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Capillary breakup extensional rheology and SANS

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Capillary breakup extensional rheomerty (CaBER) as a method for investigating short-time relaxation mechanisms and extensional properties of soft matter has immensely gained in importance since its invention almost 40 years ago. Despite its widespread use, this method has never been combined with high resolution in-situ structural investigations such as small angle scattering.
We demonstrate the general possibility of combining CaBER with small angle neutron scattering (SANS) at the KWS-2 diffractometer for high time-resolution structural investigations of soft matter with a focus on the liquid and gel state.
With a typical flux of 2.5 x 107 cm-2 s-1 for a collimation at 8 m with a 50 x 50 mm² aperture and a thermal neutron wavelength of 5 Å, we can investigate suspensions with suspension viscosities in the range of 0.1 – 1000 Pas under uniaxial elongational flow at high extension rates. Due to the limited scattering volume, we need on the order of 100 measurement cycles with an approximate duration of 1 h to obtain structural data with a minimum possible time resolution of 50 µs using the event mode for neutron detection. Reproducibility is ensured by our newly developed bottom plate geometry for the HAAKE CaBER 1 setup, preventing the liquid droplet from escaping the field of view over the relatively large number of cycles. Combining the setup with a highspeed camera, we can monitor the filament thinning and rupture with a frame rate of up to 15000 s-1. In this way, we can extract the extensional viscosity and even ultra-short time relaxation modes, e. g., on the order of 100 µs for dilute PEO suspensions.
Our CaBER-SANS setup is unique and has a large potential interest for investigating the structural changes of biopolymer suspensions such as cellulose, and DNA, but also for numerous other colloidal and polymer suspensions.

Authors: LANG, Christian (Forschungszentrum Jülich GmbH); Prof. LETTINGA, Pavlik (Forschungszentrum Jülich GmbH); Dr HENDRICKS, Jan (KU Leuven); Prof. CLASEN, Christian (KU Leuven)

Presenter: LANG, Christian (Forschungszentrum Jülich GmbH)

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