Department of Mechanical Engineering
THE UNIVERSITY OF HONG KONG

SEMINAR

Title: Kosmotropic Electrolyte Engineering for Sustainable Zn Batteries

Speaker: **Prof. SANG-YOUNG LEE***

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Date: **27 December, 2025**

Time: **10:30am – 12:00noon**

Venue: **The Tam Wing Fan Innovation Wing Two, HKU**

Abstract:

Aqueous Zn batteries hold strong potential as safe and sustainable energy-storage systems, yet their practical realization requires electrolytes capable of regulating water activity, stabilizing interfaces, and supporting diverse electrode chemistries. In this talk, I introduce a kosmotropic electrolyte engineering strategy that restructures hydrogen-bond networks and ion hydration shells to address these challenges. Kosmotropic anions generate highly ordered anion–water clusters that suppress free-water reactivity and enable on-demand miscibility control between aqueous and nonaqueous electrolyte components, yielding biphasic liquid electrolytes that independently optimize cathode redox kinetics and Zn-metal reversibility for long-life cycling and high energy density. Insights from kosmotropic hydration-shell stabilization, originally demonstrated in aqueous processing media for high-energy lithium cathodes, further underscore the universal capability of kosmotropic species to regulate interfacial water structure and suppress parasitic reactions. Building on this foundation, soft-acidic/hard-basic zwitterions modulate Zn^{2+} solvation by disrupting hydrogen-bond networks, weakening Zn^{2+}–anion interactions, and accelerating desolvation. This solvation restructuring enables stable Zn plating/stripping and high-energy anode-free Zn full-cell operation even at −40 °C, with anti-freezing behavior extending to −95 °C. Overall, this work positions kosmotropic electrolyte engineering as a versatile molecular design platform for sustainable, low-temperature, and long-life aqueous Zn batteries.

References

[1] S. Y. Lee et al., *Energy Environ. Sci*. 15 (2022) 5217.
[2] S. Y. Lee et al., *Energy Environ. Sci*. 17 (2024) 1961.
[3] S. Y. Lee et al., *Nature Comm.* 16 (2025) 1686.

BIOGRAPHY

Sang-Young Lee is a distinguished professor in the Department of Chemical and Biomolecular Engineering at Yonsei University, Korea. He received BA in Chemical Engineering from Seoul National University in 1991, MS, and PhD in Chemical Engineering from KAIST in 1993 and 1997, respectively. From 2001 to 2002, he conducted postdoctoral research at Max-Planck Institute for Polymer Research. Prior to joining academia, he worked as a principal research scientist at LG Chem's Batteries R&D Center from 1997 to 2008, where he led the development of ceramic-coated separators (SRS®), which is now a global industry standard in EV batteries. He is a fellow of both Korean Academy of Science and Technology and National Academy of Engineering of Korea. His research interests include the high-mass-loading electrodes, organic material-based solid-state batteries, cellulose-based paper batteries, and flexible/wearable power sources. He has authored over 230 peer-reviewed publications, filed more than 300 patents, and his work has been cited over 15,000 times, with an h-index of 72. He received the 2025 ECS battery division technology award. He currently serves as a director of the Yonsei Battery Research Center, a head of the battery engineering department, and an editor for the Journal of Power Sources.

ALL INTERESTED ARE WELCOME

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