Chemical Engineering Distinguished Young Scholars Seminar

Composite Nanoparticles for Electronic Applications

Jeff Richards
NRC Fellow
National Institute of Standards & Technology

Date: Monday, August 17, 2015
Time: Lecture: 4:00-5:00 p.m.
Place: PAA A110
Happy Hour in Benson Hall Lobby

Abstract

Advances in synthetic techniques have enabled a revolution in the design of colloidal dispersions containing particles with uniform size, shape and composition. In turn, studying these uniform particle populations has provided a sophisticated understanding of how the intrinsic characteristics of a nanoparticle determine the strength and range of inter-particle interactions and consequently the extrinsic properties of the dispersion. The intimate link between the intrinsic and extrinsic properties of a colloidal dispersion provides a powerful design paradigm for the development of new materials for a wide range of engineering problems. I will present two examples of the use of novel nanoparticle formulations to address specific challenges in the development of renewable energy. In both examples, understanding both the intrinsic and extrinsic relationships of the colloidal dispersion have important implications for making improvements performance.

In the first example, aqueous dispersions of composite conjugated polymer/fullerene nanoparticles are investigated for organic solar cell applications. Similar to their thin-film counterparts, the performance of these composites is a function of the distribution of polymer and fullerene within the particle volume. Contrast Variation Small Angle Neutron Scattering (CV-SANS) is used to investigate how the internal structure of these composite nanoparticles changes as a function of the production process. These structural features are related to their electronic performance using conductive probe Atomic Force Microscopy (AFM). In the second example, I will show ongoing work in the design and synthesis of nanoparticles that possess a mixed ionic and electronic conducting adsorbed polymer layer. We hypothesize that this polymer layer will allow for electrical charge percolation in concentrated suspensions without the onset of mechanical percolation or prohibitively high viscosities. We use neutron scattering and electron microscopy to interrogate the properties of the polymer layer and relate these to dispersion's viscosity and dielectric properties. These new materials will have relevance to flow capacitor and battery applications.

Bio

My primary research interests include the development and characterization of functional colloids as building blocks for optoelectronic applications. I received my PhD in August 2014 from the Department of Chemical Engineering at the University of Washington working for Dr. Lilo D. Pozzo. I worked briefly as a postdoctoral research for Dr. Norman Wagner in the Department of Biomolecular and Chemical Engineering Department at the University of Delaware and then joined the NIST Center for Neutron Research in Gaithersburg, MD as a NRC Fellow. My current research focus at the NCNR is on the development of composite mixed ionic and electronic conductive metal oxide particles for flow battery applications.

CHEMICAL ENGINEERING
UNIVERSITY *of* WASHINGTON
Knowledge and solutions for a changing world