Pattern Formation and Scaling in Critical Polymer Mixtures Under Simple Shear Flow

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The behavior of polymer blends under shear flow is of profound scientific as well as technological importance. In situ light scattering and optical microscopic instrument has been developed at NIST which permit detailed morphological studies of such systems under simple shear. For phase-separated blends near a critical point of unmixing, homogenization occurs via repeated domain fragmentation, which gives way to distinct patterns in the strong-shear limit. Data for a variety of systems collapse onto universal scaling curves that are in good agreement with modern theories of nonequilibrium critical phenomena. The corresponding composition change from both shear deformed domain and matrix can be obtained from the fluorescence microscopy which is part of the multi-detection systems of our instrument. The corresponding shear induced critical temperature shift can be compared to that of previous measurements in the quiescent one-phase region. For strongly incompatible mixtures, or systems deep into the two phase region, however, the shear response saturates in a manner that has deep implications for the flow-induced blending of polymeric fluids.

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