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## Special Topic: Functional Gels

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doi: [10.1007/s10118-026-3692-8](https://doi.org/10.1007/s10118-026-3692-8)

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## COVER

Cover Image: adapted from Wen-Guang Liu and Jian-Hai Yang (Article pages 1606–1632).

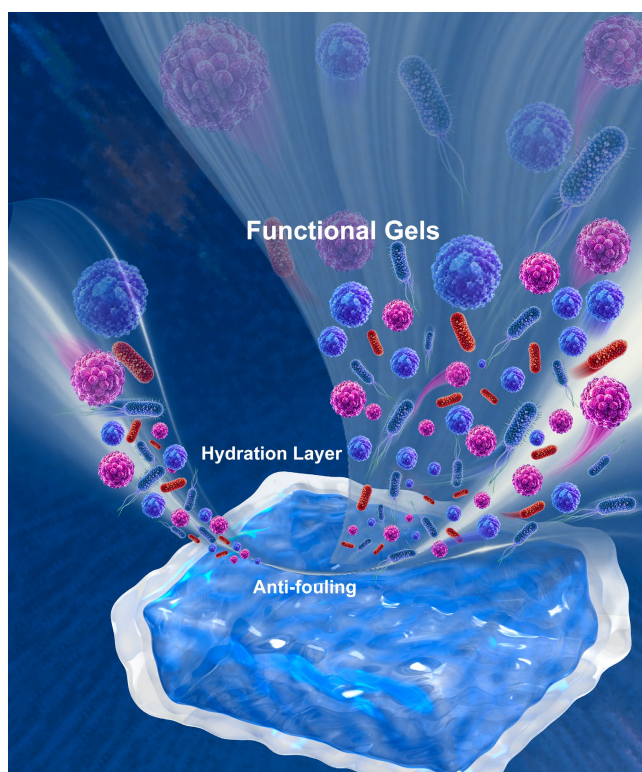
## Cover Image

### Anti-biofouling Hydrogels: Surface Hydration, Classification, and Biomedical Applications

Li-Ping Lang, Hong-Ying Wang, Kuan Cheng, Dan-Yang Chen, Xu Tian, Yu-Qin Cheng, Wen-Guang Liu, and Jian-Hai Yang

Tianjin University

Hydrophilic polymer hydrogels, through the synergistic effect of a dense hydration layer and steric repulsion, construct dual barriers—energetic and physical—to efficiently resist the adhesion of non-specific proteins, bacteria, and cells.



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## Contents

### Preface

#### Special Topic on Functional Gels

Pei-Yi Wu, Ming-Jie Liu, Feng Yan, and Tao Xie

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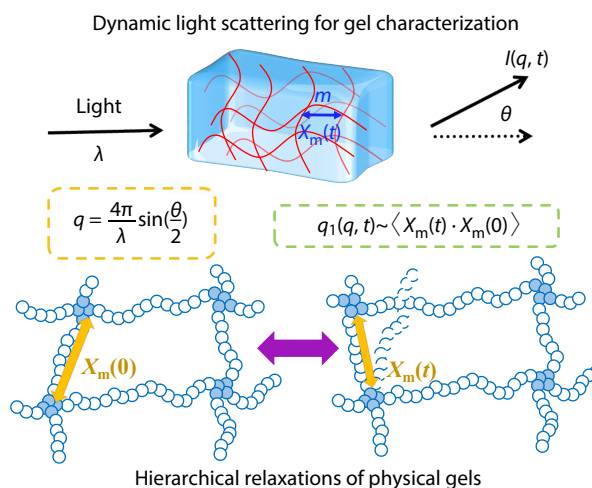
## Feature Articles

## Advanced Light Scattering Characterization and Physics for Functional Polyelectrolyte Gels

Yu-Sen Jie and Di Jia

Institute of Chemistry, Chinese Academy of Sciences; University of Chinese Academy of Sciences

Light scattering is a powerful technique for characterizing the elasticity, microstructures and dynamics of various functional hydrogels. The average bond binding energy and lifetime of the physical crosslinks in gel networks can also be extracted from dynamic light scattering characterization results.



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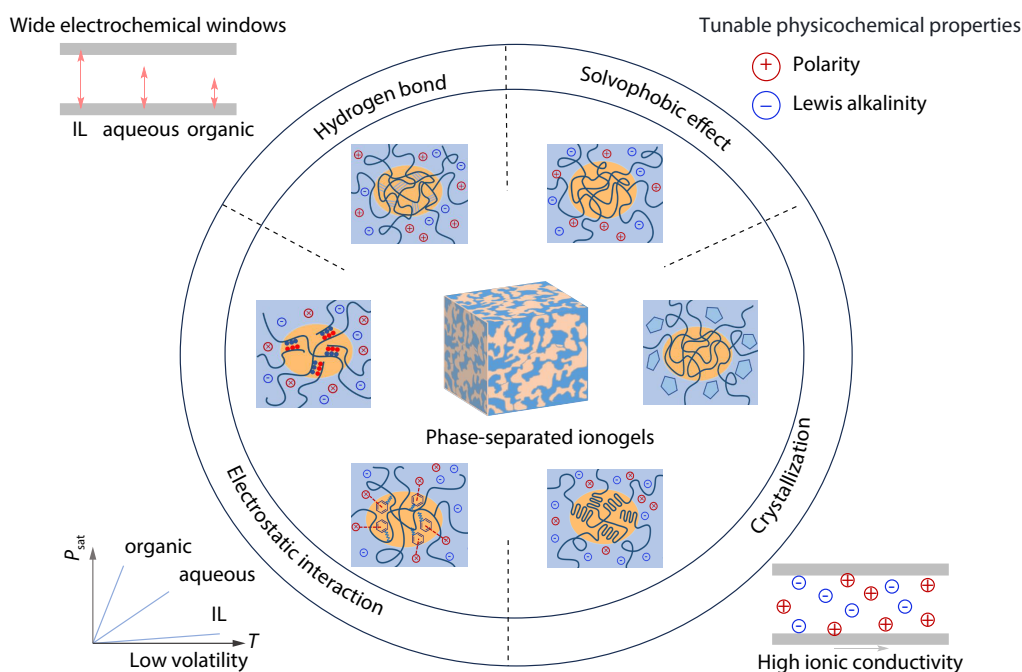
## Reviews

## Phase Separation Enabled Functional Ionogels

Xue Wang, Xin Fu, Lie Chen, and Ming-Jie Liu

China Agricultural University; Beihang University

This review summarizes the unique microphase separation phenomena in ionogels, driven by the distinct physicochemical properties of ionic liquids (ILs). It highlights how these specific phase-separation mechanisms and tailored microstructures, enabled by ILs, lead to advanced functionalities not typically achievable in conventional hydrogels or organogels.



