonic-assisted mixing followed by precipitation, drying, and molding. HA isolated from oxidized coal waste from the Shubarkol deposit served as the matrix component, and reduced graphene oxide (RGO, Sigma-Aldrich, USA) served as the modifier. RGO was pre-dispersed in an aqueous medium using ultrasound to break down aggregates and obtain a stable dispersion, after which it was added to the HA solution. Composites were obtained at HA:RGO weight ratios of 90:10, 80:20, and 70:10 (wt %) and ultrasonic treatment times of 15, 30, and 60 minutes.

Results

It was shown that ultrasonic treatment parameters have a significant impact on the chemical structure and functional properties of the composites. The optimal ultrasonic treatment time was found to be 30 minutes. With further increases in time, degradation of the HA structure and a decrease in the functional group content were observed. The introduction of reduced graphene oxide shifts thermal degradation processes to higher temperatures, indicating increased thermal stability of the materials.

Conclusions

The resulting composite materials are characterized by a developed surface structure and improved thermal properties, making them promising sorption materials for the removal of pollutants from wastewater and aquatic environments.



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sciforum-189168: Tailoring thermomechanical performance of carbon fiber/polyimide composites via carbon nanotube interface engineering

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Carbon fiber/polyimide (CF/PI) composites are promising for aerospace applications but suffer from poor interfacial bonding, limiting their strength and toughness. This study introduces non-functionalized short carbon nanotubes (CNTs) as a physical modifier to simultaneously enhance the thermomechanical performance of CF/PI. CNTs were dispersed in DMAC solvent, mixed with PI resin at varying concentrations, and fabricated into unidirectional laminates via solution-based prepreg and hot pressing. The results demonstrate that CNTs significantly enhance the room temperature and high-temperature mechanical properties of CF/PI, improving interlaminar fracture toughness, flexural strength, and interlaminar shear strength (ILSS). However, at 300°C, ILSS remained unaffected due to the decomposition of the sizing agent on the carbon fiber surface. CNTs also improved the thermal stability and conductivity of the composites, with thermal conductivity and resin stability benefiting from the formation of a CNT-based conductive network. The aforementioned improvements in the mechanical and thermal behavior of CF/PI are attributed to the improved interfaces between CF and PI. CNTs reinforce the interfacial bonding between the polyimide resin, carbon fibers, and CNTs via π - π interactions. On this basis, CNTs exhibit a unique structure that promotes mechanical strength through bridging effects within fiber gaps. This enhancement in bonding further contributes to the overall mechanical and thermal performance of the CF/PI composite. Notably, the glass transition temperature decreased at lower CNT contents but increased at higher CNT concentrations.



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sciforum-179681: The relationship between the dielectric properties of dielectric elastic composites and the three-dimensional dispersion structure of fillers

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Dielectric elastomer composites (DE) are a class of functional materials characterized by electromechanical response. The dispersion of fillers in the matrix critically determines the dielectric properties of the composite, yet traditional characterization methods fall short of providing a comprehensive and precise description of the filler dispersion structure. Nano-resolution scanning transmission electron tomography (ET) enables the quantitative three-dimensional characterization of filler dispersion within the matrix. In this study, high-dielectric-constant nanosilica (SiO_2) and high-insulation isoprene rubber (IR) were selected to prepare SiO_2 /IR composites exhibiting both high dielectric constant and high breakdown strength. The three-dimensional dispersion structures of fillers in composites with varying SiO_2 volume fractions were visualized and quantitatively characterized using ET. The results show that with increasing SiO_2 volume fraction (Φ_f), the interface area, aggregate size, and agglomerate branching degree gradually increase, while the face-to-face distance between agglomerates decreases. These structural changes account for the observed increases in dielectric constant and conductivity, as well as the reduction in breakdown strength. When Φ_f is below 6.3%, the inter-agglomerate distance is too large for charge path formation, and the increase in dielectric constant is primarily governed by interfacial polarization. When Φ_f exceeds 6.3%, charge paths gradually form, and the significant rise in conductivity becomes the dominant factor contributing to the enhanced dielectric constant. These findings highlight the critical role of three-dimensional dispersion structure in governing dielectric performance, establishing 3D-STEM as an essential tool for the microstructure-guided design of advanced functional composites.



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Session 6. Polymer Applications

sciforum-181926: Diradicaloid-loaded polypeptide nanoparticles for two-photon NIR phototheranostics

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Stable organic radicals, with unique electronic transitions from the ground state (D0) to the doublet excited state (D1), show promise as high-fluorescence quantum yield dyes. While organic small-molecule photosensitizers (PSs) have advanced for tumor photodynamic therapy (PDT), opportunities exist to enhance their performance and functionality. Herein, we synthesized Thiele's fluorocarbon derivative diradicaloid TFC-I with nearly 100% PLQY and integrated it into amphiphilic polypeptide nanoparticles, P-TI, using a precursor-doping approach. It is worth emphasizing that the amphiphilic polypeptide as a nano-carrier is a highlight because of its excellent biocompatibility, good stability in blood circulation and rapid metabolism in vivo. P-TI demonstrated notable features including high photostability, aggregation-induced emission, bright near-infrared fluorescence, substantial quantum yield (37% PLQY), robust near-infrared two-photon absorption (~400 GM cross section), and superior ROS generation compared to commercial PSs. In vitro and in vivo experiments confirmed that P-TI performed well in mitochondria-targeted PDT, two-photon fluorescence imaging, and biosafety. This work highlights the use of organic stable radicals with precursor-doping for efficient PDT and deep tumor tissue imaging.



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sciforum-180345: Highly Interconnected Uniform Nanoporous Polyimide Separators: Controllable Fabrication and Electrochemical Performance

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Polyimide (PI) is a polymer material containing imide rings in its main chain. The stable aromatic heterocyclic structure endows it with excellent thermal stability (thermal decomposition temperature typically exceeding 500 °C), good chemical inertness, and high mechanical strength, making PI an ideal choice for high-safety lithium-ion battery separators.

Current research has employed the droplet superspreading technique to prepare sponge-like porous PI battery separators with highly uniform pore structures. Compared with conventional fabrication methods, this technique improves the cycling stability of lithium-ion batteries. However, it has been found that the internal pores of PI films prepared by this method are mostly closed, resulting in poor interconnectivity. This leads to high Li^+ transfer resistance, which not only limits the long-term cycling performance of the battery but also impedes rapid Li^+ migration under high electric fields, thereby preventing high-rate charge/discharge capabilities.

To address this drawback, this study introduces polyvinylpyrrolidone (PVP) as a porogen into the superspreading system. The porogen slows down the diffusion rate of the solvent into the coagulation bath, promoting the formation of uniform and fine pores while interconnecting adjacent pores and opening the closed ones. As a result, a PI separator with a three-dimensional interconnected sponge-like porous structure is successfully constructed, effectively resolving the issue of poor pore interconnectivity in PI films prepared by the superspreading technique. Concurrently, both the porosity and electrolyte wettability of the membrane are enhanced, significantly reducing Li^+ transfer resistance. This enables the battery to achieve rapid Li^+ migration at a high rate of 5 C, meeting the requirements for fast-charging applications. Moreover, the finer and more uniform pore structure facilitates homogeneous Li^+ transport through the separator pores, further improving the cycling stability of the battery and its ability to suppress dendrite growth, thereby extending its cycle life.



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sciforum-174572: Alginate-chitosan microbeads encapsulated bacteriophage phiKZ as model of bacteriophage delivery polymer system

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Infections caused by antibiotic-resistant bacteria are a significant global health concern. A potential solution to this issue is the use of bacteriophage therapy. In this research, we designed alginate-chitosan microbeads as a model for delivering the PhiKZ bacteriophage to combat *Pseudomonas aeruginosa* infections.

Four types of microbeads were obtained by ion gelation: blank alginate (AN) and alginate-chitosan (ANCS), and bacteriophage-loaded formulations (AP and APCS, respectively) [1]. For their functionalization, a high-titer PhiKZ lysate was obtained by concentration in PEG/NaCl [2]. The alginate-chitosan APCS formulation achieved nearly 99% phage loading efficiency, whereas the pure alginate beads AP demonstrated lower encapsulation of approximately 40%.

The phage release study showed a robust initial burst of phages within the first three hours of incubation, followed by a prolonged phage release for up to 48 hours in physiological saline solution experiments. AP and APCS microparticles demonstrate high bactericidal activity compared to blank AN and ANCS. After just three hours of incubation, a statistically significant decrease in the number of bacterial cells was observed (CFU/ml, $p < 0.0001$ ANOVA). With longer incubation (9 hours), the level of inhibition of *P. aeruginosa* PAO1 reaches approximately 99.9% compared to the control samples.

Assessment of cytotoxicity by the CCK-8 test in all experimental groups after 24 h showed good biocompatibility and no pronounced cytotoxic effects.

References

- [1] J. Kaur, A. Kour, J.J. Panda, K. Harjai, S. Chhibber. *AAPS PharmSciTech*. **2020**, 21(6), 233. DOI:10.1208/s12249-020-01763-4.
- [2] F. Kunisch, J. Wagemans, M.G. Moreno. *Research Square*(preprint), **2023**. DOI: 10.21203/rs.3.pex-1956/v1



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sciforum-175041: Bacterial Cellulose as a Versatile Polymer Platform for Advanced Wound Dressing Applications

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Bacterial cellulose (BC), a naturally derived polysaccharide produced by *Komagataeibacter xylinus*, has attracted considerable interest for advanced wound dressing applications. Its ultra-pure, nanofibrillar 3D membrane exhibits high crystallinity, mechanical strength, and exceptional water retention, while its biocompatibility support moist wound healing, epithelialization, and mechanical protection [1–3]. However, native BC lacks inherent antimicrobial activity, which has driven extensive research into various physicochemical modifications [1].

Our studies aimed to enhance the antimicrobial properties of BC through physical and chemical modifications for wound dressing applications. These strategies included: (i) in situ generation of Ag and/or ZnO NPs, (ii) impregnation with Ag and/or ZnO NPs, plant extracts, or antibiotics, and (iii) plasma treatment followed by grafting of polymers possessing intrinsic antimicrobial activity [4–8].

Modified bacterial cellulose can be fabricated into diverse wound dressing formats, such as hydrated films, composite membranes, and drug-loaded hydrogels, suitable for minor or acute wound treatment [4–8]. Its tunable structure makes bacterial cellulose a versatile platform for advanced wound dressings with tailored mechanical and therapeutic properties.

Acknowledgement

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References

- [1] V.-D. Girard, J. Chaussé, P. Vermette, J. Appl. Polym. Sci. 2024, 141, e55163.
- [2] G.O. Isopencu, et.al., Carbohydr. Polym. Technol. Appl. 2021, 2, 100057.
- [3] K. Park. et. al., In: Handbook of Hydrocolloids (Second Edition), Woodhead Publishing, Chapter 26, 2009, 724-739.
- [4] V. Dincă et.al., Arab. J. Chem., 2020, 13 (1), 3521-3533.
- [5] E. Rusen et. al., Cellulose, 2023, 30, 4293-4314
- [6] A. Mocanu et.al., Scientific Report, 2019, 9, Article 17687, 1-10.
- [7] F.L. Zorilă et. al., Carbohydr. Polym. Technol. Appl., 2025, 10, 100796, 1-17.
- [8] Mocanu A. et.al., O.S.I.M. Patent Application a202600110/26.02.2026.



