***UNIVERSITY OF RHODE ISLAND***
***Department of Chemistry***
***SEMINAR***

***Room 105 Beaupre Center***
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## *"Pinpointing Transient Processes and Inhomogeneity Within Batteries: Aiding Design of Rechargeable Alkaline and All-Solid-State Li Cells"*

***HOST***

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**Pinpointing Transient Processes and Inhomogeneity Within Batteries:**
**Aiding Design of Rechargeable Alkaline and All-Solid-State Li Cells**

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*Northeastern University, Department of Chemical Engineering*

Among the most pressing problems of our time are the electrification of vehicles and the transition to renewable solar and wind power generation on a global scale. Developing new battery designs is essential to achieving both goals, and there has been a corresponding increase in battery research and development. Fundamental knowledge of electrochemistry is in demand for scientists and engineers entering the workforce, and companies seek to produce batteries and battery materials to meet an accelerating demand. Electrochemical systems such as batteries involve the kinetics and thermodynamics of charge transfer reactions, coupled to conduction and transport of chemical species. This coupling often leads to inhomogeneous processes within batteries, whose hermetic seals and casings can hide unexpected behavior. In fact, transient and inhomogeneous events within batteries frequently trigger degradation mechanisms, and lead to battery failure.

We have used *in situ* and *operando* characterization techniques to observe phenomena within batteries during cycling. These methods are powerful because they eliminate the possibility that materials are oxidized or altered during extraction from the battery and sample preparation. In particular, we have developed methods based on synchrotron light that can reveal both long-range and short-range molecular order within battery materials, often with tomographic-type spatial resolution. This talk will discuss recent mechanistic details discovered for two systems: (1) rechargeable alkaline batteries, which are low-cost and high-safety, making them ideal candidates for batteries integrated into the power grid on a massive scale; and (2) solid-state Li batteries, which hold the promise of higher energy density and higher safety than current-day Li-ion batteries, by replacing the flammable liquid electrolyte with solid $Li^+$ conducting materials. Successful development and commercialization of these new battery chemistries will require detailed mechanistic knowledge of their failure modes, which our work addresses.

**Bio:**

Joshua Gallaway is the DiPietro Assistant Professor in Chemical Engineering at Northeastern University, where he has founded the Analysis of Complex Electrochemical Systems Laboratory (ACES Lab). He received his PhD in chemical engineering from Columbia University in 2007. Working with his advisor Prof. Scott Calabrese Barton, he characterized the electron transfer rates of enzymes embedded in oxygen-reducing hydrogels. After his PhD work he completed a postdoctoral appointment with Prof. Alan West, also at Columbia, studying non-uniform current distributions in sub-micron interconnect features for the semiconductor industry. He then joined the newly-formed CUNY Energy Institute in a research position funded by the Wallis Foundation. There he worked on an ARPA-E funded project headed by Distinguished Professor Sanjoy Banerjee, which resulted in the spin out company Urban Electric Power. His recent research has focused on using high energy synchrotron techniques to visualize non-uniform reactions within battery electrodes.