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收件人: Weihong guo <guoweihong@ecust.edu.cn>

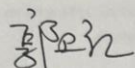
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Ms. Ref. No.: **CEJ-D-26-37873R1**

Title: Metal-Ion Coordination-Regulated TA@rGO Dual-Network Hydrogels for Synergistic Mechanical-Electrical Enhancement and Machine-Learning-Assisted Motion Recognition
Chemical Engineering Journal

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With kind regards,

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Metal-ion coordination-regulated TA@rGO dual-network hydrogels for synergistic mechanical-electrical enhancement and machine-learning-assisted motion recognition



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Metal-Ion Coordination-Regulated TA@rGO Dual-Network Hydrogels for Synergistic Mechanical-Electrical Enhancement and Machine-Learning-Assisted Motion Recognition

Yan Zhao, Linfeng Hu, Shuo Liu, Yuzheng Liu, Weihong Guo* guoweihong@ecust.edu.cn

Shanghai Key Laboratory of Advanced Polymeric Materials, Key Laboratory for Ultrafine Materials of the Ministry of Education, School of Materials Science and Engineering, East China University of Science and Technology, Shanghai, People's Republic of China

*Corresponding author.

ABSTRACT

The development of flexible sensors requires hydrogel materials with high mechanical strength, electrical conductivity, and multifunctional adaptability. However, achieving simultaneous enhancement of mechanical and electrical properties remains challenging due to the trade-off between network reinforcement and charge transport. Herein, a modular conductive hydrogel strategy based on metal-ion coordination regulation is proposed. A tannic acid-reduced graphene oxide (TA@rGO) conductive filler is incorporated into a polyacrylamide/sodium alginate (PAM/SA) double-network hydrogel, and the resulting PAM/TA@rGO/SA hydrogel is denoted as PTGS. Subsequently, dynamic coordination interactions between $\text{Cu}^{2+}/\text{Fe}^{3+}$ ions and oxygen-containing groups of SA, as well as polyphenolic sites of TA, are utilized to prepare PTGS- Cu^{2+} and PTGS- Fe^{3+} hydrogels with tunable properties. Metal-ion coordination significantly improves the mechanical performance, with PTGS- Fe^{3+} achieving tensile and compressive strengths of 1100 kPa and 3330 kPa, respectively. Unlike conventional ion-conducting hydrogels, where enhanced crosslinking generally suppresses conductivity, TA@rGO-mediated electronic pathways allow metal-ion coordination to simultaneously improve conductivity, reaching 17.8 S m^{-1} for PTGS- Fe^{3+} . Moreover, different coordination states endow the hydrogels with distinct sensing characteristics, including wide-range strain detection, balanced sensitivity and detection range, and high sensitivity at low strain. Combined with machine learning algorithms, the hydrogels enable material-state recognition and