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sciforum-173852: Bioactive Edible Polymer Films Enriched with Asparagus By-product Extract for Sustainable Active Food Packaging

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The increasing environmental burden of conventional plastic packaging has driven interest in sustainable, biodegradable, and functional materials for food preservation. Agro-industrial residues, such as asparagus by-products, are rich in polyphenols and offer potential as bioactive additives in edible films. This study aimed to develop a starch chitosan-based edible film incorporated with polyphenol-rich asparagus by-product extract and evaluate its functional performance. Films containing 0–5% w/w APBE were prepared and characterized for physiochemical properties, mechanical strength, antioxidant activity (DPPH & ABTS), and antimicrobial efficacy against *Escherichia coli* and *Staphylococcus aureus*. FTIR spectroscopy was used to assess molecular interactions, and application trials were conducted on fresh-cut fruits to evaluate preservation effects during storage. Incorporation of Asparagus by-product extract significantly enhanced tensile strength, reduced water solubility, increased antioxidant activity, and exhibited strong antimicrobial effects. FTIR analysis confirmed hydrogen-bonding interactions between Asparagus by-products extract phenolic and polymer matrix. Fruit storage trials demonstrated delayed microbial growth and reduced oxidative browning. These results indicate that asparagus by product extract starch chitosan films provide a sustainable, bioactive and functional alternative to conventional packaging, valorizing agricultural waste while extending food shelf life.



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sciforum-180079: Biopolymer-graphene aerogels as green sorbents for β -blocker detection in environmental water matrices

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Introduction: Sustainable polymer-based sorbents are attracting growing interest for environmental monitoring applications. In this work, a biopolymer–graphene hybrid aerogel was investigated as a green extraction material for the determination of β -blockers in environmental waters, with emphasis on analytical efficiency, reduced material consumption, and future integration into miniaturized workflows.

Methods: A dispersive solid-phase extraction (d-SPE) method was developed using aerogels composed of chitosan (CS), polyvinyl alcohol (PVA), and reduced graphene oxide (rGO). Four formulations with different graphene contents were synthesized and characterized by Fourier-transform infrared spectroscopy, scanning electron microscopy, and Brunauer–Emmett–Teller surface area analysis. Experimental parameters, including sorbent amount, sample pH, and extraction time, were optimized. The final method was coupled with LC–MS/MS for the determination of six β -blockers in river, lake, marine, and wastewater samples.

Results: Among the tested materials, the aerogel containing 5% rGO showed the best extraction performance. The synthesized aerogels exhibited high porosity (80–99.8%), and the selected material provided efficient adsorption through hydrogen bonding and π – π interactions. The method demonstrated satisfactory analytical performance, with coefficients of determination ranging from 0.99 to 0.999, repeatability of 4.4–13.7%, and reproducibility of 4.6–12.2%, together with high recoveries and satisfactory selectivity across different environmental water matrices. The sorbent remained effective for up to five reuse cycles, further supporting its practical and sustainable character. Greenness and innovation were confirmed by ComplexMoGAPI, BAGI, and VIGI assessment tools.

Conclusions: The proposed biopolymer–graphene aerogel is a promising sustainable sorbent for the determination of pharmaceutical residues in environmental waters. Its satisfactory analytical performance, reusability, and green profile support its potential contribution to greener environmental analytical methodologies.



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sciforum-174427: Comb-like polyelectrolytes as co-catalysts of water performed Suzuki reaction

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Due to Green Chemistry principles the usage of toxic solvents should be reduced so that the micellar catalysis of organic reactions in water becomes more and more popular. Comb-like polyelectrolytes are effective co-catalysts for micellar catalysis, they show low threshold aggregation concentrations and high solubilization capacity. Polymeric surfactants enable to perform different organic reactions in water, their catalytic activity in Suzuki reaction is considered in this work. As co-catalysts have a polymeric structure the aim of the current work is to identify the influence of degree of the polymerization (DP) on their catalytic behavior. Besides the effect of homopolymer modification with units capable to form donor-acceptor complexes with real catalyst of Suzuki reaction was also investigated.

Polyelectrolytes (poly(11-acryloyloxyundecyl-*N*-methylpiperidinium bromide)) were synthesized by free radical polymerization in water and RAFT-polymerization with subsequent polymeranalogous quaternization reaction. The real percentage of modifiers with pyridine, bipyridine and terpyridine fragments was determined by UV-spectroscopy. The model Suzuki reaction of phenylboronic acid and 1-bromo-4-nitrobenzene with PdCl₂ as catalyst was performed in water. ¹H NMR spectroscopy was used for measurement of conversion of the functional groups and for DP calculation.

It was found that the modification of comb-like polyelectrolyte with units capable to form donor-acceptor complexes with true catalyst of Suzuki reaction reduces its catalytic activity and leads to inhibition in high concentration (0,005 M) of modified co-catalyst. As for the polymers with controlled molecular weight, RAFT-agent's fragments inhibit Suzuki reaction. Summing up polymeric co-catalysts without fragments enable to form donor-acceptor complexes with real catalyst show the highest catalytic effect in micellar catalysis.

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sciforum-180502: Controlled Preparation and Mechanical Properties of Stretchable Polyurethane Films Based on Super-Spreadable Droplets

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Stretchable polymer films are widely used in flexible electronic devices, solar cells, biomedicine and other fields. However, how to effectively regulate the structure and mechanical properties of stretchable polymer films is still a challenge. In this paper, based on the principle of superspreading, a technique for preparing stretchable thermoplastic polyurethane (TPU) films was developed to control the structure and mechanical properties of TPU films. The main research contents include the rapid preparation of TPU films by constructing a droplet superspreading system, and the influence of solidification bath components, polymer solution concentration and other key factors on the thickness, pore size and mechanical properties of TPU films. The experimental results show that under proper concentration of TPU/N, N-dimethylformamide (DMF) solution and composition of solidification bath, TPU films with good homogeneity and excellent mechanical properties can be obtained. The thickness is adjustable from 20–50 μm , the tensile strength is up to 40 MPa, and the strain is up to 2500%. It provides a new technical support for the development of new flexible electronic devices.



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sciforum-174744: Copolymers based on nonionic and cationic surfactant monomers as co-catalysts for the Suzuki reaction

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Organic solvents are widely used in chemical synthesis, yet they account for over 80% of organic waste and pose significant environmental risks. Within the principles of green chemistry, water is considered a promising alternative solvent. However, most organic substrates are poorly soluble in water, requiring strategies such as phase transfer, solubilization, and micellar catalysis using surfactants. Conventional low-molecular-weight surfactants form micelles only above a critical micelle concentration, necessitating relatively high amounts of catalyst. In contrast, polymeric amphiphiles form catalytically active aggregates even at low concentrations. Comb-like polymers, in particular, offer broad possibilities for structural modification and fine-tuning of micellar catalyst properties.

Cationic based on 11-bromoundecanol and nonionic based on 11-aminoundecanoic acid surface-active monomers were successfully synthesized. Homopolymers and copolymers with varying ratios of charged to uncharged units was obtained by free radical polymerization in water. The model Suzuki reaction was performed in water. The structure of the resulting monomers, their degree of conversion during polymerization, and the conversion of the substrate in the Suzuki reaction were determined using ¹H NMR spectroscopy. Methods of luminescence and UV spectroscopy, dynamic light scattering were used. Using a combination of dynamic light scattering and viscometry data, the average molecular weights of the polymers were calculated.

All the polymers exhibited catalytic activity. At 5×10^{-3} M, polymers containing cationic units achieved conversions above 90%, with no clear leader. At 100-fold lower concentration, the 10:1 cationic/nonionic copolymer gave the highest conversion, likely due to optimal solubilization and micropolarity. Polymer molecular weight showed no detectable effect on substrate conversion within the studied range.

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sciforum-180208: Coupling of Electrostatic Interactions and Electroosmotic Flow in the Translocation of a Single-stranded RNA through Charged Nanopores

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The electric-field-driven translocation of charged biopolymers, such as single-stranded RNA (ssRNA), through charged nanopores is a process of considerable importance for many biotechnology applications. However, the translocation dynamics is complex and influenced by the interplay of intra- and extra-chain electrostatic interactions (ESIs) and electroosmotic flow (EOF) inside the nanopore. To advance our understanding of how these three factors couple to determine the translocation behavior, we use computational simulations to systematically study the ssRNA translocation by varying both the salt concentration and nanopore surface charge density. First, we find that a reduction of the intra-chain ESI, which solely depends on the salt concentration, facilitates the translocation. Second, while both the extra-chain ESI and EOF are governed by the nanopore charges and can exert similar effects on the translocation, their dependencies on the salt concentration exhibit opposite influences, especially at low salt concentrations. These aspects create a complex coupling and thus lead to diverse translocation behaviors.



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sciforum-180588: Design super-strong and biomedical polyurethane materials with molecular “Lego bricks”

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How to design high performance elastomers with tensile strength exceeding 50 MPa from commercially affordable feedstocks has been a challenge. In contrast to previous attempts via introducing stronger molecular interactions using expensive raw materials, we design super-strong polyurethanes utilizing sequence engineering, hard/soft microphase morphology control, and hierarchical hydrogen bonding while using commercially available monomers. Through joint control of sequence length and crystallization, we realize biocompatible, body-temperature shape-memory polyurethane elastomer with tensile strength up to 80 MPa and skin-like nonlinear mechano-response, suitable for 4D printing and minimally invasive devices. By combining hierarchical hydrogen bonding with ring-chain units in hard domains, we synthesize a family of TPUs exceeding 50 MPa tensile strength with tunable Young's modulus from 3 to 100 MPa and high ductility. Building on these structure–property insights, several biomedical polyurethanes were developed, including a degradable body-temperature shape-memory elastomer, a water-induced-hardening hydrogel for chronic cervical spinal cord compression models, and a lithographically patterned artificial tympanic membrane scaffold. The artificial tympanic membrane scaffold achieves broadband hearing restoration and excellent biocompatibility, addressing the long-standing deficit in high-frequency recovery.



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sciforum-167128: Drug-loaded polymer particles based on polyester copolymers

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Introduction

Polyester-based copolymers have attracted significant interest for drug delivery systems due to their biodegradability, biocompatibility, and tunable physicochemical properties. Our recent works focus on the rational synthesis of aliphatic polyesters and block copolymers to develop nanoscale carriers with controlled degradation and drug release profiles suitable for biomedical applications.

Methods

Various polyester architectures, including poly(ethylene adipate), poly(ϵ -caprolactone), and poly(L-lactic acid)-based block copolymers, were synthesized using melt polycondensation and ring-opening polymerization techniques. Copolymer composition and molecular weights were precisely adjusted to tailor material properties. Nanoparticles were prepared via emulsification-solvent evaporation or self-assembly methods. Comprehensive characterization was conducted using NMR, SEC, DSC, DLS, and enzymatic degradation assays, alongside in-vitro biocompatibility and antimicrobial activity evaluations.

