ChemE MIT Chemical Engineering

Seminar Series
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Electrifying Nonaqueous Chemical Production with Scalable Aqueous Electrochemistry

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4:15 pm, Reception 4pm
66-110

In this talk, I will describe a general strategy to electrify nonaqueous chemistry using aqueous electrochemistry by transporting ion-electron pairs as charge-neutral fragments across engineered interfaces. I will first introduce aqueous-nonaqueous interfacial proton-coupled electron transfer (ANIPCET) as a framework that leverages mature aqueous electrodes and membranes while enabling selective transformations in a separated nonaqueous phase without electrolyte cross-contamination. In a liquid-liquid system, we successfully electrified the industrial H_2O_2 synthesis method with improved selectivity, further demonstrating high Faradaic efficiency at industrially relevant current densities while reducing metal contamination and electrolyte pollution. I will then extend the concept to aqueous-solid-nonaqueous interfaces, where electrochemically generated aqueous ion-electron pairs are transferred through a solid mediator to drive nonaqueous hydrogenations and oxidations, with tunable selectivity and mass transport.

Finally, I will connect these interfacial concepts to device-level design rules, introducing a unified picture of organic diffusion electrodes (ODEs) for interfacial reactivity and transport between aqueous electrochemistry and nonaqueous chemistry. The robustness of such systems is demonstrated with water-sensitive nonaqueous electrosynthesis and crossover-intolerant applications such as isotope separation. Together, these results outline a clear path of utilizing scalable aqueous electrochemical infrastructures for sustainable nonaqueous chemical production through selective interfacial ion-electron transfer.

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