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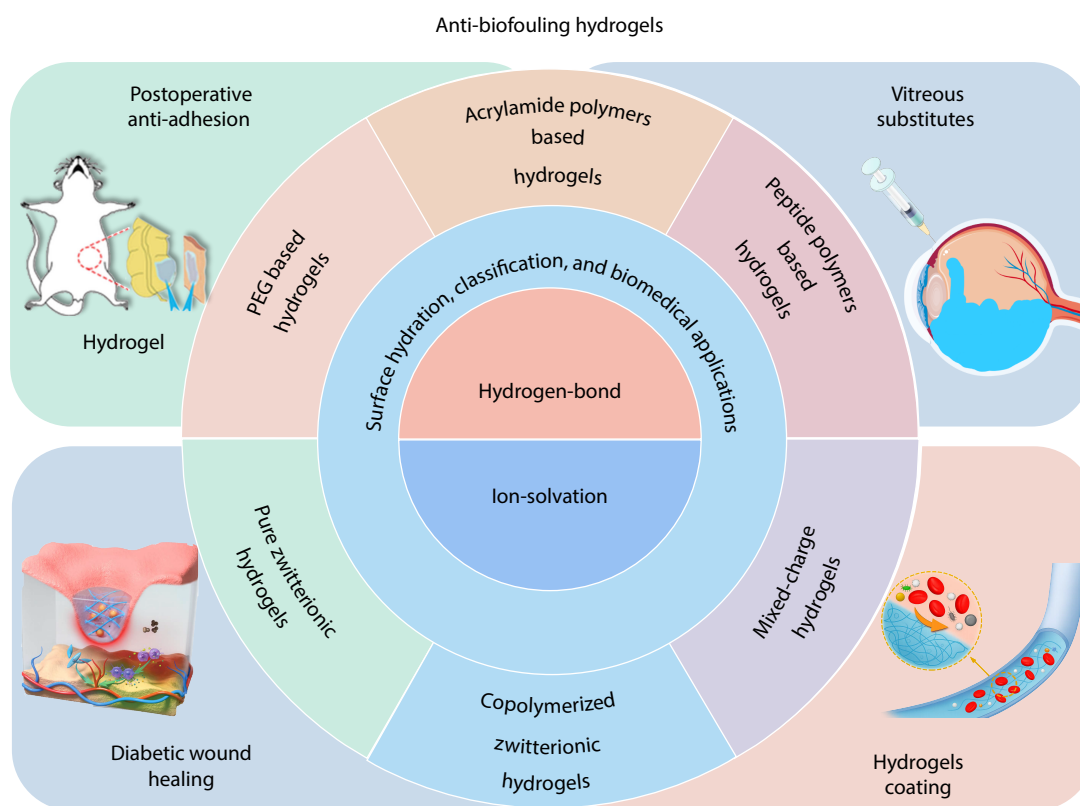
<https://doi.org/10.1007/s10118-026-3591-z>

## Anti-biofouling Hydrogels: Surface Hydration, Classification, and Biomedical Applications

Li-Ping Lang, Hong-Ying Wang, Kuan Cheng, Dan-Yang Chen, Xu Tian, Yu-Qin Cheng, Wen-Guang Liu, and Jian-Hai Yang

Tianjin University

This review elucidates the anti-biofouling mechanisms of hydrogels, with a focus on surface hydration interactions—specifically hydrogen bonding and ion solvation—and categorizes the hydrogels based on these mechanisms. It also underscores their biomedical applications, including vitreous substitutes, anti-adhesion barriers, diabetic wound dressings, and device coatings, offering design insights for durable, biocompatible interfaces.



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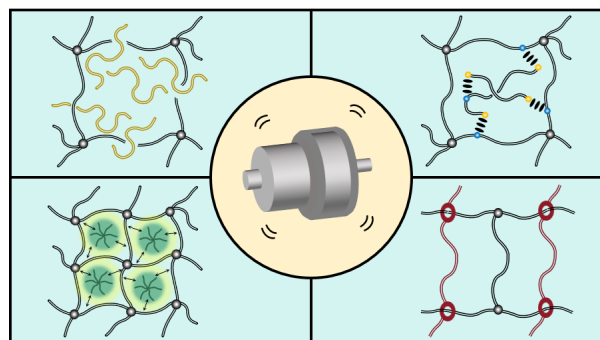
## High Energy Dissipation Polymer Gels by Regulating Relaxation of Confined Chains

Wei Shi, Zong-Zheng Zhang, Ying Li, Chun-Yi Peng, Hao Zha, Jin Huang, and Ming-Jie Liu

Beihang University

Composite structure of viscous fluids and elastic skeletons in biological tissues inspired designs of high energy dissipation gels by viscoelastic regulation of networks and confined chains. This work summarized progress of damping gels from perspective of network structure, which will promote development of damping polymers towards extreme conditions.

High energy dissipation polymer gels for vibration control



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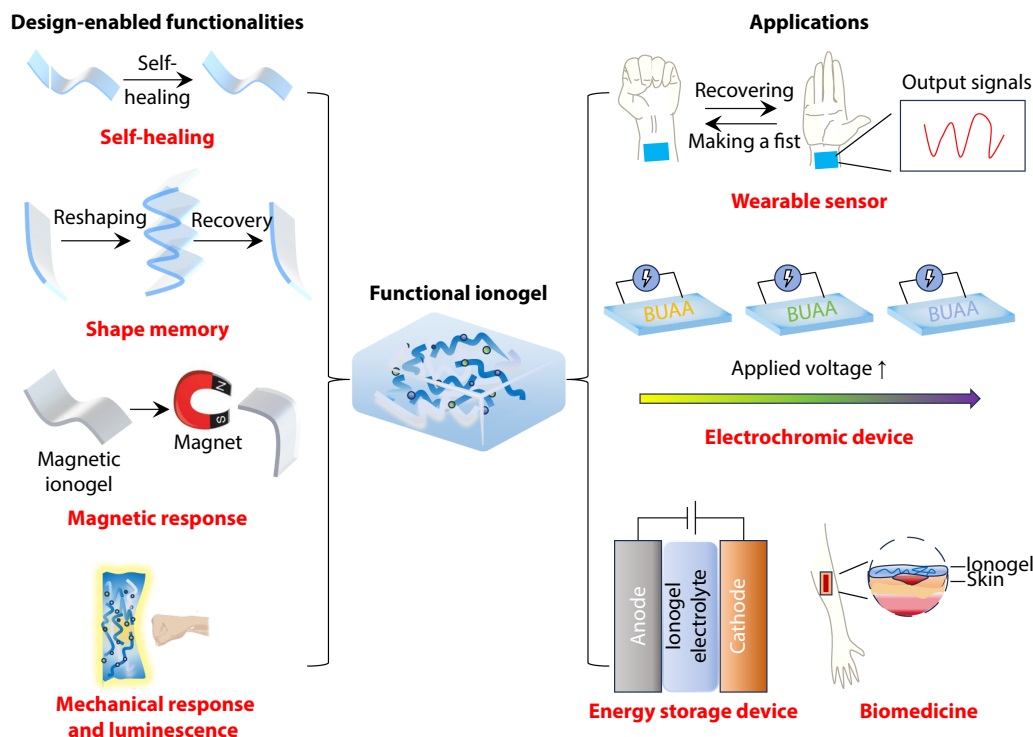
<https://doi.org/10.1007/s10118-025-3475-7>

## Functional Ionogels: Design Principles and Applications

Rui Wu, Jin-Qi Zhang, Xun Xiao, and Mei-Xiang Wang

Beihang University, China; Peking University, China; Zhejiang University, China; North Carolina State University, United States

In addition to their inherent properties, ionogels can acquire additional functionalities (e.g., self-healing, shape memory, and luminescence) through rational structural design and the introduction of functional additives. These functional ionogels have great potential in applications such as energy storage devices, wearable sensors, biomedicine, and electrochromic devices, etc.



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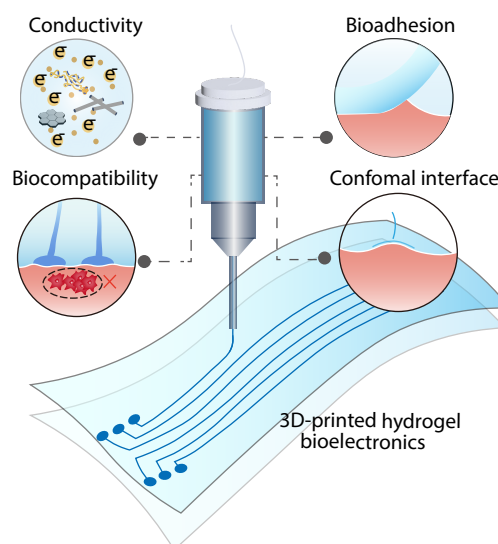
<https://doi.org/10.1007/s10118-026-3584-y>

## Direct Ink Writing 3D Printing of Hydrogel Bioelectronics

Yu Xue, Fu-Cheng Wang, Qiao-Bo Wang, Liang-Jie Shan, Hui Li, and Ji Liu

Jiangxi Science and Technology Normal University; Southern University of Science and Technology

Direct-ink-writing 3D printing provides a versatile platform for fabricating advanced hydrogel bioelectronics. This review outlines recent advances, beginning with hydrogel ink design that balances printability and functionality through rheology, conductivity, adhesion, and biocompatibility. It subsequently emphasizes their application in state-of-the-art bioelectronics, highlighting their advantages in electrophysiological recording, stimulation, and biosensing.



