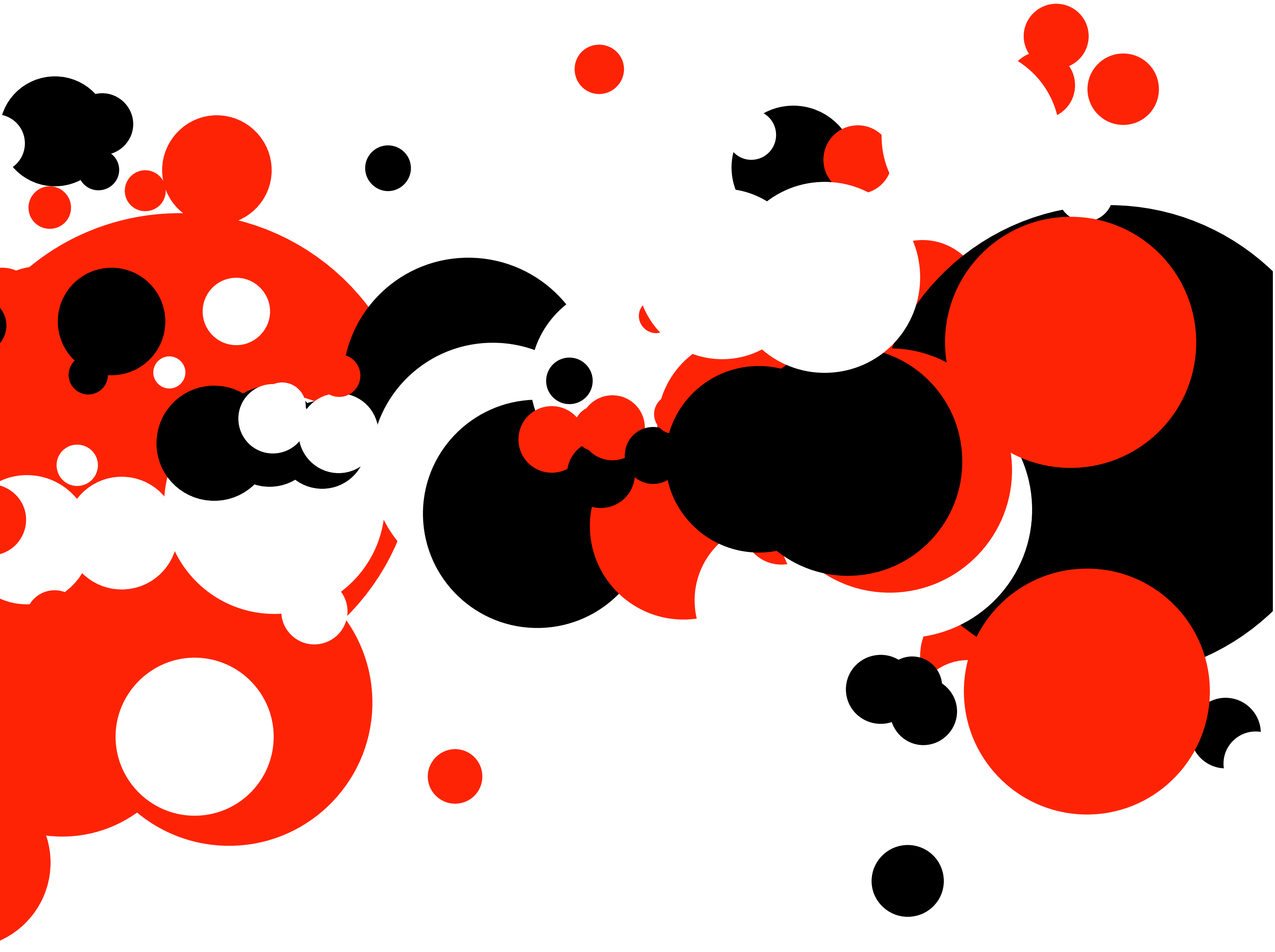
University of Technology Sydney

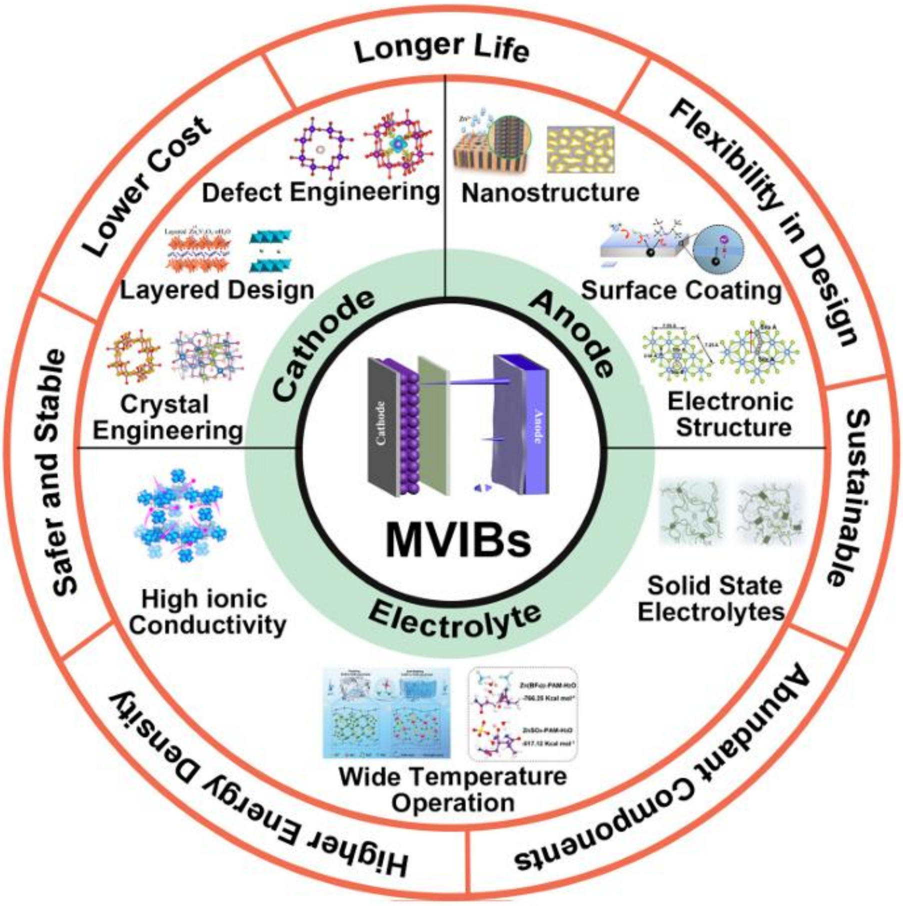
Centre for Clean Energy Technology

Research Highlights in 2025



1. Asif Mahmood,†* Zhe Bai,† Tan Wang, Yaojie Lei, Shijian Wang, Bing Sun, Hajra Khan, Karim Khan, Kening Sun and **Guoxiu Wang***, "Enabling high-performance multivalent metal-ion batteries: current advances and future prospects", **Chemical Society Reviews**, 54, 2369-2435, 2025. IF = 40.4. DOI: 10.1039/D4CS00929K

   ABSTRACT: The battery market is primarily dominated by lithium technology, which faces severe challenges because of the low abundance and high cost of lithium metal. In this regard, multivalent metal-ion batteries (MVIBs) enabled by multivalent metal ions (e.g. Zn^{2+}, Mg^{2+}, Ca^{2+}, Al^{3+}, etc.) have received great attention as an alternative to traditional lithium-ion batteries (Li-ion batteries) due to the high abundance and low cost of multivalent metals, high safety and higher volumetric capacities. However, the successful application of these battery chemistries requires careful control over electrode and electrolyte chemistries due to the higher charge density and slower kinetics of multivalent metal ions, structural instability of the electrode materials, and interfacial resistance, etc. This review comprehensively explores the recent advancements in electrode and electrolyte materials as well as separators for MVIBs, highlighting the potential of MVIBs to outperform Li-ion batteries regarding cost, energy density and safety.



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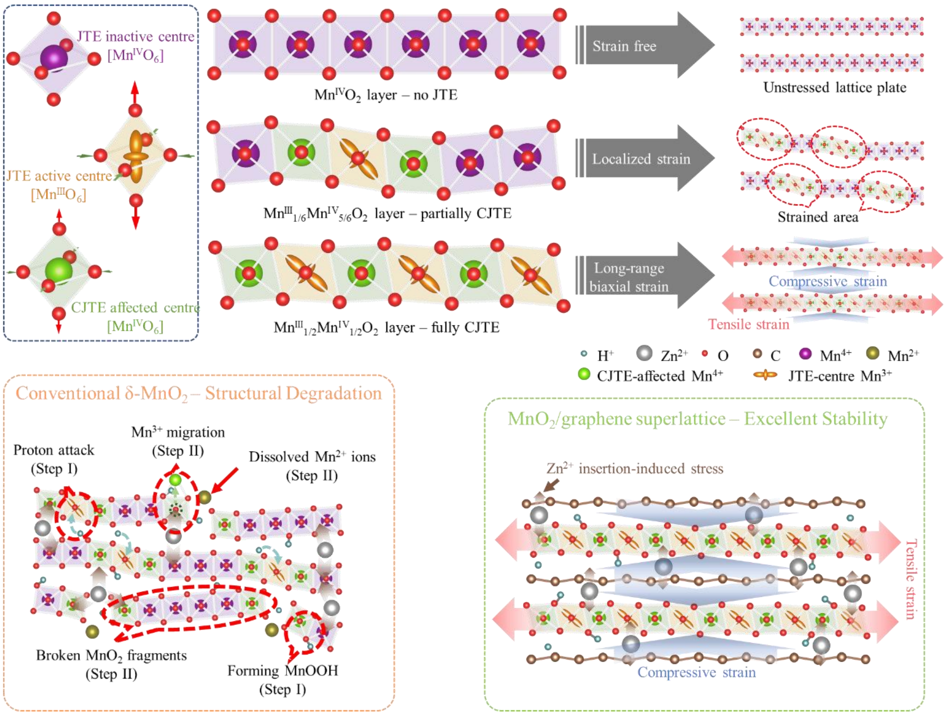
2. Shijian Wang[1], Xin Guo[1], Kun Huang[1], Amritroop Achari, Javad Safaei, Yaojie Lei, Dongfang Li, Qinfen Gu, Chenghua Sun, Lucy Gloag, Steven Langford, Andre Geim, Rahul Raveendran Nair*, and **Guoxiu Wang***, "Cooperative Jahn-Teller effect and engineered long-range strain in manganese oxide/graphene superlattice for aqueous zinc-ion batteries", **Nature Communications**, 16, 5191, 2025. IF = 16.6. DOI: 10.1038/s41467-025-60558-y.

ABSTRACT: The Jahn-Teller and cooperative Jahn-Teller effects are phenomena that induce asymmetry in individual ions and solid-state lattices and are commonly observed in structures containing specific transition metals, such as copper and manganese. Although the Jahn-Teller effect causes lattice distortions that stress electrode materials in rechargeable batteries, strategically utilising the strain generated by cooperative Jahn-Teller distortions can enhance structural stability. Here we introduce the cooperative Jahn-Teller effect on MnO_2 by constructing a two-dimensional superlattice structure with graphene crated in the bulk MnO_2/graphene composite material. The strong interaction between MnO_2 and graphene increases the concentration of high-spin Mn^{3+} ions, creating orderly long-range biaxial strains that are compressive in the out-of-plane direction and tensile in the in-plane direction. These strains mitigate Zn^{2+} intercalation stress and proton corrosion, enabling over 5000 cycles with 165 mAh g^{-1} capacity retention at 5 C (1 C = 308 mA g^{-1}) in aqueous zinc-ion batteries. Our approach offers an effective strategy to significantly enhance the lifetime of rechargeable batteries by introducing the cooperative Jahn-Teller effect that overcomes the stress of ion insertion in electrode materials.



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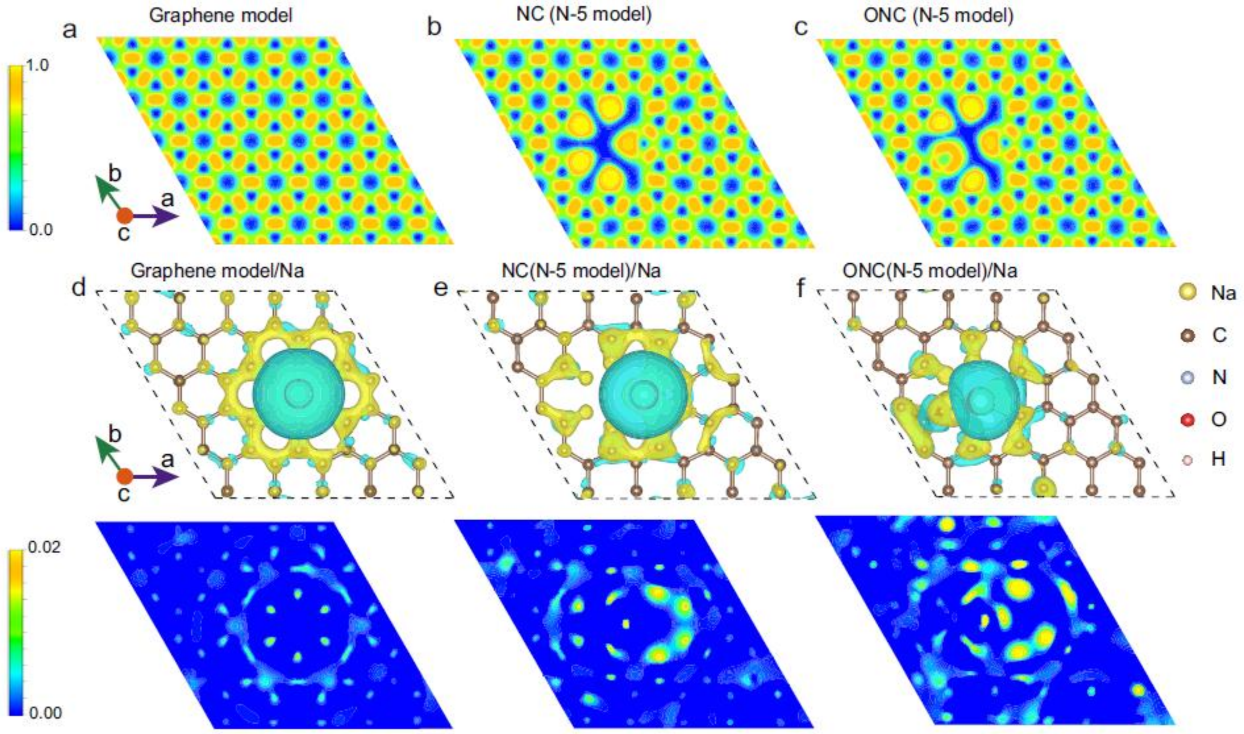
3. Jiabao Li, Ruoxing Wang, Lanlan Han, Tianyi Wang, Yusuke Asakura, Chengyin Wang, **Guoxiu Wang**, Xingtao Xu, Yusuke Yamauchi, "Unveiling the neglected role of oxygen dopin gin nitrogen-doped carbon for enhanced capacitive deionization performance", **Nature Communications**, 16, 1996, 2025. IF= 16.6. DOI: 10.1038/s41467-025-56694-0.

   ABSTRACT: Nitrogen-doped carbons (NCs) have demonstrated notable advantages for application in capacitive deionization (CDI). However, the potential roles of different nitrogen configurations in the CDI process, especially how the neglected oxygen doping synergistically works, remain unclear. In this work, we systematically addressed these critical issues and revealed the significant role of trace oxygen doping in enhancing the desalination performance of NC electrodes. By introducing oxygen into nitrogen-doped carbon nanosheets (ONC-S), using guanine as the precursor, we obtained abundant pyridinic and pyrrolic nitrogen configurations. This design aims to synergistically enhance the charge distribution, wettability, and ion diffusion of the target electrodes. Compared with commercial activated carbon and other state-of-the-art materials, our ONC-S electrode demonstrates superior specific capacitance, excellent cycling stability, and enhanced desalination efficiency. These findings highlight the synergistic effects of trace oxygen doping and the nitrogen configuration, offering valuable insights into the mechanisms driving the improved CDI performance.



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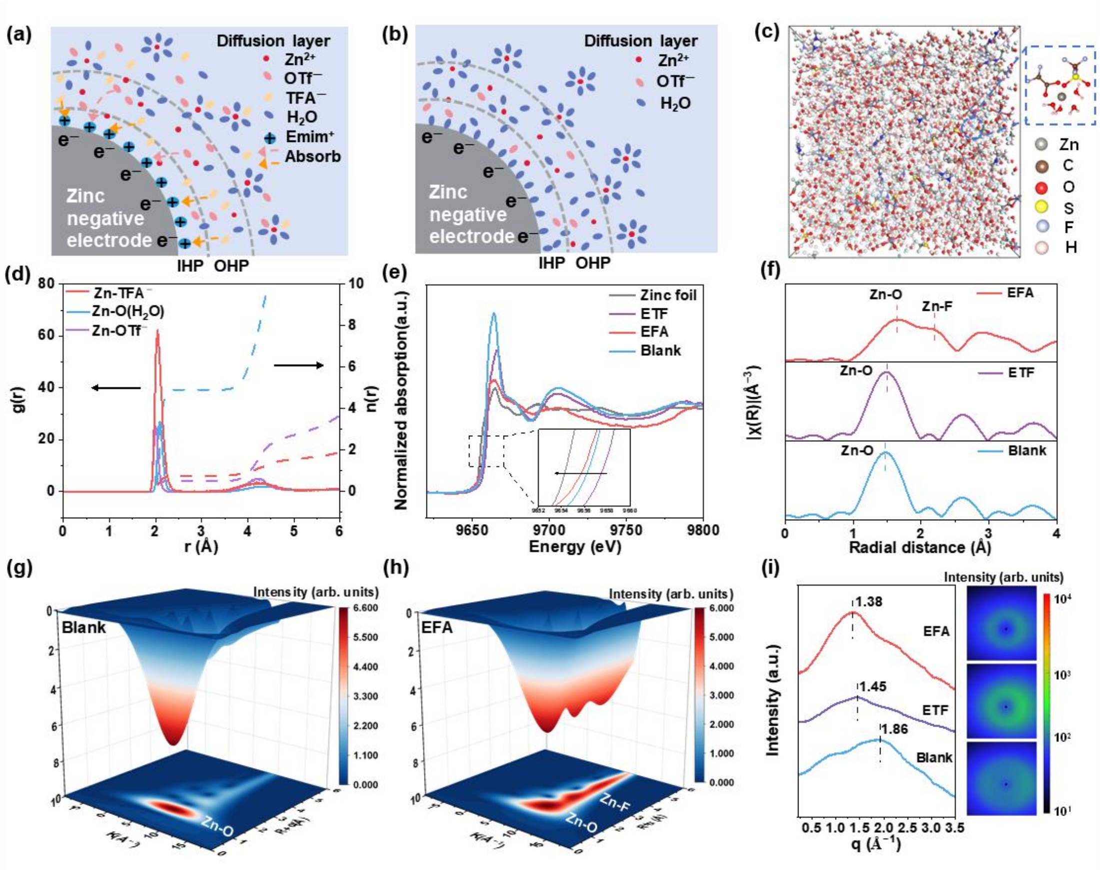
4. Sinian Yang, Shunshun Zhao, Haojie Xu, Xinwei Wang, Xuanrui Huang, Qi Yang, Yong Chen*, **Guoxiu Wang***, Shimou Chen*, "Gradient Chaotropic Regulation of Zn^{2+} Solvation Chemistry for Low-Temperature Zinc Metal Batteries", **Nature communications**, 2025. IF= 16.6. DOI: 10.1038/s41467-025-67426-9

   Abstract: Aqueous zinc-ion batteries have emerged as a promising system for safe and sustainable energy storage. However, their practical application is hindered by detrimental interfacial side reactions and inadequate low-temperature performance. Herein, we report the design of a gradient chaotropic ionic liquid (IL)-based aqueous electrolyte ($Emim^+$-TFA^-/OTf^--Zn^{2+}-H_2O), which can simultaneously fulfil the conflicting demands of dendrite-free zinc deposition and low-temperature operation. By forming an antifreeze electrolyte with a hydrophobic yet salt-philic interface, the proposed formulation overcomes the limitations of conventional IL-based systems that rely on H2O-lean compositions, complex additives, or elaborate solvent mixtures. Thus, the assembled zinc-ion cells exhibit improved zinc plating/stripping stability. At a current density of 0.1 mA cm^{-2} and 0.1 mAh cm^{-2}, the Zn||Zn symmetric cells endure prolonged zinc plating/stripping, exceeding 13, 000 h at −30 °C and 6690 h at −40 °C. In full cells, Zn||VO_2@VO maintains nearly 100% capacity retention over 3500 cycles at 0.2 A g^{-1} and −40 °C. This gradient chaotropic Zn^{2+} electrolyte design provides a versatile platform for effective antifreeze Zn^{2+} solvation chemistry and accelerated interfacial ion transport, enabling high-performance zinc batteries in subzero environments.



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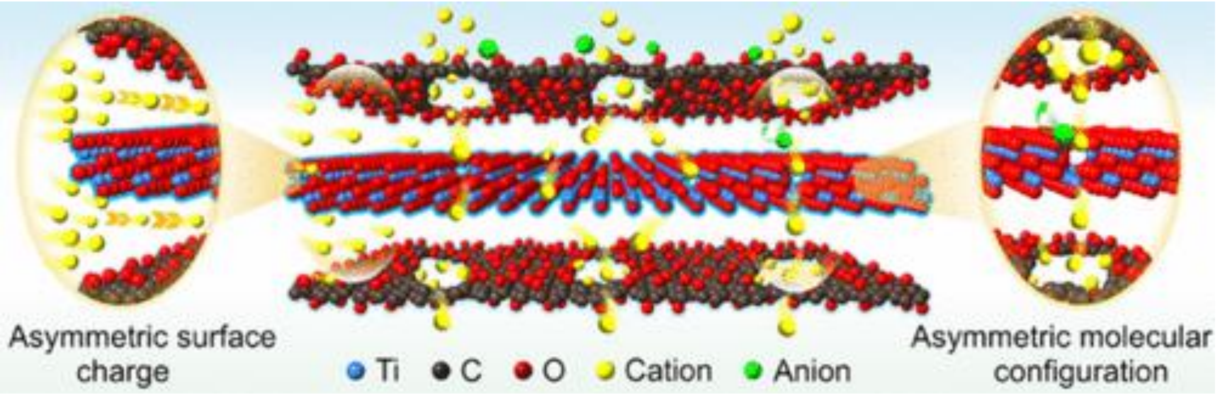
5. Chao Liu, Caichao Ye, Jiali Wang, Ting Yang, Anqi Ni, Tianning Zhang, Kunpeng Mao, Long Chen, Shijian Wang, Jingwen Sun, Wenqing Zhang, Xin Wang, Jianfei Che, Pan Xiong*, **Guoxiu Wang***, Junwu Zhu*, “Molecular-Scale Asymmetry Nanochannels for High-Efficiency Osmotic Energy Generation”, **Journal of the American Chemical Society**, 2025. IF=15.6. DOI: 10.1021/jacs.5c08016

   ABSTRACT: Osmotic power, as an example of iontronics, can convert an ion gradient to electrical energy by the membrane-based reverse electrodialysis technique. However, its efficiency in harvesting osmotic energy is mostly dependent on ion permeability and selectivity during transmembrane diffusion. The two-dimensional (2D) heterogeneous interface establishes molecular-scale asymmetric structure and charge that is expected to exert a crucial effect on the ion permeability and selectivity but remains unexplored. Here, we designed a 2D nanofluidic membrane with molecular-level asymmetric channels that can achieve high cation selectivity while maintaining outstanding ion conductivity. When applied to osmotic energy generators, this membrane can exhibit a high cation selectivity coefficient of 0.985 and a superior energy conversion efficiency of up to 47.1%, coupled with an excellent output power density of over 20 W m^{-2} in mixing the artificial seawater and river water. The Na$^+$ ions transport through a 2D heterostructured membrane via an interface-induced contiguous ion adsorption-diffusion mechanism is uncovered. The asymmetric pore structure and negative charge distribution enable highly selective adsorption of Na$^+$ ions and subsequently fast transport in the molecular-scale asymmetric nanochannels. This work provides an in-depth understanding of ion transport in asymmetric nanochannels and further inspires their applications in other advanced energy-harvesting devices.



