

Jan 17, 2013

Rational Nanostructure Design for Efficient Energy Devices



Yan Yao

Assistant Professor

Dept. Electrical &
Computer
Engineering

University of
Houston

Houston, TX 77204

Abstract: Efficient energy conversion and storage play important roles in the renewable energy landscape. In developing next-generation high-performance and low-cost batteries and solar cells, significant challenges exist at both the fundamental and practical levels. In this talk, I will discuss how rational nanostructure design can provide us a unique opportunity to manipulate the electrons, ions and photons to obtain remarkable device performance. In the first example, I will demonstrate a new approach to broad-band light trapping by forming whispering-gallery resonant modes inside a spherical nanoshell structure. Using nanocrystalline silicon (nc-Si) as a model system, the absorption of a single layer of 50-nm-thick spherical nanoshells is equivalent to a 1- μ m-thick planar nc-Si film. Then I will show lithium-ion battery anodes made of interconnected hollow spherical structure are capable of accommodating large mechanical strain without pulverization. The structure design is theoretically guided to effectively reduce lithium-diffusion-induced stress and experimentally verified with long electrochemical cycling life. Finally, I will show the approaches of nanoscale morphology engineering for efficient polymer bulk-heterojunction solar cells.

Biography: Dr. Yao is an Assistant Professor in the Department of Electrical and Computer Engineering at the University of Houston. He received his Ph.D. from the University of California, Los Angeles in 2008. He was a senior scientist at Polyera Corporation from 2008 to 2010 and a postdoctoral scholar at Stanford University from 2010 to 2012. His research focuses on the materials and devices for energy storage and conversion: understanding the structure-property-performance relationship at the atomic level and designing nanostructured materials for advanced lithium batteries, solar cells, and catalysts. (<http://yao.ee.uh.edu>) Dr. Yao has published 32 papers in peer-reviewed journals with total citation over 5500. His honors include the Roberts A. Welch Professorship (2012), Excellence in Graduate Polymer Research Award (2008), and the Chinese Government Award for Outstanding Students Abroad (2007).