Chinese J. Polym. Sci. 2026, 44(2), 1667–1680

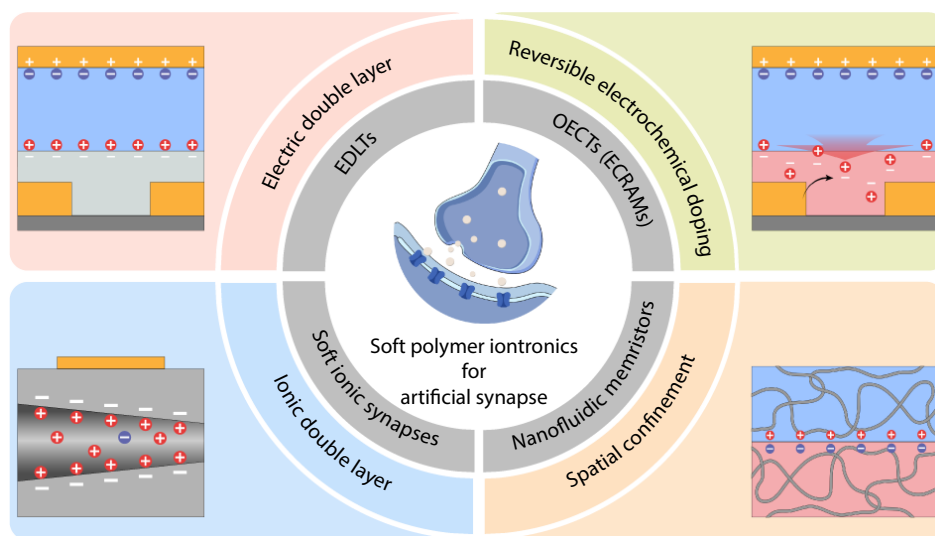
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## Soft Polymer Iontronics for Neuromorphic Intelligence

Sen Liu, Heng Zhan, Lu-Wei Zhang, Zi-Zhi Wang, and Zhou-Yue Lei

*Donghua University; Southeast University*

This review covers four ion-conductive soft polymer devices-ion-gated transistors (IGTs), electrochemical random-access memory cells (ECRAMs), nanofluidic memristors, and soft ion synapses-highlighting their mechanisms, challenges, and integration potential for biomimetic synaptic plasticity.



*Chinese J. Polym. Sci.* 2026, 44(6), 1681–1694

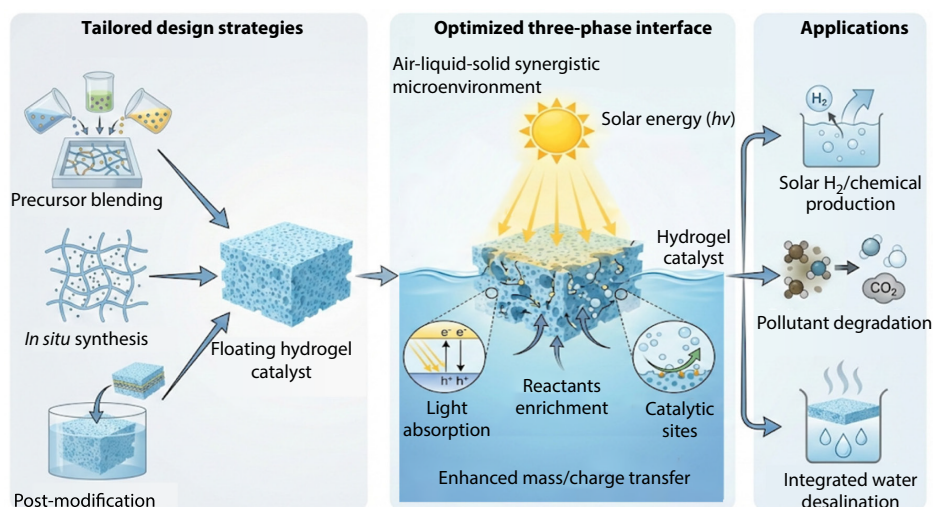
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## Engineering Hydrogel-based Self-floating Catalytic Materials for Interfacial Solar-driven Chemistry

Jia-Xin Gao and Wen-Wei Lei

*Yanshan University*

This review highlights hydrogel-based self-floating catalysts as innovative interfacial platforms for solar-driven chemistry. By establishing stable three-phase interfaces, these materials overcome traditional mass-transfer limitations and catalyst agglomeration. We analyze core construction strategies and demonstrate their versatile applications in pollutant degradation, hydrogen production, and desalination.



*Chinese J. Polym. Sci.* 2026, 44(6), 1695–1715

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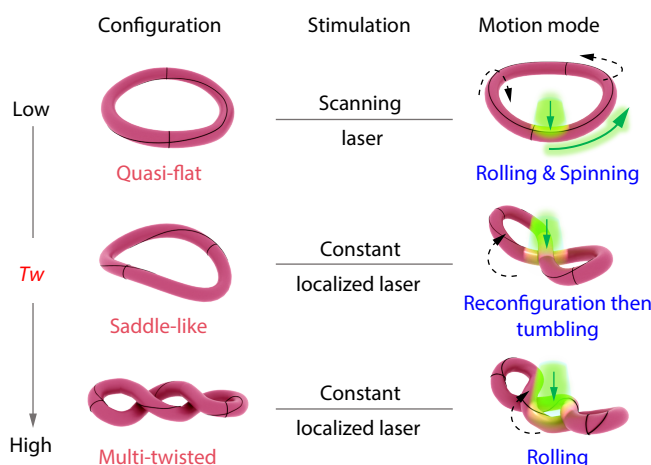
## Research Articles

## Pre-Twist-dependent Configurations of Hydrogel Rings and Their Distinct Modes of Self-sustained Locomotion

Han-Lei Cheng, Qing-Li Zhu, Zhi-Jian Wang, Josef Breu, and Zi-Liang Wu

Zhejiang University, China; University of Bayreuth, Germany

Programming built-in twist ( $Tw$ ) in hydrogel rings generates distinct configurations with specific stress distributions, enabling multiple self-sustained motion modes: coupled rolling and spinning, irregular tumbling, and stable rolling. This work demonstrates that internal stress programming provides a versatile strategy for achieving diverse locomotion within a single soft material system.



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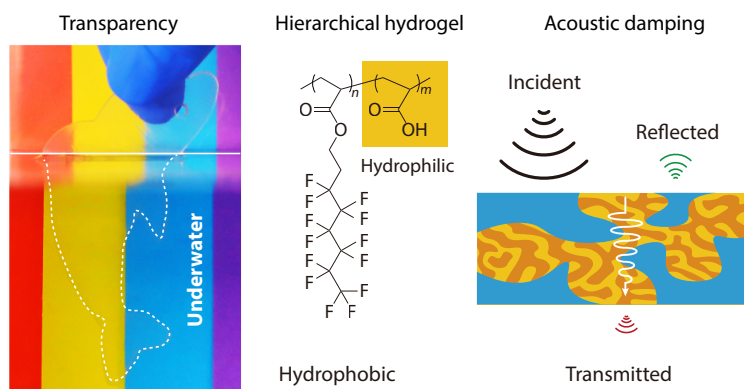
<https://doi.org/10.1007/s10118-026-3646-1>

## A Transparent Acoustic Damping Hydrogel with Dual-scale Bicontinuous Microphase Separation

Chen-Chen Lou, Bao-Hu Wu, Sheng-Tong Sun, and Pei-Yi Wu

Donghua University, China; Jülich Centre for Neutron Science (JCNS) at Heinz Maier-Leibnitz Zentrum (MLZ) Forschungszentrum Jülich, Germany

This work presents a hierarchical hydrogel that combines optical transparency and acoustic damping capacity. The hydrogel features a dual-scale bicontinuous nanostructure comprising three intertwined phases: hydrophilic, hydrophobic, and aqueous. This architecture enables acoustic impedance matching with water, strong vibrational damping, and ultrahigh absorption of sound.



