THE OHIO STATE UNIVERSITY

The William G. Lowrie Department of Chemical and Biomolecular Engineering Graduate Program

Cordially invites you to attend a seminar on

Structure and Dynamics in Nanostructured Polymeric Materials for Sustainable Energy

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College of Engineering
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Thursday, October 15th, 11:30 AM

Zoom Webinar URL:
https://osu.zoom.us/j/97651982136?pwd=WGlnVXg2QjNGcDN5VUQ0bkNHTnZKdz09
Password: 701190

Bio

Daniel T. Hallinan Jr. is an Associate Professor at the Florida A&M University–Florida State University College of Engineering with interest in fundamental polymer physics of nanostructured materials such as block copolymers and polymer-grafted nanoparticles as well as applications related to energy sustainability. He is a chemical engineer with bachelors degrees from Lafayette College and a PhD from Drexel University. His post-doctoral research was conducted at Lawrence Berkeley National Lab and the University of California, Berkeley. He is actively involved in the polymer communities of the American Physical Society and the American Institute of Chemical Engineers. He recently received an NSF CAREER Award, and has testified before a U.S. Congressional Subcommittee in support of national synchrotron facilities, which his group uses extensively.

Abstract

Our research is fundamentally driven by the desire to understand how nanostructure impacts the dynamics and macroscopic properties of polymers. We focus on two classes of single-component, nanostructured polymeric materials: block copolymers and polymer-grafted nanoparticles. Specifically, we are interested in poly(ethylene oxide) (PEO), a remarkable polymer with low glass transition temperature that can dissociate alkali metal salts (such as those of lithium). In addition, PEO is hydrophilic and selective to CO_2 over other gases. When it is combined with a hydrophobic polymer in a high-molecular-weight block copolymer it forms strong, free-standing membranes that are of potential interest as lithium battery electrolytes. When it is grafted to a nanoparticle, the inherent free volume can be modified, which is interesting for gas/vapor separation membranes. Battery and membrane separation performance requires rapid, selective transport. Transport, in turn, is affected by the structure and dynamics of the polymeric material. Two of our recent experimental results will be presented: (1) time-resolved X-ray scattering studies of a block copolymer composed of PEO and polystyrene (a glassy polymer that confers mechanical strength) and (2) detailed investigation of the structure and properties of gold nanoparticle (Au NP) monolayers. The first project uses X-ray photon correlation spectroscopy (XPCS), a time-resolved technique that can probe dynamics on nanometer length scales in polymer melts. In an attempt to understand the physical origin of the surprising collective dynamics observed with XPCS, we compare XPCS results with chain dynamics probed using small-amplitude oscillatory rheology. In the second project, we have developed a patented technique to deposit Au NPs in well-ordered monolayers. The spacing between NPs is dictated by the molecular weight of the ligands attached to the particle surfaces. Thus, particle spacing has been used to examine the conformations of grafted PEO chains in solvents of varying quality. In summary, two of our recent studies will be presented that are part of our effort to understand how nanostructure affects the mesoscopic properties of polymeric materials. The eventual goal is to elucidate how mesoscopic properties are transmitted to the macroscopic scale which ultimately dictates the performance of polymer membranes in sustainable energy applications.