UNIST | SCHOOL OF ENERGY AND CHEMICAL ENGINEERING

Organic Redox Flow Batteries for Long-Duration Energy Storages

• Time: 2025.12.09. (Tue) 16:00-17:15

• Place: 104-E206 Classroom

Speaker

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Abstract

Redox flow batteries (RFBs) are intensively researched at the moment, as they are most likely to provide a solution to the global demand for grid-scale energy storage. Given the scale of the intended application, realistic solutions must be scalable, cheap, and safe. Organic molecules are ideal, in principle, and they can be derivatized to optimize their performance. Yet, clear and successful demonstrations of this advantage and rational strategies of how to guide the design of new molecules have rarely been reported. Herein, I show that starting from naphthalene diimide (NDI) that is highly redox-active, but absolutely insoluble in water. We can rationally design a highly soluble charge carrier by tethering four ammonium functionalities to the NDI core that disrupts the long-order π-stacking that is a key feature leading to precipitation. Notably, the radical intermediate NDI– forms π-stacked dimers and tetramers during the charging process, where the radical character is nullified by antiferromagnetic coupling. It stabilizes radical intermediates without precipitation, and NDI delivers the state-of-the-art performance of RFBs at neutral pH. Our approach provides a simple solution to long-standing problems in the field, i.e., solubility, radical reactivity, and operational pH, and the mechanism of stabilizing radical intermediates is generally applied to organic RFB systems.