BIG energy seminar series

Addressing the scale and complexity of the global energy challenge.

Mechanistic Analysis of Electrochemical Oxygen Reduction and Development of Economical Silver-alloy Catalysts for Low Temperature Fuel Cells

Dr. Adam Holewinski

Georgia Institute of Technology

Date: Thursday, February 27, 2014 at 2:30 pm
Location: Caruthers Biotechnology Building, A115 (East Campus)

Abstract:

The oxygen reduction reaction (ORR), $O_2+4H^++4e^- \rightarrow 2H_2O$, is the major source of efficiency loss in low-temperature fuel cells. Expensive, Pt-based materials have been found to be the most effective ORR catalysts, but exploration of more economic alternatives has been hampered by stability constraints for metals at typical fuel cell operating conditions (e.g. low pH and high potential). Many metals exhibit enhanced corrosion stability at high pH, and recent advances in alkaline membrane technology have made fuel cell operation at high pH feasible. In basic medium, Ag is redox stable and shows ORR activity that is competitive with Pt on a cost basis. In this study we exploit mechanistic insights from microkinetic modeling and quantum chemical calculations to identify alloys of Ag and 3d elements with enhanced ORR activity and experimentally confirm their high activity. Though these alloys are not favored to form thermodynamically, we utilize novel synthesis techniques that generate near-surface alloy structures that are stable under operating conditions. We demonstrate their superior ORR activity with rotating disk electrode experiments, and perform thorough structural characterization of the bulk and surface properties with a combination of cyclic voltammetry, x-ray diffraction, and aberration-corrected electron microscopy with spatially resolved electron energy loss spectroscopy. We have additionally performed tests to selectively leach free 3d-metals from the materials and demonstrate that the enhanced activity is caused by perturbation of Ag by the alloying element rather than any direct interaction between O_2 and the 3d elements.

Bio:

Dr. Holewinski attended the University of Michigan for his BS, MS, and PhD in Chemical Engineering. He spent some time in industry on internships with both Pfizer and BP. Brian conducted his Ph.D. research on electrocatalytic systems with Suljo Linic at Michigan. Dr. Holewinski recently began a Postdoc with Chris Jones at Georgia Tech, working on hybrid, organic-functionalized catalytic materials as adsorbents and catalysts.

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