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. 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 (e.g., catalytic hydrogenation) provide for the preparation of model functionalized (e.g., saturated) 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 at national facilities, along with X-ray and light scattering conducted in our laboratory. 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 properties, particularly for block copolymers, which we investigate in conjunction with the scattering experiments.

This basic research program affects a variety of technologically important fields, including polymer processing, composites, fracture mechanics, separations, catalysis, and drug delivery.

Selected Publications


