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SHEAR-INDUCED POLARIZED LIGHT IMAGING (SIPLI) TECHNIQUE FOR RHEO-OPTICAL STUDIES OF POLYMERS

O. O. Mykhaylyk

Department of Chemistry, University of Sheffield, Sheffield, S3 7HF, United Kingdom

O.Mykhaylyk@sheffield.ac.uk

Visualization remains the most effective tool in many areas of science especially in the field of polymers and biomaterials. Since polymeric liquids subjected to external field (flow) demonstrate a related anisotropy in their refractive index and stress, flow birefringence has become one of the phenomena to be widely used in polymer characterization. The sensitivity and dynamic range of the birefringence techniques enable a connection between fluid motion and microstructural response to be established. Although, there are limits dictated by flow geometries selected ones can be used for fieldwise birefringence measurements i.e. for visual observations of the flow. In this respect, torsional parallel disks geometry, commonly used in rheology, has a strong potential for rheo-optical characterization of polymers. Surprisingly, this potential has not been explored yet. Based on this geometry, recently developed shear-induced polarized light imaging technique for rheo-optical measurements of polymeric liquids (O. O. Mykhaylyk, Soft Matter, 2010, p. 4430-4440) will be presented. The duel functionality of the shearing discs used in the torsional geometry allows a rheometer (or a shearing device) to be coupled with a polariscope. Changes in the birefringent properties of the materials observed in the polarized light images are related to the applied shear flow. Since the chosen geometry has a radial distribution of flow field parameters, the technique is combinatorial and allows properties of materials to be tested in a wide range of shear rates in a single measurement. This gives a unique opportunity for in-situ studies of shear-induced phenomena such as stress, orientation and structural transitions taking place in soft matter (gels, polymers, copolymers, liquid crystals and colloids). Example of applications of the technique on polymer melts, copolymer solutions and biopolymers will be given. The SIPLI measurements will be compared with rheology and small-angle X-ray scattering results.