Results

The synthesized polyesters and copolymers exhibited well-defined structures, narrow molecular weight distributions, and controllable thermal and degradation behaviors. Nanoparticles showed uniform sizes typically in the 100–200 nm range and good colloidal stability. Degradation rates were strongly influenced by copolymer composition, enabling modulation of drug release kinetics. In vitro biological studies confirmed cyto and hemocompatibility as well as antimicrobial activity, supporting their suitability for biomedical use.

Conclusions

These studies demonstrate that controlled synthesis of polyester-based copolymers enables the development of versatile, biodegradable drug delivery systems with tunable properties. Such materials hold strong potential for advanced therapeutic delivery applications.

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sciforum-174233: Effects of mineralized alginate hydrogel microspheres on the growth and differentiation of MG63 cell line

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Alginate hydrogel is a promising biomaterial for bone tissue engineering due to its biocompatibility and ability to mimic the extracellular matrix. This study is aimed to optimize the preparation of alginate hydrogel microspheres via electrostatic spraying (ES) [1] and evaluate different mineralization strategies to enhance their potential for osteogenic applications.

Microspheres were fabricated using an ES system with key parameters systematically optimized to control microsphere diameter and morphology. Mineralization was induced via counter-diffusion (CD) method and introduction of alkaline phosphatase (ALP) [2] in the system. Mineral content was quantified by Inductively Coupled Plasma/Optical Emission Spectrometry, revealing higher calcium incorporation in groups with high phosphate concentration CD method and ALP encapsulation compared to controls.

MG63 cells were embedded in mineralized alginate hydrogel microspheres for evaluation of growth and differentiation [3]. Alizarin Red S staining, flow cytometry, and RT-qPCR were used to detect the effects. The results showed that alginate hydrogel microspheres with addition of ALP and β -glycerophosphate effectively promoted the differentiation of the MG63.

These results demonstrate that both high-phosphate CD method and ALP-mediated enzymatic mineralization effectively enhance the mineralization of alginate microspheres. Mineralized alginate hydrogel microspheres effectively promoted the differentiation of MG63. The optimized ES and mineralization protocols provide a foundation for developing mineralized alginate-based scaffolds for bone regeneration.

- [1] Xie, M., Olderøy, M., et al. Alginate-controlled formation of nanoscale calcium carbonate and hydroxyapatite mineral phase within hydrogel networks. *Acta Biomater.* 2010, *6*(9), 3665–3675.
- [2] Nakamura, T., Nakamura-Takahashi, A., et al. (2020). Tissue-nonspecific alkaline phosphatase promotes the osteogenic differentiation of osteoprogenitor cells. *Biochemical and Biophysical Research Communications*, *524*(3), 702–709.
- [3] Smith, H. L., Gray, J. C., et al. (2023). Tri-lineage differentiation potential of osteosarcoma cell lines and human bone marrow stromal cells from different anatomical locations. *International Journal of Molecular Sciences*, *24*(4), Article 3667.



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sciforum-170265: Electret Melt-Blown Nonwovens with Long-lasting Efficiency Based on Novel Charging Concept and Polymer Design

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Due to its excellent combination of cost/performance ratio and processability, polypropylene is widely used in many fields, including filtration applications.¹ The predominant production technology of such webs is melt blown (MB) fiber technology. The very low viscosity melt passes through a die and is accelerated quickly by high-speed air; a dense layer is formed thereafter. The web properties, like web weight, fiber diameters, etc., can be tailored easily with production conditions and polymer parameters. The formed web can capture particles via inertial collision, interception, and diffusion filtration mechanisms². However, it loses efficiency when the particle size is small (e.g. 300nm), this is very critical since pathogens fall into this size range. The easiest way to capture such small particles with melt blown web is via electrostatic attraction²⁻³. Due to its nature, polypropylene does not show attractive permanent charging behavior⁴. An additive approach is being developed to solve the problem^{2, 4-5}.

In the current work, we present development work based on the combination of an innovative charging concept and a novel polypropylene polymer concept. This novel approach does not only show high charging efficiency under different charging methods but also has very enduring charge stability over time. This development merges the advantages of non-phthalate catalyzed polypropylene in melt blown and a novel powerful charging additive, it provides an excellent stance in terms of product safety and environmental benefits.



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sciforum-180171: Formulation and Evaluation of Polymer-based Sponges for Wound Dressing Applications

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Introduction: Microbial infections commonly cause a delay in the process of wound healing, resulting in chronic wounds. Most wound dressing products currently used for the treatment of chronic wounds suffer from several limitations, including poor antibacterial activity and an inability to absorb excess wound exudate. Polymer-based sponges can possess high porosity that is suitable for the absorption of excess exudates. They can also be loaded with bioactive agents to enhance their biological activities, including antibacterial efficacy. **Methods:** Sponges were formulated from cross-linked gelatin and polyethylene glycol (PEG) using the freeze-drying method. Bioactive agents (metronidazole and Ag nanoparticles) were loaded into the polymeric sponges to improve their antibacterial activity. FTIR, SEM/EDX, and TGA were used to characterize gelatin/PEG sponges, followed by porosity analysis, *in vitro* cytotoxicity, biodegradability, antibacterial studies, and wound scratch healing assay. **Results:** Characterization techniques confirmed the successful fabrication of sponges loaded with bioactive agents. The porosity ranged between 15.64–91.10%, depending on the amount of gelatin in sponges. The sponges were biodegradable, indicating their capability to induce skin regeneration. The *in vitro* biological studies exhibited superior antibacterial activity against most of the Gram-negative and Gram-positive bacteria, high cell viability of normal cells of more than 70%, and a significant reduction of more than 60% in the scratch area at 96 hours. **Conclusion:** The sponges loaded with metronidazole and Ag nanoparticles showed interesting properties (high porosity, superior antibacterial activity, excellent biocompatibility and biodegradability, and high rate of wound closure) that can promote acceleration of the wound healing process of bacterial-infected wounds.



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sciforum-180646: From traditional techniques to surface-enhanced Raman spectroscopy for monitoring industrial polymer aging

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Recent interest has emerged regarding the resilience of modern and contemporary artworks, particularly installations, sculptures, and other pieces created from mixed materials. It has only been in recent decades that museums, conservators, and material scientists have dedicated efforts to assess the current condition of these artworks and study the deterioration of the materials involved especially plastics. They aim to predict how these materials will evolve and develop strategies for conserving and managing collections. Herewith, we present and discuss our findings regarding the current condition and long-term stability prediction of several pieces from the Santiago de Compostela Museum of Contemporary Art. These objects serve as examples highlighting critical issues stemming from the improper use of industrial polymers.

On the one hand, we developed an analytical methodology based on traditional techniques, which consists of the following formal steps: (i) compositional analysis of the artworks, with particular attention to critical polymeric components; (ii) evaluation of its current state of conservation; (iii) investigation of the accelerated ageing of reference polymer samples, to confirm the hypotheses made in the previous step and to analyse thoroughly processes, mechanisms and the kinetics governing the material degradation; and (iv) monitoring of the natural ageing of the artworks, to finally predict the long term behaviour of the artworks.

On the other hand, we developed a novel non-destructive and non-invasive methodology based on nanostructured surface-enhanced Raman spectroscopy (SERS) substrate for detecting degradation markers from the surface of plastic contemporary artworks. The procedure offers a very sensitive tool for detecting the low molecular weight products formed during ageing, which, under a more general view, enlightens degradation mechanisms.

The presentation compares the results and conclusions obtained using traditional techniques with the potentiality of the SERS-based methodology.



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sciforum-180440: High-performance acrylate dielectric elastomers under low electric fields through self-plasticizing

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Dielectric elastomers (DEs), a class of smart materials, are widely used in non-magnetic electrodes, soft robotics, haptic feedback devices for their unique electrical and mechanical properties. However, current commercial DEs require high driving electric fields to achieve usable actuation strain, as well as high energy density and high power output. Such electric fields are often close to the material's breakdown field, making the material prone to electromechanical instability and posing safety risks. To achieve large strain under lower electric fields, this study prepares macromolecular crosslinking agent (BMI) using butyl acrylate, methacrylamide, and isocyanatoethyl methacrylate via free radical polymerization. Combined with butyl acrylate, DEs with good actuation performances are synthesized by UV curing. There are a large number of free oligomers in the polymer by regulating the reaction time, which can play a plasticizing role. The modulus is effectively reduced through the free oligomer plasticizer in the copolymer. BMI-BA exhibits a high actuation sensitivity factor, a 25% actuation strain under a low electric field of 13.07 kV/mm. Linear actuator based on BMI-BA demonstrates good displacement and mechanical output.



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sciforum-174513: Hydrophobically Modified Comb-Like Polyelectrolytes as Efficient Nanoreactors in Aqueous Media

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Modern organic synthesis can solve many important problems; however, many traditional solvents and catalysts are harmful to human health and the environment. Therefore, the development of green synthesis methods has become an important research direction. When selecting green solvents or catalytic systems, factors such as safety and low toxicity must be considered. Water is one of the most attractive environmentally friendly solvents, but a major limitation is the low solubility of organic compounds.

One possible solution is the use of surfactants that form micelles – supramolecular structures with hydrophilic and hydrophobic parts. Micelles improve the solubility of organic compounds in water and can act as reaction environments. This approach is known as micellar catalysis. Polymeric micelles are more stable than low-molecular-weight surfactants and can work under different conditions.

Comb-like polyelectrolytes are promising because their structure can be easily modified. They contain hydrophobic and charged fragments and can form stable micellar structures in aqueous solutions. In this work, hydrophobic fragments based on styrene and pyridine units were introduced into comb-like polyelectrolytes to improve micelle formation and catalytic properties.

The copolymers showed very low association concentrations and solubilized hydrophobic compounds at low polymer content. The introduction of styrene units slightly reduced solubilization compared with the homopolymer, but the copolymers still showed strong catalytic activity. The model hydrolysis reaction was accelerated by about 7–9 times, and polymeric catalysts were more effective than conventional surfactants.

These results show that comb-like polymeric micelles are promising environmentally friendly catalytic systems for reactions in water.

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sciforum-173789: Hydrophobicity overcoming, comb-like polyelectrolytes for micellar catalysis

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Due to 12 Green Chemistry principles the usage of toxic solvents should be reduced so that the micellar catalysis of organic reactions in water becomes more and more popular. New comb-like polyelectrolytes based on quaternized esters of 11-bromoundecanol and acrylic acid were obtained in this work. These compounds have low critical association concentrations (less than 0.0001 M) and are capable of solubilizing low-polarity substances even at high dilution. These compounds were tested as micellar catalysts for hydrolysis reactions of organic and phosphoric acid esters (for some catalysts, acceleration by 10-100 times were observed compared to the hydrolysis reaction in water in the absence of a catalyst). Comb-like polyelectrolytes have proven to be effective not only in reactions aimed at the destruction of molecules, the acceleration of which is achieved mainly due to the local concentration of the substrate and reagent by the mechanism of solubilization and ionic attraction, but also in constructive organic reactions, where the ability to stabilize transition states and steric effects in the micellar pseudophase become important. The key focus of the report will be on studying the features of the Suzuki–Heck coupling reaction catalyzed by palladium chloride in water, where a comb-like polyelectrolyte acts as a co-catalyst. By varying the type of ionic group and the length of the hydrophobic spacer between the polar group and the polymer chain as well as introducing functional additives at the stage of polyelectrolyte synthesis, it is possible to control the catalytic activity of these compounds and optimize the catalyst structure for selected organic reactions using water as the main solvent.

