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Single Polymer Dynamics under Large Amplitude Oscillatory Extensional (LAOE) Flow YUECHENG ZHOU[1], CHARLES M. SCHROEDER, Univ of Illinois - Urbana — Over the past two decades, advances in fluorescence imaging and particle manipulation have enabled the direct observation of single polymer dynamics in model flows such as shear flow and planar extensional flow. The vast majority of single polymer studies, however, has focused on chain dynamics using simple transient step forcing functions. In order to study single polymer dynamics in non-idealized model flows, there is a clear need to implement more complicated transient flow forcing functions. In bulk rheology, large amplitude oscillatory shear (LAOS) was widely used to study the linear and nonlinear viscoelasticity of materials, but not yet been applied to molecular rheology. In this work, we directly probe single polymer dynamics using oscillatory extensional flow in precisely controlled microfluidic devices. We are able to generate large and small amplitude sinusoidal oscillatory extensional flow in a cross-slot microfluidic device while imaging the conformational dynamics of a single polymer trapped at the stagnation point. In this flow, polymer chains are stretched, squeezed, and rotated between extensional/compressional axes in a highly dynamic and transient manner. Using this technique, we studied the dynamics and coil-stretch transition of a single λ-DNA as a function of the Weissenberg number (Wi) and Deborah number (De). Moreover, we use Brownian dynamics simulation to map a wide range of Pipkin space for polymers from linear steady-state conditions to non-linear unsteady-states. Our results reveal a critical Wi at the coil-stretch transition that is function of the De in LAOE flow.

[1]Department of Materials Science and Engineering

Yuecheng Zhou
Univ of Illinois - Urbana

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