



~~Special Polymer Physics Seminar ~~

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301 Steidle Bldg.

A tale of two surfactants: combining light and neutron scattering with rheology to understand shear banding and shear induced phase transitions in wormlike micellar solutions

Cationic surfactants that self-assemble into viscoelastic, worm-like micelles (WLM) can exhibit an interesting flow anomaly known as shear-banding, which is characterized by extreme shear thinning and the formation of stratified flow. This transition has been postulated to be due to a flow-aligned state, which is often associated with a nearby (in composition space) equilibrium phase. Here, we exploit some unique opportunities afforded by the development of new flow-SANS and rheo-SALS instruments, coupled with rheology and particle tracking velocimetry, to elucidate the mechanism of this rheological anomaly.

Measurements of the micellar segmental alignment, flow kinematics, and mesoscale microstructure are presented for two model WLM solutions, providing the first local measurements of the microstructure and rheology through the shear banded state. Distinct differences in behavior are observed for two different classes of surfactants that correlate with the underlying equilibrium phase behavior and surfactant topology (linear versus branched). In one, shear banding is associated with increased segmental alignment of the WLMs, while in the other, shear banding results from strong density fluctuations associated with surfactant network formation. The results demonstrate that different flow-induced microstructures can result in shear banding and that the behavior correlates with the underlying phase behavior of each surfactant. We also demonstrate how the combination of rheology, flow kinematics, and SANS measurements of flow-induced microstructure locally in the flow field can be used to critically evaluate constitutive equations for WLMs.