Research Areas

Applied & Computational Mathematics
Materials Theory
Polymer Science & Engineering

Research Interests

Research in my group aims to improve our theoretical understanding of complex polymer liquids. We use a combination of analytic and computational approaches. Much of our recent work has focused on self-assembled equilibrium structures of systems that contain block copolymers or on the dynamics and rheology of liquids and gels containing polymers with stiff backbones.

Our work on systems that contain block copolymers has relied heavily on the use of numerical self-consistent field theory (SCFT) to predict equilibrium structures, and has often been motivated by and/or carried out in collaboration with experimental colleagues. Recent work along these lines has included analysis of complex morphologies in both triblock and diblock copolymer melts, and analysis of the use of block copolymers as surfactants in immiscible polymer blends. We are now working on theoretical methods that attempt to systematically improve upon SCFT by taking into account the effects of the collective composition fluctuations that SCFT ignores.

Studies of solutions and networks of rigid backbone polymers are motivated in part by the important structural roles played by semiflexible protein filaments such as F-actin in cellular biology. We are trying to provide a sound understanding the rheology of solutions and gels of such polymers on the basis of a wormlike chain model of polymer conformations, in both dilute and highly entangled concentration regimes. Our work in this area has included both analytic theory, and the use of Brownian dynamics simulations to characterize chain motion in highly entangled solutions.

Awards
Selected Publications


Diffusion of copolymer surfactant to a polymer/polymer interface, D.C. Morse, Macromolecules 40, 3831 (2007).


Block copolymer surfactants in immiscible homopolymer blends: swollen micelles and interfacial tension, K. Chang and D.C. Morse, Macromolecules 39, 7746 (2006)


Linear elasticity of cubic phases in block copolymer melts by self consistent field theory, C.A. Tyler and D.C. Morse, Macromolecules 36, 3764 (2003).


A Rouse-like model of liquid crystalline polymer melts: director dynamics and linear viscoelasticity, D. Long and D.C. Morse, J. Rheology 46, 49 (2002)

Dynamics of kink bands in layered liquids: theory and in situ SAXS experiments on a block copolymer melt, L. Qiao, D.C. Morse, and K.I. Winey, Macromolecules 34, 7858 (2001)
