

The Physics of Soft and Biological Matter

Optical Coherence Tomography Velocimetry of complex fluids

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Optical Coherence Tomography (OCT) Velocimetry is a new technique for studying rheological systems that uses advances from medical imaging. It is a useful addition to the growing range of optical rheometry techniques [1].

Light is scattered off a sheared fluid and an interferometer with a low coherence infra-red light source allows Doppler signals to be measured for slices of fluid 9 microns thick, with a probe volume of 3.4 pico litres, allowing velocity profiles to be observed for opaque materials with sample thicknesses of several millimetres [2].

Studies of these velocity profiles allow a deeper level of understanding of complex flow phenomena than is possible with classical bulk rheology measurements. OCT Velocimetry is competitive with other velocimetry techniques in terms of spatial and temporal resolution as well as the range of materials it is able to probe [3].

OCT velocimetry has been demonstrated with a range of complex fluid samples including food stuffs (margarine and tomato sauce), polymeric samples, namely polyacrylamides (PAM) which display elastic turbulence related shear banding behaviour and wall slip depending on polymer concentration and molecular weight, Figure 1 [4], and hard sphere colloidal suspensions which display shear banding in dense suspensions.

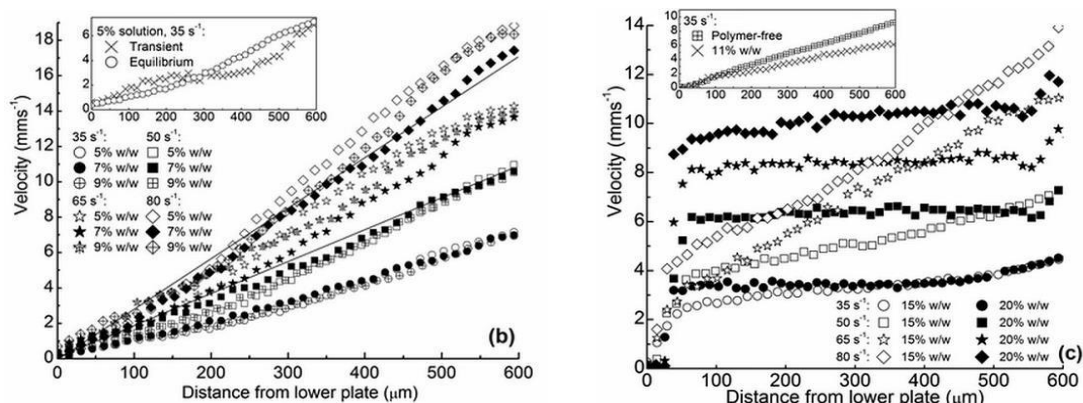


Figure 1: Left- Shear banding in PAM samples of 5% w/w concentration at a range of shear rates. Right- Wall slip in PAM samples of high concentrations (15% w/w and 20% w/w) at a range of shear rates.

We also present improvements to our original embodiment of the method, which uses modulation techniques and a Mach Zender interferometer in order to improve SNR and widen the measurable range of shear velocities.

The technique is also capable of providing quantitative measurement of velocity fluctuations of the flow, providing additional useful information on complex flow phenomena and the onset of turbulence.

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