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sciforum-173645: Hyperbranched polyethoxysiloxane – a unique silica precursor polymer for preparation of nanostructured silica materials

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Monomeric tetraethoxysilane is the most widely used silica precursor in the sol-gel process. Here, we report a unique polymeric silica precursor, hyperbranched polyethoxysiloxane (PEOS), a highly hydrophobic liquid that exhibits interfacial activity in oil/water systems due to amphiphilicity induced by hydrolysis of ethoxy groups at the interface. Consequently, PEOS can stabilize various types of emulsions—including oil-in-water, water-in-oil, water-in-oil-in-water, and even high-internal-phase emulsions—without the need for additional surfactants. After conversion of PEOS into silica, the internal phase can be encapsulated within a silica shell. When a monomer serves as the oil phase, the synergy between polymerization and PEOS conversion leads to the formation of polymer@SiO₂ core-shell particles, nanocapsules, nanorattles, or Janus-like particles. These structures arise from the delicate interplay among PEOS hydrolysis and condensation rates, polymerization kinetics, emulsion stability, and phase separation within the emulsion droplets. Furthermore, substitution with hydrophilic poly(ethylene glycol) monomethyl ether (PEG) yields intrinsically amphiphilic PEG-PEOS derivatives with significantly enhanced interfacial activity. PEG-PEOS polymers can self-assemble in water, and the resulting soft assemblies are subsequently converted under basic conditions into mesoporous aerogel particles with very low density, hollow nanoparticles, or ultrasmall solid particles, depending on the degree of substitution. The addition of a hydrophobic organic liquid to aqueous dispersions of PEG-PEOS results in the spontaneous formation of oil-in-water emulsions that resemble PEG-PEOS self-assembled structures swollen by the organic liquid. Upon basic conversion, these emulsions yield silica aerogel particles as well as hollow nanocapsules loaded with the organic liquid. Finally, it is demonstrated that enzymes can be efficiently encapsulated within silica hollow nanoparticles by dispersing an appropriate PEG-PEOS polymer in an aqueous enzyme solution.



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sciforum-180078: Iron-based MOF-embedded polymeric monoliths for sustainable PFAS determination with high-resolution mass spectrometry

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Introduction: Hybrid polymer-based sorbents emerge as promising materials for environmentally friendly analytical applications, combining functional versatility with efficient extraction performance. In this study, an iron-based metal-organic framework (MOF) embedded within a polymeric monolith was developed as a composite sorbent for the sustainable determination of per- and polyfluoroalkyl substances (PFAS) in environmental water samples.

Methods: The MOF-polymer composite was applied in a solid-phase extraction procedure designed to reduce solvent and material consumption while maintaining analytical performance. The extraction process was optimized using experimental design, and the final method was coupled with liquid chromatography-high-resolution mass spectrometry (LC-HRMS). The greenness and practicality of the method were evaluated using relevant green analytical metrics.

Results: The hybrid sorbent exhibited high porosity and favorable surface properties, with a BET surface area of 803 m²/g, pore volume of 0.43 cm³/g, and external surface area of 144 m²/g. The optimized method required only 20 mg of sorbent and showed excellent linearity ($R^2 > 0.999$), limits of detection of 4–95 ng/L, and limits of quantification of 12–314 ng/L. Precision was satisfactory, with RSD_r 11% and RSD_R 15%. Recovery studies in environmental water matrices yielded values of 67–125%, demonstrating applicability to tap, marine, river, runoff, effluent, groundwater, and lake water samples.

Conclusions: The proposed iron-based MOF-polymeric monolith is a promising sorbent for sustainable PFAS determination in environmental waters. Its satisfactory analytical performance, low sorbent consumption, and compatibility with green analytical principles support its potential for environmental monitoring of persistent contaminants.



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sciforum-180557: Lignin self-healing coatings based on thermo-reversible Diels-Alder reaction for anticorrosion applications

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In the current research, we explored the fabrication of thermo-reversible polymer networks made of bio-based materials to address the growing need for greener and more sustainable polymer coating. Herein, we developed thermally self-healing lignin-based coatings with strong anticorrosion performances through Diels-Alder crosslinking strategy. Accordingly, organosolv lignin was first functionalized by furan moieties and then used for thermally crosslinking by 4,4'-bismaleimidodiphenylmethane (BMI) after spin casting on the surface of steel sheets. Under the optimum conditions, the obtained coating could generate smooth and defect free layers. Noticeably, a thin layer (18 μm) of this coating could increase the E_{corr} from -481 mV (for bare steel) to $+142$ mV and it could reduce the corrosion rate (CR) over 3300 times. Importantly, the thermo-reversibility of the network endows excellent self-healing ability to this lignin-based coating. Indeed, the lignin self-healing coatings based on thermo-reversible Diels-Alder reaction provides a creative strategy for bio-based materials applied in anticorrosion applications with high-performance.



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sciforum-180809: Low Dielectric and High Electromagnetic Transmitting Polymeric Foams Made from Supercritical Fluid Foaming

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Air possesses the lowest dielectric constant and dielectric loss; therefore, engineering air into a structured material offers a promising pathway to achieve optimal low-dielectric performance. Supercritical fluids offer distinct advantages, including residue-free processing, rapid dissolution and diffusion, and high nucleation efficiency. By utilizing supercritical fluid microcellular processing technology with a polymer matrix, it is possible to fabricate highly electromagnetic wave-transparent "Air Material" featuring uniformly distributed air voids and ultra-low dielectric properties. In the context of millimeter-wave applications, the diameter of air bubble is significantly smaller than the signal wavelength, thereby eliminating signal transmission scattering. Furthermore, the cell wall thickness is far less than one-tenth of the signal wavelength, which significantly attenuates signal reflection. The extensive, uniform distribution of air bubbles also minimizes signal absorption. Ultimately, this results in a dielectric loss as low as 0.0001, enhancing signal gain and efficiency when employed as antenna substrates, thereby extending the signal transmission distance.



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sciforum-174695: Molecularly Imprinted Biopolymer Integrated on Silicon Electrochemical Sensors for Pesticide Detection

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The increasing presence of organic pollutants such as glyphosate in water resources poses significant environmental and public health challenges, necessitating the development of sensitive, selective, and field-deployable analytical tools. Electrochemical sensors have emerged as promising candidates due to their rapid response, low cost, and potential for miniaturization; however, their performance is often limited by poor selectivity toward small, electrochemically inactive analytes. In this work, we introduce a silicon-based electrochemical sensor platform that integrates nanocrystalline graphite (NCG) electrodes with molecularly imprinted polymers (MIPs) derived from biopolymers for the selective detection of glyphosate. The NCG working electrode, lithographically patterned on a silicon/silicon dioxide substrate alongside integrated reference and counter electrodes, provides a robust and reproducible conductive interface that is fully compatible with microfabrication processes. A chitosan-based MIP layer, formed through controlled electrodeposition in the presence of glyphosate, yields recognition cavities tailored to the molecular size, shape, and functional groups of the target analyte.

The use of a biopolymer such as chitosan not only enhances environmental sustainability but also offers abundant functional groups for efficient imprinting and strong analyte binding. Surface characterizations via FTIR, Raman spectroscopy, and scanning electron microscopy confirm the successful formation of the MIP layer on the NCG surface. Electrochemical evaluations demonstrate that the MIP-functionalized sensor exhibits an extended linear detection range (0.05–75 ng/mL), an exceptionally low limit of detection (0.015 ng/mL), and high selectivity against structurally similar pesticides. Recovery tests in real water samples show excellent accuracy and reproducibility. This work highlights the synergistic integration of biopolymer-based MIPs with silicon-compatible electrode architectures, opening new avenues for polymer-engineered, miniaturized electrochemical devices for environmental monitoring of organic contaminants.

FUNDING

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sciforum-182851: Organosilicon [1]benzothieno[3,2-b]benzothiophene-containing oligomers and polymers for solution processible organic electronics

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Dialkyl derivatives of [1]benzothieno[3,2-b]benzothiophene (BTBT) are known as excellent organic semiconductors. However, their solution-processed high mobility thin films were found to be unstable during storage leading to strong degradation of organic field-effect transistors (OFETs) characteristics [1]. As opposite, siloxane dimers of 2,7-dialkyl-BTBT were found to form not only stable thin films, but also self-assembled on the air-water interface monolayer films with good semiconductor properties, which could be used in OFETs, ultrasensitive gas sensors and electronic noses based on them [2,3]. Similar properties were discovered for silazane dimers [4] and organosilicon tetramers of BTBT [5]. In this work synthesis and properties of siloxane homo- and copolymers with 2,7-dialkyl-BTBT side groups are reported. Dependencies of content of BTBT-containing side groups and molar weight characteristics of the copolymers [6] on their physical-chemical properties, phase behavior and semiconductor characteristics are discussed. The ways of improving field-effect mobility and long-term stability of BTBT derivatives by organosilicon oligomer and polymer architectures are discussed.

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References:

1. P.A. Shaposhnik, A.A. Trul, E.Yu. Poimanova, et. al. *Org. Electron.* **2024**, 129, 107047.
2. M.S. Polinskaya, A.A. Trul, O.V. Borshchev, J. *Mater. Chem. C* **2023**, 11(5), 1937-1948
3. A.A. Trul, V.P. Gaidarzhi, A.A. Abramov, et. al. *ACS Appl. Electron. Mater.* **2026**, 8(2), 871-882.
4. E.A. Bobrova, M.S. Skorotetcky, B.S. Kuleshov, et. al. *Nanomaterials* **2026**, 16(2), 124.
5. I.O. Gudkova. E.A. Zaborin, A.I. Buzin, et. al. *Molecules* **2025**, 30, 4639.
6. E.A. Zaborin. O.V. Borshchev, A.I. Buzin et. al. *Macromol. Rapid Commun.* **2026**, DOI: 10.1002/marc.70276.



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sciforum-192995: Photoactive Materials for Water Treatment, Soft Robots and Tumor Theragnosis

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Sun light gives us warmth, which is the basic photo-thermal effect. To enhance the efficiency of photo-thermal energy conversion, scientists have developed numerous ingenious materials to satisfy a variety of human needs for daily life of modern society. Our research group has investigated a series of photoactive materials, such as conductive polyaniline, nanocarbons, supramolecular assemblies, nanometal particles, etc., as effective photo-thermal conversion media, and explored many practical applications. In this lecture, I will present our recent works on (1) solar distillation devices to obtain fresh water from seawater and polluted waters based on electroactive polyaniline, graphene, carbon nanowires and bioactive compounds, (2) construction of photo-thermal driven 2D/3D shape memory actuators and soft robots based on vitrimers and liquid-crystalline elastomers, and/or (3) nanobiomedical systems for photo-imaging, photoprobing, photo-thermal, photochemical and photodynamic diagnosis and therapeutical treatment of various tumors. (I wish to thank a cadre of research collaborators and students for their hardwork and tremendous contributions to this work, and Tsinghua University, NSFC, Ministry of Science and Technology, Ministry of Education and industrial companies in China for the financial support.)