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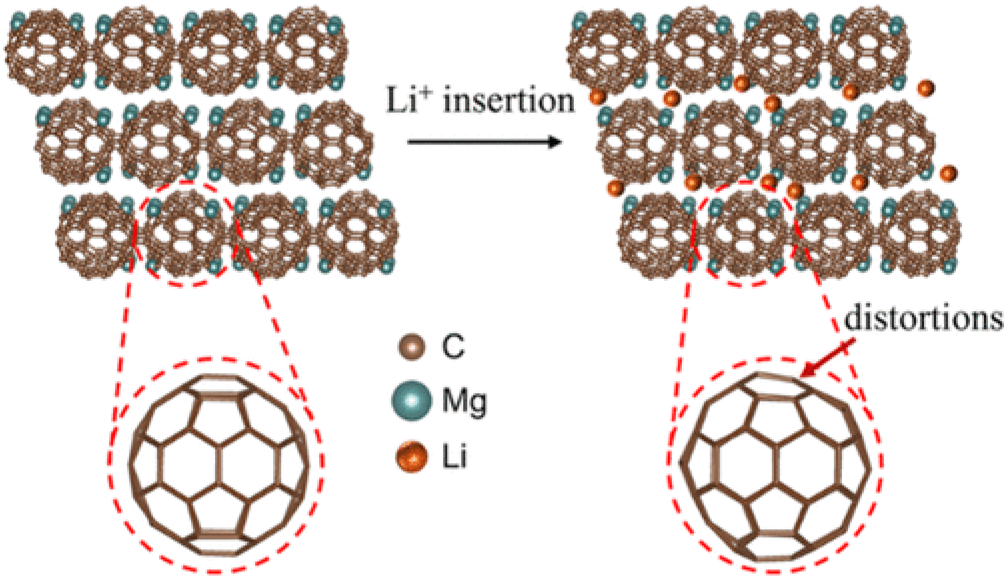
6. Shijian Wang, Heng Liu, Yaojie Lei, Dongfang Li, Yameng Fan, Liang Hong, Xin Guo, Meng Wang, Zefu Huang, Yong Chen, Xu Yang, Jinqiang Zhang, Hao Li and **Guoxiu Wang***, "Covalent Bridges Enabling Layered C_{60} as an Exceptionally Stable Anode in Lithium-Ion Batteries", **Journal of the American Chemical Society**, 2025. IF=15.6. DOI: 10.1021/jacs.5c17338

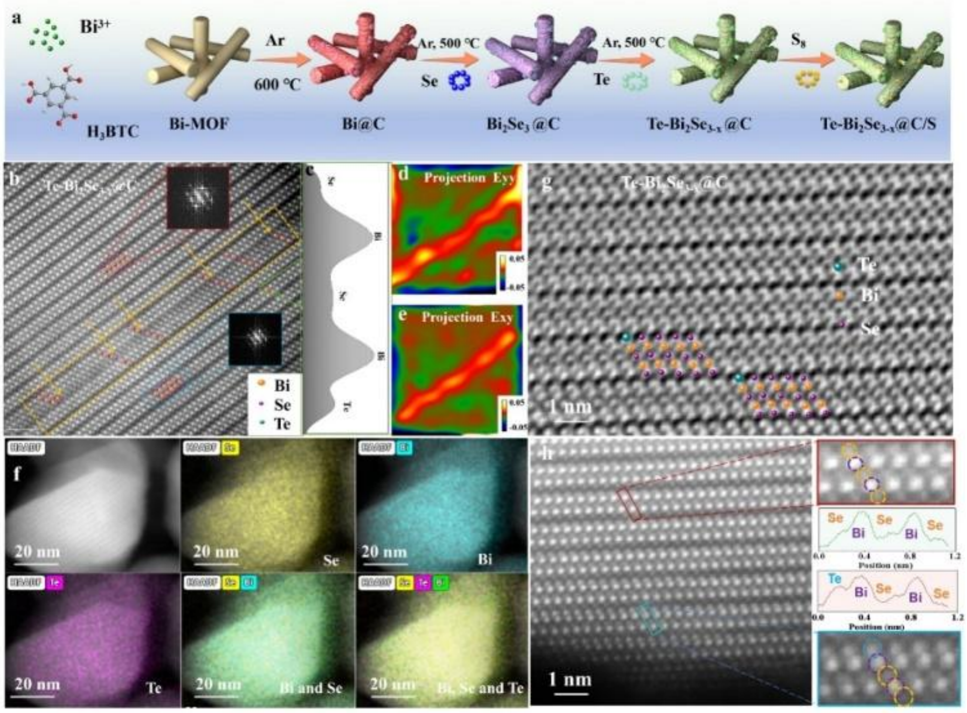
ABSTRACT: Fullerene (C_{60}) exhibits rich redox chemistry but suffers from severe dissolution of reduced fulleride species in carbonate electrolytes, leading to poor reversibility and rapid capacity fading. Here, we demonstrate covalent bridging as a general strategy to stabilize the fullerene framework using Mg4C60. Mg atoms promote intercage covalent connections through C–C single bonds and [2+2] cycloaddition bonds, transforming a van der Waals molecular solid into a layered polymeric framework. Comprehensive characterizations reveal that such bridging effectively suppresses dissolution, preserves structural integrity, and enables a reversible Li^+ storage process. Interestingly, unlike pristine C_{60} that undergoes multiple phase transitions, Mg4C60 exhibits slope-type electrochemical profiles reminiscent of soft carbon yet originates from an ordered two-dimensional framework. Comprehensive mechanistic studies reveal reversible fullerene cage distortions accompanied by the dynamic reconstruction of sp2 electronic states, while the covalently bridged scaffold remains intact. This work establishes covalently bridged fullerenes as a new class of durable carbonaceous anodes and provides a general pathway for designing ordered carbon frameworks with enhanced stability for next-generation rechargeable batteries.



https://pubs.acs.org/doi/abs/10.1021/jacs.5c17338

7. Chen Huang, Jing Yu, Chao Yue Zhang, Zhibiao Cui, Ren He, Linlin Yang, Bingfei Nan, Canhuang Li, Xuede Qi, Xueqiang Qi, Junshan Li, Jin Yuan Zhou, Oleg Usoltsev, Laura Simonelli, Jordi Arbiol, Yao-Jie Lei*, Qing Sun*, **Guoxiu Wang*** and Andreu Cabot*, "Anionic Doping in Layered Transition Metal Chalcogenides for Robust Lithium-Sulfur Batteries", **Angewandte Chemie International Edition**, 64, e202420488, 2025, IF=16.6. DOI: 10.1002/anie.202420488

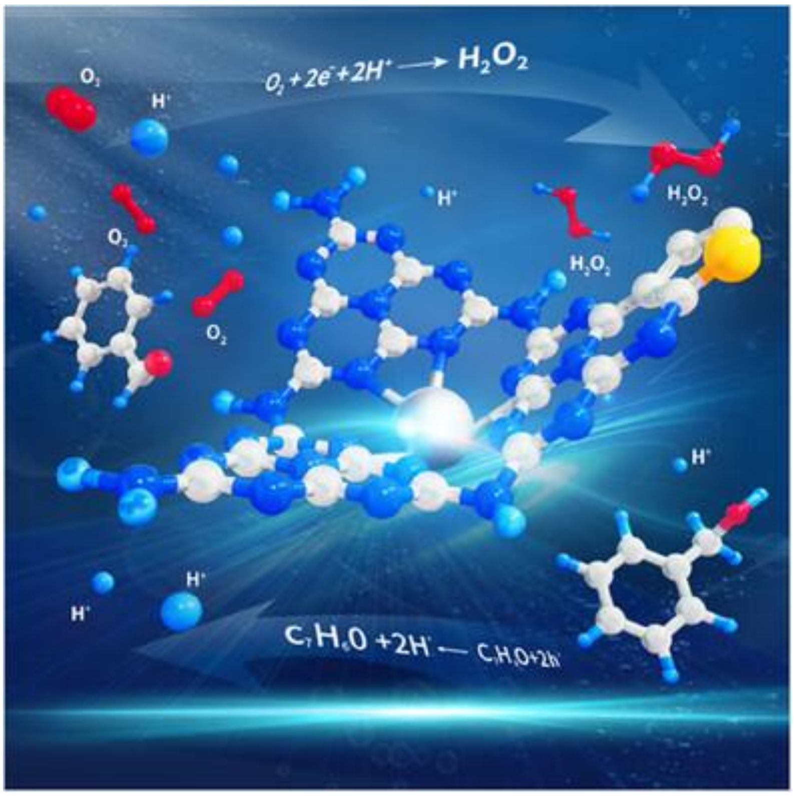
ABSTRACT: Lithium-sulfur batteries (LSBs) are among the most promising next-generation energy storage technologies. However, a slow Li-S reaction kinetics at the LSB cathode limit their energy and power densities. To address these challenges, this study introduces an anionic-doped transition metal chalcogenide as an effective catalyst to accelerate the Li–S reaction. Specifically, a tellurium-doped, carbon-supported bismuth selenide with Se vacancies ($\text{Te–Bi}_2\text{Se}_{3-x}$@C) is prepared and tested as a sulfur host in LSB cathodes. X-ray absorption and in situ X-ray diffraction analyses reveal that Te doping induces lattice distortions and modulates the local coordination environment and electronic structure of Bi atoms to promote the catalytic activity toward the conversion of polysulfides. Additionally, the generated Se vacancies alter the electronic structure around atomic defect sites, increase the carrier concentration, and activate unpaired cations to effectively trap polysulfides. As a result, LSBs based on $\text{Te–Bi}_2\text{Se}_{3-x}$@C/S cathodes demonstrate outstanding specific capacities of $1508\ \text{mAh}\cdot\text{g}^{-1}$ at 0.1 C, excellent rate performance with $655\ \text{mAh}\cdot\text{g}^{-1}$ at 5 C, and near-integral cycle stability over 1000 cycles. Furthermore, under high sulfur loading of $6.4\ \text{mg}\cdot\text{cm}^{-2}$, a cathode capacity exceeding 8 $\text{mAh}\cdot\text{cm}^{-2}$ is sustained at 0.1 C current rate, with $6.4\ \text{mAh}\cdot\text{cm}^{-2}$ retained after 300 cycles under lean electrolyte conditions ($6.8\ \mu\text{L}\cdot\text{mg}^{-1}$).



https://onlinelibrary.wiley.com/doi/10.1002/anie.202420488

8. Xiaoyu Zhou, Kuanhong Cao, Shouqiang Huang, Haonan Wu, Zhen Cao, Hang Liu, Peng Chen, Dawei Su, **Guoxiu Wang**, Tianyi Wang, Chengyin Wang, Huan Pang, "Synergistic Conversion of Hydrogen Peroxide and Benzaldehyde in Air by Silver Single-Atom Modified Thiophene-Functionalized g-C_3N_4", **Angewandte Chemie International Edition**, 64, e202505532, 2025, IF=16.6. DOI: 10.1002/anie.202505532

ABSTRACT: This study reports the synthesis of silver single-atom-loaded thiophene-conjugated carbon nitride (Ag@T-C3N4), a material with high carrier concentration and efficient carrier separation. Under visible light, Ag@T-C_3N_4 catalyzes hydrogen peroxide (H_2O_2) production and benzyl alcohol oxidation to benzaldehyde, achieving production rates of 4729.82 $\mu mol \cdot g^{-1} \cdot h^{-1}$ for H_2O_2 and 19.71 $mmol \cdot g^{-1} \cdot h^{-1}$ for benzaldehyde. The synergy between thiophene conjugation and silver atoms extends visible light absorption and accelerates the 2-electron oxygen reduction reaction (ORR), enhancing H_2O_2 yield. Photogenerated holes oxidize benzyl alcohol to benzaldehyde, while the biphasic benzaldehyde-water system enables spontaneous product separation. In situ Raman spectroscopy, rotating disk electrode testing, EPR, GC-MS, and DFT calculations highlight the critical role of thiophene-silver synergy in optimizing reaction pathways, enhancing catalyst-intermediate interactions, and reducing Gibbs free energy, improving H_2O_2 and benzaldehyde synthesis. This study provides new insights for designing carbon nitride-based photocatalysts and offers a strategy for co-producing value-added chemicals.



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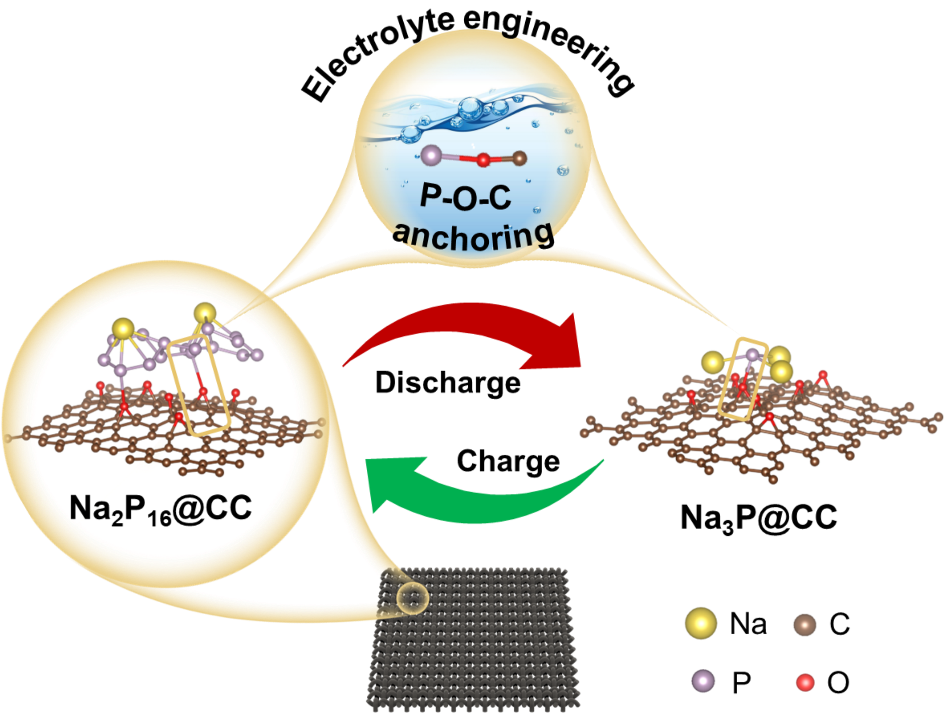
9. Xin Guo, Shijian Wang, Jiaao Wang, Hong Gao, Zefu Huang, Weihong Lai, Wei Kong Pang, Jiangtao Qu, Mai H. Nguyen, Cheng-Jie Yang, Chung-Li Dong, Hao Liu, Graeme Henkelman, Michel Armand, Doron Aurbach, Guoxiu Wang, “Unlocking the Potential of Phosphorus Anodes for Sodium-IonBatteries via Tailored Reversible Na/Polyphosphide Chemistry”, **Angewandte Chemie International Edition**, 64, e202509929, 2025, IF=16.6. DOI: 10.1002/anie.202509929

ABSTRACT: To surmount the inherent limitations and fully harness the remarkable ultra-high specific capacity (2,596 mAhg^{-1}) of phosphorus (P) anode for sodium-ion batteries (SIBs), we unveil an alternative fast and reversible electrochemicalpathway based on $Na_2P_{16} \leftrightarrow Na_3P$, which transcends the barriers posed by sluggish reaction kinetics in solid-state red P. It entails the immobilization of dissolved sodium polyphosphide (Na_2P_{16}) onto carbon cloth (CC) matrices via robust C-O-P bonding (Na_2P_{16}@CC), and the intrinsic superior malleability of Na_2P_{16} effectively mitigates the issue of electrodepulverization caused by volumetric changes of red P during (de)sodiation. Additionally, the profound chemical adsorptionof surface oxygen-doped CC toward phosphorus species and the utilization of weakly solvating cyclic carbonate solventssynergistically inhibit the vexing dissolution of high-order polyphosphides in the electrolyte. By capitalizing on theadvances of the novel reaction mechanism, the Na_2P_{16}@CC composite anode material achieves improved sodium storageperformance with a high initial reversible capacity of 1.75 mAh cm^{-2} at 0.1 mA cm^{-2} and a capacity retention of 81% over600 cycles. This work opens an avenue toward the rational design of P-based anodes for high-energy SIBs.



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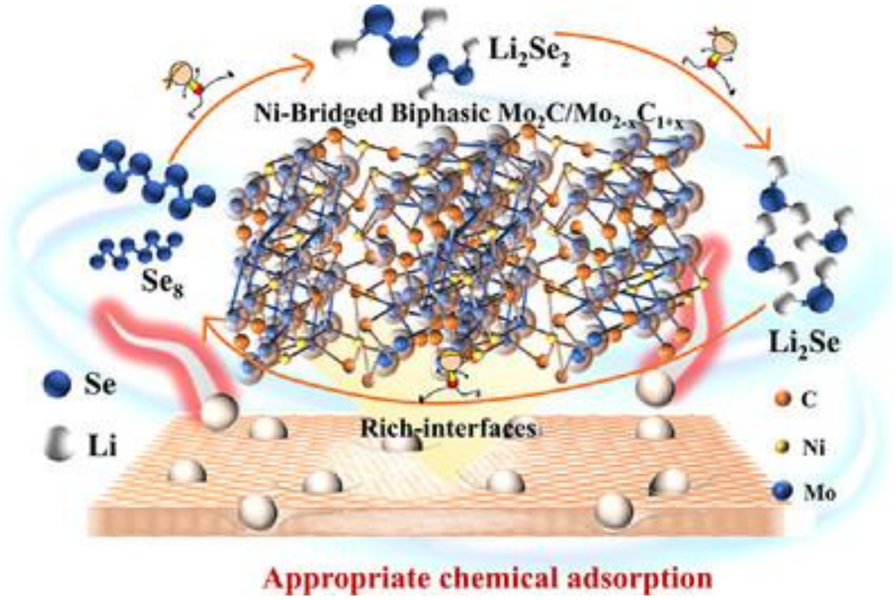
10. Jiayi Li, Hong Gao, Dingyi Zhang, Li Gao, Shijian Wang, Congcong Li, Xinyao Yuan, Chao Yuan, Xinming Nie, Jinqiang Zhang, Yufei Zhao, **Guoxiu Wang**, Hao Liu, "Ni-Bridged Biphasic Molybdenum Carbide Interfaces: A Synergistic Catalyst for High-Performance Lithium–Selenium Batteries", **Angewandte Chemie International Edition**. 64, e202519816, 2025, IF=16.6. DOI: 10.1002/ange.202519816

ABSTRACT: Transition metal catalysts are key to developing high-performance lithium-selenium (Li-Se) batteries. Herein, we report a rationally designed Ni-bridged biphasic molybdenum carbide (Mo_2C) with a multi-interface structure that exposes abundant active sites and significantly enhances the electrochemically reversibility of Li-Se batteries under high current operation. The synergistic integration of catalytic and conductive functions facilitates the rapid deposition and conversion of Se/Li_2Se_x, effectively preventing electrode passivation caused by inactive accumulation during high-rate and long-term cycling. Furthermore, Ni serves dual roles as a structural bridge to link Mo2C lattice and an electronic modulator to optimize the d-orbital configuration of Mo, thereby maximizing the catalytic efficiency of functionalized Mo_2C. The synergistic effects of adsorption, desorption, and catalysis enable the rationally designed metal carbide/Se electrode to promote not only the rapid conversion of long-chain Li2Sen species but also the solid–solid transformation of Li_2Se_2 into Li_2Se. As a result, the electrode achieves full-process catalytic conversion in Li–Se batteries, delivering excellent cycling stability and high-rate performance. Even under high Se loading (5.6 mg cm^{-2}), the electrode delivers an initial capacity of 400 mAh g^{-1} at 0.1 C. These results highlight the effectiveness of the synergistic adsorption/desorption/catalysis mechanism in enabling a fast solid–solid conversion pathway for Li-Se batteries.



