MULTIPLE PARTICLE TRACKING (MPT) STUDY ON HIGHLY ELASTIC ACRYLIC THICKENER SOLUTIONS: TREATMENT OF PARTICLE LOCALIZATION ERRORS

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Synthetic acrylic polymers are frequently used as thickening agents in water-based coatings and adhesives or personal care products. Typically, these commercial alkali-swellable acrylates (as well as various other polymeric thickeners) form inhomogeneous partly aggregated or cross-linked solutions. Inter- and/or intramolecular aggregation is due to hydrophobic groups randomly distributed along the chains. Such thickener solutions cover a wide range of rheological behavior, ranging from weakly elastic, almost Newtonian to highly elastic gel-like. Despite its high technical relevance, little is known so far about the contribution of the micro-scale inhomogeneities to the bulk viscoelastic properties. Here we use the method of Multiple Particle Tracking (MPT), to quantify the degree of structural and mechanical microheterogeneity of such acrylic thickener solutions. MPT is more and more used to study local mechanical or rheological properties of soft matter on a 0.1-1 μm length scale. The basic idea is to monitor the Brownian motion of inert fluorescent tracer particles by means of digital video microscopy. Statistical analysis of tracer trajectories allows for a characterization of sample inhomogeneity and in the case of homogeneous fluids a generalized Stokes-Einstein equation relates their mean squared displacements to the bulk shear moduli, G' and G''. Various sources of error may lead to a misinterpretation of experimental data. So called static and dynamic errors, caused by noise and the finite exposure time of the imaging setup, can considerably alter the apparent dynamics of sample. Moreover, trajectory artefacts caused by unavoidable ambiguities due to indistinguishable tracer particles entering or leaving the focal plane can lead to misjudgement of fluid properties. The limitations of MPT measurements due to these inaccuracies in particle localization will be discussed in detail and for different commercial acrylic thickener solutions it will be demonstrated how to get accurate results for the bulk viscoelastic properties of highly elastic homogeneous materials and a reliable characterization of local rheological properties in the case of inhomogeneous fluids.