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sciforum-174767: physics Challenges in High-Pressure Hydrogen Storage

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Abstract

High-pressure hydrogen storage at 700 bar represents one of the most demanding engineering challenges for the deployment of hydrogen mobility. Hydrogen tanks must operate under extreme mechanical and environmental conditions while ensuring strict impermeability and long-term structural integrity. Such tanks constitute complex multi-material systems composed of three primary elements: a polymer liner ensuring hydrogen tightness, a carbon fiber reinforced composite shell providing mechanical resistance, and a metallic insert guaranteeing structural continuity and sealing. Beyond the intrinsic behavior of each component, overall performance is governed by the integrity of critical interfaces between liner, composite, and metal insert, where adhesion, stress concentrations, and potential gas migration may occur. The structure is subjected to severe service conditions: operating pressures up to 700 bar with burst requirements around 1750 bar, temperature variations from -40°C to $+85^{\circ}\text{C}$, cyclic pressurization, rapid filling inducing self-heating, and multiple loading modes including tension, confined compression, fatigue, creep, and impact. Hydrogen permeation through polymers involves coupled diffusion–solubility mechanisms strongly dependent on microstructure and aging phenomena, while composite damage evolution and interfacial decohesion critically affect durability.

Research in this domain is inherently multiphysics and multiscale, spanning molecular diffusion to macroscopic structural response. Predictive modeling requires coupling diffusion, thermo-mechanical behavior, fracture mechanics, and aging kinetics. Advanced numerical simulation combined with experimental investigation is essential for durability assessment and design optimization. Artificial intelligence methods further enable data-driven correlations between processing parameters, microstructure evolution, and in-service performance.

In this seminar, selected key results from our recent research activities will be presented, particularly on permeability control, interface behavior, multiphysics modeling, and ultrasonic-based non-destructive monitoring strategies.



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sciforum-171222: Polymer Binder Design for Advanced Li-ion Batteries

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The demand for next-generation Li-ion batteries is driving the development of smaller, lighter cells capable of ultra-fast charging. Polymer binders play a critical role in electrode fabrication by enabling high loading of active materials with energy densities surpassing those of conventional systems. In this work, we introduce and evaluate two novel binder formulations validated in silicon (Si)-based anodes, which can deliver capacities up to ten times higher than graphite.

The first binder is derived from lignin, a renewable by-product of the pulp and paper industry. Chemical modification of lignin yields a binder compatible with both silicon and graphite, providing improved adhesion and promoting the formation of a stable solid-electrolyte interphase (SEI). Silicon-graphite composite electrodes prepared with this lignin-based binder exhibited excellent cycling stability, achieving capacities above 1200 mAh g⁻¹ for more than 500 cycles in both half- and full-cell configurations.

The second binder is an ionomeric waterborne polyurethane (WPU) designed with long soft segments and short polar chains containing carboxylic groups. Partial neutralization with LiOH produces lithium carboxylates that enable multipoint anchoring to Si/SiO_x surfaces, reversible ionic interactions, and Li-ion conductive pathways. Micro-silicon anodes employing this WPU ionomer demonstrated superior electrochemical performance compared to conventional polymer binders such as polyacrylic acid.

Together, these binder systems highlight material-driven pathways to enhance the mechanical integrity, interfacial stability, and electrochemical performance of high-capacity silicon anodes for advanced Li-ion batteries.



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sciforum-174580: Polymer Organized Surface Microstructure Effect on Eukaryotic Cells Growth and Differentiation

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Alongside surface material composition, structure of the surface topography plays an important role in cells attachment, growth and differentiation which makes it crucial for cancer research and regenerative medical applications [1]. Poly(3-hydroxybutyrate) (PHB) and its copolymers and composites [2] are biocompatible and biodegradable materials that allow controlled production of various surface structures from electrospinning and striped molds to organized honey-comb topography. Polymer composition also might include different compounds that can promote and direct cells differentiation such as statins like hydroxyapatite or simvastatin that has been shown to promote osteo-differentiation in MG63 and MSC cell lines and neuro-like differentiation in SH-SY5Y cell line.

Encapsulation of statins also requires a controlled approach to the selection of conditions based on the cell line and desired effect. Polymer encapsulation allows to eliminate toxic effect alongside controlled release.

This study revealed that many cell lines morphologically react on organized surface topography which then promotes cell differentiation. SH-SY5Y, MG63 and rats MSCs cells all demonstrate elongation and alignment with microstructure on both electrospinning scaffolds with different thickness, oriented grooves on mold-leached films and depending on pore size and circularity of honey-comb structures. Thickness of electrospinning fibers, their orientation, size and circularity of honey-comb pores and distance between oriented grooves on films and statins encapsulation all require careful controlled production and consideration regarding the expected cell's reaction.

References

- [1] Werner, M.; Blanquer, S.B.G.; Haimi, S.; et al. Surface Curvature Differentially Regulates Stem Cell Migration and Differentiation via Altered Attachment Morphology and Nuclear Deformation. *Advanced Science* 2017, vol. 4, no. 2, 1600347.
- [2] Zhuikov, V.A.; Zhuikova, Y.V.; Makhina, T.K.; et al. Comparative structure-property characterization of poly(3-hydroxybutyrate-co-3-hydroxyvalerate)s films under hydrolytic and enzymatic degradation: finding a transition point in 3-hydroxyvalerate content. *Polymers (Basel)*, 2020, 12(3), E728



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sciforum-174732: Probing Melatonin's Release Pattern Using Synthetic Biopolymers

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INTRODUCTION

Melatonin (*N*-acetyl-5-methoxytryptamine) (MLT) is a naturally occurring hormone produced endogenously primarily in the suprachiasmatic nucleus. MLT exhibits a plethora of uses and particularly in the treatment of sleep disorders (sleep onset and maintenance).

However, due to its short biological half-life, MLT cannot maintain effective plasma concentrations for a prolonged period when is exogenously taken in immediate release formulations. The present study aims at developing modified release systems capable of gradually releasing MLT, thereby sustaining its pharmacological effect over eight hours.

Modified-release tablets (200 mg) were prepared using new polymeric excipients based on polylactic acid (PLA). Both neat PLA and PLA copolymers with polyethylene glycols (PEG) of varying molecular weights were used, producing PLA-PEG 4000, PLA-PEG 6000, and PLA-PEG 8000, which were used along with other excipients.

MATERIALS AND METHODS

Matrix tablets were prepared by direct compression, placed in a USP Type II dissolution apparatus (pH medium 4.5) and the aliquots were analyzed at $\lambda_{\max} = 278$ nm using a uniSPEC 2 UV-Vis spectrophotometer.

RESULTS

The release of MLT from the formulations F1 and F4 follows a similar pattern. Moreover, from these two systems the % release of MLT, at $t=240$ min, is about 85%, rendering them suitable for further development towards confronting sleep onset problems.

The release of MLT from the F2 and F3, follows a more sustained pattern, reaching 84% at $t=480$ min. This profile is like that of the commercially available drug Circadin.

The release pattern of MLT from the F5 and F6 formulations, which involve the copolymers PLA-PEG 8000 and PLA-PEG 4000, is almost coincidental, possibly because the quantities of the rest excipients in these formulations are the same.

CONCLUSION

Overall, MLT's release pattern motif from F2, F3, and F5, F6, satisfies the requirements for dealing with sleep onset and sleep maintenance dysfunctions.



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sciforum-181478: Regulation of Fluorinated Polyurethane Acrylate Nanoimprint Resists and Impact on Liquid-Crystal Lens Performance

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Liquid-crystal (LC) lenses are key components for compact, electrically tunable optical systems in AR/VR applications. Nanoimprint lithography provides a scalable route for fabricating Fresnel LC lenses, while the polymer resist used in imprinting plays a critical role in determining microstructure fidelity, demolding reliability, mold lifetime, and ultimately device performance. In this work, a highly crosslinked fluorinated polyurethane acrylate (FPUA) system was employed as the nanoimprint UV resist, and its function as a structure-defining and performance-governing polymer material for LC optical devices was systematically investigated.

Fresnel LC lenses were fabricated through nanoimprint, cell assembly, LC filling, and modulation transfer function (MTF) characterization. By varying fluorine content, polyurethane segments, and crosslinking degree in parallel, a series of FPUA resists with tunable surface energy, toughness, and modulus were designed and evaluated. A multidimensional framework combining SEM, profilometry, adhesion tests, and demolding-force analysis was established to correlate polymer properties with imprint reliability, structural retention, and optical performance.

The results show that the performance of the FPUA resist depends on the balance among interfacial adhesion, friction, and cohesive strength. Increasing fluorine content reduced surface energy and improved release behavior, while polyurethane segments enhanced toughness and suppressed damage during demolding. Meanwhile, a higher crosslinking degree increased modulus and improved structural retention, but excessive rigidity caused brittle failure. Through this parallel material design, an optimized FPUA resist achieved reliable demolding, extended mold lifetime, maintained shape-fidelity errors within 5%, and effectively suppressed MTF degradation during repeated imprinting.

In conclusion, this work highlights the decisive role of fluorinated polyurethane acrylate as a functional polymer resist for nanoimprinted LC lenses. The proposed material-design strategy provides practical guidance for polymer formulation in AR/VR optical systems and advances the scalable manufacturing of high-performance tunable photonic devices.



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sciforum-176592: Research on Optimization of Fresnel Lens Molding Process by Combining Rapid Heat Cycle Molding Technology with the Principle of Rupert's Tears

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Rapid Heat Cycle Molding (RHCM) is an emerging eco-friendly injection molding technology that markedly improves the surface quality of plastic parts, producing high-gloss products without melt marks. It eliminates subsequent spraying processes, thus cutting production costs, simplifying the production flow and shortening the cycle. Lens molding is a core process in optics and optoelectronics, and its molding quality and optical performance directly determine the application effect of end products. However, the limitations of temperature control in traditional molding processes have become a key factor restricting the improvement of lens precision. This study integrates the rapid heating and cooling principle of Rupert's Tears preparation with RHCM technology to optimize the Fresnel lens molding process. Firstly, RHCM was adopted for injection molding of Fresnel lenses with two heterogeneous material combinations (LSR/PC and PC/LSR for upper and lower layers), and the material combination with better physical properties under initial parameters was screened out. Subsequently, with melt temperature, mold temperature, curing time and pressure as key parameters, experimental design was completed via Latin Hypercube Sampling. Combined with the Reinforcement Learning-Markov Decision Process (RL-MDP), predictions and decisions were made on the residual stress and shrinkage displacement index of lenses under different parameter combinations, to explore parameter influence laws and screen optimal injection parameters. The results show that the optimized RHCM-based Fresnel lens molding process significantly improves lens manufacturing quality and optical performance, while effectively reducing production costs and shortening the cycle. This study provides an efficient process optimization method for optical device manufacturing, and has important practical and reference value for advancing the development of optical and optoelectronic technologies.



