Nonlinear shear rheometry of polymer melts and solutions

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We report on nonlinear shear rheometry applied to polymer melts and solutions in both entangled and unentangled regime. We demonstrate that the complete set of viscometric functions, namely viscosity, first and second normal stress differences can be obtained over a wide range of Rouse-Weissenberg numbers, well into the stretching regime. For well-characterized linear polymers (mainly polystyrene), we identify stretching and tumbling regimes and compare with current state-of-the-art modeling and simulations. In this framework, we explore the effect of macromolecular architecture on the rheological response in transient shear. In particular, we probe the nonlinear shear rheology of model systems such as star, comb and ring polymers, and their mixtures with linear polymers. From the transient shear tests, we evaluate characteristic deformation parameters, that is, the strain corresponding to the stress overshoot and the ratio between the maximum viscosity and the steady state viscosity. We compare such parameters for the different molecular architectures, and extract the associated scaling laws. The validity of the Cox-Merz rule is also assessed for the different polymer systems.

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