**Polymers in fast flows**

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Fast flows of polymers are ubiquitous in processing, and hence remain a topic of immense technological relevance and scientific importance, full of unexplained experimental evidences. For example, in fast steady shear flows polymers exhibit a decreasing viscosity with increasing shear rate. Such a feature (beneficial in polymer processing) is not quantitatively predicted by any molecular theory, even in the simple case of low molar mass (i.e., unentangled) polymers.

Fast extensional flows have also revealed an unexpected behaviour of high molar mass (i.e., entangled) polymers. Melts and solutions with the same number of entanglements, while behaving in the same way in fast shear flows, behave very differently in extension: polymers in solutions are more prone to extension thickening (i.e., to chain stretch) than in the melt state, even if compared at the same Rouse-time-based Weissenberg number (a dimensionless measure of the flow strength). Several interpretations have been offered, the most appealing invoking flow-induced reduction of the monomeric friction coefficient, but no consensus has been reached.

Unexplained features also emerge in the transient flows. Before approaching the steady state of fast shear flows, entangled polymers exhibit a clear stress undershoot after the well-known overshoot. Such a feature, not predicted by any molecular theory, has been attributed to flow-induced molecular tumbling, an unexpected phenomenon in network-like entangled polymers, while expected in dilute ones. Flow-induced molecular tumbling in entangled polymers has recently been confirmed by molecular dynamics simulations, and seemingly linked to flow-induced disentanglement, another key mechanism affecting the fast flow behaviour, with potential beneficial effects in polymer processing.

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