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sciforum-195099: Sustainable and Mass-producible Epoxy Vitrimer-Based Gel Polymer Electrolytes

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With the growing demand for high-energy-density energy storage devices, lithium metal batteries (LMBs) using lithium metal as anodes have emerged as promising candidates. However, the issues of lithium anodes, such as dendrite growth, poor compatibility with liquid electrolytes, and safety concerns, pose challenges for their practical use. Therefore, gel polymer electrolytes (GPEs) become popular due to their good compatibility with lithium anodes. However, traditional GPEs suffer from poor mechanical strength, complex fabrication processes, lack of self-healing ability and recyclability, which hinder their large-scale and sustainable application. Here we present an epoxy vitrimer (cross-linked network with dynamic covalent bonds) as GPE for LMBs, synthesized from commercially available raw materials of epoxy resins by a simple technology of hot-pressing. The epoxy vitrimer-based GPE shows good electrochemical performance, with over 1000 hours of stable cycling in Li symmetric cells and impressive cycling retention of 92.4% after 200 cycles in $\text{LiFePO}_4/\text{Li}$ cells. Moreover, dynamic covalent bonds endow vitrimer with remarkable self-healing ability and recyclability, which would further improve the cycling and safety aspects of the battery. Therefore, due to its low material costs and simple manufacturing process, epoxy vitrimer-based GPE has a great potential for sustainable mass production in practical application in LMBs.



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sciforum-196417: Tailoring Precursor Ionization Using Nanoscale Counterions for High-Performance Perfluorosulfonic Acid Membranes in Vanadium Redox Flow Batteries

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Perfluorosulfonic acid (PFSA) cation exchange membranes are essential for vanadium redox flow batteries (VRFBs), but the impact of precursor ionization on their performance remains underexplored. This study systematically adjusts the ionization of PFSA precursors (PF-SO₂F) through nanoscale counterions (Na⁺, K⁺, Me₄N⁺) to enhance ion transport selectivity. Our findings show that the type of counterion significantly influences ionization levels and hydration, resulting in various nanophase-separated morphologies. The K⁺-modified membrane (PKH) uniquely strikes an optimal balance, achieving a high proton conductivity of 82 mS/cm and a markedly reduced vanadium ion permeability of 25×10⁻⁷ cm²/min. This is due to K⁺ smaller hydrated radius, which encourages the formation of continuous yet compact ionic channels. As a result, the PKH membrane delivers superior VRFB performance, including a prolonged open-circuit voltage of 49.2 hours and excellent long-term cycling stability with 85% capacity retention after 200 cycles. Conversely, membranes with the bulkier Me₄N⁺ ion face incomplete precursor activation and high impedance, limiting their usefulness. This research reveals a clear link between counterion-driven ionization kinetics, nanostructure, and battery performance, proposing a precursor-centric approach to develop high-performance PFSA membranes for flow battery applications.



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sciforum-181524: The influence of divalent metal cation contamination (Ca^{2+} , Mg^{2+} , Fe^{2+} , Cu^{2+}) on the degradation of Nafion membrane transport performance for proton exchange membrane fuel cells: A molecular dynamics study

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Proton exchange membrane fuel cells (PEMFCs) undergo aging damage and produce metal ion contamination during operation, which reduce the performance of PEMFCs. This study systematically investigates and compares the effects of four divalent metal ions (i.e. Ca^{2+} , Mg^{2+} , Fe^{2+} , Cu^{2+}) on the proton exchange membrane (PEM) transport performance for PEMFCs using molecular dynamics (MD) simulation method. Six different types of contamination models are established to investigate the effects of metal ions on the structure and kinetic properties of Nafion membrane. Results demonstrate that all divalent metal ions severely degrade proton and water transport by binding to sulfonate groups and disrupting the hydrophilic network. However, the degree of influence of four metal ions is different. Cu^{2+} and Fe^{2+} have the most detrimental impact due to strong sulfonate affinity and tendency to form stable states. Ca^{2+} affects transport by compressing hydrophilic channels, while Mg^{2+} has a relatively weaker effect as it tends to retain the hydration shell. These results reveal the mechanism of metal ion contamination at the molecular level, providing guidance for the development of more durable and pollution resistant proton exchange membranes.



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sciforum-174388: Uniplanar crystalline phase orientation in PBS films

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The growing environmental impact of conventional plastics has heightened interest in sustainable and biodegradable alternatives. Biodegradable polymers, such as Poly(butylene succinate) (PBS), are increasingly considered for applications in packaging and environmental protection due to their biodegradability, thermal stability, and melt processability. PBS films also exhibit relatively low gas and water vapor permeability compared to conventional polymers, highlighting their potential as barrier materials in biodegradable application.

In this study, PBS samples were processed under different pressures throughout a compression molding process to investigate how processing conditions affect molecular orientation and the resulting barrier performance. Samples obtained at atmospheric pressure exhibited a largely disoriented structure, whereas higher pressures promoted molecular alignment. The structural differences were characterized by WAXD analysis. Oriented PBS samples showed improved barrier performance compared to disoriented counterparts, demonstrating that pressure-induced orientation can be an effective approach to modulate functional properties. Previous research indicates that the barrier properties of PBS-based films are strongly influenced by microstructural features such as crystallinity and molecular orientation, which affect water transport and diffusion behaviour.

These findings highlight the potential of processing strategies to tailor the performance of biodegradable polymers, offering insights for their application in sustainable packaging and environmentally relevant technologies. The results suggest that the effect of process parameters, such as the pressure, can significantly influence the structure–property relationship in PBS, which is critical for developing biodegradable materials with enhanced functional capabilities.



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Session 7. Polymers and the Environment

sciforum-175039: UV-aging of model undyed and dyed polystyrene microparticles

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Polystyrene (PS) microplastics (MPs) are widespread in the environment, originating from the degradation of various materials. During their lifetime, MPs are subjected to a number of environmental factors that cause aging. The aromatic structure of PS renders it highly sensitive to UV light, making model PS microplastics ideal for studying photoaging processes, which dramatically change their physico-chemical properties, structure, chemical activity and ecological impact.

In real-world conditions, MPs often contain various additives such as dyes, pigments, solvents, etc. Rhodamine B (RhB) is widely used in the textile, paper printing, and plastic industry. Environmental contamination with RhB is frequently detected in soils, wastewaters and even rivers worldwide. RhB can adsorb onto MPs and may well affect their aging under UV light and properties of the aged material. Therefore, studying both undyed and dyed microplastics provides more realistic data on their environmental behaviour.

In this study, we simulated natural UV aging by exposing both undyed and RhB-dyed PS microspheres to controlled UV irradiation over various time periods. FTIR analysis revealed chemical changes on their surfaces, including photooxidation and aromatic structure degradation, resulting in more polar compounds and a more negative zeta potential, indicating increased surface acidity and electrostatic interaction potential. We examined RhB adsorption on both pristine and UV-aged PS microparticles. Aging enhanced the adsorption capacity of undyed PS, but UV-aged RhB-dyed PS exhibited lower adsorption capacity compared to its unaged form.

Photoaging significantly affects the surface properties of microplastics, resulting in an increase in their sorption capacity. To evaluate their environmental and health impacts accurately, it is crucial to separate the aging of dyed samples from that of undyed ones, as their properties and, consequently, environmental influence differ.

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sciforum-169218: A New Generation of Micro and Macroporous Polymer Films: From Structural Design to High-Impact Environmental Applications

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Introduction: This communication presents a new generation of micro and macroporous polymeric films based on a high performance commercial polymer: poly(2,6-dimethyl-1,4-phenylene) oxide (PPO). The focus is on the development of Nanoporous Crystalline (NC) phases, which represent an “exception” in polymer science. By leveraging these unique structural features, we address critical modern challenges in environmental remediation, chemical sensing, and molecular separation, bridging the gap between fundamental macromolecular chemistry and sustainable industrial solutions.

Method: 2D WAXD, DSC, TGA, FTIR and SEM analyses were performed.

Results: We discuss co-crystallization procedures designed to enhance guest uptake and kinetics in NC polymer films. A methodology for achieving PPO membranes showing very High Surface Area (HSA), reaching values up to 620 m²/g, in films from a few to hundreds of microns, is presented. Furthermore, innovative sulfonated HSA NC PPO films will be presented, featuring a hydrophilic sulfonated amorphous phase as well as hydrophobic NC crystalline phases, ensuring both functionality and structural integrity up to 180°C. These innovative films reveal extraordinarily high pollutant uptake as well as faster sorption kinetics, making them highly effective for rapid contaminant removal.

Conclusion: Innovative HSA NC PPO films, combining reusability, transparency, flexibility, and high sorption kinetics, are expected to offer a sustainable and efficient alternative to traditional porous media in the field of environmental remediation.

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sciforum-174768: A Redox-Responsive Nanoplatfrom for Heavy Metal Complexation and Plant Growth Promotion

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Plant growth regulators are widely used in agricultural applications to enhance yields. However, the low efficiency and specificity lead to severe resource waste and serious environmental concerns. Functional polymer-modified nanocarriers have the potential for targeted delivery of plant growth regulators. Herein, a redox-responsive thiol-functional polymer brush grafted silica nanocarrier (SiO₂-S-S-IAA) was developed for targeted delivery of plant growth regulators via surface polymerization engineering. Thiol-functional polymer brushes can respond to the specific concentration gradient of glutathione (GSH), thereby achieving selective release of the model plant growth regulator 3-indoleacetic acid (IAA). It was found that SiO₂-S-S-IAA significantly promoted plant growth, its root length and stem length increased by 29.35% and 33.99%, respectively, compared to plants grown in DI water. Moreover, the thiol groups in the polymer layer exposed after the redox reaction serve as coordination sites to capture heavy metal ions (Hg²⁺, As³⁺/As⁵⁺, Cd²⁺, Pb²⁺) and form stable complexes, with the highest adsorption efficiency observed for Hg²⁺ (up to 57.95%), thereby preventing the migration of heavy metals into edible plant parts. This “release-capture” mechanism enhanced the efficacy of agrochemicals while immobilizing soil contaminants. By combining stimulus-responsive polymers with inorganic materials, this polymer composite provides a new approach to smart delivery of agrochemicals and contributes to the zero-pollution ambition.



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sciforum-169679: Design, preparation and application of monodisperse polymer microspheres in ion chromatography-mass spectrometry

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Ion chromatography, as a key technique for analyzing inorganic ions and small-molecule acids, has attracted much attention in recent years. However, existing commercial stationary phases face severe challenges in separating sterilization byproducts. At the chemical mechanism level, due to insufficient understanding of the interaction mechanism between the stationary phase microenvironment and target molecules, existing modification strategies mostly rely on trial-and-error experiences such as increasing hydrophilicity and adjusting chain length. At the physical mass transfer level, insufficient uniformity of packing materials and pore structures not optimized for small molecules hinder physical diffusion, resulting in low column efficiency and slow analysis speed. Although some studies have used thermodynamic models or molecular dynamics to explain retention mechanisms, a systematic theoretical guidance is still lacking. Based on this, this study introduces the concept of materials genomics, aiming to achieve a leap from "experience-based trial and error" to "rational design" in stationary phase construction through "theoretical simulation-guided targeted design." First, density functional theory and molecular dynamics simulations were used to calculate and screen suitable functional groups and pore structures based on the electrostatic potential and steric hindrance characteristics of disinfection byproducts. Then, using self-made monodisperse polystyrene microspheres as a matrix, a modified one-step swelling method was adopted to achieve the swelling and chloromethylation of the microspheres in one step. Quaternization modification was then completed by introducing preferred groups through chemical derivatization, thus preparing a novel stationary phase. Finally, this stationary phase was applied to an IC-ESI-MS/MS analytical system, and its separation performance for nine common haloacetic acids and halooxides was systematically evaluated.