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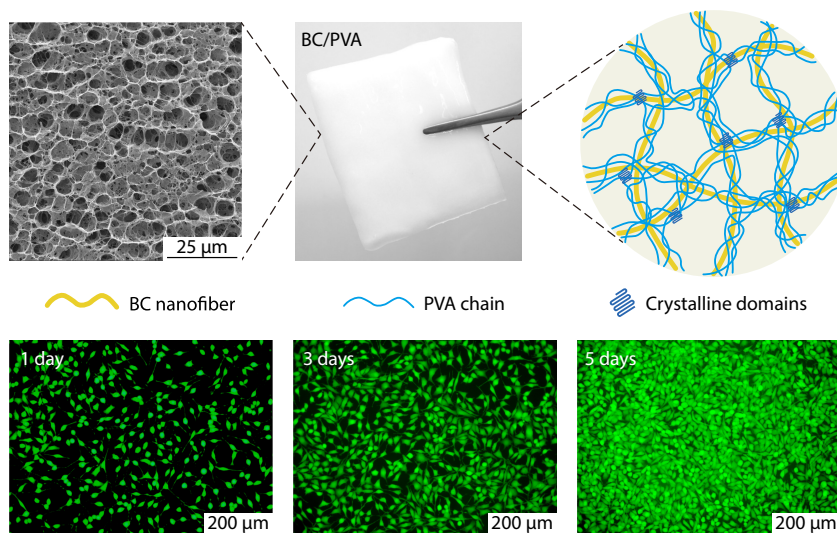


## Strong and Tough High-water Content Double-network Hydrogels

Shu-Xing Yin, Guo-Jun Che, Cheng Qian, Meng Yu, Can Zhou, Sheng-Wen Kong, Chuang-Qi Zhao, and Lei Jiang

University of Science and Technology of China

This study proposes a strategy to fabricate strong and tough double-network hydrogels through multiple freeze-thaw cycles. Network densification endows hydrogels with exceptional mechanical performance. Moreover, the hydrogel possessed a high water content (up to 95%) and excellent biocompatibility.



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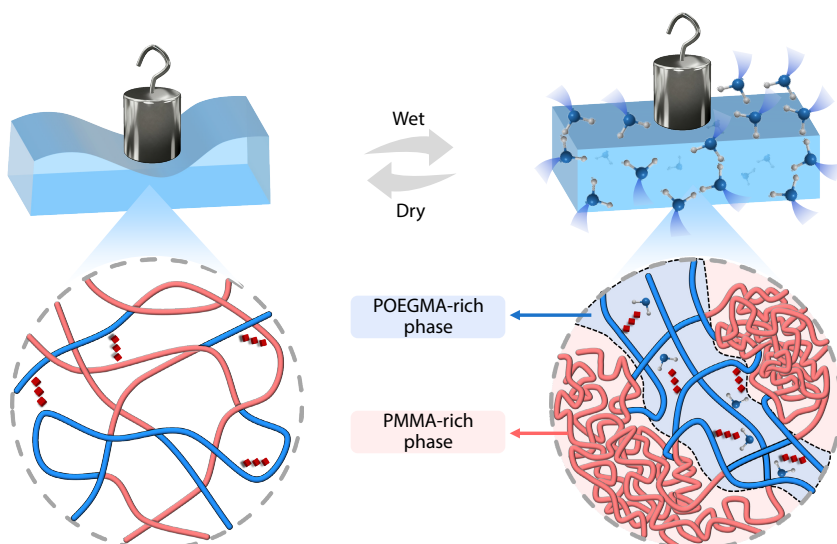
<https://doi.org/10.1007/s10118-026-3684-8>

## Water Swelling-induced Stiffness Enhancement of Polymer Hydrogels

Yi Yu, Wei Zhou, Tao Chen, and Wei Lu

Ningbo Institute of Materials Technology and Engineering, Chinese Academy of Sciences; University of Chinese Academy of Sciences

A hydrogel film based on the synergistic interaction of hydrophilic and hydrophobic side chains was successfully developed and achieved reversible stiffness changes spanning four orders of magnitude *via* the formation and dissociation of water-induced phase separation.



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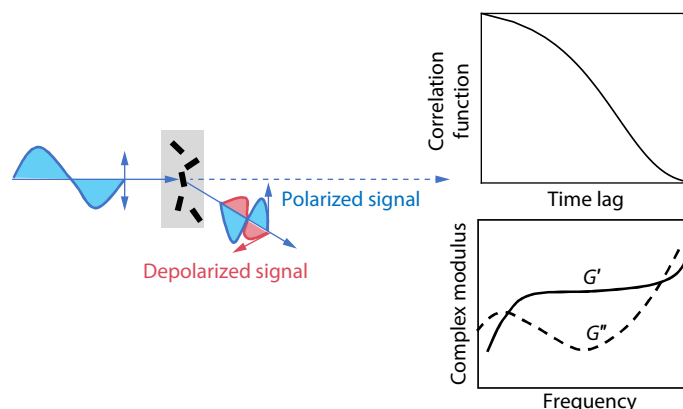
<https://doi.org/10.1007/s10118-026-3597-6>

## The Monitoring of Anisotropic Tracer Nanoparticles by Depolarized Dynamic Light Scattering for Micro-rheology with Improved Contrast and Accuracy

Bing-Hui Xue, Yuan Liu, and Pan-Chao Yin

South China University of Technology

This study develops a micro-rheology method using gold nanorods as probes monitored *via* depolarized dynamic light scattering. It enables fast, accurate viscoelasticity measurements across diverse soft materials, from polymer solutions to biological fluids.



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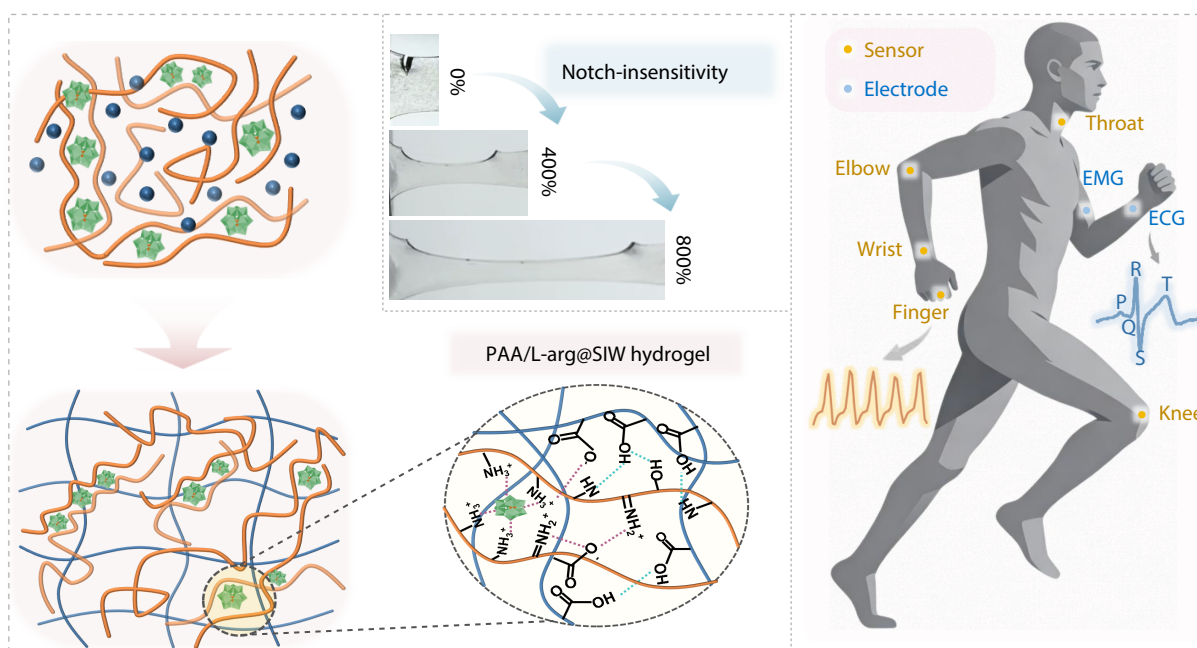
<https://doi.org/10.1007/s10118-025-3445-0>

