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Preparation of a CaBER Sample Environment and Microfluidic Devices for In-Situ Scattering Measures of Polymer Solutions in Extensional Flow

Tuesday, 20 June 2023 11:00 (15 minutes)

Microfluidic flows using hyperbolic contractions and capillary break-up extensional rheometery (CaBER) have emerged as key techniques to characterize polymer solutions experiencing uniaxial extensional flow [1,2]. In this work, two approaches are presented to explore the microstructural evolution during extensional flows and relate those features in situ to the macroscopic properties exhibited by polymer solutions during extension. A CaBER sample environment has been prepared for use at small angle scattering (SAS) beamlines to conduct simultaneous CaBER-SAS experiments by configuring the instrument such that the beamline, linear motor, and high-speed camera are perpendicular to one another. An essential feature of the setup is a novel geometry and sample cell to allow for repeated testing of a single polymer solution sample by limiting effects such as solvent evaporation and inconsistent (re)loading conditions. As a second approach a multi-channel microfluidic device has been prepared. The channel profiles resemble hyperbolic contractions and have been manufactured through selective laser etching by. To allow for microstructural characterization in situ the channels within the microfluidic device have been arranged in a 2D array, increasing the overall effective volume of material within the device, and ensuring sufficient signal in a SANS environment. Solutions of 35 kDa and 8 MDa PEO in water with concentrations in the dilute and semi-dilute regimes have been tested in both devices to determine the setup's efficiencies during repeated testing in the CaBER environment as well as to characterize the flow profile within the stacked microfluidic device.

References:
[1] S. L. Anna, et al., J. Non-Newtonian Fluid Mech., 87, 2 (1999)
[2] T. J. Ober, et al., Rheol Acta, 52 (2013)

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