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sciforum-173903: Environmental Impacts of Waste Tyre Reuse and Material Recovery Strategies in South Africa: An LCA Approach

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Globally, more than one billion waste tyres are generated annually, yet only 10% are recycled, leading to large stockpiles and growing environmental risks. This challenge is mirrored in South Africa (SA), which produces approximately 11 million waste tyres yearly, far exceeding the capacity of its limited recycling and recovery infrastructure. In response, SA has prioritised tyre retreading, rubber crumbing, and rubber-modified asphalt as key reuse and material recovery strategies. However, despite their increasing uptake, the environmental performance and associated burdens of these methods remain insufficiently assessed using robust life cycle assessment (LCA) approaches. This study applies a detailed LCA to quantify the environmental loads and damaging impacts of these reuse and material recovery strategies. Using SimaPro 9.4.0.2 with the Ecoinvent 3 database and the ReCiPe 2016 method, assessed at both midpoint and endpoint levels, the analysis evaluates impacts on ecosystems, human health, and material resource depletion. Findings show that approximately 6% of SA's waste tyres are directed to reuse and 22% to material recovery. Rubber-modified asphalt exhibited the highest environmental impacts across most categories, 60% higher than alternative pathways, primarily due to elevated mineral resource depletion (2.14E-04 kg Cu eq) and fossil fuel depletion (7.31E-02 kg oil eq), despite reducing the use of virgin aggregates and bitumen. Waste tyre retreading generated the second-highest impacts (25%), largely driven by the harmful effects associated with synthetic rubber used in the process. Mechanical grinding contributed 15% of total environmental loads but showed the highest water resource depletion potential (1.14E+03 m³). Despite these burdens, reuse and material recovery significantly reduce landfilling and its associated hazards. Their impacts can be mitigated through improved dust suppression, odour control, and cleaner production measures. Overall, the study demonstrates that waste tyre reuse and material recovery support SA's transition toward sustainable waste management, technological advancement, and socioeconomic development.



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sciforum-156445: High-efficiency waste PET depolymerization and high-value utilization of depolymerized products

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Waste polyethylene terephthalate (PET) methanolysis into dimethyl terephthalate (DMT), which serves as a raw material for regenerated PET, is a promising route for industrial application but still faces harsh methanolysis conditions and low economic effectiveness in DMT-to-rPET process. Herein, we propose a tandem strategy for low-temperature PET methanolysis using machine learning method to screen deep eutectic solvents (DESs) based on structure-activity relationship to methanolysis performance, followed by hydrogenation of DMT into high-value product dimethyl 1,4-cyclohexanedicarboxylate (DMCD). Based on quantum chemical descriptors of various DESs and corresponding DMT yields, a high-fidelity machine learning correlation was established. Reusable and metal-free 1,5-diazabicyclo[4.3.0]non-5-ene/4-methylimidazole (DBN/4MI) was predicted and then confirmed to possess the best catalytic performance due to the strong hydrogen-bonding interactions with the reactants, which significantly reduced activation energy with DMT and EG yields reaching 95% and 89%, respectively, under mild conditions of 130 °C, 0.72 MPa, and 1 h. DBN/4MI exhibited good applicability to various real waste PET samples and other polyesters (PBT, PBS, PETG, and PBAT). The generated DMT was hydrogenated over Ru-based catalyst to yield 99.1% DMCD with superb catalytic activity and stability. This work provides a guideline for developing green media to facilitate PET depolymerization and subsequent upcycling processes.



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sciforum-186423: Mechanistic Evaluation of POP-Based Visible-Light Photocatalysis for Tracking Thiabendazole Removal Pathways

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Porous organic polymers (POPs) have emerged as promising metal-free photocatalysts for sustainable water treatment, considering their conjugated structures, high surface area, chemical stability, and ability to utilize visible light. POPs were applied for the visible-light-assisted removal of thiabendazole (TBZ), a persistent fungicide frequently detected in agricultural runoff and food-processing wastewater [1]. Beyond evaluating removal efficiency, the central objective was to develop a kinetic approach capable of clarifying fate of TBZ during photocatalytic treatment.

A coupled kinetic model was developed to describe reversible adsorption–desorption in the dark and photocatalytic degradation under visible-light. The model quantifies TBZ in the liquid phase and on the catalyst surface, allowing the removal mechanism to be divided into adsorption-based retention and true photocatalytic degradation. This distinction is important because apparent contaminant removal from water does not necessarily indicate chemical degradation; pollutants may instead remain adsorbed on the catalyst surface. Therefore, the proposed model provides a mechanistic tool to determine whether a catalyst mainly removes contaminants by adsorption or by degradation, while also predicting whether adsorbed molecules are released back into solution or degraded on the surface [2].

The effects of visible-light intensity and solution pH were incorporated into the kinetic framework. Light intensity showed a direct relationship with degradation rates, whereas adsorption and desorption were less affected. In contrast, pH strongly influenced TBZ speciation, surface interactions, adsorption capacity, and degradation pathway distribution. The highest adsorption contribution was observed near pH 6.8, while maximum photocatalytic degradation occurred around pH 4.4. The model described the experimental data with deviations below 4% and was also applicable under variable natural sunlight intensity. POPs achieved up to 96% TBZ removal and retained reusability over multiple cycles. Overall, this work demonstrates how advanced kinetic modeling can transform photocatalytic evaluation from removal measurement to contaminant fate prediction.

Reference

1. <https://doi.org/10.1016/j.cej.2021.133349>.
2. <https://doi.org/10.1016/j.cej.2025.159526>.



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sciforum-187150: Micro- and Nanoplastics in Agricultural Crops: Plant Responses to Plastic Particles, Additives and Aged Polymers

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Mulch films, contaminated irrigation water, organic fertilizers and atmospheric deposition release micro- and nanoplastics (M/NPs) into agricultural soils. Surveys across 28 Chinese provinces report average farmland abundances of $\sim 4,500$ items kg^{-1} , with site-level concentrations reaching 6.2×10^5 items kg^{-1} , levels sufficient to affect soil function and crop productivity (Lian et al., 2024). However, most plant toxicity studies still rely on short-term exposures using pristine particles, overlooking additive chemistry and polymer ageing.

Plants absorb M/NPs through roots and leaves. Particles below ~ 100 nm may enter cells via endocytosis, larger particles penetrate through lateral-root junction cracks and the apoplast before translocating through the xylem into leaves, stems and edible tissues (Yu et al., 2024; Liu et al., 2023). Foliar uptake occurs through stomata or retention within trichomes and cuticles, with electrostatic interactions influencing adhesion (Liu et al., 2023). A meta-analysis reported photosynthetic declines of 7–12%, chlorophyll reductions of 11–13%, and projected crop-yield losses of 109–361 Mt yr^{-1} across major crops (Zhu et al., 2025). M/NP exposure also impairs stomatal function and gas exchange, while inducing reactive oxygen species accumulation, lipid peroxidation and oxidative stress (Yu et al., 2021; Pehlivan et al., 2026). Metabolic disruption includes altered amino acid accumulation, inhibition of lignin and jasmonic acid biosynthesis, and disturbance of redox homeostasis and phytohormone regulation in soybean, rice and barley (Qiu et al., 2023; Zhou et al., 2021; Li et al., 2021).

Additives represent a parallel exposure. Phthalic acid esters (PAEs), constituting 20–60% of mulch-film mass, leach into soils and edible tissues (Viljoen et al., 2023). Ageing by UV exposure, fragmentation and soil weathering further oxidizes polymer surfaces, accelerates additive release and increases contaminant binding. Real agricultural exposures involve aged, additive-loaded particles rather than pristine materials. Consequently, reliable agricultural safety thresholds require integrated assessment of polymer chemistry, ageing, additive release and crop responses.



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sciforum-174818: Migration of Organic Additives from Low-Density Polyethylene into Human Skin: An Ex Vivo Study

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Plastics are ubiquitous in daily life, frequently coming into direct contact with human skin. To improve performance, plastic materials contain various additives such as antioxidants, UV stabilizers, and plasticizers, which may migrate from the polymer into the surrounding environment. This study investigates the migration of five commonly used polymer additives—Chimassorb 81, Irgafos 168, Irganox 1010, Irganox 1076, and UV 326—from low-density polyethylene into human skin. Using Franz Diffusion Cells and full-thickness human skin samples from multiple donors, we examined additive migration in the skin and their distribution within skin layers using HPLC MS analysis of dermis, epidermis and receptor liquid extracts. Our results confirmed the migration of all tested additives into the epidermis, with Chimassorb 81 exhibiting the highest uptake. Irganox 1076 demonstrated deeper penetration into the dermis. However, no additives were detected in the receptor liquid, suggesting limited systemic absorption within the 24-hour experimental timeframe. These findings highlight the potential for dermal exposure to plastic additives as one of the main paths of human exposure to additives along with inhalation and ingestion paths.



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sciforum-175033: Molecular Dynamics Simulations of Chain Detachment and Additive Leaching in Aged Micro- and Nanoplastics in Aqueous Environment

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Micro- and nanoplastic pollution in aquatic environments is a major environmental challenge that has attracted increasing scientific attention over the past decade. Upon exposure to water, these particles undergo aging and degradation, leading to the release of polymer fragments and the leaching of hazardous additives. Experimental investigation of these aging-induced processes remains challenging due to limited access to nanoscale structural and dynamical details. Molecular simulations provide a complementary approach, enabling direct insight into microscopic mechanisms governing these processes.

In this work, we employ all-atom molecular dynamics simulations on the microsecond timescale to investigate these processes in thin polymer films and nanometer-scale polymer particles of polyethylene and polyvinyl chloride, serving as molecular models of micro- and nanoplastics. For these systems, we quantify the characteristic timescales of (i) detachment of polymer chains and fragments and (ii) migration and subsequent release of plasticizing additives into water. Particular attention is given to the effects of aging on these processes by considering models with varying numbers of oxygen-containing functional groups and different degrees of internal chain scission. In addition, dominant structural evolution pathways of nanometer-scale polymer particles are identified through analysis of the simulation trajectories.

Taken together, our results demonstrate that molecular dynamics simulations can directly resolve aging-induced chain detachment and additive leaching at the molecular level, providing mechanistic insight into early-stage degradation processes relevant to micro- and nanoplastics in aquatic environments.

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sciforum-173424: Network polyanions as multifunctional soil amendments

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Two main directions of applying polyelectrolytes as soil ameliorants include: 1) the use of linear polymers to create polymer-soil cover, which prevents wind/water erosion; 2) the use of crosslinked hydrogels, capable of long-term moisture retention in soil. However, descriptions of polymeric soil conditioners with combined effect are scarce. This work presents a set of novel polymeric soil conditioners with double effect.

The first material is a microgel (crosslinked copolymer of polyacrylic acid and N-isopropylacrylamide) with diameter of dry granules of 40 nm and degree of swelling of 210. 1% solution of microgel was sprinkled over the soil surface to form a polymer-soil crust. The small size of separate microgel particles allowed binding soil particles. The crust was stable against 54 m/s wind and water flows; simultaneously, it enhanced water retention properties due to microgel network structure (the plant-available water range (AWR) rose from 3% to 16%).