## Interface-engineered Ionically Conductive Polyoxometalate-based Hydrogels with High Stretchability and Notch-insensitivity for Wearable Sensors

Xiao-Jiao Shi, Yu-Bin Zhang, Na Li, Yu-Xuan Qiao, Ya Liang, Gong-Kuo Yu, Ai-Hong Su, Ze-Cheng Song, Dan-Dan Song, Ti-Feng Jiao, and Zhi-Hui Qin

Yanshan University

A tough and notch-insensitive conductive hydrogel is developed by introducing L-arginine-regulated polyoxometalate nano-crosslinking domains. The hydrogel exhibits high stretchability, robust ionic conductivity, and sensitive strain sensing, enabling stable electrocardiogram (ECG) and electromyography (EMG) signal monitoring for wearable bioelectronics.



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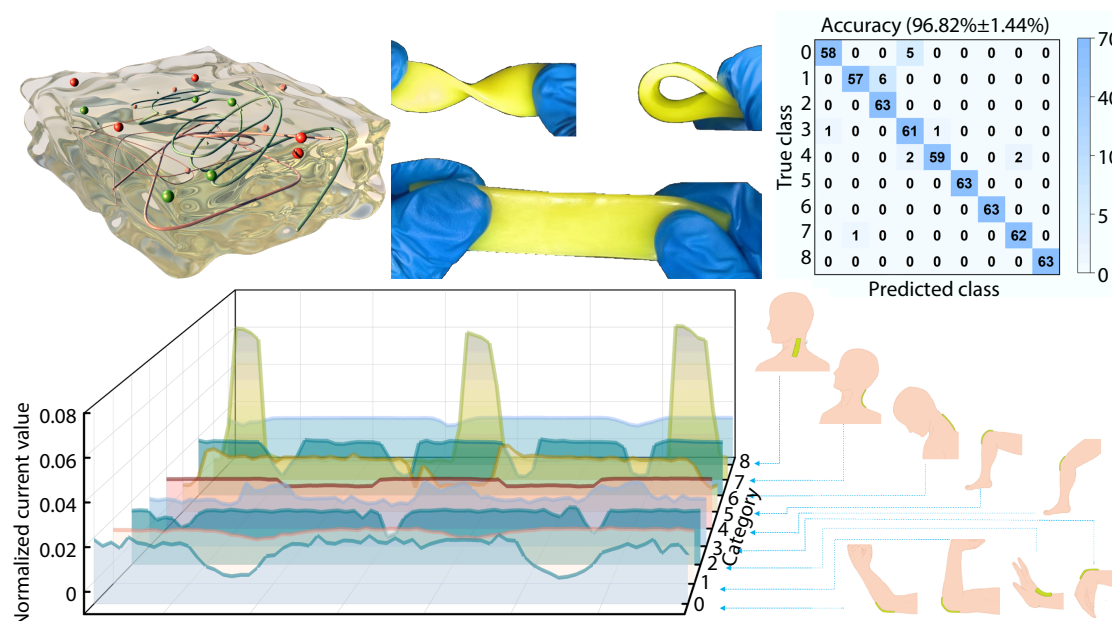
<https://doi.org/10.1007/s10118-026-3571-3>

## Self-powered Posture Recognition Based on Thermoelectric Hydrogel

Yu-Hao Zhang, Guo-Shun Cui, Saeed Ahmed Khan, Lang-Hua Shi, Hao-Zhe Zhang, Kun Yang, Xuan-Sen Zhao, and Hu-Lin Zhang

Taiyuan University of Technology, China; Sukkur IBA University, Pakistan

This study presents a flexible hydrogel-based posture recognition system capable of accurately identifying nine distinct human postures. By integrating thermoelectric sensing with artificial intelligence algorithms, the system achieved a recognition accuracy of 96.82%. The real-time dynamic visualization of posture data was enabled using a custom-developed visualization platform.



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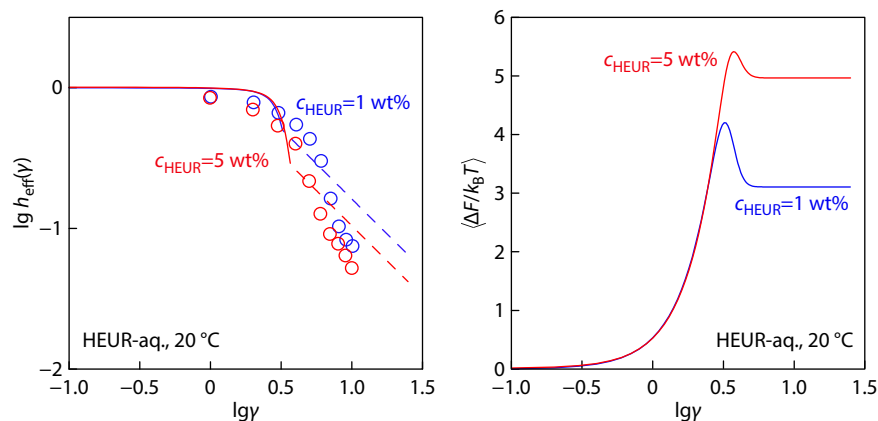
<https://doi.org/10.1007/s10118-025-3440-5>

## Nonlinear Stress Relaxation of End-associative Hydrophobically Modified Ethoxylated Urethane (HEUR) Solutions under Step Strain

Yu-Xuan Pei, Quan Chen, and Hiroshi Watanabe

Changchun Institute of Applied Chemistry, Chinese Academy of Sciences, China; University of Science and Technology of China, China; Kyoto University, Japan

Nonlinear softening factor  $h_{\text{eff}}$  of hydrophobically modified ethoxylated urethane (HEUR)-aq. solutions at long times, defined with respect to short-time hardened state, is considerably well described by a simple model formulating strain-induced HEUR micelle fusion followed by micelle opening/splitting associated with a free energy increase  $\langle \Delta F / k_B T \rangle$  under strain.



