Department of Materials Science and Engineering Seminar Series 2026

Design and Fabrication of MOF-Based Solid-State Electrolytes for Advanced Lithium Metal Batteries

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Date and time: 27th April, 3-5pm

Venue: EA-06-05

Abstract

At the forefront of next-generation energy storage, metal-organic frameworks (MOFs) are undergoing a fundamental transformation—from traditional inactive fillers into active, rationally designed hosts for solid-state electrolytes (SSEs). By advancing the concept of "Framework-Immobilized Solvents", this work establishes how precise nano-confinement and framework chemistry uniquely dictate lithium-ion coordination and transport. Ultimately, this investigation elucidates the underlying confinement-modulation mechanisms, providing a feasible structure-property pathway for developing high-performance, inherently safe solid-state lithium metal batteries.

This research traces the evolution of these "Frameworked Electrolytes" (FEs) across four progressive stages, bridging fundamental physical models with practical battery integration. An analysis of the unique dynamics governed by strict nano-confinement within the sub-nano pores of HKUST-1 serves as the foundational study. Building on these insights, the engineering of the host environment is further explored through a comparison of neutral and anionic UiO-66 frameworks, revealing how intrinsic electrostatic charges can be isolated to accelerate ionic mobility. Furthermore, the efficacy of targeted functional engineering is demonstrated via thiol-grafted architectures (ZIF-8-SH), which actively and dynamically regulate Li^+ migration barriers at a molecular level. Ultimately, through the establishment of

comprehensive guiding rules for ideal MOF-guest pairings, the successful integration of these custom-tailored FEs into advanced solid-state lithium-sulfur batteries is demonstrated, highlighting MOFs as a highly versatile, designable material platform for the future of energy storage technologies.

Biography

Tuo Wang is currently a Ph.D. candidate at the MSE department under the supervision of Prof. John Wang. His research focuses on solid-state electrolytes and its application in lithium metal batteries.

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HOST: Assoc Prof Andreeva-Baeumler, Daria