The second material is a hydrogel (crosslinked copolymer of acrylamide, potassium acrylate and starch) with ~0.5 mm-sized dry granules and degree of swelling of 440. The swollen hydrogel was mechanically weak and, consequently, easily deformable and spreadable over the soil surface. Due to its liquid-like behavior and ability to cover soil particles with a uniform film, a polymer-soil crust was obtained, which also withstood strong wind/water streams and increased the AWR from 3% to 21%.

We compared the presented materials with conventional polymeric soil amendments. First, a linear polymer, polyacrylic acid, also created a mechanically stable polymer-soil crust, but had no impactful water retention. Second, a highly-crosslinked hydrogel, copolymer of acrylamide and potassium acrylate, enhanced the water regime of sandy soil, but did not form any mechanically stable structure.

This way, a new class of double-effect polymeric soil amendments, which combine properties of conventional materials, was proposed.



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sciforum-175967: Photoaging-Induced Chemical Leaching from Poly(lactic acid) Micro- and Nanoplastics: A Suspect and Non-Target LC-HRMS Study

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Introduction: Poly(lactic acid) (PLA) is widely promoted as a bio-based and compostable alternative to conventional petrochemical polymers covering packaging and consumer applications. Nevertheless, limited information exists regarding the release of chemical constituents from PLA micro- and nanoplastics (MPs/NPs), particularly under environmental aging. MPs and NPs may act as carriers of intentionally added substances (IAS) and non-intentionally added substances (NIAS) sources, including also degradation products. In this light, the present work investigates the leaching behavior of additives, monomers, and oligomers from PLA MPs and NPs before and after simulated solar aging.

Methods: PLA MPs (≈ 2 mm) were produced via mechanical milling, while NPs (≈ 200 nm) were synthesized using an oil-in-water emulsification/solvent evaporation technique. Both fractions were suspended in ultrapure water and exposed to simulated solar irradiation for defined intervals, alongside dark controls. Leachates were extracted using solid-phase extraction (HLB cartridges) and analyzed by ultra-high-performance liquid chromatography coupled with high-resolution mass spectrometry (LC-HRMS). A combined suspect and non-target screening strategy was applied using an in-house database ($>9,600$ entries) and spectral libraries (mzCloud).

Results: Weathering conditions promoted importantly the release of monomers, oligomers, and NIAS, particularly from PLA NPs, showing a broader and more intense leaching profile when compared to MPs. Additives such as phthalates and antioxidants were detected in both dark and aged samples, with increased abundance after irradiation. Unique transformation products emerged following aging, indicating photoinduced degradation and migration processes.

Conclusions: Particle size and photoaging strongly influence the chemical release profile of PLA particles; findings highlighting the chemical complexity of PLA-derived leachates and thus emphasizing the need to incorporate chemical leaching assessments into environmental risk evaluations of biodegradable plastics, especially at the nanoscale.

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sciforum-174387: Pollutant removal from wastewater throughout a functionalized membrane based on poly(2,6-dimethyl-1,4-phenylene)oxide (PPO)

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Emerging contaminants in wastewater are becoming a serious concern, posing significant risks to aquatic ecosystem and human life. In this context different strategies have been introduced over the years but adsorption is getting a lot of interest because it is not expensive, is easy to perform and adsorbents can also be regenerated and reused.

Considering this, it is essential to find and introduce new efficient adsorbent materials that can remove contaminants from wastewater. Different kind of polymers have been studied for sorption purpose, but recently polymers capable of forming nanoporous crystalline phases (NC) have gained attention in this field, and, in particular, poly(2,6-dimethyl-1,4-phenylene)oxide (PPO), a commercially available polymer, turned out to be very promising since it showed very high kinetics uptake of pollutants even from dilute aqueous solution.

In this communication PPO films with NC phases used to remove contaminants, in particular dyes and organic pollutants such as PCE, nicotine, from water will be presented. Further, a sulfonation procedure of the polymer was performed: remarkable and unique results were achieved since kinetic uptakes and removal efficiency were higher due to the sulfonic groups present in the PPO amorphous phase; indeed by enhancing hydrophilicity, and by exposing anionic groups, it can both improve the diffusion of the pollutant molecules in the NC phase and, further to this, it promotes the removal of cationic contaminants by electrostatic interactions.

Adsorption kinetic and thermodynamic were studied throughout mathematical model, and different effects (such as initial concentration of contaminant, variation of temperature, pH and adsorbent dosage, etc.) were studied to better understand the mechanism of adsorption involved in this process.

Moreover, recent results based on physical functionalization to obtain PPO films presenting amorphous hydrophilic phase and nanocrystalline hydrophobic phase, showing high surface area for organic pollutant removal, will also be presented.



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sciforum-185096: Polystyrene Foam Degradation by *Zophobas Morio* Larvae

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Pollution by synthetic polymers is one of the most serious environmental problems today. In terrestrial ecosystems, soils serve as the primary sink and migration route for plastic debris. Once plastic particles enter the soil, they may undergo abiotic degradation and inevitably interact with soil biota, especially detritivores. However, the interaction between pedofauna and plastics remains poorly understood, despite growing research interest.

This work investigates the real-life impact of *Zophobas morio* beetle larvae on foamed polystyrene, focusing on microplastic formation. Larvae were cultured under three conditions: normal nutrition (oat bran), a mixed diet, and polystyrene foam as the sole food source. The majority of larvae survived and successfully pupated across all groups. The primary interaction between larvae and polystyrene was mechanical destruction, as larvae excavated extensive tunnel networks within the foam, generating a finely dispersed microplastic fraction.

Comprehensive spectroscopic analysis (FTIR, Raman, and NMR) revealed no significant chemical differences between the original polystyrene and the larval-crushed material. Furthermore, gel permeation chromatography (GPC) confirmed that neither contact with *Z. morio* larvae nor passage through their gastrointestinal tract altered the molecular weight of polystyrene.

Our findings demonstrate that the primary outcome of larval activity on polystyrene foam is physical crushing into microplastics, without any detectable chemical modification or polymer degradation. This underlines the importance of distinguishing purely mechanical fragmentation from true biodegradation when assessing the role of soil invertebrates in plastic fate.

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sciforum-180506: Porous Hydrogel-Based Janus Photothermal Distillation Membranes with Enhanced Anti-fouling and Water Flux for Seawater Desalination

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Photothermal membrane distillation (PMD) leverages interfacial photothermal heating to drive water evaporation, offering a promising route for freshwater production in remote or water-scarce regions using renewable energy. Janus membranes with hydrophilic hydrogel layers can absorb water at the surface and repel hydrophobic organics, enhancing fouling resistance and facilitating water evaporation, thereby improving PMD efficiency and stability. However, conventional dense Janus membranes restrict vapor transport, while complex seawater constituents cause severe fouling and scaling, limiting long-term reliability in practical PMD desalination. In this study, we developed a porous photothermal hydrogel layer composed of poly(vinyl alcohol)/carbon nanotube (PVA/CNT) using a droplet superspreading strategy. The three-dimensional porous hydrogel network creates a synergistic effect that enhances vapor generation, vapor transport, and anti-fouling performance during PMD. Desalination tests conducted with a direct contact membrane distillation (DCMD) setup under one-sun irradiation showed that the porous hydrogel layer achieved a freshwater production rate of $28 \text{ kg}\cdot\text{m}^{-2}\cdot\text{h}^{-1}$ and a photothermal conversion efficiency of 95.4%, representing a 24% increase in flux compared to a dense hydrogel layer. In addition, the hydrogel layer effectively resisted pore wetting induced by surfactants and organic contaminants. This work presents a novel design of Janus membranes with a porous hydrogel layer for sustainable and stable PMD desalination in practical environments.



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sciforum-175970: TiO₂-Decorated Nanolignin hybrids as Functional Fillers in Poly(lactic acid) (PLA) Membranes for Photocatalytic Applications

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The incorporation of eco-friendly functional fillers into biobased polymer matrices represents a promising strategy toward multifunctional and sustainable materials. Titanium dioxide (TiO₂) nanoparticles are widely studied for the photocatalytic degradation of pharmaceutical contaminants in water; however, their use in powder form requires post-treatment separation, increasing energy demand and operational costs. Immobilization of TiO₂ onto solid supports represents a more practical and sustainable alternative. Lignin, a renewable aromatic biopolymer rich in hydroxyl groups, can act as a bio-derived scaffold for TiO₂ anchoring, enabling hybrid photocatalytic systems. In this work, TiO₂-lignin hybrid nanostructures were prepared and subsequently integrated into poly(lactic acid) (PLA) membranes to develop active polymeric materials for environmental applications. In this work hybrid composites were synthesized via a pH-responsive precipitation route at three TiO₂:lignin mass ratios (20:1, 10:1, and 5:1). The electrostatic assembly was performed under mildly acidic conditions to promote interfacial interaction and controlled deposition of TiO₂ (P25) onto kraft nanolignin. The resulting hybrid fillers were isolated, dried, and incorporated into PLA matrix via solvent casting to fabricate composite membranes. Interfacial and chemical interactions were analyzed using Fourier transform infrared spectroscopy (FTIR) and X-ray photoelectron spectroscopy (XPS), while particle size and surface charge were evaluated by dynamic light scattering (DLS). The physical properties of prepared composites have been also studied. The successful decoration of lignin by TiO₂ nanoparticles was confirmed using FTIR, XPS and DLS. The incorporation of hybrids into PLA produced homogeneous films, where filler composition influenced dispersion, thermal stability, and matrix crystallinity. Higher TiO₂ loadings enhanced photocatalytic degradation of selected pharmaceuticals under UV irradiation, whereas lignin-rich systems improved dispersion and matrix compatibility. Thus, the TiO₂:lignin ratio controls the balance between photocatalytic performance and polymer-filler interaction, enabling the design of multifunctional PLA membranes for sustainable water/wastewater treatment.



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sciforum-179968: Waste-to-Resource Nano-Magnetic Chitosan Composite for the Hybrid Adsorption and Sustainable Recovery of Pt(IV) and Pd(II) from Real Refinery Wastewater

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A sustainable and effective recovery system is vital for responding to the growing demand for PGMs and mitigating the environmental risks posed by their presence in industrial wastewater. In this study, a new Nanomagnetic chitosan composite was used to simultaneously recover Pt(IV) and Pd(II) ions from a real-world refinery wastewater sample. The Nanomagnetic chitosan composite was synthesized using waste crab-shell-derived chitosan and iron from acid mine drainage, a waste-to-resource approach to sustainable synthesis. After detailed characterization of the Nanomagnetic chitosan composite, magnetic chitosan nanoparticles were successfully synthesized, with magnetite nanoparticles homogeneously embedded in the chitosan network. Under optimal conditions, the Nanomagnetic chitosan composite recovered 95% of Pt and 92% of Pd from a real-world refinery wastewater sample. Due to the strong correlations between the Langmuir, Freundlich, and Sips isotherms, a hybrid adsorption mechanism involving monolayer coverage and surface heterogeneity was proposed. According to the Langmuir isotherm, the adsorption capacity of Pt ($q_{\max}$) was in the range of 90–95 mg/g, and the adsorption capacity of Pd ($q_{\max}$) was in the range of 80–89 mg/g. This indicates a hybrid adsorption mechanism, as supported by the Sips model. Based on the kinetic results, both physisorption and chemisorption contribute to adsorption. After six regeneration cycles, the material retained an 83% recovery efficiency.



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