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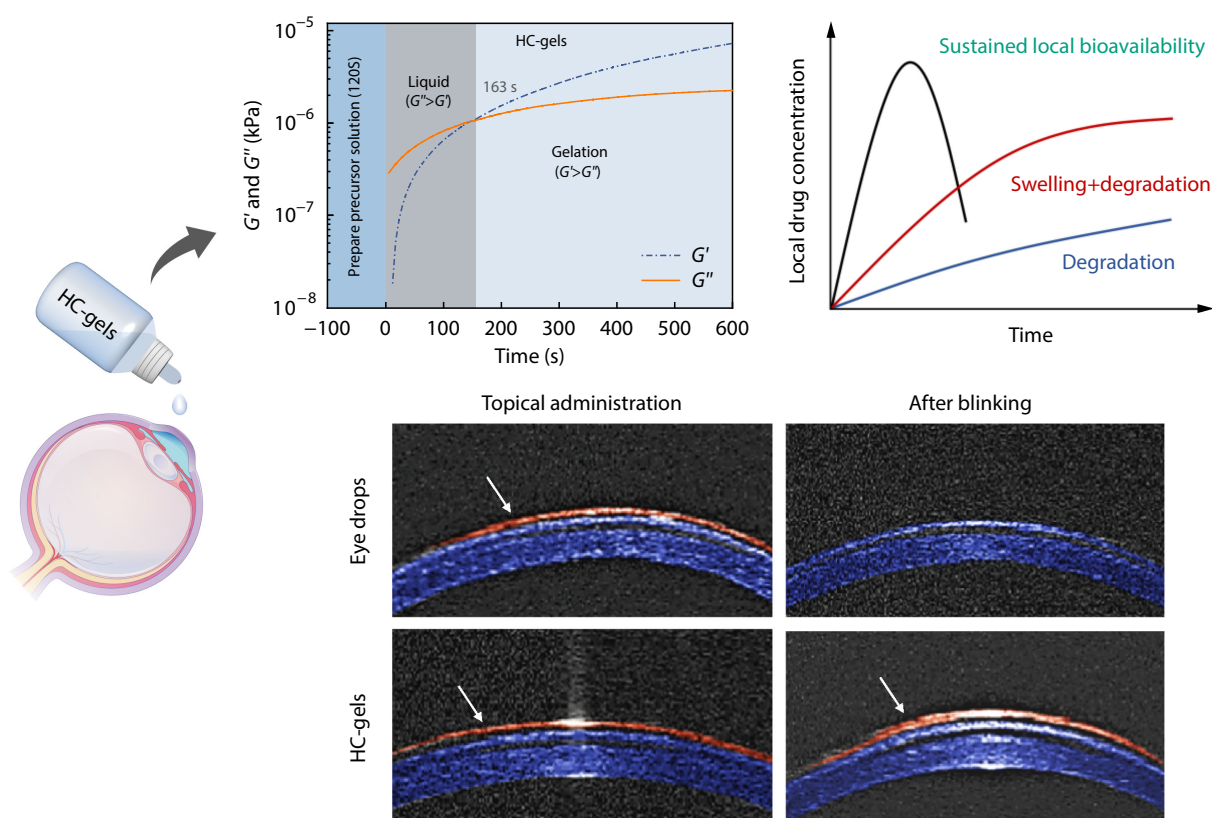
<https://doi.org/10.1007/s10118-026-3573-1>

## Polysaccharide-based Hydrogel Formed via *In situ* Schiff Base Reaction with Contact Lens-like Ocular Surface Coverage for Sustained Ophthalmic Drug Delivery

Xin Yang, Hai-Hua Wang, Chao-Jun Yue, De-Hua Tan, Ge Sun, Shuai-Jun Guo, Hai-Liang Pei, Yu-Lin Hu, Shan-Hao Feng, Yang Qiao, Yi-Ming Hua, Li-Juan Zhang, Shi-Lei Zhu, Ya-Nan Ye, and Qiang Zheng

Shaanxi University of Science and Technology; Taiyuan University of Technology; China Institute for Radiation Protection; Shanxi Eye Hospital, Shanxi Medical University; Zhejiang University

A dual dynamic *in situ* gel rapidly forms within the ocular clearance window and conforms during blinking, reducing drug loss while improving ocular retention and bioavailability.



Chinese J. Polym. Sci. 2026, 44(6), 1804–1819

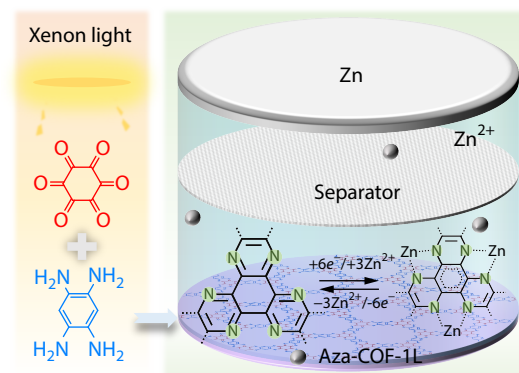
<https://doi.org/10.1007/s10118-026-3614-9>

## A Pyrazine-based Covalent Organic Framework as a Cathode Material for Aqueous Rechargeable Zinc-ion Batteries

Ke-Jun Jin and Ying-Jian Yu

Kunming University

Aza-COF-1L with dense pyrazine redox sites was synthesized via a fast light-assisted method. It exhibits high capacity and stability as a superior cathode for zinc-ion batteries.



Chinese J. Polym. Sci. 2026, 44(6), 1820–1829

<https://doi.org/10.1007/s10118-026-3610-0>

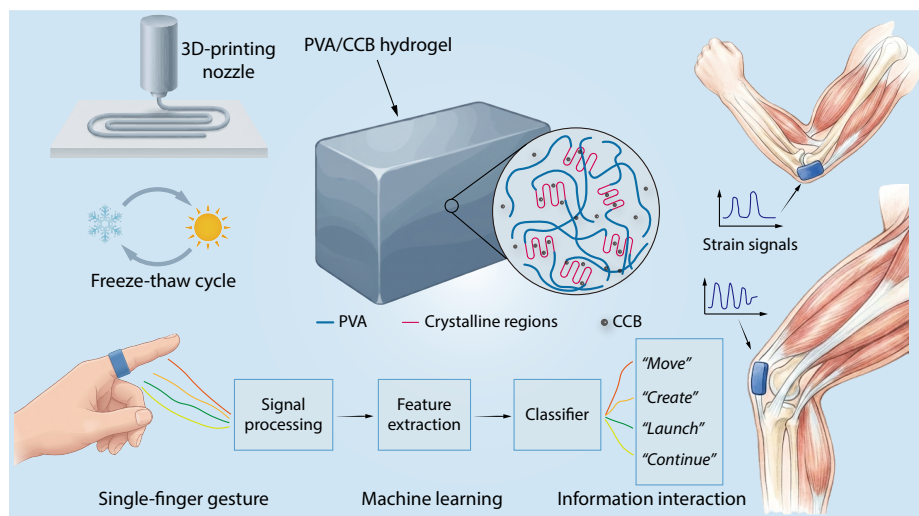


## Hysteresis-free and Fatigue-resistant Conductive Hydrogel Electronics towards Intelligent Human-machine Interaction

Liu-Yu Zhang, Gen Li, Gui-Neng Li, Yu-Zhu Hou, Hua Li, Yu Xue, Wei-Jing Zhao, and Bao-Yang Lu

Nanchang University; Jiangxi Science and Technology Normal University; Shanghai Sixth People's Hospital Affiliated to Shanghai Jiao Tong University School of Medicine; Nanchang Jiaotong Institute

The microphase-separated poly(vinyl alcohol) (PVA)/conductive carbon black (CCB) interlocking hydrogel enables low-hysteresis, high-stability strain sensing for precise motion and gesture monitoring, and, through machine-learning analysis of continuous signals, supports intelligent human-machine interaction.



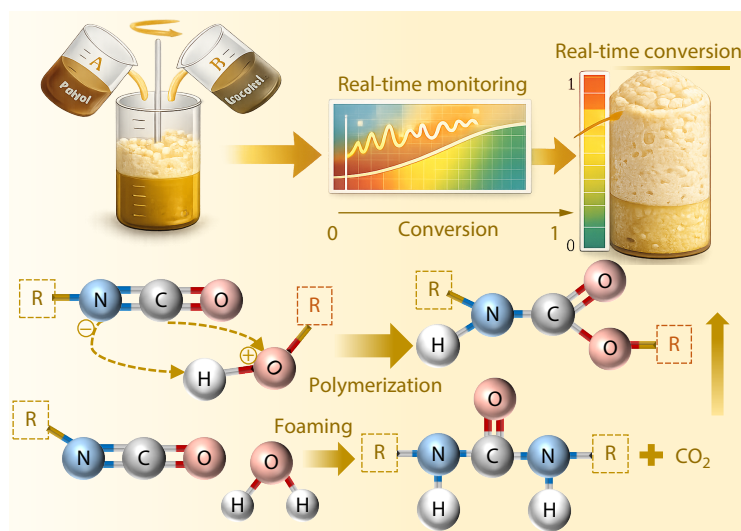
Chinese J. Polym. Sci. 2026, 44(6), 1830–1842 <https://doi.org/10.1007/s10118-026-3616-7>

## Real-Time Monitoring of Component Conversion during the Foaming and Curing Process of Self-expanding Polyurethane Grouts

Xiao-Long Li, Xuan-Xuan Zi, Xiao-Feng Liu, Ming Guo, Yan-Hui Zhong, and Bei Zhang

Zhengzhou University

A real-time approach quantifies polyol, water, and apparent isocyanate conversions in high  $-NCO$  polyurethane grouts by ATR-FTIR (carbamate  $C=O$ ) and LiDAR volume tracking, revealing three-stage kinetics with faster foaming than gelation.



