Entangled Polymer Melts in Extensional Flow - Characterization by Combined Rheology and Small-Angle Neutron Scattering

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ENTANGLED POLYMER MELTS IN EXTENSIONAL FLOW RHEOLOGY AND SMALL-ANGLE NEUTRON SCATTERING

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Liquid bridges occur in a variety of situations in nature - yet our understanding of the dynamics and stability is very limited. Examples of liquid bridges are the process used by spiders to form draglines and the process used by cats lapping milk. We have an extended program aiming to provide generic knowledge about the process in which macromolecular fluid filaments are extended and stretched and show how the extensional properties are related to the properties on individual molecules. We combine structural and rheological studies of a series of model polymers with different composition and architectures. The project entails synthesizing model polymer systems of precisely known molecular architecture, subjecting these materials to controlled extensional flows and to measure the molecular deformation under controlled flow situation by SANS. Neutron contrast is obtained using specific deuterium labeled molecules.

Figure 1: Samples as available after being exposed to different extensional flow rates.

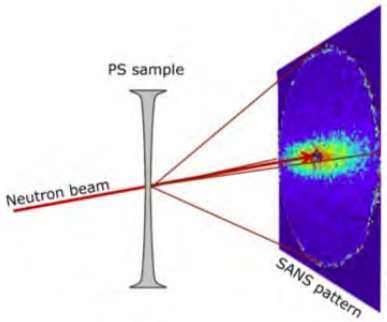

Figure 2: Schematic illustration of the molecules to be studies and the SANS experiment.

We have targeted different systems: first a “simple” sample of homogeneous high-molar mass polymers, where only the central part of a fraction of the polymers were D-labelled with the aim to highlight the polymer deformation and avoid influence of fast relaxation near the polymer ends [1]. Another example is a bimodal mixture of linear polymer chains with respectively high and low molar mass, and we have studied samples with more complex geometry, including POM-POM architecture. The 2D-SANS data have typically Lozenge shaped contour which is analyzed using the Read- McLeish-model of stretched polymer network [2]. The structure and rheology are measured both as a function of stain flow velocity, final Hencky strain ratio and during the relaxation after cessation of extensional flow.

References

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