Research Areas
Polymer Science & Engineering

Research Interests

Polymer structure and dynamics, self-assembly

We are pursuing a molecular-level understanding of polymer structure and dynamics. Currently, we are most interested in multicomponent systems -- copolymers, homopolymer blends, and their mixtures -- in solution and in the bulk state. Such materials are of great commercial interest, due primarily to the potential flexibility for tailoring superior combinations of physical properties. The overall scientific challenge is to understand how the thermodynamic interactions among the components control both structure and dynamics. For example, the (net) repulsive interactions between blocks of a block copolymer lead to spontaneous self-assembly into a variety of microstructures, each with a periodicity set by the molecular size, i.e., in the tens of nanometers. The same interactions may cause a blend of the corresponding homopolymers to undergo macroscopic phase separation. However, this separation is often quite slow, and may be arrested (e.g., by vitrification, crystallization, or added copolymer surfactant) to produce interesting morphologies with characteristic dimensions on the micron scale. In these, and other situations under study, the already distinctive dynamic properties of polymers may couple in unexpected ways to structural features.

A host of experimental techniques are employed, including structural probes, such as scattering of light, x-ray, and neutrons, and microscopy. We take particular advantage of cryogenic transmission electron microscopy, to examine micellar structures in water, organic solvents, and ionic liquids, without the need for sample staining. Measurements of collective dynamics, by dynamic light scattering and rheology, are also routinely pursued. Another specialty is chain diffusion using the transient optical grating technique of forced Rayleigh scattering. Finally, most of the polymer samples employed are synthesized in-house.

Awards

Award in Polymer Chemistry, American Chemical Society, 2010
Selected Publications


