**Diffusion and Dynamics in Nanostructured Membranes**

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We are interested in understanding how nanostructure impacts the dynamics and macroscopic properties of polymers. This seminar will focus on amphiphilic block copolymers. Specifically, we are interested in poly(ethylene oxide) (PEO), a remarkable polymer with low glass transition temperature that is hydrophilic, is selective to CO2 over other gases, and is able to dissociate alkali metal salts (such as those of lithium). When combined with a glassy polymer, such as polystyrene (PS), a microphase separated block copolymer can be obtained due to the mutual incompatibility of PEO and PS. The two-phase nanostructure enables the formation of strong, free-standing membranes of potential interest for membrane separations and lithium batteries. These applications require rapid, selective transport. Transport, in turn, is affected by the structure and dynamics of the polymeric material. The glassy PS confers mechanical strength, while the PEO provides selective transport pathways. The seminar will focus on water diffusion in PEO-PS block copolymers, as well as the structure and dynamics of the material itself. Key techniques that will be covered are time-resolved Fourier Transform infrared spectroscopy (FTIR), as well as time-resolved X-ray scattering and oscillatory shear rheology. The presence of water was found to have interesting impact on the hierarchical structure of the block copolymer, which in turn affected water diffusion. Specifically, water dissolved PEO crystallites. A model was developed to capture the combined mechanisms of diffusion and crystallite dissolution. In addition, both morphology of the nanostructure and temperature had significant impact on water diffusion. Block copolymer dynamics was probed with X-ray photon correlation spectroscopy (XPCS) and compared to chain dynamics probed with small-amplitude oscillatory shear rheology. The work provides some insight into how mesoscopic properties are transmitted to the macroscopic scale which ultimately dictates the performance of polymer membranes in sustainable energy applications.

# Biographical Summary of Daniel T. Hallinan Jr.

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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 and artificial muscles. He is a chemical engineer with bachelors degrees from Lafayette College and a PhD from Drexel University, during which he studied at the University of Bologna for 5 months. His post-doctoral research was conducted at Lawrence Berkeley National Lab and the University of California, Berkeley. He is involved in the polymer communities of the American Physical Society and the American Institute of Chemical Engineers. He has 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.

