THE CITY UNIVERSITY OF NEW YORK
College of Staten Island

THE GRADUATE CENTER
CITY UNIVERSITY OF NEW YORK

The CSI Chemistry Department Presents

Professor Robert J. Messinger

Department of Chemical Engineering and NASA-CCNY Center for Advanced Batteries for Space, The City College of New York

Molecular-Scale Understanding of Aluminum Metal Batteries for Sustainable & Low-Temperature Electromobility Applications

Date: 02/02/2023 **Time: 2:30 PM** **Room: 6S-138**

Rechargeable aluminum (Al) metal batteries are an emerging energy storage technology with great promise: aluminum is energy dense, low cost, inherently safe, earth abundant, and highly recyclable. Despite these opportunities, their technological development has been hindered by fundamental challenges associated with Al electrochemistry. Few electrolytes enable the reversible electrodeposition of Al metal at room temperature, while few positive electrode materials have been demonstrated that exhibit high energy density and cycle life within those electrolytes. Here, I will discuss recent progress in the design and molecular-scale understanding of Al-organic and Al-graphite batteries for sustainable and low-temperature electromobility applications. Understanding of their ionic and electronic charge storage mechanisms will be elucidated up from the atomic scale, revealed by a combination of electrochemical techniques, spectroscopic methods, and quantum chemical calculations, particularly multi-dimensional solid-state nuclear magnetic resonance (NMR) spectroscopy. For Al-organic batteries, we reveal that anthraquinone-based organic electrodes store charge by electrochemical enolization reactions coupled with charge-compensating complexation of polyatomic chloroaluminous cations. For Al-graphite batteries, we show that polyatomic chloroaluminate anions intercalate into graphite electrodes pseudocapacitively, reveal molecular insights into observed supercapacitor-like rate capabilities, and design ionic liquid electrolyte mixtures that enable enhanced low-temperature operation. In aggregate, the results provide new molecular-level understanding of emerging aluminum battery technologies designed towards sustainable and low-temperature energy storage applications.

Robert J. Messinger is an Associate Professor and the Director of Graduate Studies in the Department of Chemical Engineering at The City College of New York (CCNY). He is a core faculty member of the City University of New York (CUNY) Energy Institute. He earned a B.S. in chemical engineering from The Ohio State University (2006) and a Ph.D. in chemical engineering from the University of California, Santa Barbara (2012). Afterwards, he studied physical chemistry and electrochemistry at the CNRS, France, first as a European Union Marie Curie Postdoctoral Fellow in Orléans (2012-2014) and then jointly with the CNRS and Grenoble Institute of Technology (2014-2015). At CCNY, his research group studies electrochemical materials and multi-phase fluids for energy & environmental applications, with a strategic emphasis on measuring, understanding, and controlling phenomena up from the atomic scale that govern macroscopic material and device properties. He is an expert in multi-dimensional solid-state NMR spectroscopy. He won an NSF CAREER award (2019). Prof. Messinger is the Founding Director of the NASA-CCNY Center for Advanced Batteries for Space.

For More Information Contact: Michal Kruk (718-982-4030; Michal.Kruk@csi.cuny.edu)