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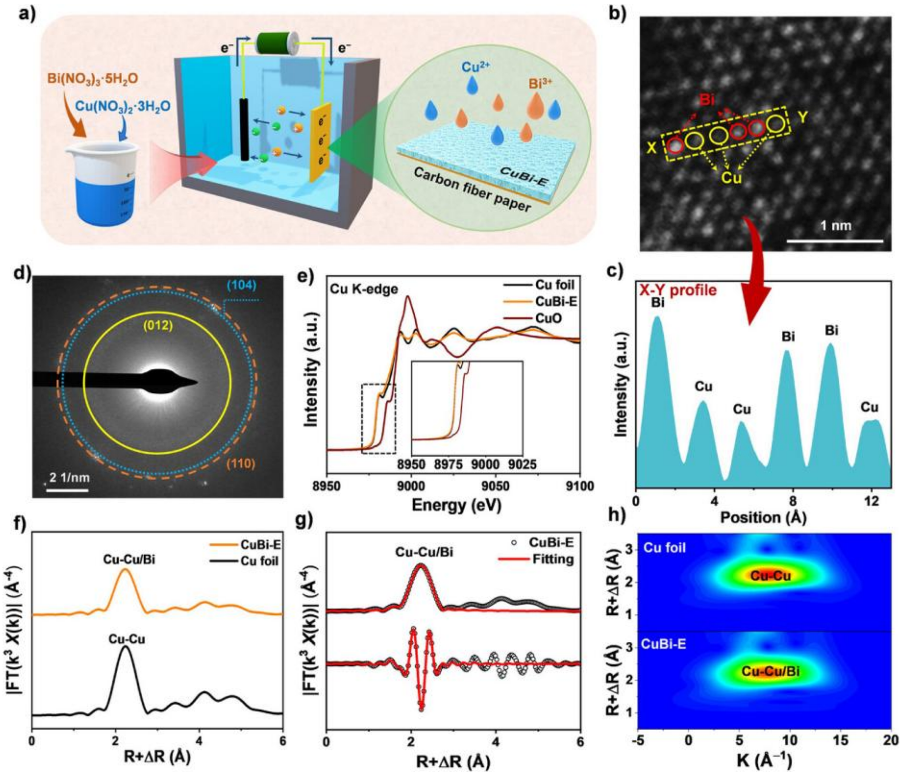
11. Zhikeng Zheng, Xiaobo Zheng, Prof. Ligang Wang, Huiming Wen, Ke Li, Zhenhao Xu, Yameng Fan, Peng Li, Suyu Zhang, Bin Liu, Dingsheng Wang, Kai Yan, **Guoxiu Wang***, "Harnessing Electrocatalytic Coupling of Carbon Dioxide and Methanol for High-Efficiency Formic Acid Production", **Angewandte Chemie International Edition**. 64, e202512078, 2025, IF=16.6. DOI: 10.1002/anie.202512078

ABSTRACT: The coupling of electrocatalytic CO_2 reduction (ECR) and methanol oxidation reaction (MOR) presents a promising strategy for simultaneous cogeneration of formic acid (FA) at both cathode and anode. However, sluggish kinetics, low selectivity and efficiency hinder practical application. Herein, we demonstrate an integrated ECR||MOR system employing CuBi cathode and NiCo anode for energy-efficient FA cogeneration. The CuBi alloy achieves high Faradaic efficiencies (FE > 90%) for FA generation over an extensive potential range (>400 mV), attributed to the accelerated formation of HCOO* intermediates in facilitating FA production. Meanwhile, the NiCo alloy reached a remarkable FE of 97.5% for FA generation at 1.4 V versus reversible hydrogen electrode, benefiting from rapid HCOO* intermediate formation that effectively mitigates CO toxicity. This unique system delivered a current density of 10 mA cm^{-2} at a voltage of 2.07 V, representing a substantial reduction of 320 mV compared to water electrolysis. Across a wide operational voltage window (2.0-2.8 V), the system consistently delivered total Faradaic efficiencies ranging between 189% and 192%, alongside exceptional FA production capacities surpassing 400 g kWh^{-1}, which significantly outperformed traditional methods (~220 g kWh^{-1}). This work provides an efficient pathway for low-energy CO_2 utilization and sustainable FA production.



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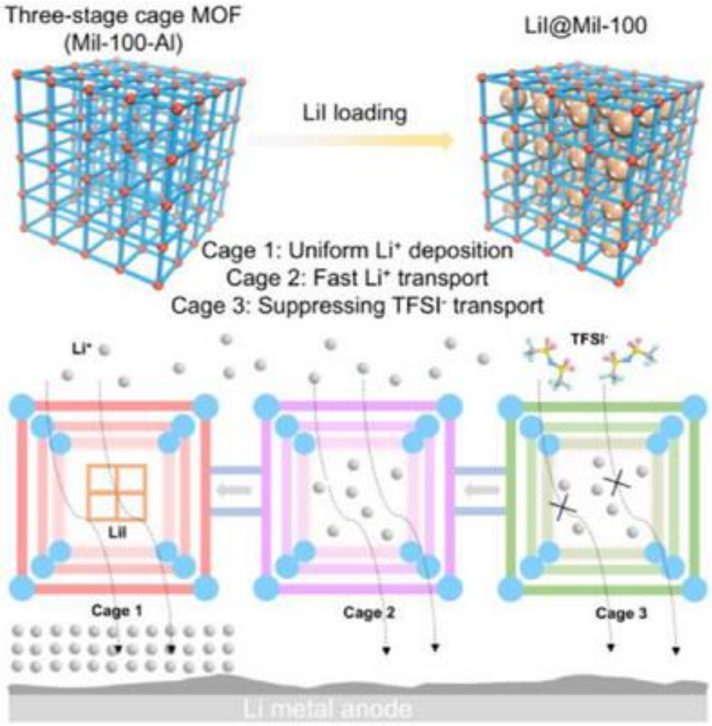
12. Xingxing Zhang, Hongli Chen, Qingmei Su, Xinglong Deng, Dequn Zhao, Weihao Shi, Liming Wang, Jinqi Chen, Fan Xi, Zeming He, Ping Yu, **Guoxiu Wang*,** Wenhuan Huang, "Halogen-Driven Ion Transport Homogenization in 3D Hierarchical MOF for Ultrastable Solid-State Lithium Metal Batteries", **Angewandte Chemie International Edition**, 64, e202511822, 2025. IF=16.6. DOI: 10.1002/anie.202511822

ABSTRACT: Solid-state lithium metal batteries (SSLMBs) are hindered by limited ionic conductivity, heterogeneous lithium flux and interfacial instability of solid-state electrolytes. Herein, we report a hierarchical ion-transport network formed by confining lithium halides (LiX, X═Cl, Br, I) within the mesoporous cages of MIL-100(Al), synergistically integrated with a PVDF-HFP polymer matrix. The 3D interconnected pores (0.5–1 nm) of MIL-100(Al) not only spatially confine anions via size-selective sieving but also enable continuous Li^+ transport through tunable host–guest interactions between the Lewis-acidic metal nodes and lithium halides. Among these, the LiI-embedded composite (E-LiI) exhibits a high Li^+ transference number (0.88 at 25 °C) and favorable interfacial kinetics, attributed to strong anion coordination and homogeneous Li^+ plating. Structural characterizations confirm uniform LiX distribution within the MOF framework. In addition, density functional theory (DFT) calculations and COMSOL simulation elucidate halogen-dependent desolvation energetics and Li^+ transport kinetics. SSLMBs employing E-LiI electrolytes demonstrate exceptional cycling stability (capacity retention ∼100% after 600 cycles at 2C) with high-voltage cathodes and wide-temperature adaptability. This work advances the rational design of multi-scale ion-conductive frameworks and the pivotal role of lithium halide in regulating Li deposition kinetics, offering a transformative strategy for high-energy-density solid-state battery systems.



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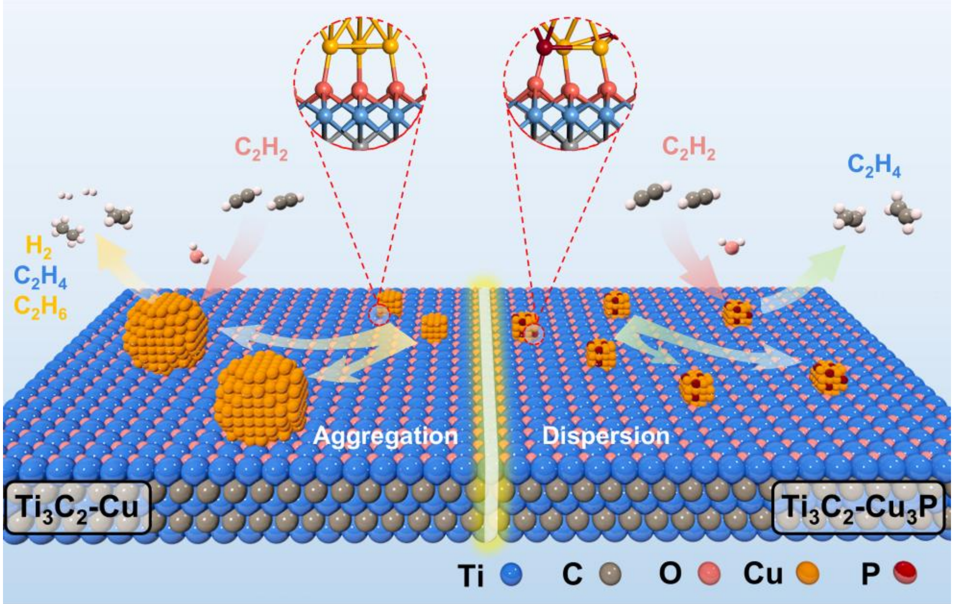
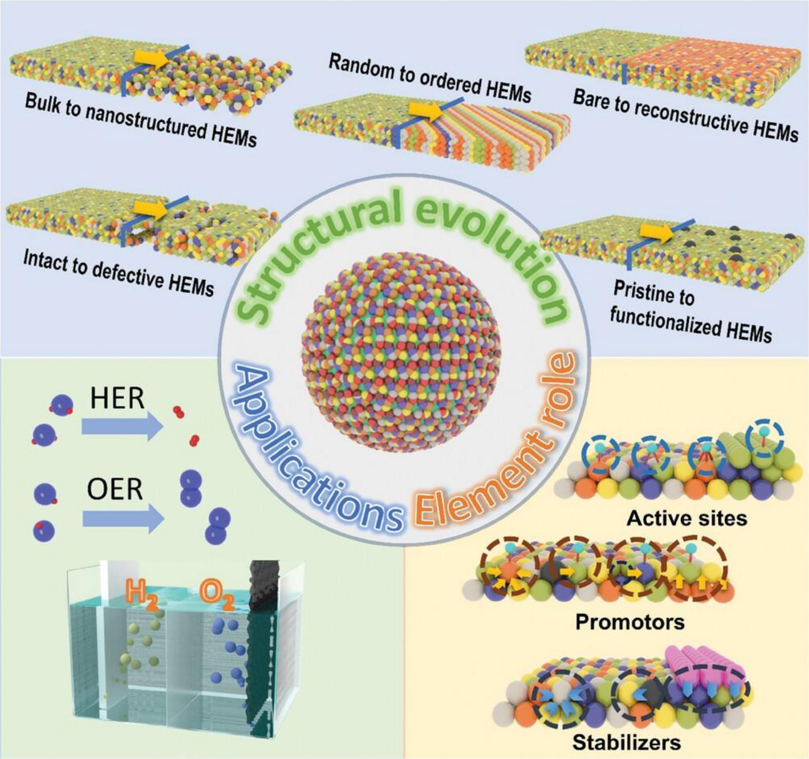
13. Zeliang Wu#, Qihui Guan#, Tao Wang, Dongfang Li, Ming Lei, Wei Hong, Shixia Chen, Shijian Wang*, **Guoxiu Wang***, and Jun Wang*, "Toward Industrial Electrosynthesis of Ethylene: Energy-Efficient and Stable Acetylene Semi-Hydrogenation on a Copper Phosphide/MXene Electrocatalyst", **Angewandte Chemie International Edition**, e18909, 2026. (***Very Important Paper***) IF =17. DOI: 10.1002/anie. 202518909.

ABSTRACT: Electrocatalytic semi-hydrogenation of acetylene to ethylene (EHAE) using renewable electricity represents a promising alternative approach for ethylene production. However, its relatively low energy efficiency (EE) and insufficient electrocatalyst stability hinder its industrial applications. The conduct a techno-economic analysis indicates that the EHAE process becomes profitable when the EE exceeds 22.8% at an industrial current density of 0.2 A cm^{-2}. Herein, we report a novel electrocatalyst featuring firmly immobilized copper phosphide (Cu_3P) nanoparticles on MXene nanosheets (Ti_3C_2/Cu_3P) for a stable EHAE process at industrial currents using membrane electrode assembly (MEA) system. Specifically, the Ti_3C_2/Cu_3P electrocatalyst achieves an EE of 23.0% at 0.2 A cm^{-2}, demonstrating its potential for practical application and economic viability. The strong interactions between Cu_3P and Ti_3C_2 MXene prevent the agglomeration and dissolution of Cu_3P nanoparticles during long-term EHAE process. Notably, in a 4 cm^2 MEA, Ti_3C_2/Cu_3P catalysts can sustain high performance for 100 h at 1.0 A with an ethylene Faradaic efficiency decay of only 0.051% per hour. Quasi in situ electron paramagnetic resonance spectroscopy and theoretical calculations indicate that Ti_3C_2/Cu_3P facilitates water dissociation and synergistically enhances the adsorption of acetylene and active hydrogen (H*), thereby accelerating the kinetics of EHAE process.



14. Yufei Zhao, Jinhu Wu, Xianjun Cao, Dongfang Li, Peng Huang*, Hong Gao, Qinfen Gu, Jinqiang Zhang*, **Guoxiu Wang**, Hao Liu*, “High-Entropy Materials for Water Splitting: An Atomic Nanoengineering Approach to Sustainable Hydrogen Production”, **Advanced Materials**, 2025, 2506117. IF=27.4. DOI: 10.1002/adma.202506117.

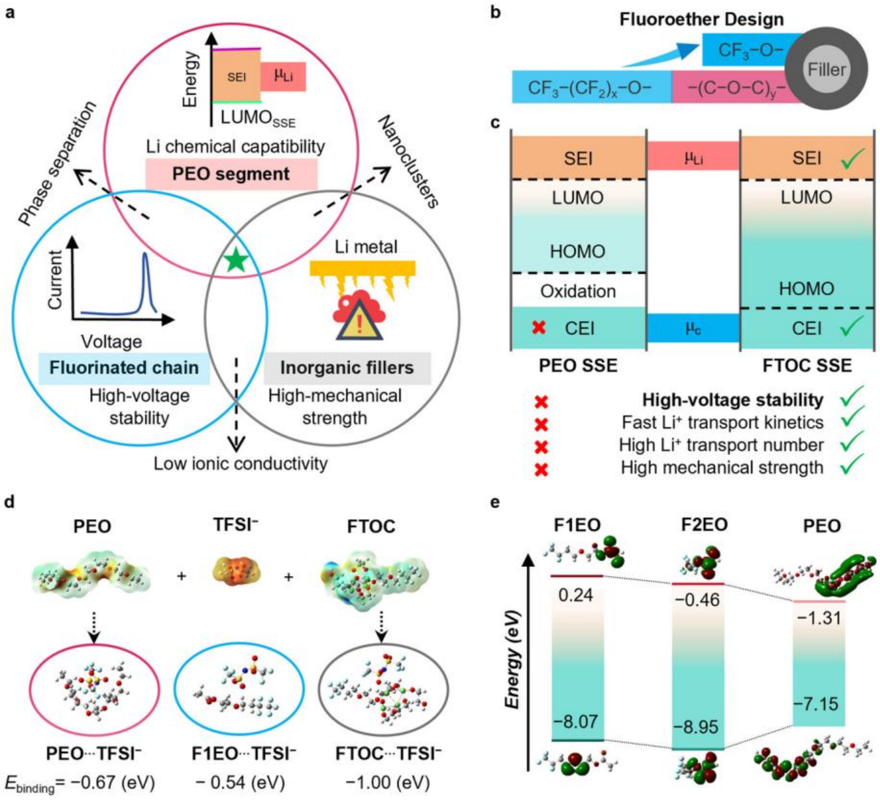
ABSTRACT: Green hydrogen production via water electrolysis is pivotal for achieving energy sustainability. However, the inherently sluggish kinetics of the hydrogen evolution reaction and oxygen evolution reaction impede the progress of water-splitting technology. Recently, high-entropy materials (HEMs) composed of at least five elements have garnered significant attention as promising electrocatalysts for water splitting, owing to their compositional versatility, structural robustness, and synergistic interactions among elements. This review comprehensively explores the development of HEMs, tracing their emergence and structural evolution via atomic nanoengineering strategies (i.e., from bulk to nanostructuring, from random distributions to relatively ordered architectures, from bare HEMs to reconstructed HEMs, from intact HEMs to defective structures, from pristine HEMs to functionalized variants) and revealing how these evolutionary steps contribute to the properties and enhance catalytic performance in water splitting. The fundamental roles of individual elements (e.g., active sites, promoters, stabilizers) in shaping the structure, stability, and catalytic activity of HEMs are examined, laying a foundation for the rational design of efficient HEM-based electrocatalysts. The review also highlights recent advances in HEM-based catalysts for water splitting, emphasizing desirable properties and elemental contributions. Finally, the remaining challenges and perspectives on the future directions of HEM-based materials in energy conversion technologies are discussed.



https://advanced.onlinelibrary.wiley.com/doi/10.1002/adma.202506117

15. Yong Chen, Xu Yang, Tianyi Wang, Xiao Tang, Dongfang Li, Shijian Wang, Yaojie Lei, Yu Han, Shimou Chen, Michel Armand, Doron Aurbach, **Guoxiu Wang***, "Fluoroether Design Enables High-Voltage All-Solid-State Lithium Metal Batteries", **Advanced Materials**, 2025, 2506020. IF=27.4. DOI: 10.1002/adma.202506020.

ABSTRACT: Developing high-voltage all-solid-state lithium metal batteries (ASSLMBs) holds transformative potential for next-generation energy storage technologies but remains a formidable challenge. Herein, a new prototype design is presented that integrates fluorinated ether segments into the traditional oxide nanocomposite phase, enabling poly(ethylene oxide)-based composite electrolytes with exceptional anti-oxidation durability and enhance overall electrochemical performance. Through a combination of experimental and computational analyses, it is demonstrated that the superior performance is attributed to the formation of reconstructed Li$^+$ solvation with weakly coordinating environments. The proposed formulation exhibits excellent Li-metal compatibility, enabling stable cycling in symmetric Li||Li cells for over 9500 h. The solid-state electrolyte also exhibits outstanding high-voltage stability with LiNi$_{0.8}$Co$_{0.1}$Mn$_{0.1}$O$_2$ cathodes, extending the operational voltage from 4.0 to 4.5 V. Moreover, the LiMn$_{1-x}$Fe$_x$PO$_4$||Li cells have delivered remarkable cycling performance, achieving over 1200 cycles with 99% capacity retention after 500 cycles. This work establishes an innovative platform for designing electrolytes with superior antioxidation properties and enhance structural durability, paving the way for the advancement of high-voltage all-solid-state lithium metal batteries.



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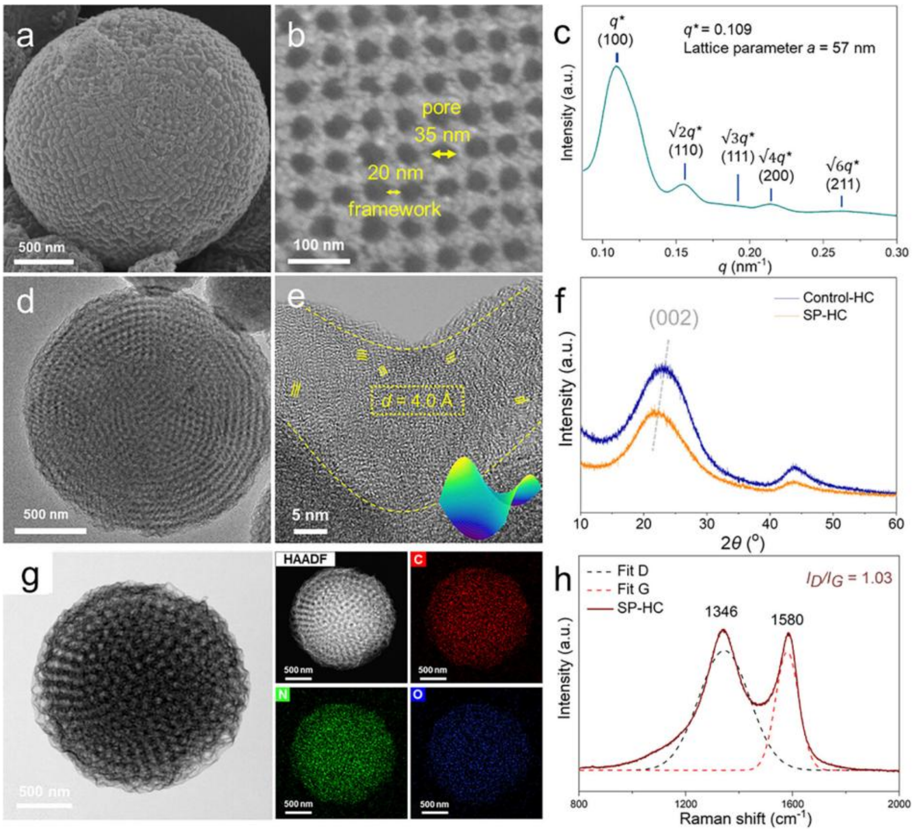
16. Chen Tang, Wenwei Zhang, Yixiao Zhang, Qinyou An, Fugui Xu, **Guoxiu Wang***, Yiyong Mai, “Bicontinuous Structure Mediated Microstructural Engineering of Hard Carbon for Enhanced Sodium Storage”, **Advanced Materials**, 2025, e11632. IF=27.4. DOI: 10.1002/adma.202511632.

ABSTRACT: Sodium-ion batteries (SIBs) are a promising energy storage technology due to the abundance and low cost of sodium resources. However, their practical application is hindered by challenges, including high irreversible capacity loss during initial cycles, poor rate performance, and structural instability. Here, a bicontinuous mesoporous hard carbon with a single primitive (SP) microstructure (coined SP–HC) is introduced that addresses these limitations through microstructural engineering. This SP–HC design increases the density and accessibility of Na^+ storage sites, enhances carbon disorder, and expands interlayer spacing, leading to improved sodium storage capacity and kinetics. The 3D continuous meso-channels enable rapid Na^+ transport, achieving an exceptional rate performance of 172 mAh g^{-1} at 10 A g^{-1} (full charge in 1 min). Remarkably, the SP-HC anode exhibits unprecedented cycle stability, retaining a high capacity of 80 mAh g^{-1} even after 100 000 cycles at a high current density of 10 A g^{-1}, which represents the best cycle stability reported for hard carbon-based anodes of SIBs. This study provides an insight into the critical role of microstructural engineering in optimizing electrochemical storage of hard carbon anodes for SIBs.



