The Influence of Chemical Structures and Macromolecular Architectures on Extensional Rheology of Polymer Melts

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Polymers are complex materials. While their monomers may have different chemical structures, the monomers can be further organized into different macromolecular architectures like linear, ring, star, comb, and dendritic shapes during synthesis. It is known that the rheological behaviour of polymer melts is very sensitive to macromolecular architectures. However, as the experimental data of nonlinear rheology especially the extensional rheology at large strains for model branched polymers is still rare, the link between the nonlinear rheological behavior and the macromolecular architectures is not fully understood. In addition, while the effect of chemical structures of the monomers is not considered in the classic tube model, a few experiments have already shown that chemical structures may influence the nonlinear extensional rheology significantly. But different even contrary explanations still exist.

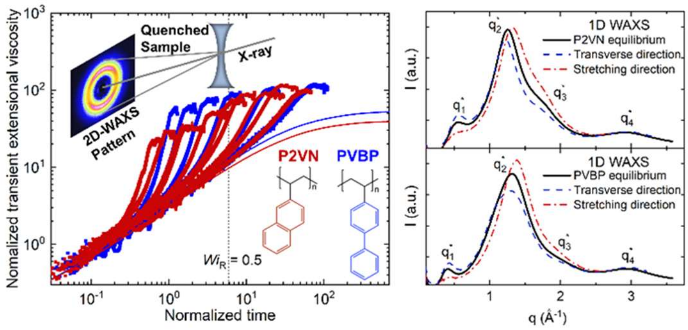

Figure 1: The transient extensional viscosity at different stretch rates of P2VN and PVBP melts (left), and the 1-D wide angle X-ray scattering results for the two melts at both equilibrium and stretched states (right).

Here we present two of our recent woks which study the influence of chemical structures and macromolecular architectures (i.e., at length scales smaller and bigger than an entangled strand, respectively) on extensional rheology of polymer melts [1, 2]. In the first work, we fix the macromolecular architecture to linear polymers, and investigate the influence of chemical structures. We compare polymer melts containing different aromatic rings in their side groups, where π-π stacking between neighbouring polymer chains may affect the rheological behaviour in extensional flow (Figure 1, left). The effect of π-π stacking is analyzed using *ex-situ* wide angle X-ray scattering (Figure 1, right). In the second work, we fix the chemical structure to polystyrenes (PS), and study the influence of macromolecular architectures.We start from the simplest branched architecture, i.e., star PS with one branch point only. We show that star PS melts with 8-10 arms behave differently from the star PS melts with 3 arms. Then the star PS melts are also compared with H and pom-pom PS melts which have two branch points.

References

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