



UNIVERSITY OF MIAMI  
COLLEGE of  
ARTS & SCIENCES

## University of Miami, Physics Department Colloquium

---

**Date:** Wednesday, Apr 1, 2026

**Time:** 4:00 pm – 5:00 pm

**Location:** Physics Library – Rm 335, Knight Physics Building

### **Organic Electrode Materials for Affordable and Sustainable Na-ion Batteries**

**Dr. Chao Luo**, University of Miami

#### **Abstract**

Na-ion batteries (NIBs) are promising alternatives to Li-ion batteries (LIBs) due to the low cost, abundance, and high sustainability of sodium resources. However, the high performance of inorganic electrode materials in LIBs does not extend to NIBs because of larger ion size of Na<sup>+</sup> than Li<sup>+</sup> and more complicated electrochemistry. Therefore, it is vital to search for high-performance electrode materials for NIBs. To this end, organic electrode materials (OEMs) with the advantages of high structural tunability and abundant structural diversity show great promise in developing high-performance NIBs. To achieve advanced OEMs, a fundamental understanding of the structure–performance correlation is desired for rational structure design and performance optimization. Tailoring molecular structures of OEMs can enhance their performance in NIBs, however, the substitution rules and the consequent effect on the specific capacity and working potential remain elusive. Herein, we explored the electrochemical performances and reaction mechanisms of various organic electrode materials based on azo, imine, and carbonyl groups for NIBs. The electrochemical performance of polymer cathode materials with an extended conjugated structure such as a naphthalene backbone structure is better than that with benzene and biphenyl structures due to faster kinetics and lower solubility in the electrolyte. It unravels the rational design principle of extending  $\pi$ -conjugation aromatic structures in redox-active polymers to enhance the electrochemical performance. The resulting organic cathodes deliver high specific capacity, long cycle life, and fast-charging capability. Post-cycling characterizations were employed to study the chemical structure and morphology evolution upon cycling, demonstrating that the active centers in the polymer cathode materials can undergo reversible redox reactions with Na<sup>+</sup> for sustainable NIBs. In addition to polymer cathodes, the impacts of structure isomerism, halogenation, conjugation structures, and spatial effects toward the electrochemical performance of carboxylate anode materials will be discussed. This presentation will offer an in-depth understanding and guidance for rational structure design and performance optimization of organic anode materials in NIBs. Our work provides a valuable guideline for the design principle of high-capacity and stable OEMs for sustainable energy storage.

#### **Biography**

Chao Luo is an Associate Professor in the Department of Chemical, Environmental, and Materials Engineering at the University of Miami. His research focuses on developing organic materials, polymers, carbon materials, carbon/sulfur composites, and electrolytes for high-energy and sustainable batteries. He obtained B.S. degree from Wuhan University and Ph.D. degree at the University of Maryland, College Park. Before moving to the University of Miami in 2024, he was an Assistant Professor and Associate Professor at the George Mason University. He has published more than 90 peer-reviewed articles with total citation over 15,000 and h-index of 54. He is also the recipient of NSF CAREER award, an Emerging Investigator 2021 by Journal of Materials Chemistry A, and an Emerging Investigator 2023 by Chemical Communications.