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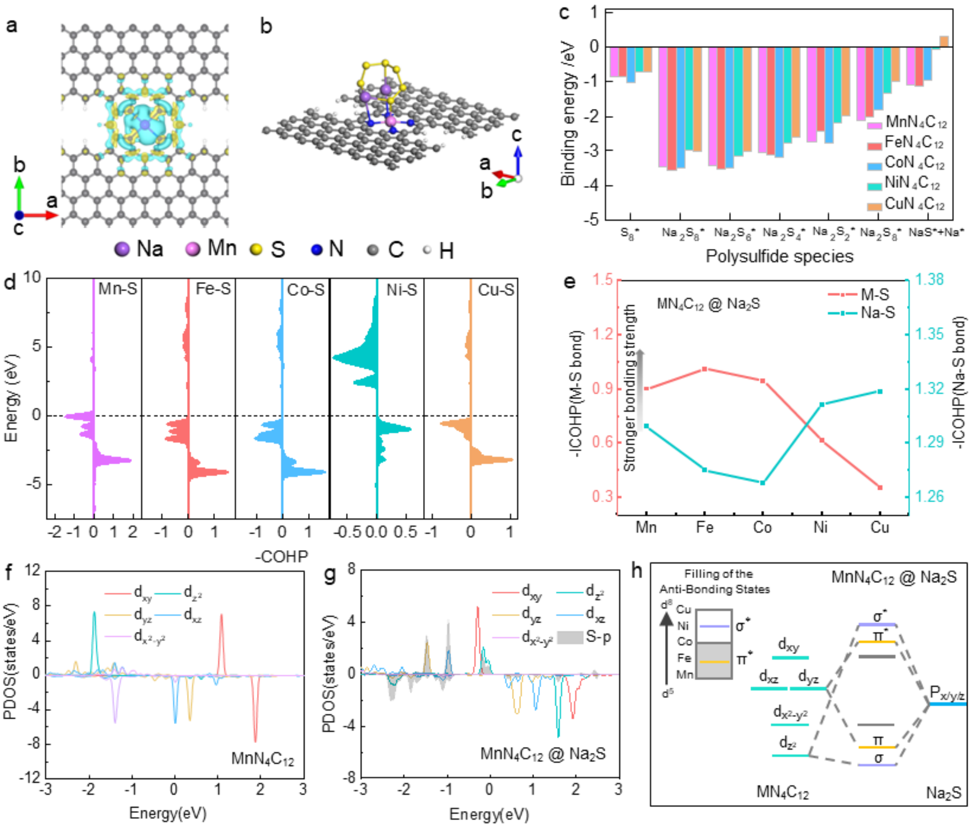
17. Hao Tian†, Yaojie Lei†, Bing Sun†, Cheng-Chieh Yang, Chi-Liang Chen, Tao Huang, Xiaoyue Zhang, Yong Chen, Ailing Song, Le Pang, Hongxia Wang, Chung-Li Dong, Sean C Smith, Wei-Hong Lai, Yun-Xiao Wang*, Xin Tan*, Hao Liu, **Guoxiu Wang***, "P-d orbital hybridization induced by transition metal atom sites for room-temperature sodium-sulfur batteries", **National Science Review**, 2025, nwaf241. IF= 16.3. DOI: 10.1093/nsr/nwaf241.

ABSTRACT: For energy storage applications involving sulfur redox reactions, uniformly dispersed metal sites in S hosts serves as an effective approach to facilitate electron transfer during charge and discharge cycles. In this study, we exploited a facile method to construct transitional single-atom catalysts to overcome the kinetic limitations for electron transportation in room-temperature sodium-sulfur (RT Na-S) batteries. By the synergistic effect of polysulfide adsorption and p-d orbital hybridization between catalysts and intermediates, electron-donating and electron-capturing capabilities of different atomic sites towards sulfur redox reactions are systematically revealed. Remarkably, atomic Mn-N4 active moiety structures possess abundant unfilled antibonding orbitals, promoting p-d hybridization and leading to superior S conversion reactions. The work establishes a design paradigm for single-atom catalysts in metal-sulfur batteries by linking atomic-scale electronic features to macroscopic performance. This atomic-level engineering strategy paves the way for high-energy-density RT Na-S batteries, with potential extensions to other multivalent sulfur-based energy storage systems.



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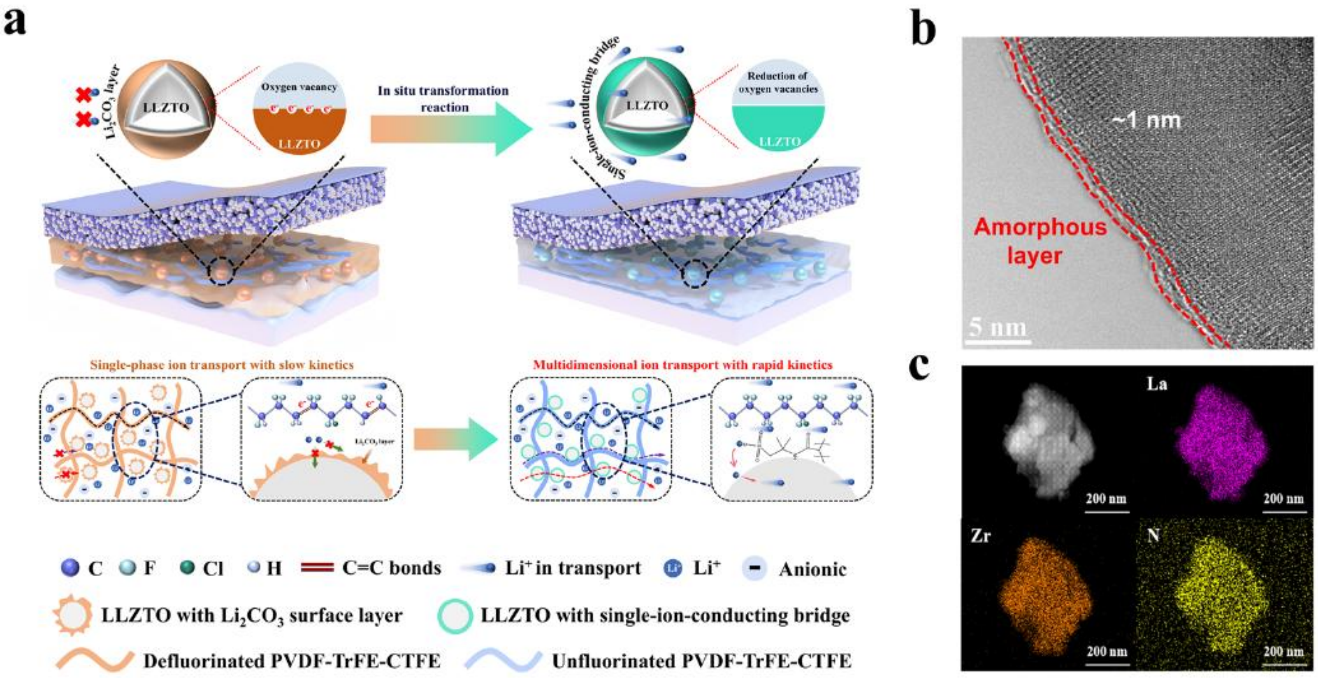
18. Jiajun Gong, Qimin Peng, Shunshun Zhao, Taolue Wen, Haojie Xu, Weiting Ma, Zhicheng Yao, Yong Chen*, **Guoxiu Wang***, and Shimou Chen*, "Built-in single-ion-conducting polymer bridges for superior ion transport enabling long-life and high-voltage lithium–metal batteries", **Energy & Environmental Science**, 18, 5511-5523, 2025. IF=32.4. DOI: 10.1039/D5EE01338K.

ABSTRACT: Composite polymer electrolyte (CPE)-based Li metal batteries have emerged as the most promising candidates for next-generation batteries. However, intrinsic incompatibility between composite phases severely compromises electrolyte performance. Herein, we propose a built-in single-ion-conductor bridge that seamlessly links the garnet-type oxide phase with PVDF-based polymer matrixes, enabling excellent composite compatibility and superior Li^+ fluxes throughout the bulk electrolyte. The 2-acrylamido-2-methylpropanesulfonic acid molecule is chosen to *in situ* convert the inert surface layer of garnet fast-ion conductors into a molecular single-ion-conducting layer with rapid ionic transport, effectively bridging ion transport among multiple components. The resulting CPE exhibits remarkable long-cycling stability under extreme conditions (*e.g.*, high voltage of 4.5 V, high loading of 10.2 mg cm^{-2}, and low temperature of −30 °C). Specifically, the assembled Li‖$LiNi_{0.9}Co_{0.05}Mn_{0.05}O_2$ pouch cells delivered a stable cycling for 1200 cycles at 0.5C. Moreover, the strategy is readily applicable to sodium metal batteries, achieving decay-free performance over 2200 cycles. Thus, it offers a promising approach for fabricating high-performance solid-state batteries.



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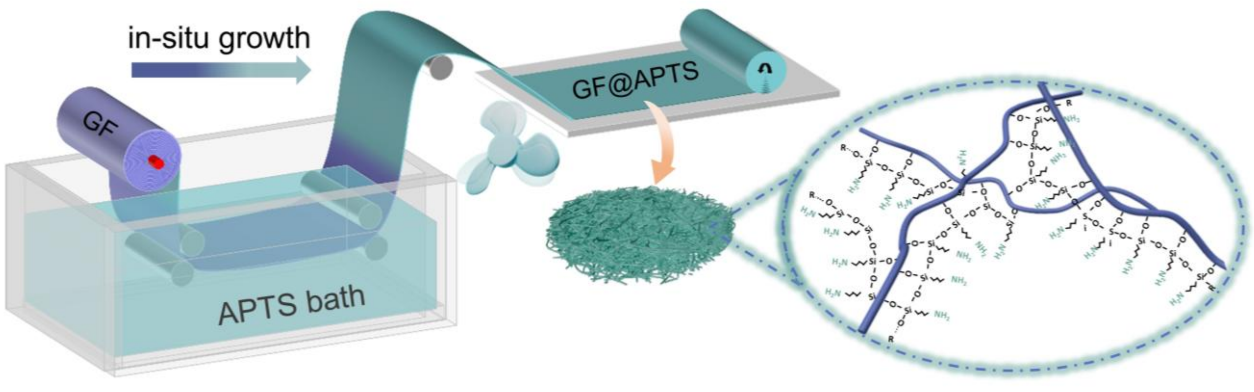
19. Mengcheng Huang‡, Yaojie Lei‡, Yajun Hu, Wei-Hong Lai, Yun-Xiao Wang, Chunyu Liu, Shengli Zhai* and **Guoxiu Wang***, “Interfacial Ionic and Thermal Regulation for Highly Reversible and Ultra-Reliable Zinc-Ion Batteries”, **Energy & Environmental Science**, 2025. IF=32.4. DOI:10.1039/D5EE01635E

ABSTRACT: Prevalent glass fiber separators in aqueous Zn-ion batteries (ZIBs) offer inadequate control over interfacial reactions, contributing to the rapid growth of Zn dendrites and aggravated parasitic reactions. Moreover, the stability of ZIBs under extreme operating conditions remains a critical yet often overlooked issue. Here, we present a novel silane-decorated glass fiber separator with engineered physical structures and surface chemistry, facilitating highly reversible and ultra-reliable ZIBs. Silane strengthens the separator, resists stress, and forms heat-insulating char layers under flame, ensuring reliability in extreme conditions. Silane networks also function as fillers that enhance pore uniformity for even Zn^{2+} flux. The amino groups in silane demonstrate comprehensive management of interfacial anions, cations, water transfer and reaction kinetics. This capability induces Zn^{2+} to concentrate at the interface, accelerates Zn^{2+} transfer, reduces deposition barriers, and obstructs water molecules and sulfate ions from participating in parasitic reactions. Consequently, dendrite-free Zn plating/stripping is achieved with 99.4% Coulombic efficiency over 250 cycles, stable charge/discharge performance for 7000 hours, and remarkable cycling stability and flame resistance for Zn//V full batteries. This strategy demonstrates versatility across various separator materials and battery chemistry, offering a promising route to more reliable and higher-performing energy storage systems.



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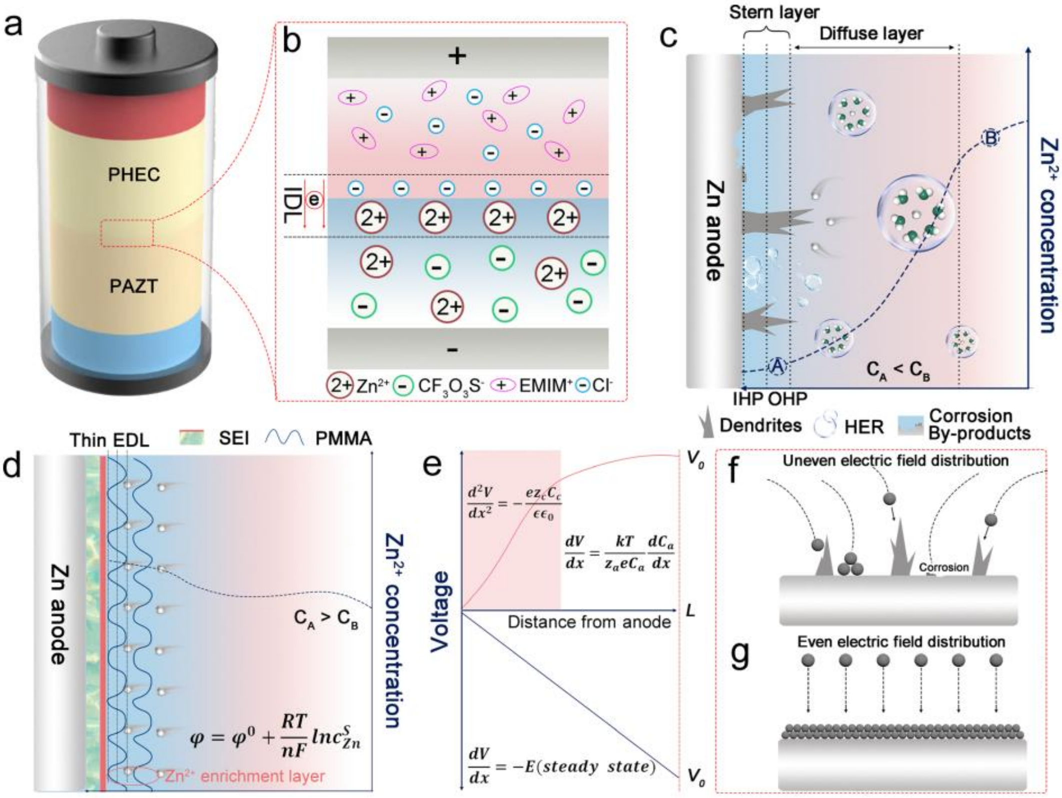
20. Shunshun Zhao, Sinian Yang, Xuanrui Huang, Xinwei Wang, Haojie Xu, Qing Ma, Yong Chen, **Guoxiu Wang***, Shimou Chen, “A Janus-type quasi-solid-state electrolyte enabling dual-ion relay for long lifespan of nonaqueous zinc batteries”, **Energy & Environmental Science**, 18 (18), 8618-8630, 2025. IF=30.8. DOI: 10.1039/D5EE03224E

ABSTRACT: Quasi-solid-state or solid-state electrolytes are promising to address the long-standing challenges in zinc batteries, such as zinc dendrite formation and inevitable side reactions. Herein, we report an anhydrous Janus quasi-solid-state electrolyte that enables superior long-cycle performance of zinc batteries *via* a dual-ion relay mechanism. The spontaneously formed built-in electric field between PVDF-HFP and PMMA polymer layers induces an ionic double layer (IDL), which effectively addresses the inherent limitations in ionic transport kinetics within solid-state anhydrous systems operating under low-salt-concentration conditions. Benefiting from the electrolyte-constructed IDL and the derived organic outer–inorganic inner gradient SEI, effective ion rectification and transport have been achieved. Thus, Zn||Zn symmetric cells exhibited highly reversible zinc plating/stripping without dendrite growth, achieving cycle lifetimes exceeding 13 300 h at 25 °C and 3000 h at 60 °C. A full battery with a polyaniline cathode demonstrated exceptional stability (>10 000 cycles) and reliable operation from 25 °C to 80 °C. This innovative strategy significantly advances solid-state electrolyte design for zinc batteries and establishes a new paradigm for high-performance, safe, and durable energy storage systems.



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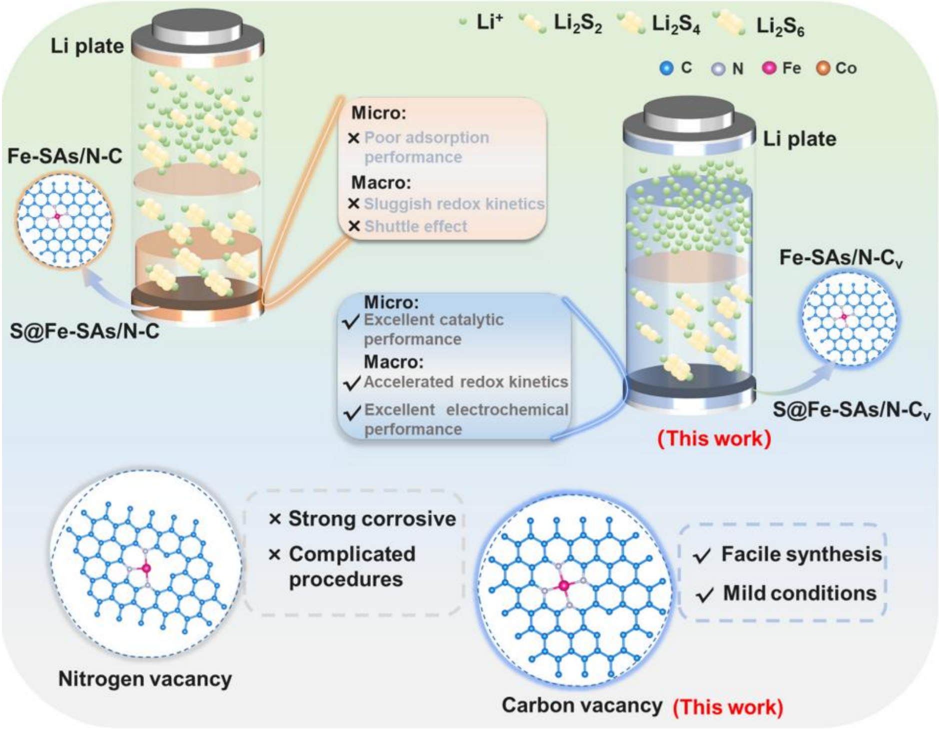
21. Jie Zhang, Dawei Yang, Canhuang Li, Qianhong Gong, Wei Bi, Wei-Hong Lai, Shengjun Li, Yaojie Lei, Guangmin Zhou, Andreu Cabot and **Guoxiu Wang***, “Promoting sulfur redox kinetics of atomically dispersed Fe-NC electrocatalysts by carbon vacancies toward robust lithium-sulfur batteries”, **Energy & Environmental Science**, 18 (16), 7905-7915, 2025. IF=30.8. DOI: 10.1039/D5EE00262A

ABSTRACT: Single-atom catalysts (SACs) have become the key to overcoming the inherent limitations of lithium–sulfur (Li–S) batteries due to their exceptional catalytic activity, high selectivity, and strong affinity towards lithium polysulfides (LiPSs). The effectiveness of SACs is influenced by complex electronic structures. Accordingly, precise tuning of these surroundings is crucial to fully utilize SACs. In this work, we demonstrated that the performances of SACs in LiPS redox reactions can be optimized by vacancy engineering. This strategy can retain the benefits of SACs as anchoring and electrocatalytic centers for LiPSs, while optimizing their electronic structures to promote rapid charge transfer and enhance the conversion efficiency of LiPSs. Specifically, iron-based SACs supported on nitrogen-doped carbon containing abundant carbon vacancies (Fe-SAs/N–C_v) were tested as a sulfur host in Li–S batteries. Density functional theory calculations indicate that Fe-SAs/N–C_v effectively anchors LiPSs and reduces the decomposition energy barrier of Li_2S. Thermodynamic analyses further elucidate that Fe-SAs/N–C_v can accelerate LiPS redox reactions. As a result, Fe-SAs/N–C_v hosts exhibit excellent rate performance and superior cycling stability. Furthermore, we demonstrated that Fe-SAs/N–C_v can be applied in Li–S pouch cells to achieve stable cyclability. This work showcases that the vacancy engineering strategy is effective to fine-tune the performance of SACs in Li–S batteries.



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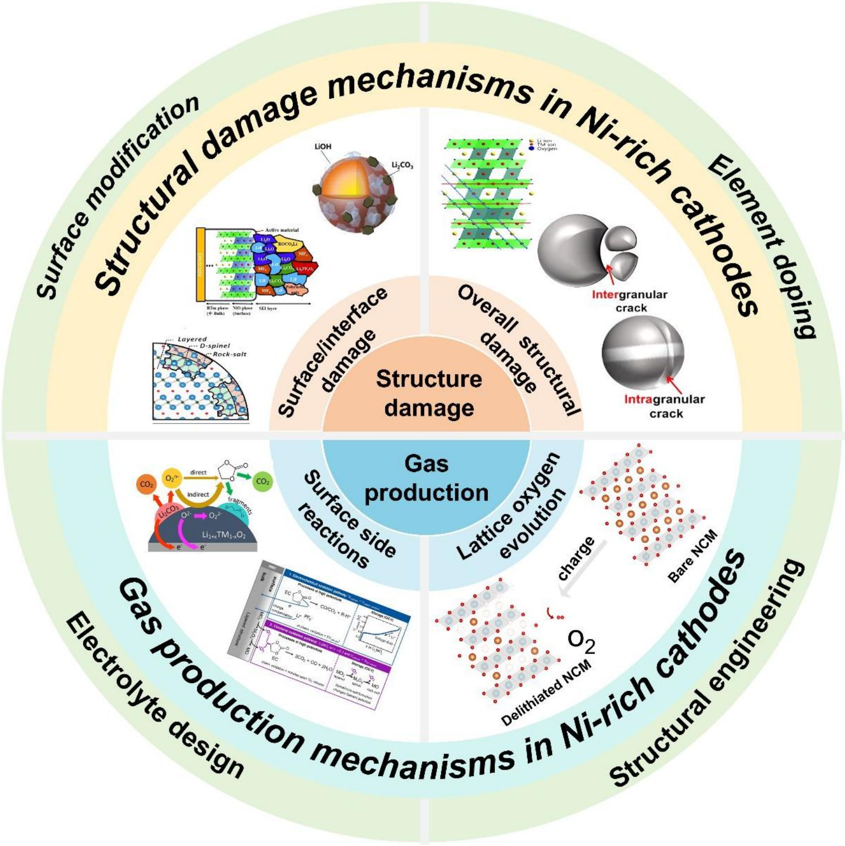
22. Ziqi Liu, Yiming Zhang, Shanshan Pan, Yong Chen, Keer Yang, Shanxi Wu, Musong Liu, Lei Hu, Shuaicheng Jiang, Xiaopeng Wang, **Guoxiu Wang*** and Meng Yao, “Addressing the fundamental issues in Ni-rich cathodes: degradation mechanisms and mitigation strategies”, **Energy & Environmental Science**, 19, 84-125, 2026. IF=30.8. DOI: 10.1039/D5EE04213E

ABSTRACT: The rapid growth of electric vehicles (EVs) is driving an urgent demand for lithium-ion batteries (LIBs) with higher specific energy, longer life, and uncompromised safety. Ni-rich layered oxides ($LiNi_xCo_yMn_{(1-x-y)}O_2$, $x \geqslant 0.8$) have emerged as leading cathode materials for next-generation LIBs, owing to their high capacity and energy density. Further increasing Ni content is essential for improved performance and cost reduction. However, it also introduces new obstacles, necessitating thoughtful design of cathode composition, morphology, and microstructure, as well as the development of electrolyte formulations. In this review, we discuss the multiple failure mechanisms of Ni-rich cathodes in terms of two major aspects: structural degradation and gas release. We elucidate the key factors contributing to chemical, crystallographic, and microstructural degradation in Ni-rich cathodes, and summarize the various origins of gas evolution associated with these materials. Another key theme of this review is the modification of Ni-rich cathodes to address the practical hurdles that limit their use in long-range and high-safety EVs. Accordingly, we present a comprehensive overview of the latest Ni-rich cathode modification strategies for next-generation EV platforms.



