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IAPME Seminar

Design Strategies for In Situ Polymerized Gel Composite Electrolytes

4 August 2025

Prof. Hong GUO
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Venue: N23-4018
Time: 15:00 - 15:45
Hosted by: Prof. Huaiyu SHAO

Abstract

Solid-state batteries (SSBs) are promising next-generation energy storage solutions due to their high safety and energy density. Gel polymer electrolytes (GPEs), particularly 1,3-dioxolane (DOL)-based systems, offer advantages like mechanical flexibility, high ionic conductivity, and lithium dendrite suppression, but face challenges including limited mechanical strength and interfacial instability. To address these, Prof. Hong GUO's team developed enhanced DOL-based GPEs through multidimensional optimization. First, an in-situ polymerized PDOL-based gel electrolyte with interfacial inducer formed a stable CEI/SEI bilayer, enabling Li||Li symmetric cells to cycle stably for 2,500 hours and NCM811 full cells to retain 88.6% capacity after 300 cycles at 1C. Subsequently, titanium-based MOFs were incorporated as functional scaffolds, improving mechanical strength and Li^+ transport (ionic conductivity: 1.36×10^{-3} S cm^{-1}; Li^+ transference number: 0.71), with excellent performance in LFP/NCM90 cells. Further improvement came from integrating Co-Ti bimetallic MOFs via combined in-situ polymerization and solution casting. The resulting redox potential gradient facilitated charge transfer and activated inactive lithium, achieving 97% lithium utilization in Li||Cu cells. NCM90 and LFP full cells delivered high initial capacities (198.8 mAh g^{-1} at 1C; 139.5 mAh g^{-1} at 2C/50°C). In-situ characterization and simulations confirmed the MOF structure suppresses inactive Li^0 formation and enhances Li^+ transport kinetics, providing a feasible design pathway and theoretical foundation for high-energy-density SSBs.

Biography

Prof. Hong GUO received his Ph.D. degree at the School of Materials Science and Engineering at the University of Science and Technology Beijing in 2008, and obtained the nomination of national outstanding doctorate dissertation. He was a visiting scholar in State Key Laboratory of Fire Science in Japan from 2002/10 to 2004/9. Prof. Guo has been appointed as a Professor in School of Chemistry Science and Engineering at Yunnan University by Talents Introduce Project in 2010. He was a visting scholar at Western University in Canada from 2016/9 to 2017/10. Prof. Guo serves as Fellow of the Vebleo, a member of a council of the Chinese society of silicate solid ion branch, a member of the electrochemical society (ISE), a member of a council of the International Academy of Electrochemical Energy Science (IAOEES), and obtained the Science and Technology Award in Yunnan province.