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Wednesday Sunstone Seminar B

Electrolytes play a crucial role in energy storage devices, impacting their environmental footprint, safety, cost, and performance. This talk will cover two key areas of electrolyte research for improving batteries.

First, we will explore water-based batteries. Aqueous electrolytes, being non-flammable and less toxic, offer safer battery operation. However, their limited electrochemical stability window reduces energy density. To address this, highly concentrated "water-in-salt" (WIS) electrolytes have been developed, significantly expanding the stability window and enhancing the performance of Li-ion and Zn metal batteries for grid energy storage. Despite their advantages, WIS electrolytes have high viscosity and require large amounts of potentially toxic salts, which limits their usability. We will discuss how cation solvation, electrolyte structure, and hydrogen bonding influence the electrochemical properties and performance, particularly in Zn plating/stripping and electrolyte decomposition. Additionally, we will explore strategies for engineering relatively dilute electrolytes for efficient aqueous batteries.

Second, the talk will present a novel method for stabilizing interfaces in Li metal batteries (LiMBs). Conventional electrolytes result in low cycle life and safety issues due to "dead" lithium and dendrite formation. Prior research suggests that fluorine-rich interfacial layer chemistry is important for the stabilization of Li-metal anodes, which can be achieved when electrolytes with a high fraction of fluorinated solvents and/or salts are used. We propose an alternative approach using electrostatic attraction between positively charged readily reducible fluorinated cations and the negatively charged anode. This method enables the formation of a robust fluorine-rich interfacial layer with minimal additive (0.1 wt%), facilitating dense, conformal Li deposition. This strategy can offer a cost-effective, environmentally friendly solution for enhancing high-energy batteries.

Prof. Maria Lukatskaya is a tenure-track assistant professor of Electrochemical Energy Systems in Department of Mechanical and Process Engineering at ETH Zürich and since 2024 an Associate Editor for ACS Nano. She received her Ph.D. from Drexel University (USA) followed by postdoctoral stay at Stanford University (USA) and SLAC National Accelerator Laboratory (USA). Dr. Lukatskaya is a Highly Cited Researcher (2021-2023) and SNSF Staring Grant awardee. She received a number of international awards, including Faraday Division Horizon Prize (by Royal Society of Chemistry), Energy and Environmental Science Lectureship Award, iCANX ACS Nano Lectureship Award, MRS Gold Graduate Student Award, The George Hill Jr. Endowed Fellowship Fund and others.