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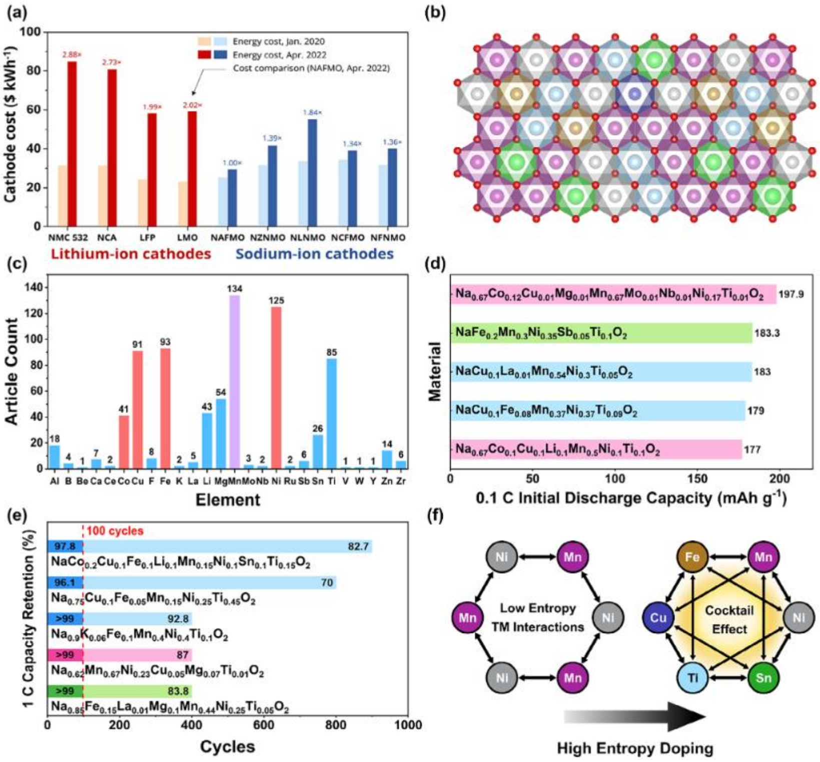
23. Eugene Bakker, Lingfei Zhao, Karim Khan, Asif Mahmood, **Guoxiu Wang***, “Comprehensive Guide for the Rational Design of High-Entropy Layered Transition Metal Oxide Cathodes for Sodium-Ion Batteries”, **Advanced Energy Materials**, e04677, 2025. IF=24.4. DOI: 10.1002/aenm.202504677.

ABSTRACT: Sodium-ion batteries (SIBs) have emerged as a cost-effective alternative to lithium-ion batteries due to the natural abundance and wide geographic distribution of sodium resources, which mitigate concerns over the scarcity and price volatility of lithium. However, the larger ionic radius of Na^+ (1.02 Å) compared to Li^+ (0.76 Å) produces inferior diffusion kinetics and structural stability. Therefore, layered transitional metal oxide cathode materials have extensively utilized high entropy doping to suppress undesirable phase transitions, improve kinetic performance, and enhance cationic and oxygen redox reversibility. Although the compositional tunability of high entropy doping offers considerable potential, it also introduces significant structural and chemical complexity. This necessitates the precise selection and optimization of dopant elements to target specific limitations observed in conventional low entropy systems. Accordingly, this review comprehensively evaluates the impact of dopant strategies and configurational entropy on the performance of compositionally proximate high entropy materials. It offers a systematic guide for rationally tailoring high entropy techniques to overcome interconnected performance-limiting obstacles across diverse undoped systems. The review clarifies the definitional controversy surrounding the term “high entropy” and elucidates the theoretical limitations that hinder the accurate prediction of high entropy materials before concluding with an outline of prospective research directions.



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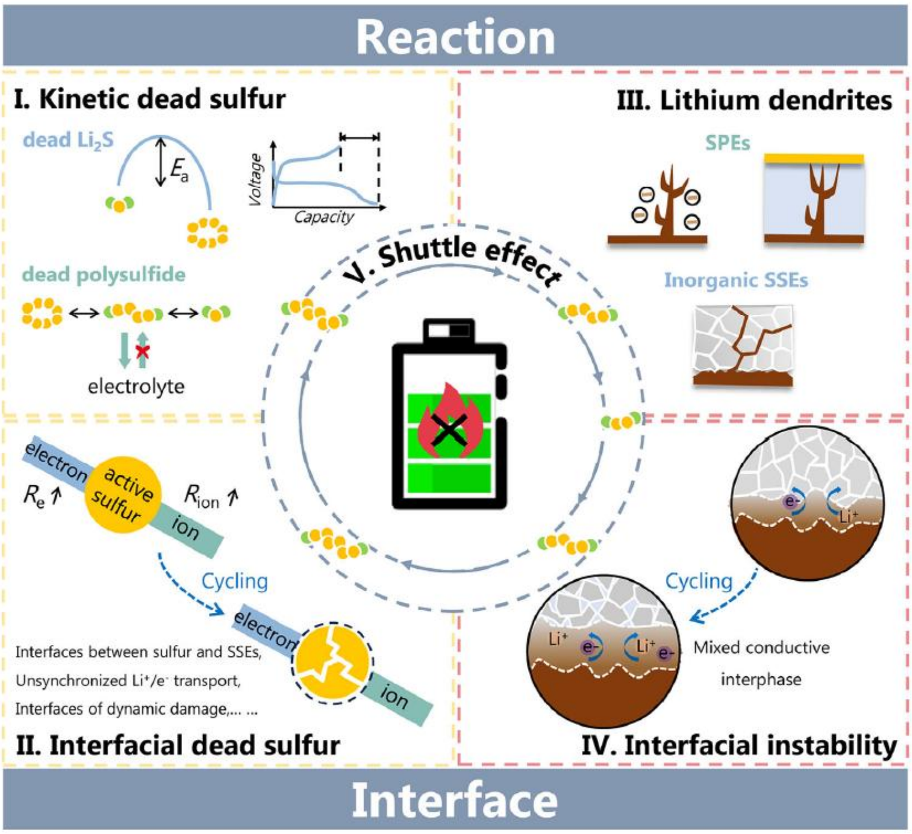
24. Ru Xiao, Zhuoyan Qu, Junxing Ren, **Guoxiu Wang***, Zhenhua Sun, Feng Li, “Current Status and Future Prospects of Solid-State Lithium–Sulfur Batteries: A Focus on Reaction and Interface Engineering”, **Advanced Energy Materials**, 2501926, 2025. IF=24.4. DOI: 10.1002/aenm.202501926.

ABSTRACT: The burgeoning development of solid-state electrolytes significantly improves the safty and practicality of solid-state lithium–sulfur batteries (LSBs). Based on mature solid-state electrolytes, challenges in electrochemical performance remain, largely due to complex reactions and interfacial issues on both sulfur and lithium sides. This review comprehensively examines the fundamental challenges and recent progress from the perspectives of reaction and interface. From a reaction standpoint, it discusses the trade-off between shuttle effect and redox kinetics, as well as the irreversible accumulation of kinetically dead sulfur across different electrolytes, which were often overlooked. Regarding interfaces, it discusses the formation of interfacial dead sulfur within the cathode and strategies to enhance the across-interface transport of charge carriers. It also analyzes mechanisms underlying lithium dendrite formation and interface failure, along with current solutions to mitigate dead lithium and extend lithium anode lifespan. In pursuit of meeting commercial demands for solid-state LSBs, engineering parameters targeting high energy density are specified by formulations, and differences in parameter design principles among different electrolyte systems are systematically analyzed. Finally, to bridge fundamental insights with practical applications, future research directions are proposed, emphasizing reaction and interface engineering for high-performance solid-state LSBs.



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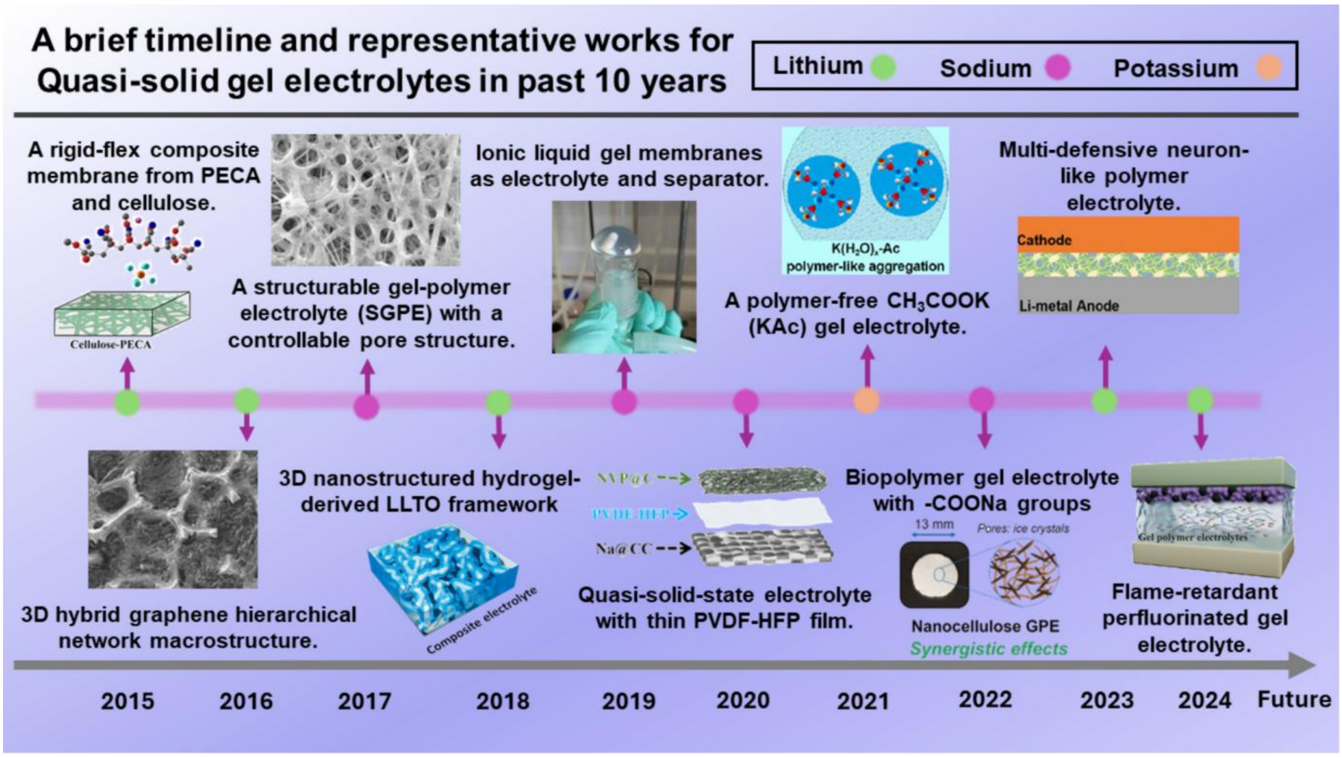
25. Jiahui Lu, Yingying Chen, Yaojie Lei, Pauline Jaumaux, Hao Tian*, **Guoxiu Wang***, "Quasi-solid Gel Electrolytes for Alkali Metal Battery Applications", **Nano-Micro Lett.** 17, 194, 2025. IF=31.6. DOI: 10.1007/s40820-024-01632-w.

ABSTRACT: Alkali metal batteries (AMBs) have undergone substantial development in portable devices due to their high energy density and durable cycle performance. However, with the rising demand for smart wearable electronic devices, a growing focus on safety and durability becomes increasingly apparent. An effective strategy to address these increased requirements involves employing the quasi-solid gel electrolytes (QSGEs). This review focuses on the application of QSGEs in AMBs, emphasizing four types of gel electrolytes and their influence on battery performance and stability. First, self-healing gels are discussed to prolong battery life and enhance safety through self-repair mechanisms. Then, flexible gels are explored for their mechanical flexibility, making them suitable for wearable devices and flexible electronics. In addition, biomimetic gels inspired by natural designs are introduced for high-performance AMBs. Furthermore, biomass materials gels are presented, derived from natural biomaterials, offering environmental friendliness and biocompatibility. Finally, the perspectives and challenges for future developments are discussed in terms of enhancing the ionic conductivity, mechanical strength, and environmental stability of novel gel materials. The review underscores the significant contributions of these QSGEs in enhancing AMBs performance, including increased lifespan, safety, and adaptability, providing new insights and directions for future research and applications in the field.



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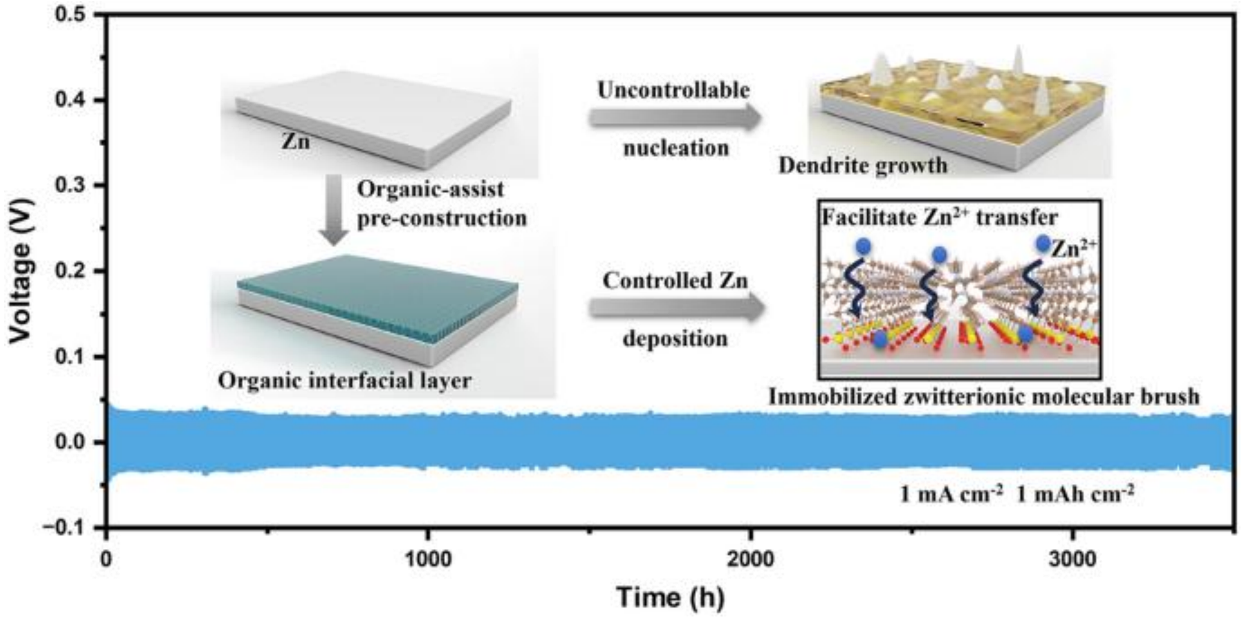
26. Limeng Sun, Xianjun Cao, Li Gao, Jiayi Li, Chen Qian, Jinhu Wu, Xinming Nie*, Hong Gao, Peng Huang*, Yufei Zhao*****, Yong Wang, Jinqiang Zhang*, **Guoxiu Wang**, Hao Liu*, “Immobilizing Zwitterionic Molecular Brush in Functional Organic Interfacial Layers for Ultra-Stable Zn-Ion Batteries”, **Nano-Micro Letters**, 17, 262, 2025. IF=31.6. DOI: 10.1007/s40820-025-01782-5.

    ABSTRACT: Rechargeable zinc-ion batteries have emerged as one of the most promising candidates for large-scale energy storage applications due to their high safety and low cost. However, the use of Zn metal in batteries suffers from many severe issues, including dendrite growth and parasitic reactions, which often lead to short cycle lives. Herein, we propose the construction of functional organic interfacial layers (OIL) on the Zn metal anodes to address these challenges. Through a well-designed organic-assist pre-construction process, a densely packed artificial layer featuring the immobilized zwitterionic molecular brush can be constructed, which can not only efficiently facilitate the smooth Zn plating and stripping, but also introduce a stable environment for battery reactions. Through density functional theory calculations and experimental characterizations, we verify that the immobilized organic propane sulfonate on Zn anodes can significantly lower the energy barrier and increase the kinetics of Zn^{2+} transport. Thus, the Zn metal anode with the functional OIL can significantly improve the cycle life of the symmetric cell to over 3500 h stable operation. When paired with the $H_2V_3O_8$ cathode, the aqueous Zn-ion full cells can be continuously cycled over 7000 cycles, marking an important milestone for Zn anode development for potential industrial applications.



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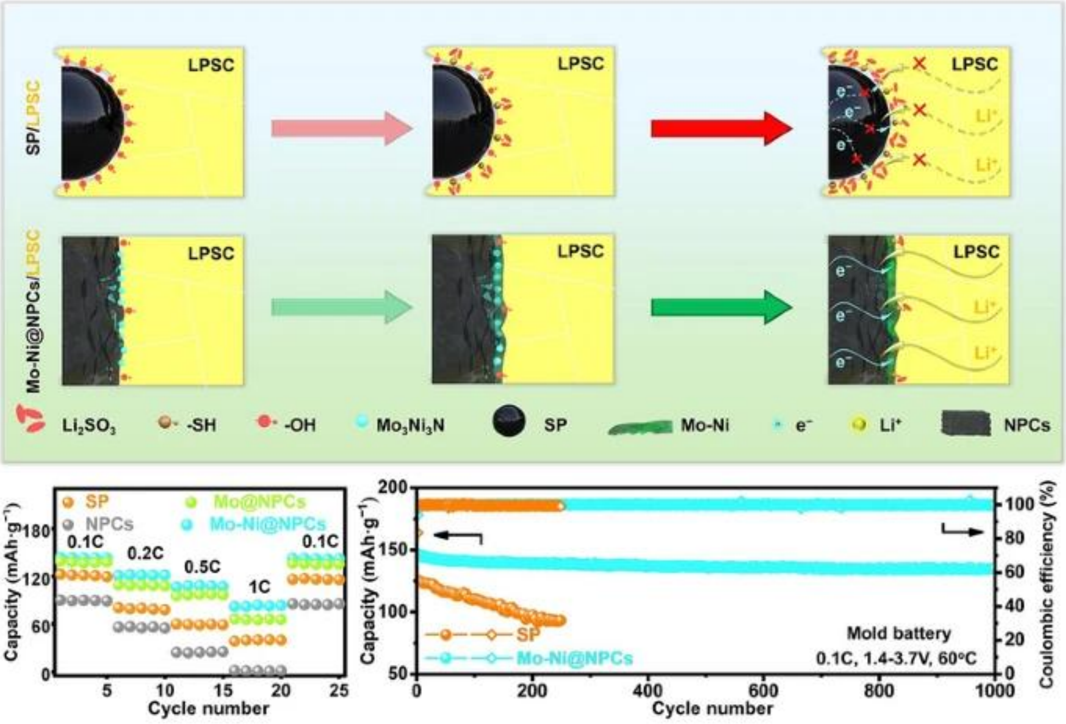
27. Xin Gao, Ya Chen, Zheng Zhen, Lifeng Cui, Ling Huang, Xiao Chen, Jiayi Chen, Xiaodong Chen, Duu-Jong Lee, **Guoxiu Wang***, “Construction of Multifunctional Conductive Carbon-Based Cathode Additives for Boosting Li_6PS_5Cl-Based All-Solid-State Lithium Batteries”, **Nano-Micro Letters**, 17, 140, 2025. IF=31.6. DOI: 10.1007/s40820-025-01667-7.

ABSTRACT: The electrochemical performance of all-solid-state lithium batteries (ASSLBs) can be prominently enhanced by minimizing the detrimental degradation of solid electrolytes through their undesirable side reactions with the conductive carbon additives (CCAs) inside the composite cathodes. Herein, the well-defined Mo3Ni3N nanosheets embedded onto the N-doped porous carbons (NPCs) substrate are successfully synthesized (Mo-Ni@NPCs) as CCAs inside $LiCoO_2$ for Li_6PSC_5Cl (LPSCl)-based ASSLBs. This nano-composite not only makes it difficult for hydroxide groups (–OH) to survive on the surface but also allows the in situ surface reconstruction to generate the ultra-stable MoS2-Mo3Ni3N heterostructures after the initial cycling stage. These can effectively prevent the occurrence of OH-induced LPSC decomposition reaction from producing harmful insulating sulfates, as well as simultaneously constructing the highly-efficient electrons/ions dual-migration pathways at the cathode interfaces to facilitate the improvement of both electrons and Li^+ ions conductivities in ASSLBs. With this approach, fine-tuned Mo-Ni@NPCs can deliver extremely outstanding performance, including an ultra-high first discharge-specific capacity of 148.61 mAh g^{-1} (0.1C), a high Coulombic efficiency (94.01%), and a capacity retention rate after 1000 cycles still attain as high as 90.62%. This work provides a brand-new approach of “conversion-protection” strategy to overcome the drawbacks of composite cathodes interfaces instability and further promotes the commercialization of ASSLBs.



