Research Areas

Materials Processing
Polymer Science & Engineering

Research Interests

Polymer processing is a challenging blend of transport phenomena, chemistry, and materials science. Our research efforts include developing and testing models for processes that involve network polymerization (such as electronics encapsulation), nanoparticle reinforced polymer composites, interfacial reaction during polymer blending, and polymerization with phase separation (for example, formation of polyurethane block copolymers during reactive foaming).

Modeling processes that include polymerization require an understanding of how the polymer structure develops. Branching theory relates network formation in cross-linking polymers through reaction kinetics to physical property changes: viscosity, modulus, strength. Applications range from producing slightly branched polymers for rheology control to lightly crosslinked proteins and tightly crosslinked sol-gel ceramics.

Reaction at the interface between two homopolymers forms a block or graft copolymer. This acts as a surfactant which stabilizes the morphology of a mixture of the two homopolymers. We are studying the interfacial chemistry and varying homopolymer structure to optimize interface reaction with application to immiscible polymer blends. Morphology control in these blends is critical for improving such properties as impact strength, adhesion and permeability.

Processes involving free surfaces, particularly coating flows of non-Newtonian fluids, are also challenging. New rheological test methods and constitutive equations are needed to accommodate the wide range of deformation rates and mix of shear and extension, which occurs in coating flows. These are incorporated into finite element models of various coating flows with emphasis on predicting experimental free surface shape, thickness, stability, and pressures.

Awards

Charles M.A. Stine Award in Materials Engineering and Sciences, AIChE - 1988.
Selected Publications


