Research Areas

- Biological Engineering
- Materials Processing
- Materials Theory
- Polymer Science & Engineering

Research Interests

The central theme of our research program derives from a desire to better understand the thermodynamics and dynamics of polymers and polymer mixtures. Three broad areas of investigation have been developed for addressing these issues: polymer synthesis, chemical modification, and molecular characterization; structural analysis by neutron, X-ray, and light scattering, and electron microscopy; dynamical characterization through rheological and processing measurements and mechanical property evaluation. These efforts address issues in each field individually, as well as contributing to our central goals.

Anionic and living free-radical polymerization represent the primary synthetic tools with which we control polymer molecular weight, molecular weight distribution, microstructure, and chain architecture. Subsequent modifications such as catalytic hydrogenation provide for the preparation of model functionalized polymers. Molecular characterization techniques include NMR, size exclusion chromatography, and light scattering.

Establishing the phase behavior and excess thermodynamic properties of polymer mixtures and block copolymers is accomplished through extensive use of small-angle neutron scattering and neutron reflection, along with X-ray and light scattering conducted in our laboratory and at national facilities. We are particularly interested in elucidating the molecular mechanisms governing nanoscale morphology formation in melts and solutions, especially in aqueous systems, and related applications.

Polymer phase state is often correlated with rheological and mechanical properties, particularly for block copolymers, which we investigate in conjunction with the scattering experiments. The ultimate material properties that are addressed include modulus, tensile strength, ductility and toughness.
This basic research program affects a variety of technologically important fields, including polymer processing, composites, fracture mechanics, drug delivery and certain medical applications. An overarching theme of this research program reflects a commitment to develop commercially viable synthetic polymers that support a society based on the sustainable use of science and technology.

Selected Publications


