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Atomic-scale Insights into Electrocatalyst Structure and Function

ABSTRACT:

The development of efficient renewable energy conversion and storage devices is one of the most important challenges of the 21st century. Fuel cell catalysis, CO₂ reduction, etc. are promising reactions for transforming our energy economy. However, these reactions are sluggish because of unfavorable reaction kinetics, and suffer from poor product selectivity. Ordered intermetallic compounds (OIC) can exhibit enhanced performance and selectivity for mediating electrochemical reactions relative to solid-solution alloys. However, OIC often require high temperature and pressure to synthesize, resulting in poor control of the morphology. Despite decades of intense research, OIC nanoparticles have failed to replace conventional nanomaterials due to a lack of low-temperature synthetic methods which can overcome slow solid-state diffusion rates, and inability to tune composition and phase while maintaining well-defined morphologies. In this talk I will discuss our efforts on the synthesis, stability, and catalytic activity of OICs prepared by electrochemical methods at room temperature and atmospheric pressure. Our strategies include the use of electrochemically induced phase transformations which enables us to convert an alloy to a noble metal rich OIC by removal of the base metal, and the direct production of OIC materials by electrochemical deposition. Developing new methods for preparing OIC compounds under ambient conditions is essential for designing catalysts for the next generation of renewable energy conversion devices.

BIO:

Anthony Shoji Hall is an assistant professor in the department of Materials Science and Engineering at the Johns Hopkins University. Prior to joining Johns Hopkins University, he was a Postdoc at MIT in the Chemistry department. He earned his PhD in Chemistry from Penn State in 2014 and a B.S. in Chemistry from UCLA in 2010. Dr. Hall has received numerous awards for his research such as the NSF CAREER award, the ECS Toyota Young Investigator Fellowship. The Hall group focuses on developing methods to produce nanostructured ordered intermetallic compounds at room temperature and atmospheric pressure for electrocatalytic applications, interrogating the structure-property relationships of electrocatalytic materials with in-situ infrared spectroscopy, and the electrochemical valorization of small molecules.