UNIVERSITY OF RHODE ISLAND
Department of Chemistry Ph.D. Seminar

2:00 PM, Friday, April 21, 2023
Beaupre Room 105

Leah Rynearson
University of Rhode Island
Department of Chemistry

Investigation of Electrolytes for Silicon-Containing Anodes and on High Voltage Cathodes in Lithium-Ion Batteries

HOST
Daniel Thomas
Department of Chemistry
401-874-5834

Investigation of Electrolytes for Silicon-Containing Anodes and on High Voltage Cathodes in Lithium-Ion Batteries

Lithium-ion batteries have become essential to modern day life as people are increasingly reliant on mobile technologies. In particular, the automotive industry is working on developing a lithium-ion battery with improved energy density and greater capacity retention to advance the capabilities of the electric vehicle past that of the traditional combustion engine.

One way to improve energy density is to switch the anode material from the relatively low energy dense graphite to the much higher capacity silicon; however, the silicon-lithium alloying process involves severe volume expansion resulting in significant particle pulverization, loss of electrical conductivity, and fracturing of the solid-electrolyte interphase (SEI) which all cause significant capacity fade over extended cycling. Therefore, utilizing different additives like lithium difluoro(oxalato)borate and lithium nitrate in the electrolyte to preferentially reduce on the surface and form beneficial SEI products can help improve the capacity retention of silicon-containing anodes for longer periods of time and increase the overall energy density of the cell.

Significant capacity loss can also be observed in cycling cathodes in full cells to high voltages and at high temperatures. This occurs due to transition metal dissolution from the cathode, ion migration through the electrolyte, and deposition on the SEI on the anode. While much research has been done to track the oxidation state of the transition metal ion in the cathode or deposited on the anode, there have been mixed reports on the chemical state of the transition metal ions dissolved in the electrolyte. Therefore, X-ray absorption spectroscopy (XAS) was performed on electrolytes extracted from full cells built with four different cathode materials and cycled at standard and high voltages to determine the oxidation state of Mn and Ni in solution. The concentration of deposited metal ions on the anode surface was determined using inductively coupled plasma-mass spectrometry (ICP-MS).