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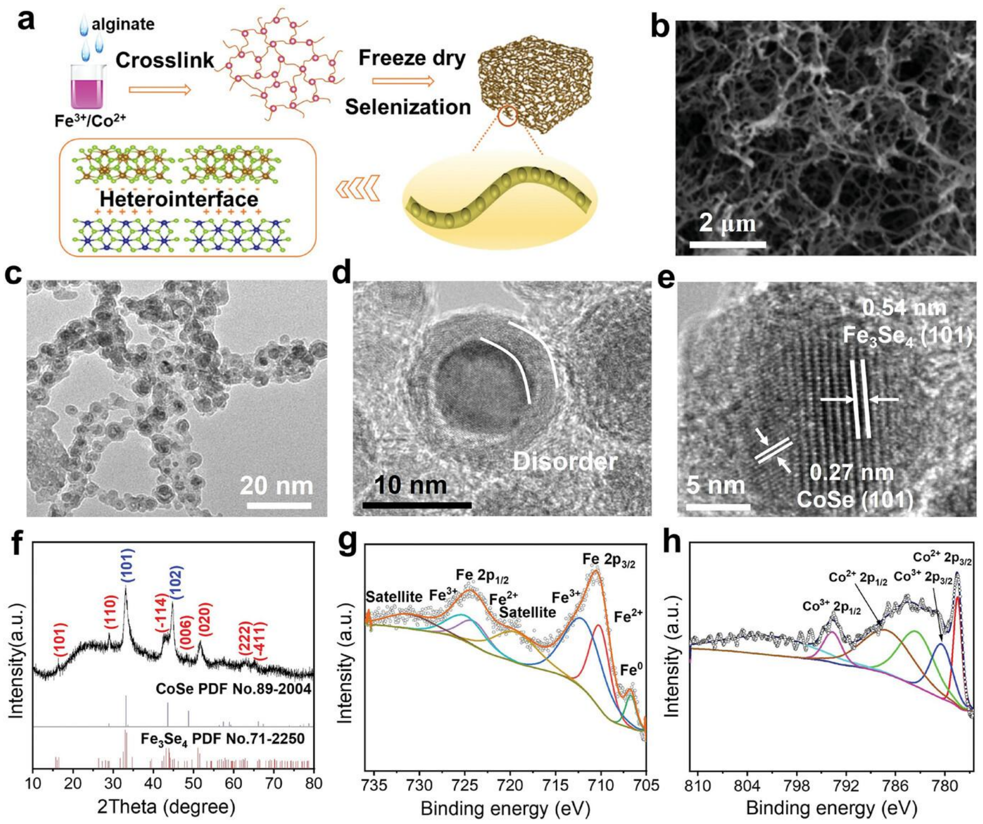
28. Chunrong Ma, Xiao Tang, Haoxi Ben, Wei Jiang, Xinyu Shao, **Guoxiu Wang***, Bing Sun, “Promoting Reaction Kinetics and Boosting Sodium Storage Capability via Constructing Stable Heterostructures for Sodium-Ion Batteries”, **Advanced Functional Materials**, 35, 2412879, 2025. IF=18.5. DOI: 10.1002/adfm.202412879

ABSTRACT: Constructing heterostructures containing multiple active components is proven to be an efficient strategy for enhancing the sodium storage capability of anode materials in sodium-ion batteries (SIBs). However, performance enhancement is often attributed to the unclear synergistic effects among the active components. A comprehensive understanding of the reaction mechanisms on the interfaces at the atomic level remains elusive. Herein, the carbon-coated Fe_3Se_4/CoSe (Fe3Se_4/CoSe-C) anode material as a model featuring atomic-scale contact interfaces is synthesized. This unique heterogeneous architecture offers an adjustable electronic structure, which facilitates rapid reaction kinetics and enhances structural integrity. In situ microscopic and ex situ spectral characterization techniques, along with theoretical simulations, confirm that the heterointerface with strong electric fields promotes Na^+ ion migration. Based on solid-state nuclear magnetic resonance (NMR) analysis, an interface charge storage mechanism is revealed, resulting in the enhanced specific capacity of the anode materials. When employed as an anode in SIBs, the Fe3Se4/CoSe-C electrode demonstrates excellent rate capabilities (218 mAh g^{-1} at 7 A g^{-1}) and prolonged cycling stability (258 mAh g^{-1} at 5 A g^{-1} after 1000 cycles). This work highlights the significance of heterointerface engineering in electrode material design for rechargeable batteries.



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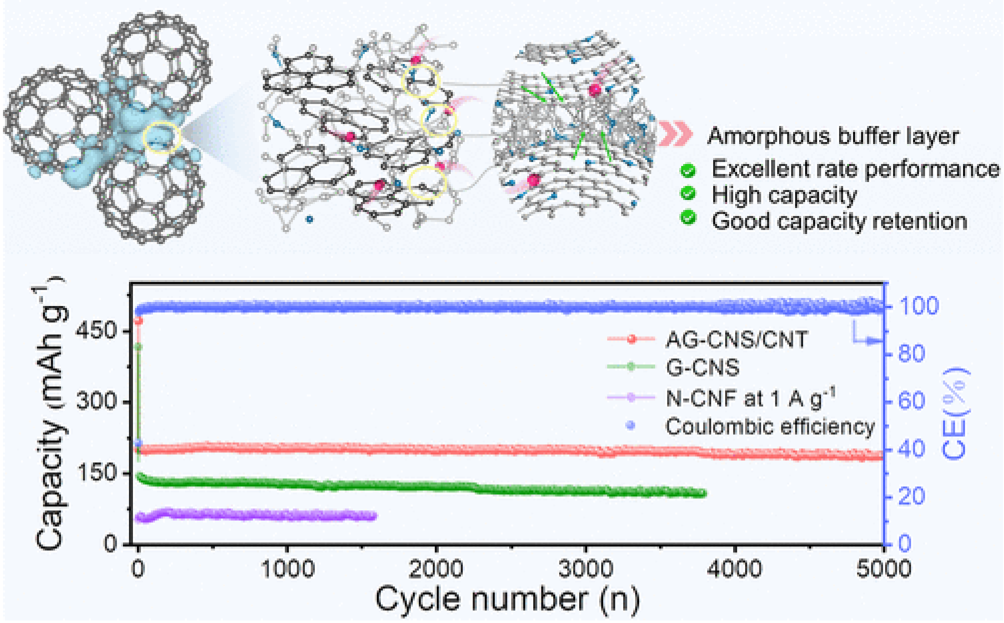
29. Xuan Li, Lijuan Tong, Junxiong Wu, Ziwei Yuan, Xiaoyan Li, So Yeon Kim, Xiaoliang Ye, Xiaochuan Chen, **Guoxiu Wang**, and Yuming Chen*, “Dual Engineering of Electronic and Mechanical Properties via Amorphous/Graphitic Hetero-Contact-Curvature Interfaces for Ultra-Stable K-Ion Storage”, **ACS Nano**, 19, 38641–38653, 2025. IF=16.2. DOI: 10.1021/acsnano.5c13247

ABSTRACT: Despite the demonstrated efficacy of contact curvature interfaces in enhancing the electrochemical performance of graphitic carbon materials for potassium-ion batteries, long-term cycling stability remains a critical challenge due to structural degradation caused by repeated volume expansion/contraction. Herein, we propose a structural design by introducing a 3–5 nm ultrathin amorphous carbon buffer layer at the contact curvature interface of graphitic carbon domains, constructing an amorphous/graphitic carbon heterocontact-curvature interface (AG-CI). Through systematic density functional theory calculations, we demonstrate that the AG-CI architecture can significantly enhance the electronic states near the Fermi level, which not only facilitates rapid electron transport but also strengthens reversible K^+ adsorption at the contact curvature interface. Concurrently, the amorphous carbon buffer layer serves as a mechanical stabilizer, effectively accommodating volume variation during charge–discharge processes, alleviating structural stress, and enabling cycling performance. This synergistic optimization of electronic conductivity and mechanical robustness leads to exceptional electrochemical performance, including rate performance (154.9 mAh g^{-1} at 4 A g^{-1}) and cycling durability (nearly 100% capacity retention per cycle). Our dual engineering strategy, which simultaneously addresses electronic and mechanical challenges, provides a versatile platform for the development of high-performance carbon-based anodes in next-generation batteries.



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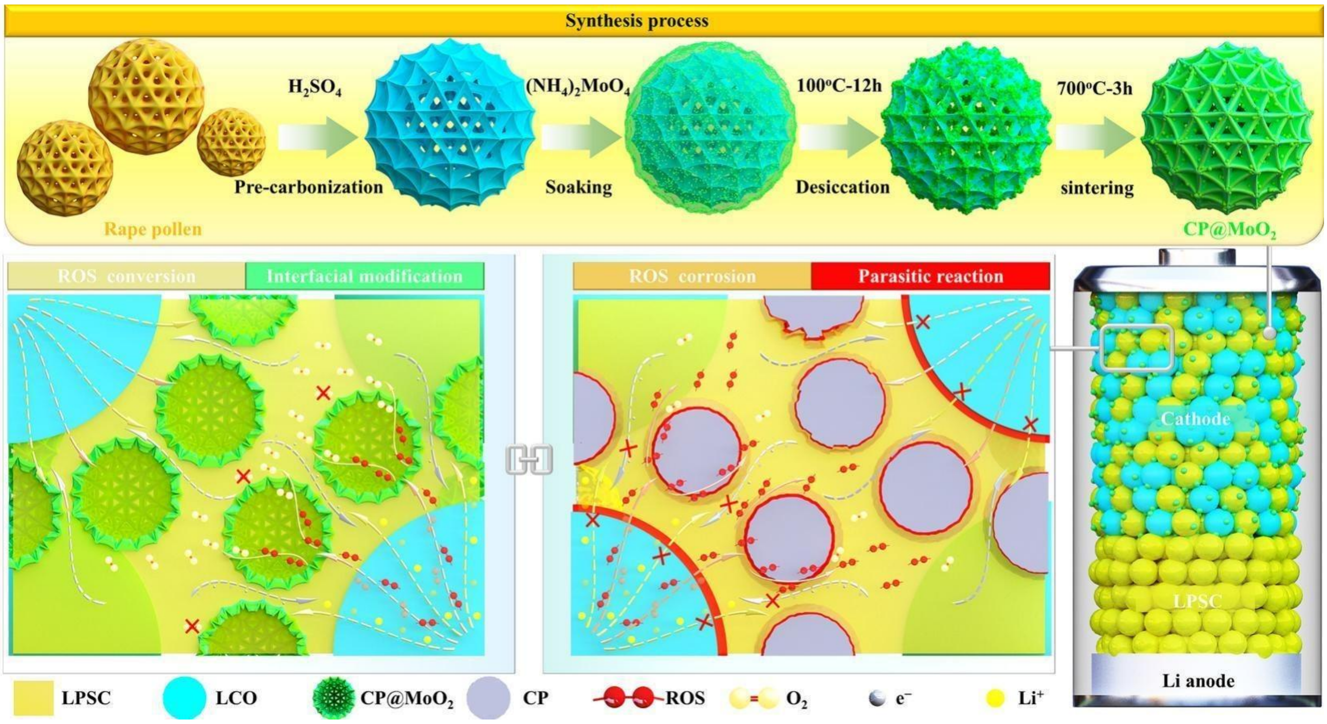
30. Ya Chen, Zhifeng Xia, Ling Huang, Lifeng Cui, Xin Gao, Meixuan Niu, Xiao Chen, Deli Zhou, Ziyang Guo, Tengfei Hu, Xiaodong Chen, Ortal Breuer, Miryam Fayena-Greenstein, Duu-Jong Lee, Doron Aurbach, **Guoxiu Wang***, “Engineering multifunctional conductive carbon-based cathode additives to stabilize high-performance all-solid-state lithium metal batteries”, **Materials Today**, 88, 368-381, 2025. IF=22.3. DOI: 10.1016/j.mattod.2025.07.007

ABSTRACT: Exceptional electrochemical performances of all-solid-state lithium metal batteries (ASSLMBs) can be achieved by effectively inhibiting damaging of reactive oxygen species (ROSs) formed by oxidation of the inevitably present surface groups on the carbon-based conductive agents (CCAs) and upon charging transition metal oxide based cathodes. Herein, we report on the use of highly effective novel CCA additive based on biomass-derived carbonaceous nanomaterials produced from carbonized pollen uniformly coated by nano MoO_2 through a bio-templating method ($CP@MoO_2$) in composite high energy cathodes of ASSLMBs. The rational design of this porous nano-composite additive not only makes it difficult for oxygen-containing functional groups to survive on the surface, but also promotes electrocatalytic adsorption and transformation of ROSs within composite cathodes, thus avoiding their detrimental effects. And rapid and homogeneous conductions of Li^+/e^- within the composite cathodes are ensured thanks to the use of the $CP@MoO_2$ additive. As a result, ASSLMBs employing typical $LiCoO_2$ and promising Li-rich Mn-based oxide cathodes could demonstrate excellent cycling stability retaining 99.9 % of discharge capacity after 500 cycles at 0.2C and display capacity retention of over 87 % after 3000 cycles at 5C with a steady average coulombic efficiency (>99.98 %).



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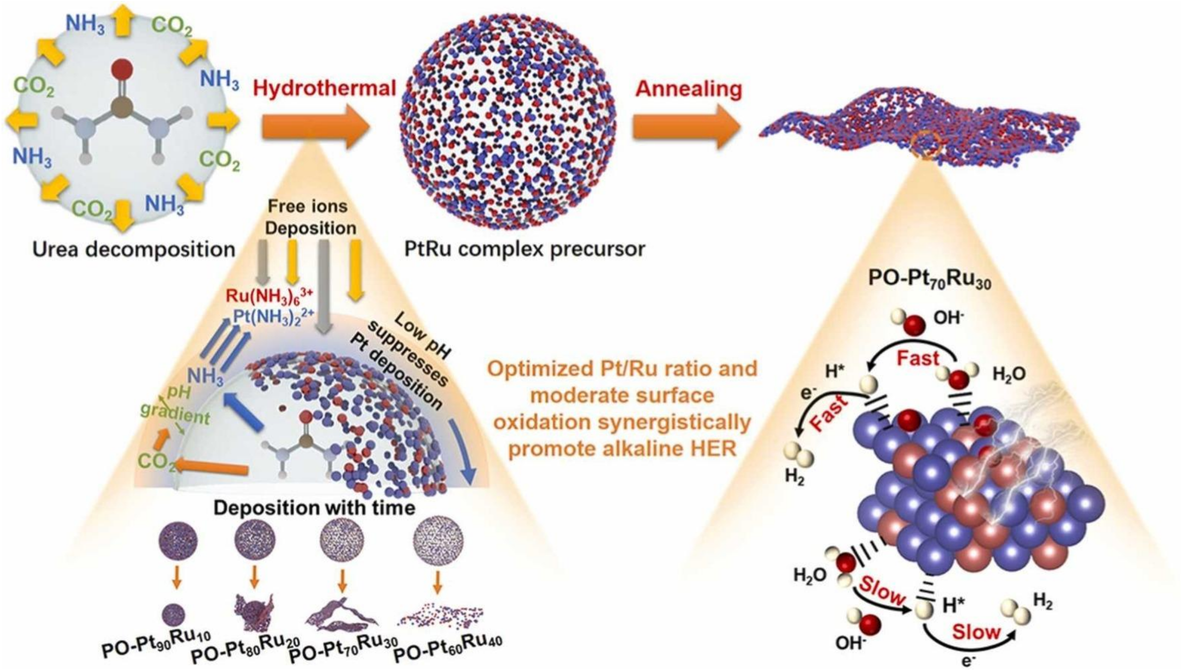
31. Xianjun Cao, Limeng Sun, Fengying Pan, Zeliang Wu, Dongfang Li, Xinming Nie*, Xiaoyan Li, Peng Huang*, Li Gao, Cheng Gong, Yufei Zhao*, Qiong Cai, Jinqiang Zhang*, **Guoxiu Wang**, Hao Liu*, “Revealing the roles of oxidation states and constituents of the alloy in alkaline hydrogen evolution reaction”, **Applied Catalysis B: Environment and Energy**, 375, 125415, 2025. IF=20.3. DOI: 10.1016/j.apcatb.2025.125415

ABSTRACT: Precious metal Pt has exhibited excellent catalytic performance in numerous electrocatalytic applications. However, the slow water dissociation kinetics hinder its alkaline hydrogen evolution reaction (HER) activity. Herein, we design the partially oxidized PtRu alloys with fine-tuned structure which can significantly enhance the alkaline HER. Theoretical calculations reveal that the alteration of Pt/Ru ratio and surface oxidation state of PtRu materials can effectively tune the water and hydrogen adsorption capability, thus impacting the alkaline HER performance. We dentify $Pt_{70}Ru_{30}$ with 3 O surface coverage with optimized adsorption energy to be the most suitable candidate for alkaline HER. Inspired by theoretical predictions, we prepare partially oxidized PtRu with tunable composition and structure via a facile urea-assisted method, with a “capture and release” reaction mechanism by generating complexing agents and pH gradients. The as-synthesized partially oxidized $Pt_{70}Ru_{30}$ electrode exhibits excellent HER catalytic activity and stability in the alkaline electrolyte, achieving an overpotential of only 11 mV at 10 mA cm^{-2} and a Tafel slope of 28 mV dec^{-1}, outperforming that of Pt/C (η_{10} = 29 mV, Tafel slope = 52 mV dec^{-1}). *In-situ* spectral measurements show that the partially oxidized Pt and Ru species in $Pt_{70}Ru_{30}$ can facilitate breaking the O-H bonds and improve the alkaline HER kinetics. This work unravels the influence of Pt/Ru ratio and surface partial oxidation on water dissociation and hydrogen adsorption, which provide guidelines for the rational design of highly efficient electrocatalysts.



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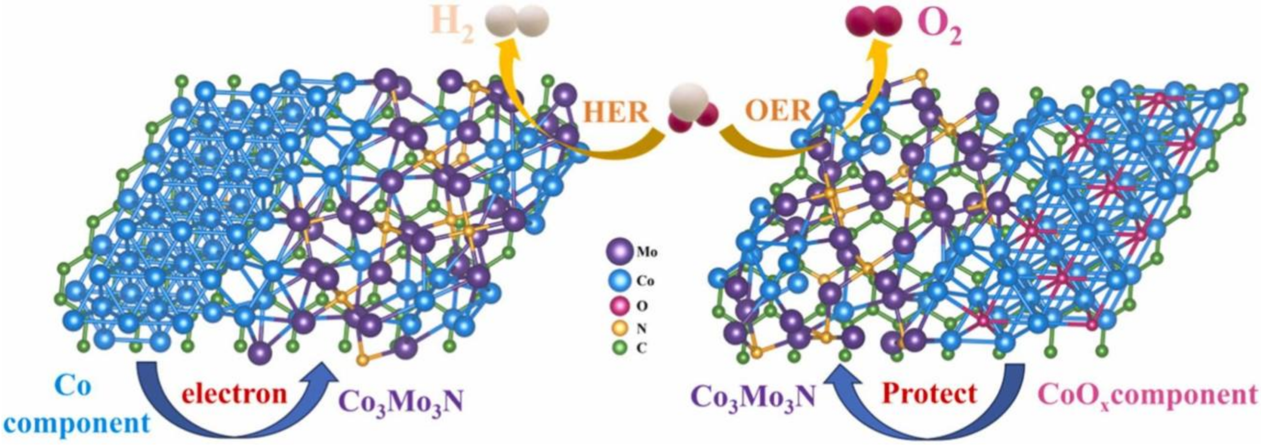
32. Gang Wang, Weiguo Huang, Tao Meng, Jia Gu, Ya Chen, Yuan Cheng, Peiyi Ji, Zejun Luo, Ziyang Guo, Xiaodong Chen, Duu-Jong Lee, **Guoxiu Wang***, “Engineering Co@Co$_3$Mo$_3$N/NPCs heterostructured ultrathin nanosheets electrocatalysts with favorable electronic configuration for boosting alkaline overall water electrolysis”, **Applied Catalysis B: Environment and Energy**, 371, 125270, 2025. IF=20.3. DOI: 10.1016/j.apcatb.2025.125270

ABSTRACT: The rational architecture of high-performance electrocatalyst is becoming imperative for H_2 production from electrochemical water splitting. Herein, the pioneering fabrication of Co@Co$_3$Mo$_3$N heterojunctions immobilized onto N-doped porous carbon substrates (abbreviated as Co@Co$_3$Mo$_3$N/NPCs) are effectuated by a combination of wet-impregnation proceedings of Co,Mo/polyaniline (PANI) precursor and subsequent carbonization/nitridation treatment. This construction can furnish the multitudinous Co@Co$_3$Mo$_3$N heterojunction interfacial sites and simultaneously trigger the synergistic effect to encourage the rearrangement of the electronic configuration and the majorization of electrochemically active sites, thus devoting to the comprehensive improvement of the electrocatalytic HER and OER performance. Accordingly, the synthesized Co@Co$_3$Mo$_3$N/NPCs electrocatalyst can deliver the exceptional electrocatalytic HER and OER performance with ultra-low overpotentials of 37 mV and 203 mV at a current density of 10 mA cm^{-2}. Meanwhile, the Co@Co$_3$Mo$_3$N/NPC electrocatalysts are assembled into zero-gap alkaline electrolyzer for overall water splitting, which afford an ultra-low voltage of 1.80 V at a current density of 500 mA cm^{-2} with ultra-long lifespan of 2400 h. Therefore, this work can provide fire-new perspective and inspiration for synthesizing the art-of-the-state bifunctional electrocatalysts for further commercial application.



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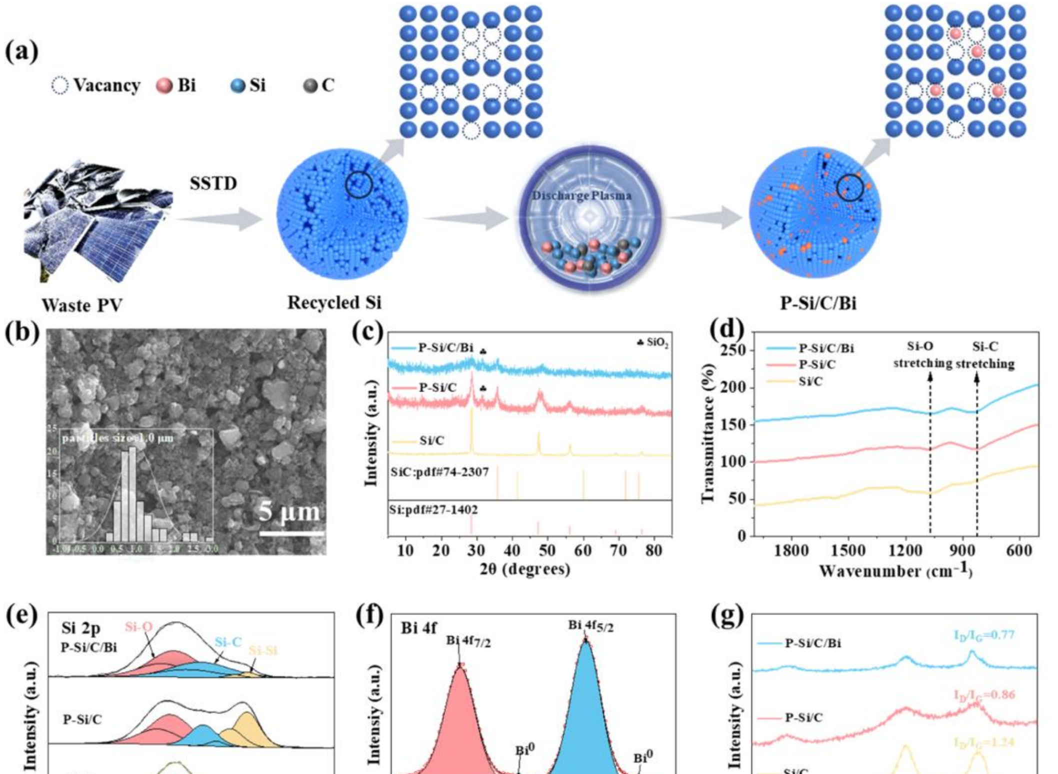
33. Dingyi Zhang, Hong Gao*, Jiayi Li, Yiwen Sun, Zeshen Deng, Xinyao Yuan, Congcong Li, Tianxiao Chen, Xingwang Peng, Chao Wang, Yi Xu, Lichun Yang*, Xin Guo, Yufei Zhao, Peng Huang*, Yong Wang, **Guoxiu Wang**, Hao Liu*, “Plasma-enhanced vacancy engineering for sustainable high-performance recycled silicon in lithium-ion batteries”, **Energy Storage Materials**, 77, 104231, 2025. IF=20.2. DOI: 10.1016/j.ensm.2025.104231

ABSTRACT: Silicon, renowned for its exceptional theoretical capacity, is a promising lithium-ion battery (LIB) anode material, yet its practical application is hindered by severe lithiation-induced volume expansion, structural instability, and high production costs. This study introduces a sustainable strategy to address these challenges by repurposing recycled photovoltaic (PV) silicon through a plasma-assisted vacancy engineering approach. By combining dielectric barrier discharge plasma-assisted milling with bismuth (Bi) modification, controlled vacancy defects are introduced into silicon microparticles, enhancing ion transport and mitigating internal stress. Bi further stabilizes the anode by absorbing mechanical stress and facilitating lithium-ion accommodation at vacancy sites. The resulting plasma induced silicon/carbon/bismuth composite demonstrates outstanding cycling stability and high-rate performance, retaining 1442 mA h g^{-1} after 300 cycles at 0.5 A g^{-1} and 525 mA h g^{-1} after 1000 cycles at 7 A g^{-1}. This scalable and eco-friendly method not only overcomes the inherent limitations of silicon anodes but also transforms PV waste into high-performance LIB materials, advancing sustainable energy storage technologies.



