PennState College of Engineering | CHEMICAL ENGINEERING

Chemical Engineering Seminar Series

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Thursday,
January 23, 2020

350 Health & Human Development Building

10:50-11:50 a.m.

FexNi100-xOy Electrocatalysts for the Oxygen Evolution Reaction: Role of Electrochemical History and As-Synthesized Properties on Atomic Structure

Abstract

FexNi100-xOy electrocatalysts have become a focus for alkaline water electrolysis and the oxidative half reaction of oxygen evolution. Under alkaline conditions, the oxygen evolution reaction (OER) can be promoted by non-precious metal oxide and hydroxide electrocatalysts. In particular, electrocatalyst compositions from first row late transition metals such as iron, nickel, manganese, and cobalt have emerged as some of the most active catalysts for the OER, and the role of iron has been identified as key within multi-metallic compositions. In our research, we have focused specifically on the iron-nickel bimetallic composition and have developed synthesis methods to be able to control the bimetallic composition, surface chemistry, and three-dimensional morphology of a suite of FexNi100-xOy nanoparticle electrocatalysts. Electrocatalytic performance testing of our suite of electrocatalysts has revealed that several of the FexNi100-xOy nanoparticle materials result in similar OER current density and stability. Through extensive characterization of the as-synthesized nanoparticle materials, we have found that the surface composition of the best-performing nanoparticles ranges from 20% to 50% Fe, and the nanoparticle materials range in the crystallinity and disorder of the bulk and surface.

With this suite of highly-active FexNi100-xOy nanoparticle electrocatalysts, we have recently been focused on ex situ and operando x-ray absorption spectroscopy (XAS) studies to understand how the chemistry of the iron and nickel species within these nanocatalysts changes as a result of exposure to the electrochemical environment. During these studies, we have discovered that the electrochemical history that the nanoparticles experience, as well as the as-synthesized properties of these nanoparticles, influence both the operando and the end-state chemistry. In this talk, I will discuss our initial findings around how changes in electrochemical history (e.g., dynamic or static applied potential) influence end-state chemistry structure, including oxidation state, phase, disorder, and coordination environment. Further, I will discuss our findings on how the as-synthesized properties may influence the operational and end-state chemistry of these FexNi100-xOy nanoparticle electrocatalysts. Results will include both iron and nickel K edge x-ray absorption near edge structure (XANES) and extended x-ray absorption fine structure (EXAFS) data for both ex situ and operando experiments, as well as characterization data and electrocatalytic performance data.

Biosketch

Lauren received her B.S. in Chemical Engineering from the University of Michigan, Ann Arbor, in 2001 and then spent several years working abroad in France and Switzerland. Subsequently, she worked in Boston for a pharmaceutical start-up company before attending graduate school at the University of Texas at Austin. She received her M.S. in Environmental Engineering in 2006 and her Ph.D. in Chemical Engineering in 2009, where she focused on understanding the precipitation of scaling salts during reverse osmosis membrane desalination. Lauren then held a National Research Council postdoctoral fellowship at the National Institute of Standards & Technology (NIST) from 2009 – 2011, with a focus on iron nanoparticle synthesis and characterization for water treatment applications. She continued at NIST as a staff scientist and led the Engineered Nanoparticle Systems Project for four years, before joining the faculty of the Ralph E. Martin Department of Chemical Engineering as an Assistant Professor in December 2015, with promotion and tenure to Associate Professor in July 2019. She currently holds the Ralph E. Martin Leadership Chair in Chemical Engineering. Her research group is interested in the intersection of water chemistry, nanomaterials chemistry, and electrocatalysis for current challenges in water, energy, and agriculture sustainability. Lauren has educational interests in leadership and writing skills, and also pursues entrepreneurial activities as a co-founder and CTO of her company, CatalyzeH2O.