CHEMICAL ENGINEERING SEMINAR SERIES

Facet-Selective and Flow-Through Electrochemistry with Metal Nanowires

Benjamin J. Wiley

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10:50 am
350 Health & Human Development Building
University Park, PA

Metal nanowires are metal sticks tens of nanometers wide and tens of micrometers long. Why metal nanowires grow in isotropic solutions when their crystal structures have cubic symmetry has been a mystery for nearly 20 years. Researchers have hypothesized that organic additives, usually called capping agents, direct anisotropic growth of nanowires by adsorbing to the sides of nanowires while leaving the ends open to atomic addition. I will show measurements with single-crystal electrodes can be used to test this capping agent hypothesis. The evidence suggests the capping agent hypothesis is wrong for at least two different nanowire syntheses.

In the second half of my talk, I will show how a three-dimensional network of nanowires can be used to achieve unprecedented rates of electrochemical conversion. Achieving a high rate of electrochemical conversion requires the use of flow-through porous electrodes, but the types of flow-through electrodes that are commercially available has not changed in ~40 years. A Cu nanowire electrode reduced Cu ions at a single-pass conversion of 75% at a flow rate 278 times greater than for carbon paper. For the intramolecular cyclization of 2,2′-bis(bromomethyl)-1,1′-biphenyl to 9,10-dihydrophenanthrene, the maximum productivity of the Cu nanowire electrode was 4 times higher than that of carbon paper. These results demonstrate the ability of nanowire electrodes to improve the productivity of electrosynthesis.

About the Speaker

Benjamin J. Wiley is an Associate Professor in the Department of Chemistry at Duke University. He received his B.S. in Chemical Engineering from the University of Minnesota in 2003, and his Ph.D. in Chemical Engineering from the University of Washington, Seattle in 2007 with Professor Younan Xia. From 2007-2009, he was a postdoctoral fellow at Harvard University in the laboratory of George M. Whitesides. He joined the Department of Chemistry at Duke University as an Assistant Professor in 2009.

Professor Wiley is the recipient of the Ralph E. Powe Junior Faculty Enhancement Award, the CAREER award from the Nation Science Foundation, the Beilby Metal from the Royal Society of Chemistry, the Buck-Whitney Award, and has been recognized as a Highly Cited Researcher by Thomson Reuters in 2014 and 2018. Since 2018, Professor Wiley has been an Associate Editor of *Nanoscale and Nanoscale Advances.*

Professor Wiley's research has focused on understanding the processes that drive anisotropic growth of metal nanostructures, and studying the structure-property relationships of metal nanostructures in the context of transparent conducting films, transparent electrocatalysts, stretchable conductors, and printable electronics. Over the last 10 years, this work has been reported in 58 publications. This work has also led to Professor Wiley being a founder of two startup companies.

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