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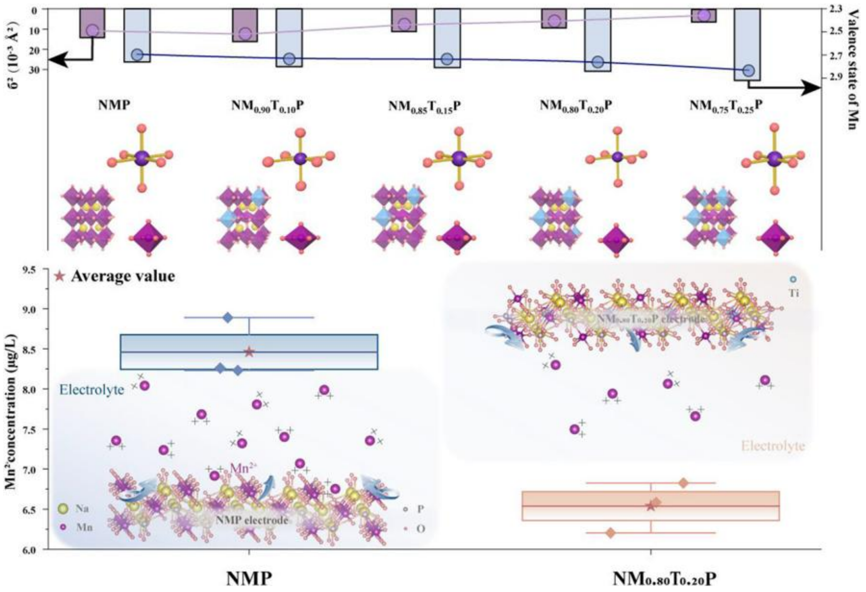
34. Jiajia An, Hanlin Wang, Lingfei Zhao, Qiang Wang, Binkai Yu, Ye Li, Wenxi Zhao, Jinqiao Hu, Jiarun Geng, Limin Zhou, He Zhu, Hui Xia, Qinfen Gu, Ruohan Yu, Mei Yang, **Guoxiu Wang***, Mingzhe Chen, "Tailored Modulation of Jahn-Teller Distortion via Electron-Lattice Coupling to Enhance the Cycling Stability of Polyanionic Cathodes for Advance Sodium-Ion Batteries", **Energy Storage Materials**, 83, 104645, 2025. IF=20.2. DOI: 10.1016/j.ensm.2025.104645

ABSTRACT: Manganese-based polyanionic compounds are one of the most promising cathode materials for sodium-ion batteries due to cost-effectiveness, high-voltage capability, and environmental friendliness. Nevertheless, the strong Jahn-Teller distortion (JTD) in high-spin Mn^{3+} state induces localized stress concentration and irreversible structural collapse, while the low-JTD state causes elevated lattice rigidity via enhanced Mn-O bond covalency, leading to inferior electrochemical stability. Herein, we propose an electron-lattice coupling modulation strategy by constructing a Ti^{4+}-mediated Mn-O-Ti superexchange interactions within the polyanionic $NaMnPO_4$ framework to enable electronic state reconfiguration and dynamic lattice response for controllable JTD regulation. We show that the strong orbital hybridization between Ti^{4+} d^0 and O 2p enhances the covalency of Mn-O bonds and broadens the Mn^{3+} e_g orbitals into Mn(e_g)-O(2p) hybridized bands, thus reducing the intrinsic electron degeneracy of the Mn^{3+} e_g orbitals. Furthermore, the flexible TiO_6 octahedra facilitate homogeneous reversible microstrains through elastic deformation and enable effective lattice stress dissipation. The $NaMn_{0.80}Ti_{0.20}PO_4$ exhibits an optimal JTD magnitude of $\sigma^2 = 0.009$ and a 91.03 % improvement in strain homogeneity compared to the pristine sample. These enhancements contribute to a high-capacity retention of 96.75 % after 500 cycles at 2 C. (*vs.* 77.85 % for $NaMnPO_4$). This work establishes a universal paradigm to modulate the JTD in high-spin transition-metal cathodes, opening new avenues for high-stability cathode design.



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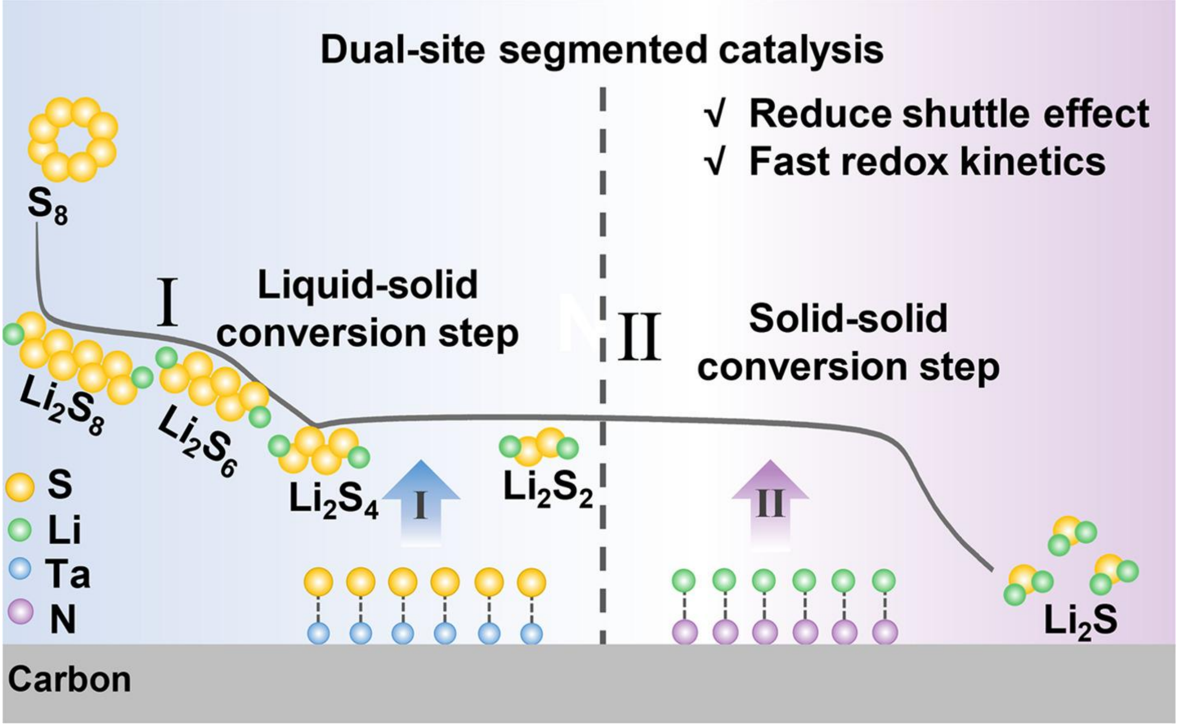
ABSTRACT: Single-atom catalysts (SACs) have emerged as an effective approach to improve the utilization efficiency of sulfur cathodes in lithium–sulfur (Li–S) batteries, owing to their unique atomic-scale catalytic interfaces. However, achieving fast reaction kinetics for both the liquid–solid and solid–solid conversion of lithium polysulfides (LiPSs) demands a tandem catalysis mechanism with multiple active sites, which remains a major challenge. Herein, we report the first example of an asymmetric Ta–N_5 single-atom catalyst (denoted Ta SAs/NC) with dual active sites engineered to trigger tandem catalysis and thereby promote the stepwise conversion of LiPSs. The asymmetric Ta–N_5 coordination environment induces electron redistribution, thereby intensifying d–p orbital hybridization between the Ta 5d and S 3p orbitals. In this tandem catalytic process, the Ta–S bond predominantly accelerates the liquid–solid conversion of LiPSs, whereas the N5–Li (N5 represents the fifth N atom in Ta SAs/NC) bond serves as the principal active site for the subsequent solid–solid conversion. Li–S batteries with the Ta SAs/NC interlayer exhibit a high capacity retention of 90.42 % after 500 cycles at 7 C. In addition, the cells with a high sulfur loading of 5.03 mg cm^{-2} deliver an exceptional initial areal capacity of 5.72 mAh cm−2 and maintain 5.01 mAh cm^{-2} after 30 cycles. Moreover, the pouch cell based on this interlayer exhibits excellent capacity decay of 0.21 % per cycle after 200 cycles.



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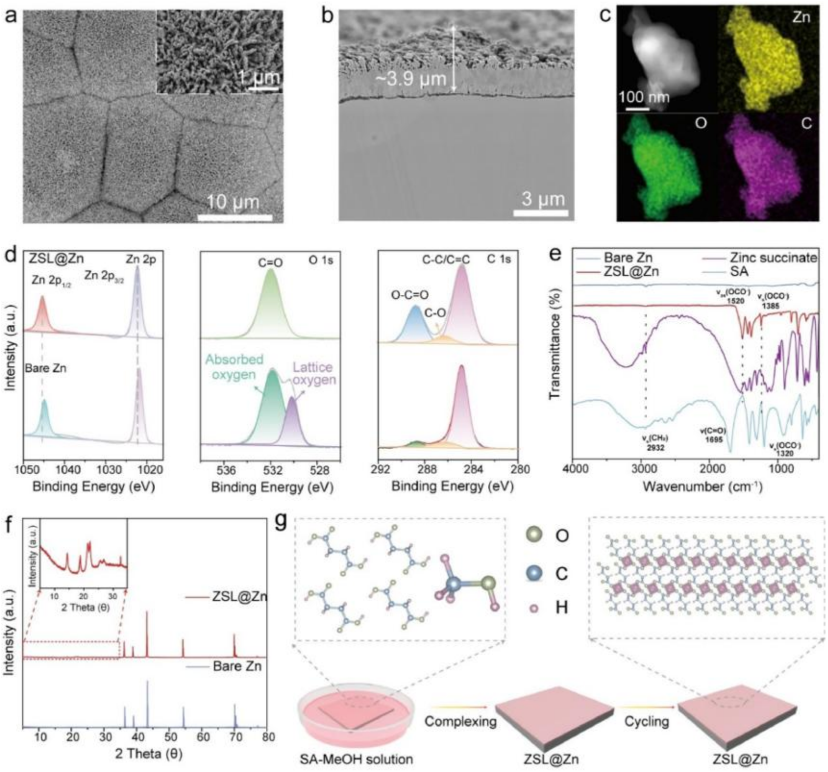
ABSTRACT: Advanced interfacial engineering is essential to address key challenges such as dendrite formation, parasitic reactions, and sluggish electrochemical kinetics, in aqueous zinc-ion batteries. In this study, by using a facile self-assembly method, we developed an armor-like interfacial layer (ZSL) on the Zn surface, serving as both an ion re-distributor and a protective barrier. This compact interfacial layer exhibits suitable hydrophilic and zincophilic features, enabling consistent and uniform Zn^{2+} flux and reducing voltage polarization. The ZSL also enhances the de-solvation process, speeds up zinc deposition kinetics, and suppresses parasitic reactions induced by water decomposition. Furthermore, it decreases the surface energy, promoting planar deposition of Zn^{2+}. As a result, the modified zinc anodes demonstrate exceptional cycling stability, maintaining a dendrite-free surface for >8000 h with minimal byproduct formation. The asymmetric cell utilizing ZSL@Zn anodes exhibits highly stable reversibility over 6000 cycles with an average Coulombic efficiency (CE) of 99.89 %. In full cells paired with $Na_2V_6O_{16}·3H_2O$ (NVO) cathodes, the Zn-ion batteries exhibit excellent rate performance and long-term cycling durability. This work highlights the significant role of in-situ interfacial layers in achieving highly stable and reversible zinc anodes for large-scale zinc-ion battery applications.



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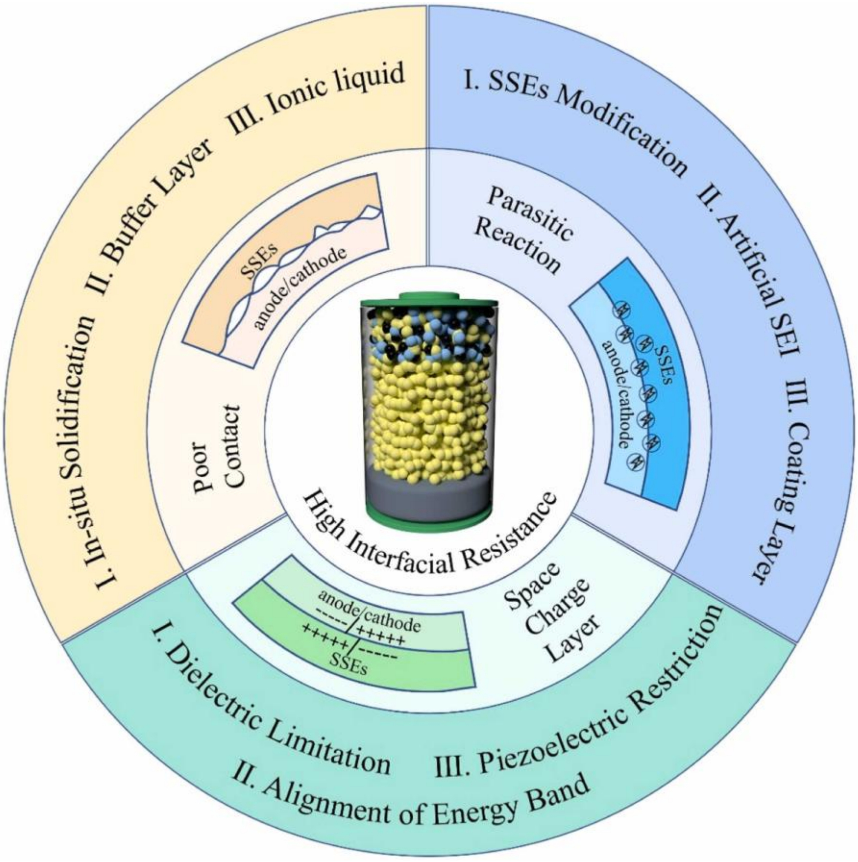
37. Ming Liu, Ailing Song, Xinyi Zhang, Jie Wang, Yuqian Fan, **Guoxiu Wang***, Hao Tian, Zhipeng Ma, Guangjie Shao, “Interfacial lithium-ion transportation in solid-state batteries: Challenges and prospects”, **Nano Energy**, 136, 110749, 2025. IF=16.8. DOI: 10.1016/j.nanoen.2025.110749.

ABSTRACT: Solid-state lithium-ion batteries (SSBs) have gained widespread attention due to their enhanced safety and energy density over conventional liquid electrolyte systems. However, their practical application is hindered by significant polarization during cycling, primarily caused by increased interface impedance. To address the challenges of slow lithium-ion diffusion, optimizing interfacial kinetics has emerged as a key strategy to improve the electrochemical performance of SSBs. However, the mechanisms behind battery failure, especially interface polarization, are not fully understood and require further investigation. This review explores the origins of interfacial polarization, including poor contact, parasitic reactions, and space charge layer, supported by theoretical calculations, experimental data, and advanced characterizations. Then, the latest progress categorized as in-situ solidification, buffer layer, ionic liquid, solid-state electrolytes modification, artificial solid electrolyte interphases, coating layers, dielectric additives, and piezoelectric additives are summarized to elucidate the underlying mechanisms of Li^+ transport across interfaces. Finally, the integration of mechanical behavior with outstanding interfacial engineering is emphasized as a key factor for advancing SSBs performance and stability, providing insights for the development of next-generation lithium-based batteries.



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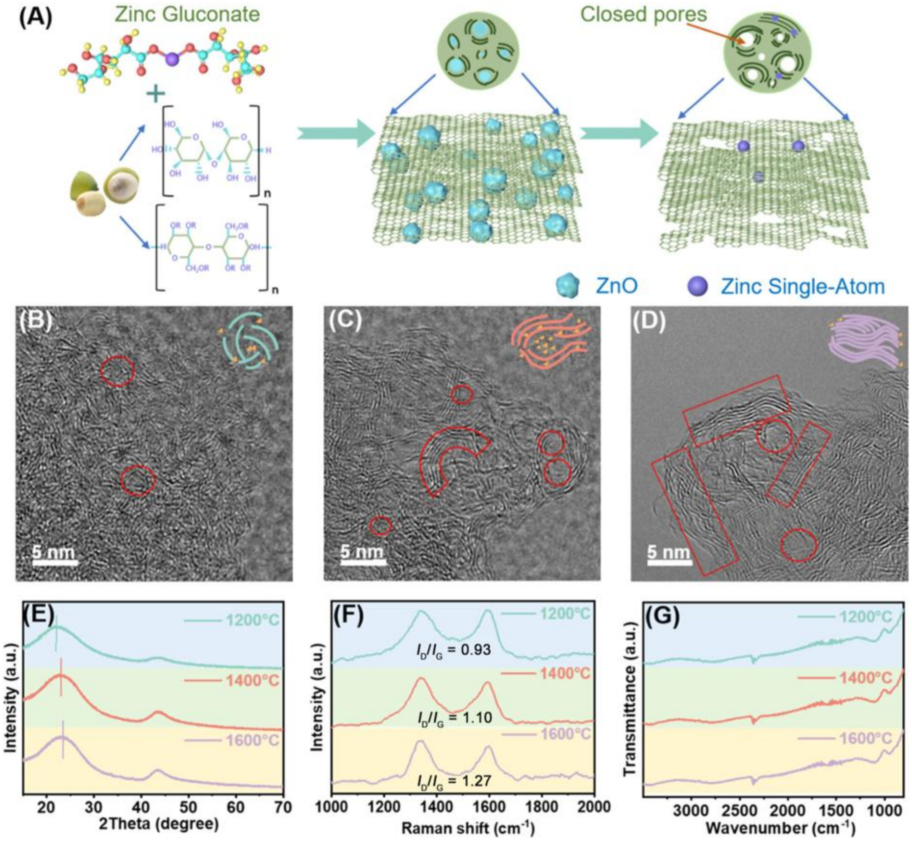
38. Guilai Zhang, Hong Gao*, Dingyi Zhang, Jun Xiao, Limeng Sun, Jiayi Li, Congcong Li, Yiwen Sun, Xinyao Yuan, Peng Huang*, Yi Xu*, Xin Guo, Yufei Zhao, Yong Wang, Yao Xiao, **Guoxiu Wang***, Hao Liu*, “Transformative Catalytic Carbon Conversion Enabling Superior Graphitization and Nanopore Engineering in Hard Carbon Anodes for Sodium-Ion Batteries”, **Carbon Energy**, e713, 2025. IF=19.5. DOI:10.1002/cey2.713

ABSTRACT: Hard carbons are promising anode materials for sodium-ion batteries (SIBs), but they face challenges in balancing rate capability, specific capacity, and initial Coulombic efficiency (ICE). Direct pyrolysis of the precursor often fails to create a suitable structure for sodium-ion storage. Molecular-level control of graphitization with open channels for Na^+ ions is crucial for high-performance hard carbon, whereas closed pores play a key role in improving the low-voltage (<0.1V) plateau capacity of hard carbon anodes for SIBs. However, creation of these closed pores presents significant challenges. This work proposes a zinc gluconate-assisted catalytic carbonization strategy to regulate graphitization and create numerous nanopores simultaneously. As the temperature increases, trace amounts of zinc remain as single atoms in the hard carbon, featuring a uniform coordination structure. This mitigates the risk of electrochemically irreversible sites and enhances sodium-ion transport rates. The resulting hard carbon shows an excellent reversible capacity of 348.5mAhg^{-1} at 30mAg^{-1} and a high ICE of 92.84%. Furthermore, a sodium storage mechanism involving “adsorption–intercalation–pore filling” is elucidated, providing insights into the pore structure and dynamic pore-filling process.



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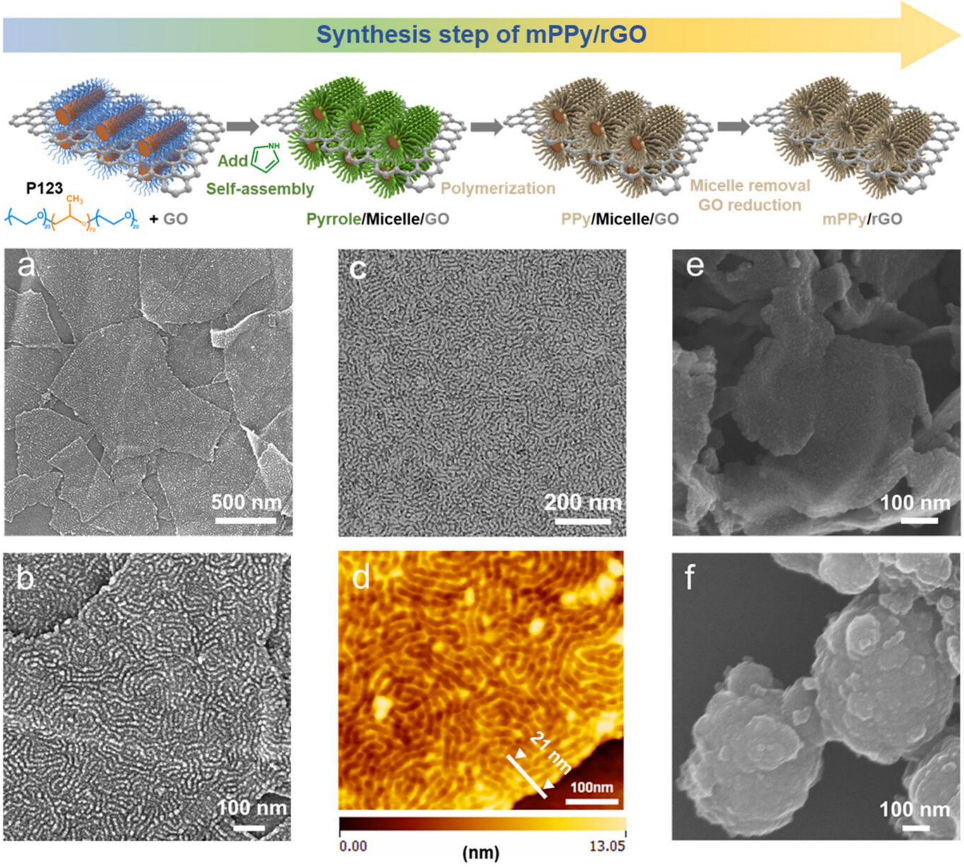
39. Chen Tang, Hongli Chen, Qian Li, Changle Li, Ying Li, Azhar Alowasheeir, Zeinhom M El-Bahy, **Guoxiu Wang**, Chongyin Zhang, Yusuke Yamauchi, Xingtao Xu, “Directional Ion Transport Through Nanoarchitected 1D Mesochannels: 2D Polymer Interfacial Engineering for High-Efficiency Capacitive Deionization”, **Advanced Science**, e04527, 2025. IF=14.3. DOI:10.1002/advs.202504527

ABSTRACT: The development of high-performance capacitive deionization (CDI) electrodes demands innovative materials that integrate rapid ion transport, high salt adsorption capacity (SAC), and oxidative stability. This challenge is addressed through a surface nanoarchitectonics strategy, constructing 2D mesochannel polypyrrole/reduced graphene oxide heterostructures (mPPy/rGO) with ordered 1D mesochannels (~8 nm) parallel to the graphene surface. By confining the self-assembly of cylindrical polymer brushes on freestanding rGO substrates, directional ion highways are simultaneously engineered that significantly reduce transport tortuosity. In addition, corrosion-resistant polymer interfaces block oxygen penetration, and strong interfacial interactions between PPy and rGO ensure efficient electron transfer. The mPPy/rGO-based CDI cell achieves breakthrough performance: ultrahigh SAC of 84.1 mg g^{-1} (4.5× activated carbon, the salt concentration: 2 g L^{-1}), and 96.8% capacity retention over 100 cycles in air-equilibrated saline solution (the salt concentration: 500 mg L^{-1}). This interfacial confinement methodology establishes a universal paradigm for designing polymer-based desalination materials with atomically precise transport pathways.