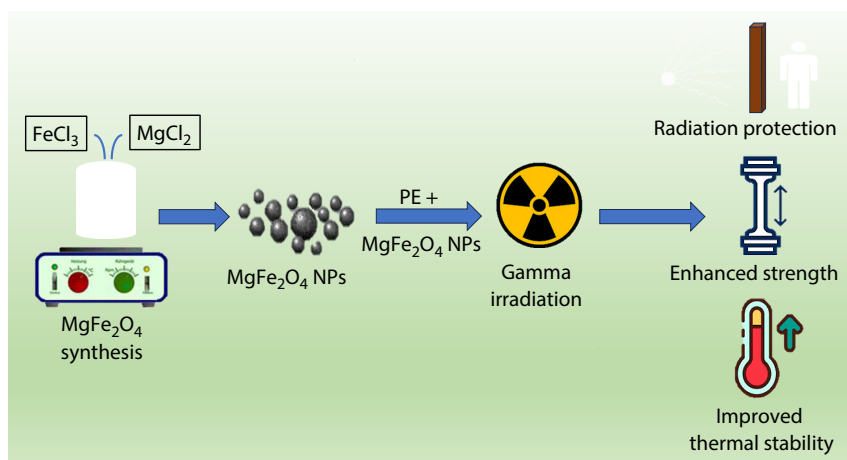
Chinese J. Polym. Sci. 2026, 44(6), 1843–1854 <https://doi.org/10.1007/s10118-026-3604-y>

## Tailoring the Surface Morphology, Mechanical, Thermal, and Radiation Shielding Properties of Polyethylene Nanocomposites *via* Nano-magnesium Ferrite and Gamma Radiation

Soma A. El Mogy, Wageeh Ramadan, and M. M. EL-Zayat

National Institute of Standards (NIS), Egypt; Egyptian Atomic Energy Authority (EAEA), Egypt; Egyptian Atomic Energy Authority, Egypt

This study develops lead-free low-density polyethylene (LDPE) nanocomposites reinforced with  $\text{MgFe}_2\text{O}_4$  nanoparticles, offering promising eco-friendly solutions for gamma-ray shielding, especially under irradiation conditions.



Chinese J. Polym. Sci. 2026, 44(6), 1855–1867

<https://doi.org/10.1007/s10118-026-3613-x>

## Ceramizable Perforated Silicone Foam for Thermal Insulation and Refractory Building Materials

Xiang-Yuan Tian, Xin Zhang, Dian-Bo Zhang, Ya Liu, Xiao-Pei Wang, and Zhen-Xiu Zhang

Qingdao University of Science and Technology

The diagram presents two scenarios: the material undergoes ceramization at high temperatures to achieve flame retardancy and heat insulation, while retaining heat at low temperatures to reduce heat loss, demonstrating its excellent flame-retardant, heat-insulating, and thermal preservation properties.



Chinese J. Polym. Sci. 2026, 44(6), 1868–1882

<https://doi.org/10.1007/s10118-026-3612-y>

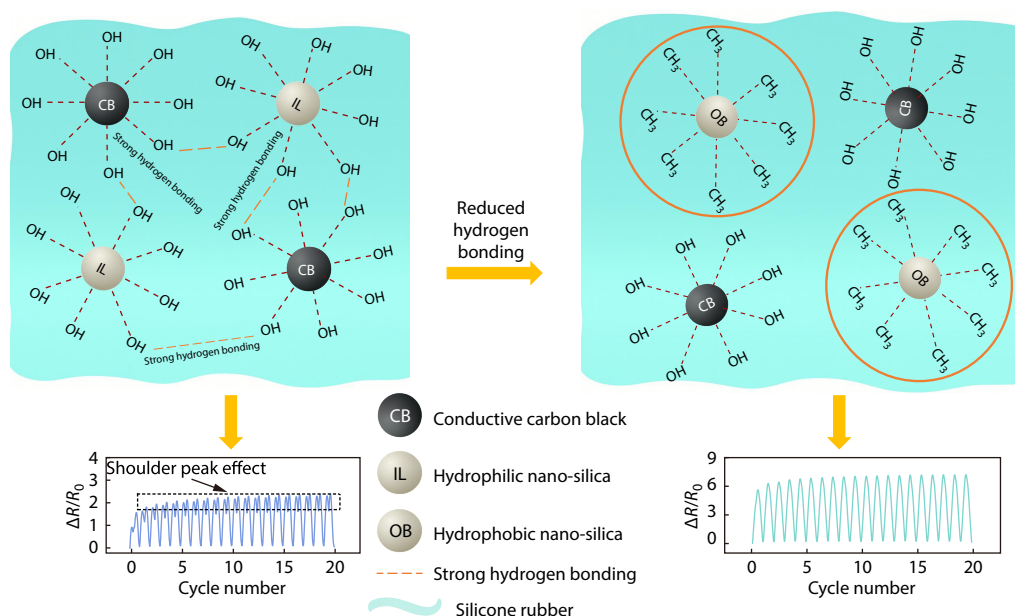


## Polarity-regulated Nano-silica Steering Carbon Black Network Evolution and Reconfiguration in Conductive Silicone Elastomers: Experimental and Molecular Simulations

Bang-Wei Wan and Yang Yang

Kunming University of Science and Technology

Hydrogen-bond regulation *via* hydrophobic nano-silica suppresses shoulder peak effects, stabilizes conductive networks, and enables highly sensitive, wide-range, and durable resistive strain sensing in conductive elastomer composites.



Chinese J. Polym. Sci. 2026, 44(6), 1883–1897

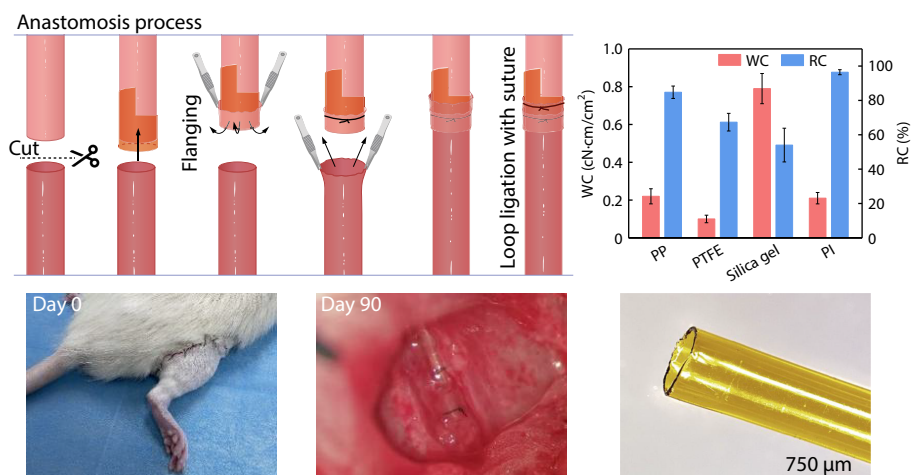
<https://doi.org/10.1007/s10118-026-3609-6>

## High-performance Polyimide Cuff Tube with Tunable Mechanics and Long-term Biocompatibility for Microvascular Anastomosis

Hui Su, Zhou-Quan Sun, Yu-Cheng Qiu, Yuan-Yuan Zhang, Jing Luo, Fei Liu, Jun Yang, Xian-Yu Zhou, Yue Zhang, and Yu-Mei Zhang

Donghua University; Shanghai Jiao Tong University School of Medicine

P84 polyimide cuff tubes fabricated *via* dry-jet wet-spinning exhibit enhanced mechanical properties after heat treatment and 90-day *in vivo* vascular patency and biosafety.



