Rheo-x-ray methods for studying complex polymer fluids under flow

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The non-Newtonian flow characteristics of polymers and other complex fluids is intimately related to the ability of flow fields to perturb molecular or meso-scale structure. Consequently, modern research emphasizes the molecular or microstructural origins of complex rheological behavior. Further, technological applications of polymers often rely on flow-induced structural changes (i.e. molecular orientation) that affect the resulting material properties. This talk will describe efforts to establish in situ x-ray scattering as a tool to probe the structure of complex polymer fluids under flow. High brilliance synchrotron sources coupled with advances in detector technology enable real-time studies of transient structural dynamics, which can, in many cases, be directly linked to macroscopic rheological behavior. The presentation will survey applications of these methods to two problems: measurement of particle orientation in polymer nanocomposites during shear flow, and studies of flow-induced structural changes during and following uniaxial extensional flow of ordered block copolymer melts.