UNIVERSITY OF RHODE ISLAND
Department of Chemistry
***Ph.D.** SEMINAR*

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"Investigation of Li-ion battery electrolyte for high voltage and low temperature applications"

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Abstract

Developing energy storage technologies play a key role in adoption of intermittent renewable energy sources and expansion of electromobility as a way of overcoming challenges related to climate change. To meet the demands of such diverse applications, Lithium-ion battery (LIB) technologies, one of the most reliable storage technologies today, have to be able to work at a wide range of operating conditions.

LIB operated at high operating potentials suffer from rapid capacity fade caused by the degradation of several components of the cell including the electrolyte. The electrolyte can undergo oxidative decomposition reactions on the cathode surface at high potentials (> 4.3 V vs Li/ Li^+) since the cathode operating potential exceeds the electrochemical stability window of the electrolyte. This oxidative decomposition of the electrolyte has been reported to result in the generation of a complicated mixture of products many of which are acidic in nature. These acidic species along with transition metals from the cathode participate in crossover reactions that degrade the anode solid electrolyte interphase (SEI) promoting capacity fade. In the first part of my talk, I will explore the correlation between the concentration of these crossover species in the electrolyte and capacity fade when the cells are cycled to high potentials.

LIB cycling performance is also strongly dependent upon the operating temperatures. In carbonate-based electrolytes, cycling performance is drastically decreased at temperatures below zero degrees Celsius because of reduced lithium ion transport properties and high charge transfer polarization at the electrode-electrolyte interphase. Low temperature performance of lithium ion batteries can be improved by using solvents that can lower viscosity which leads to better lithium ion conductivity in the bulk electrolyte and by introducing additives that aids formation of a better SEI that would reduce the charge transfer impedance. In the second part of the talk, I will present work I did in developing a novel ester based electrolyte formulation that is free of ethylene carbonate for improved low temperature performance.