Chinese J. Polym. Sci. 2026, 44(6), 1898–1911

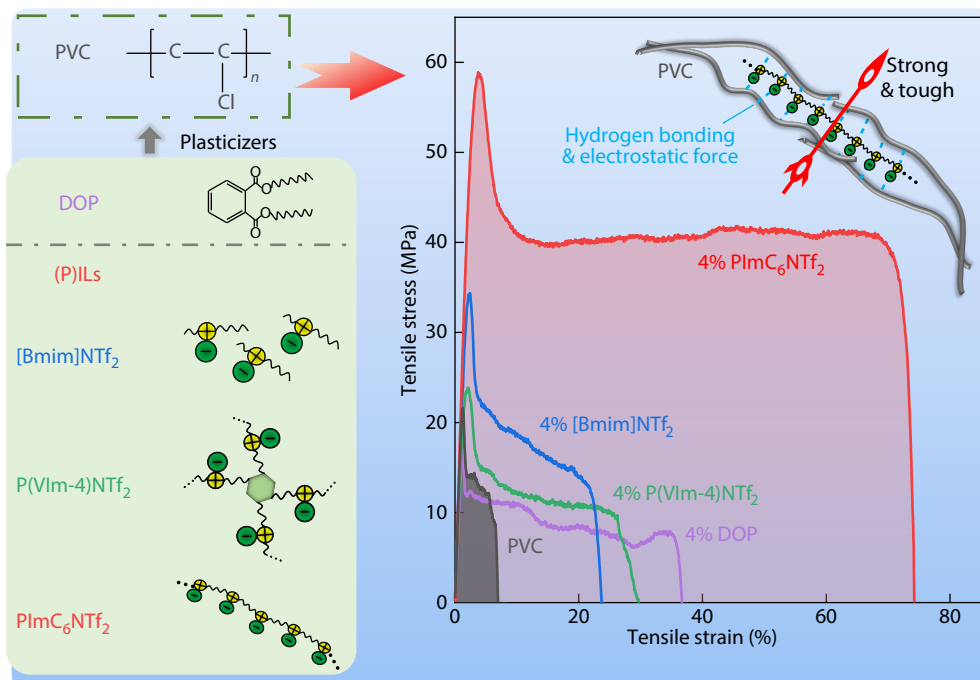
<https://doi.org/10.1007/s10118-026-3661-2>

## Plasticizing and Strengthening Poly(vinyl chloride) with Structurally Different Ionic Liquids

Xiang Gao, Ji-Shuo Ye, Zhi-Ji Liu, Jian Wu, and Ning-Zhong Bao

Nanjing Tech University; Zhejiang University; Hangzhou City University

This work investigates the reinforcing effects of ionic liquid monomer, linear and branched poly(ionic liquids) on poly(vinyl chloride) (PVC). Linear poly(ionic liquids) exhibit the best strength and toughness, which are significantly superior to dioctyl phthalate (DOP).



Chinese J. Polym. Sci. 2026, 44(6), 1912–1925

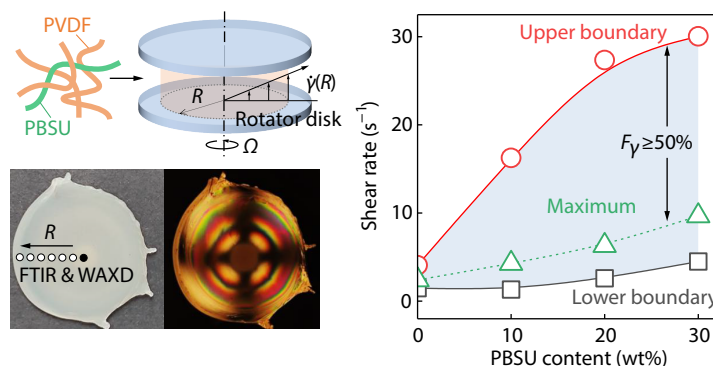
<https://doi.org/10.1007/s10118-026-3618-5>

## Melt Shear-induced $\gamma$ -Phase Crystallization of Poly(vinylidene fluoride) in Miscible Crystalline/Crystalline Blends

Ze-Kai Zheng, Shuai-Fei Zhang, Long-Qing Wang, Meng-Chao Kuang, Zhen Zhang, Chong-Yang Wang, Yan-Ping Liu, Chun-Tai Liu, and Zhen Wang

Zhengzhou University

Shear flow and the addition of poly(1,4-butylene succinate) (PBSU) synergistically enhance  $\gamma$ -phase crystallization in poly(vinylidene fluoride) (PVDF). Shear flow promotes  $\gamma$ -phase nucleation by orienting the polymer chains, while PBSU facilitates subsequent crystal growth.



Chinese J. Polym. Sci. 2026, 44(6), 1926–1939

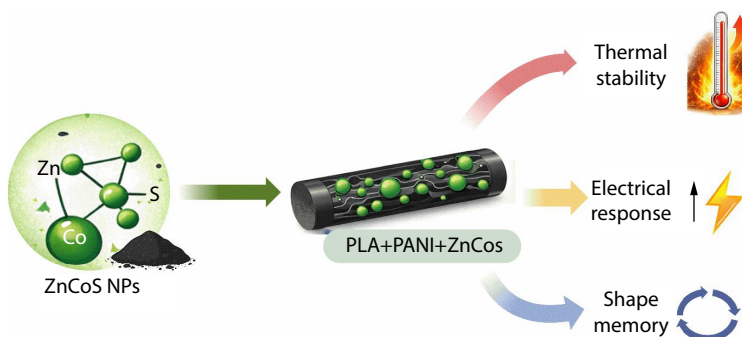
<https://doi.org/10.1007/s10118-026-3607-8>

### Interfacial and Structure-Property Relationships in Poly(lactic acid)/Polyaniline Bio-nanocomposites Incorporating Green-synthesized ZnCoS Nanoparticles

Mustafa Ersin Pekdemir, Karukh Ali Babakr, Sibel Selçuk Pekdemir, Nilay Akkuş Taş, Şeymanur Çetık, Ibrahim Nazem Qader, Sedanur Altun, Recep Taş, Mediha Kök, and Hülya Tuncer

Fırat University, Türkiye; University of Raparin, Iraq; Amasya University, Türkiye; University of Raparin, Iraq; Knowledge University, Iraq; Bartın University, Türkiye

Green-synthesized ZnCoS nanoparticles enhance interfacial polarization, thermal stability, and shape-memory recovery in poly(lactic acid)/polyaniline (PLA/PANI) nanocomposites, demonstrating structure-property correlations governed by nanoparticle loading.



Chinese J. Polym. Sci. 2026, 44(6), 1940–1954

<https://doi.org/10.1007/s10118-026-3608-7>

### Errata

#### Erratum to “Nanocomposite from Alpha-Tocopheryl Succinate and Chitosan-modified-graphene for Efficient Inhibition on Choroidal Melanoma via a Chemotherapy-assisted-photothermal Therapy”

Feng Yuan, Dan Lin, Yue Zhang, Kang Han, Qing Xu, He Ma, Ping-Ping Huang, Yong Liu, and Ling-Dan Kong

School of Biomedical Engineering, Wenzhou Medical University; Wenzhou Medical University

Chinese J. Polym. Sci. 2026, 44(6), 1955–1956

<https://doi.org/10.1007/s10118-026-3692-8>