DREXEL UNIVERSITY
Materials Science and Engineering
College of Engineering

Department of Materials Science and Engineering
Spring Seminar Series

2:45 PM, Wednesday, May 9
PISB 106

"The Promise and Challenges of Implementing Insertion Compounds in Electrochemical Deionization Devices"

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Abstract:
Insertion compound materials, which can attract significantly higher volumetric ion concentrations compared to high surface area activated carbons commonly used for CDI, are appealing and still underexplored. These materials posses stable redox potentials that can be leveraged to avoid electrolysis losses and commensurate pH shifts, and can have excellent long-term stability depending on operational conditions. They are also inherently ionically selective in that insertion compound will attract some species and reject others during electrochemical biasing. In this talk, we seek to comprehensively address benefits and challenges of using insertion compounds for CDI in different water concentrations, pH values, and compositions. Specifically, our presentation will explore (a) the origins of electrolysis and other losses in CDI systems and how insertion compounds might be used to overcome these issues, (b) the behavior of two different compound materials in solutions with a wide range of concentrations and compositions, and (c) comparative assessment of deionization devices that used static vs. slurry flow electrodes. The two insertion compounds discussed will be $Na_4Mn_9O_{18}$ and $NaTi_2(PO_4)_4$, and their performance in salt concentrations ranging from 10 to 1000 ppM will be discussed using half cell and full CDI device – level data. Results suggest that while better voltage control and volumetric ion densities are possible, overpotential losses and transport asymmetry issues can be problematic, particularly in solutions of lower concentration. The ability for insertion compounds to selectively remove one ionic species over another will also be addressed and contextualized.

Bio:
Dr. Whitacre started his career at the California Institute of Technology/Jet Propulsion Laboratory, where he studied the fundamental and applied aspects of electrochemically functional materials and devices, and was also trained as a systems engineer. Since coming to CMU in 2007, Whitacre has focused on the synergistic fields of energy storage and energy system modeling, and in the course of this work developed a novel battery chemistry/design that is manufactured and sold by Aquion Energy, a company he founded in 2008. He is the recipient of multiple awards, including the 2015 Lemelson-MIT Prize, the 2014 Caltech Resnick Institute Resonate Award, the 2017 Leigh Ann Conn Prize for Renewable Energy, and has been named a Fellow of the National Academy of Inventors. Whitacre has authored or co-authored over 75 peer review papers and is an inventor on over 30 patents that are issued or pending worldwide. Dr. Whitacre earned his B.A. Degree in Physics (within honors) from Oberlin College in 1994, and a Ph.D. (1999) in Materials Science and Engineering from the University of Michigan. In May 2017 Whitacre assumed the Directorship of the Scott Institute for Energy Innovation at Carnegie Mellon.

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