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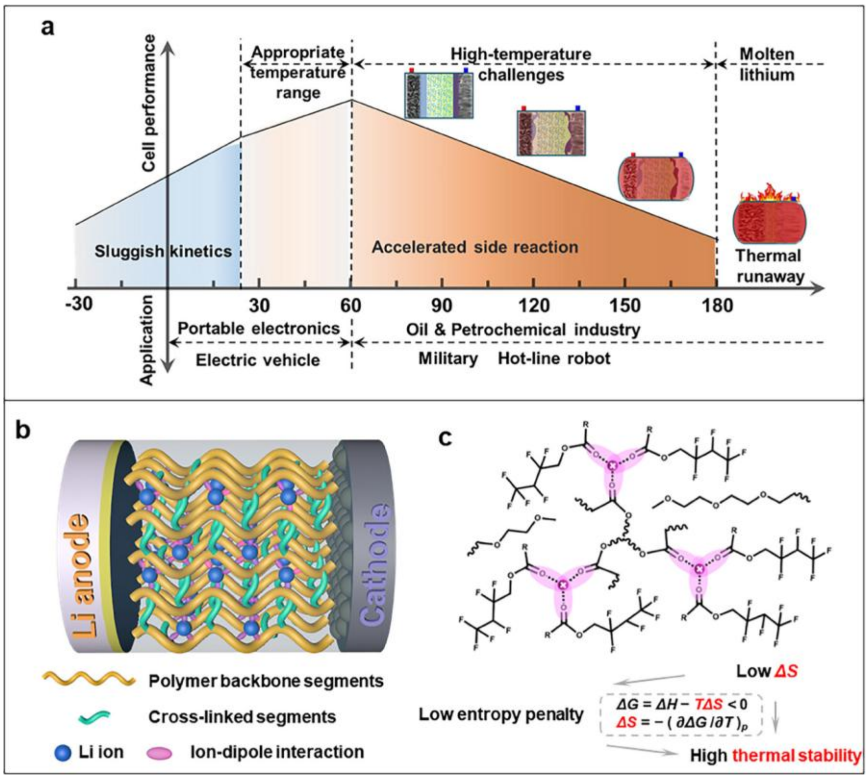
40. Weiting Ma, Shunshun Zhao, Shuang Wan, Jiajun Gong, Sinian Yang, Yong Chen*, Shimou Chen*, **Guoxiu Wang***. “Ultrahigh-Temperature-Tolerance Lithium Metal Batteries Enabled by Molecular-Level Polymer Configuration Design with Low-Entropy-Penalty Effect”, **Advanced Science**, 12, e07191, 2025. IF=14.1. DOI: 10.1002/advs.202507191

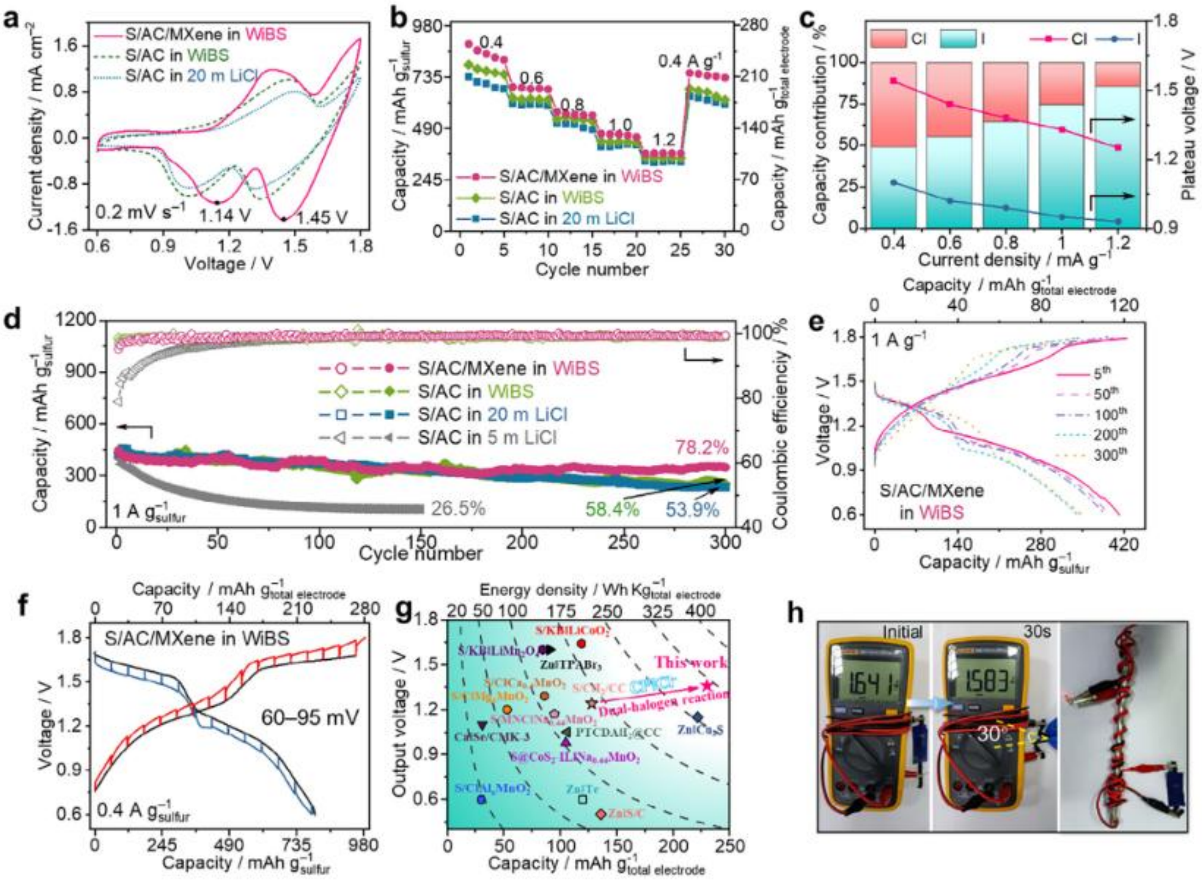
ABSTRACT: Despite their immense potential for next-generation energy storage, the practical implementation of temperature-tolerant lithium metal batteries (LMBs) under extreme thermal conditions continues to face formidable challenges. In this study, an ultrahigh-temperature-tolerance polymer-based electrolyte (UPE) prototype with a low-entropy-penalty effect is proposed. This electrolyte features a carefully engineered molecular configuration that enables stable operation of polymer-based LMBs across a broad temperature range (25-150 °C). Comprehensive experimental and theoretical analyses confirm that the unique “ester-ether-fluorinated segment” architecture enables the formation of a robust coordination framework through Li^+-multivalent ether/ester interactions and effective Li^+-ether strong-solvent-cage decoupling. The resulting polymer electrolyte integrates reactive carboxyl groups, alkali-metal-soluble ether moieties, and fluorinated segments that provide inert yet efficient ion conduction pathways. This synergistic configuration achieves high ionic conductivity, significantly improved lithium-ion transference numbers, and excellent interfacial compatibility with lithium metal. This work presents a molecular-level polymer design framework, providing a compelling direction for the development of high-performance, thermally stable lithium-metal batteries.



https://advanced.onlinelibrary.wiley.com/doi/full/10.1002/advs.202507191

41. Ronghuan Liang, Yan Wang, Chuanlong Wei, Xiao Tang,* Timing Fang, Zhezheng Ding,Qing Wang, Rui Wang, Jianjun Song, Bing Sun,* Xiaomin Liu,* and **Guoxiu Wang***, “A Highly Reversible Aqueous Sulfur-Dual-Halogen BatteryEnabled by a Water-in-Bisalt Electrolyte”, **Small**, 2502228, 2025. IF=13. DOI: 10.1002/smll.202502228

ABSTRACT: The chlorine-based redox reaction applied in aqueous rechargeable batteries (ARBs) has attracted extensive attention owing to the high theoretical capacity and redox potential. However, it generally suffers from low reversibility and poor Coulombic efficiency due to the evolution of toxic Cl_2 gas and the decomposition of aqueous electrolytes. Herein, an aqueous sulfur-dual halogen chemistry is demonstrated by employing highly-concentrated water-in-bisalt (WiBS) electrolyte, sulfur anode, and iodine composite electrodes. The freestanding iodine/carbon cloth cathode and Cl^--containing WiBS electrolyte not only enable the continuous I^+/I^0 reaction by forming $[ICl_x]^{1-x}$ interhalogens but also achieve the oxidation of Cl^- in $[ICl_x]^{1-x}$ at higher redox potential and immobilize Cl^0 species via I^+-Cl^0 chemical bonds. Therefore, the as-assembled aqueous sulfur-dual halogen batteries (ASHBs) based on the dual-halogen conversion on the cathode and the S/S_x^{2-} redox reaction on the anode deliver a high energy density of 304 Wh kg^{-1} with an average output voltage of 1.32 V. These key findings open an avenue for the development of low-cost and high-performance ARBs for energy storage applications.



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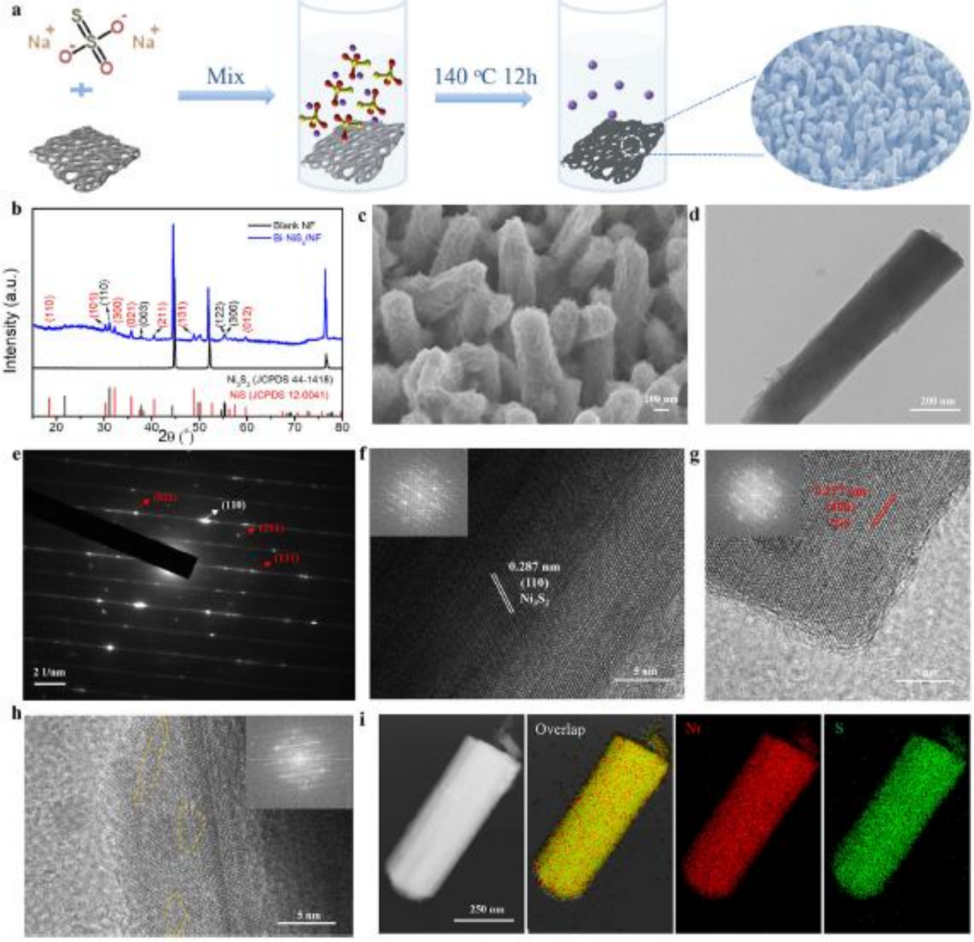
42. Xingxing Yu, Xiaochun Gao, Kang Yan, Shengwen Liu, **Guoxiu Wang***, Yang Yang, “Phase-Mixed Nickel Sulfide Nanoarrays for Electrochemical Water Oxidation at Low Overpotential”, **Small**, 2503194, 2025. IF=13. DOI:1002/smll.202503194

ABSTRACT: Transition metal sulfide materials have demonstrated exceptional electrocatalytic activities for the hydrogen evolution reaction (HER); however, their efficacy for the oxygen evolution reaction (OER) remains limited, particularly in alkaline environments. This study introduces a novel nanoarray structure composed of phase-mixed nickel sulfides, specifically rhombohedral NiS and Ni_3S_2, directly grown on nickel foam (denoted as bi-NiSx/NF) through a straightforward hydrothermal method. The optimized bi-NiS_x/NF catalyst achieves an impressive overpotential of only 43 mV to reach a current density of 10 mA cm^{-2} in 1 m KOH electrolyte. The stability test of bi-NiSx/NF under alkaline conditions uncovers that the intrinsic sulfur-rich surface plays an important role in its superior OER activity. Additionally, annealing treatments demonstrate that OER performance is closely linked to sulfur retention, further affirming the significance of this structural sulfur-rich characteristic. These findings provide valuable insights into the design of phase-mixed catalysts and the intrinsic OER activity of transition metal sulfides, paving the way for future advancements in electrocatalytic materials.



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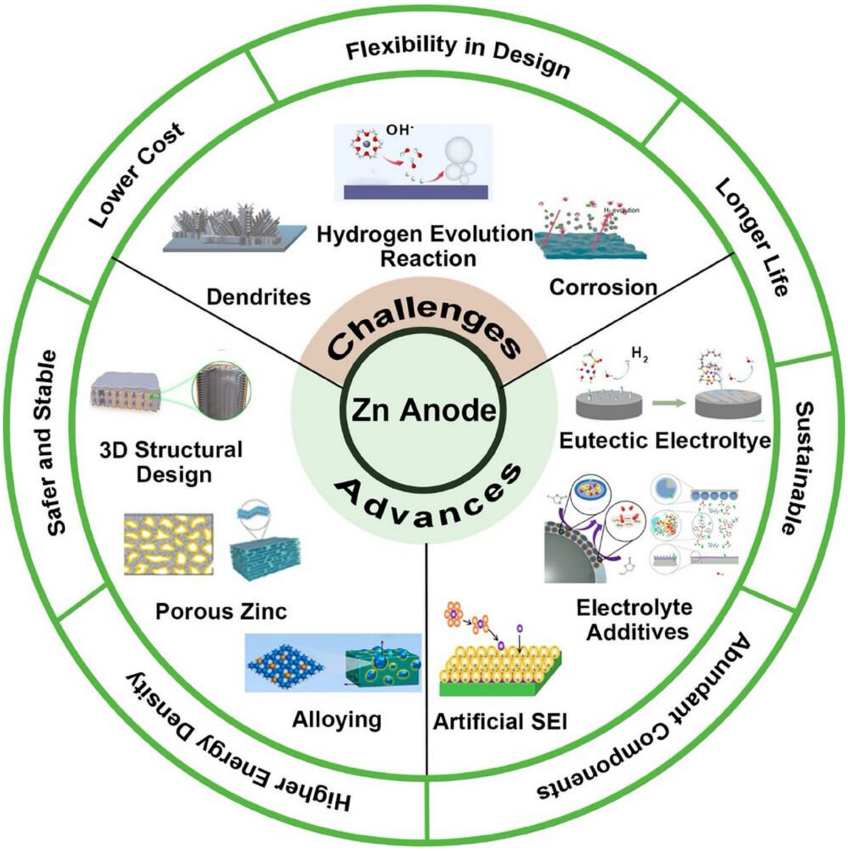
43. Hajra Khan, Chenyu Zhao, Karim Khan, Ayesha Khan Tareen, Asif Shahzad, Steven J. Langford, Hao Liu, Asif Mahmood, **Guoxiu Wang***, “Challenges and Design Strategies for Stable Zinc Anodes in Rechargeable Zinc Batteries”, **Small**, 2504170, 2025. IF=13. DOI: 10.1002/smll.202504170

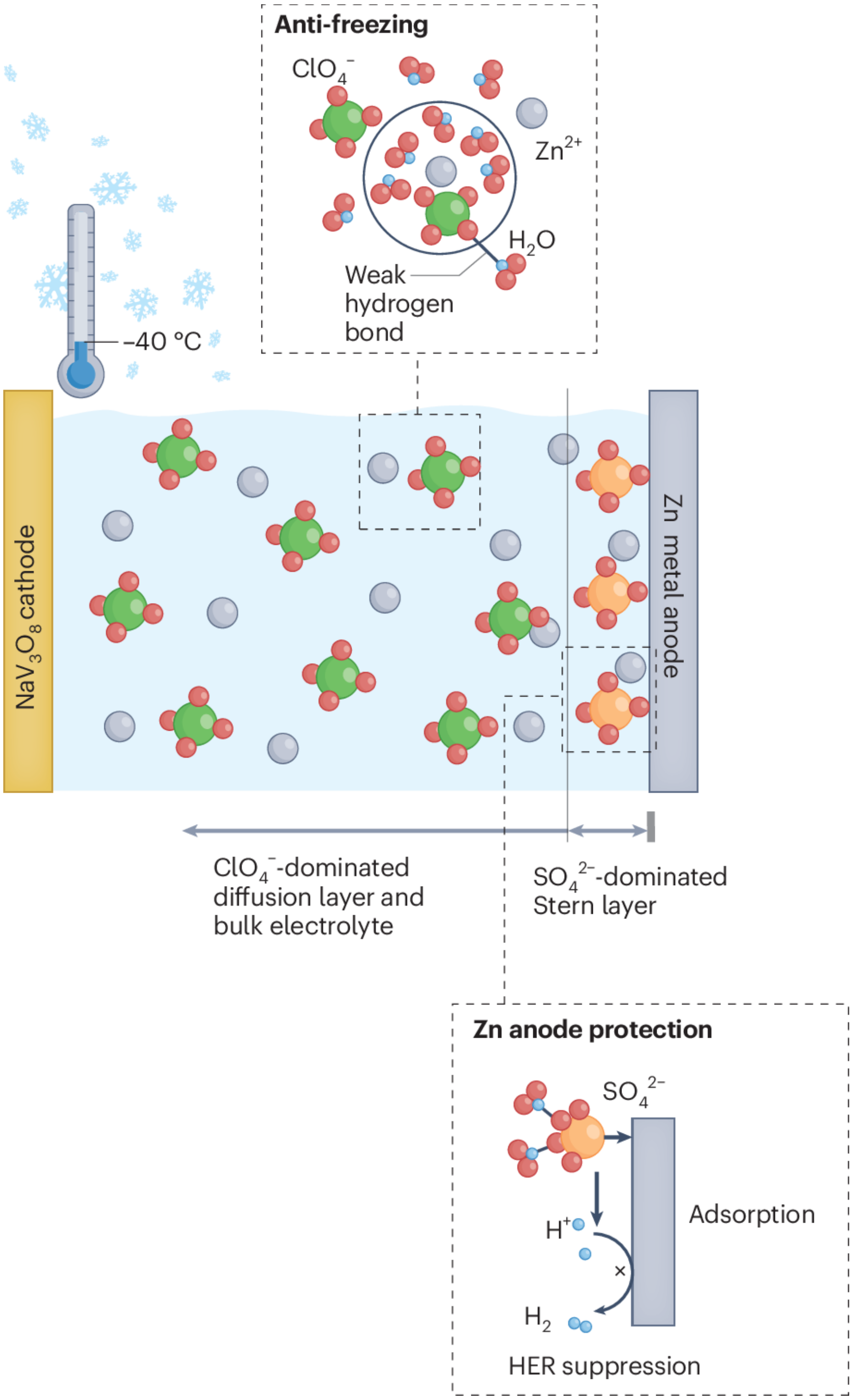
ABSTRACT: Zinc-ion batteries (ZIBs) are increasingly recognized as promising candidates for large-scale energy storage due to their high energy density, safety, low cost, and the natural abundance of zinc. However, the widespread adoption of ZIBs is limited by fundamental issues associated with the zinc metal anode, including dendrite formation, hydrogen evolution reaction (HER), passivation, self-corrosion, and poor cycling stability. In recent years, substantial efforts have been made to address these challenges through approaches such as 3D current collector design, alloying, surface modification, and electrolyte engineering. This review provides a systematic, Zn-anode-focused summary of these advances, with emphasis on structural engineering, interface stabilization, and electrolyte tailoring to improve Zn^{2+} deposition behavior. Uniquely, this work integrates recent progress in advanced characterization techniques such as in situ/operando imaging and spectroscopy, to provide deeper insights into the failure mechanism of Zn anode materials. These details are critical in real-time probing of interfacial and morphological evolutions upon charge/discharge. Finally, the review outlines the key future research directions are proposed to support the development of durable and high-performance Zn-based energy storage systems.



https://onlinelibrary.wiley.com/doi/10.1002/smll.202504170

44. Xinming Nie, Shijian Wang* & **Hao Liu***, “Aqueous batteries beating the cold”, **Nature Sustainability**, 8, 1244–1245, 2025. IF=27.7. DOI: 10.1038/s41893-025-01684-9

ABSTRACT: Aqueous zinc batteries, with intrinsic safety and low cost, struggle at low temperatures primarily because their water-based electrolytes freeze. Now a dual-salt electrolyte design enables stable battery operation even at −40 °C.



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