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Structured magnetic fluids under quasi-static shear

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This study provides experimental evidence of the impact of the morphology of initial particle structures, as influenced by an external magnetic field, on the quasi-static deformation process of magnetic fluids containing various concentrations of micro- and nanoparticles. The fluids under investigation are structured in an external magnetic field. They are then subjected to a quasi-static shear strain perpendicular to the structuring field using magnetic rheometry. In addition to the composition of the fluids, the magnetic properties of the plates of the measuring geometry and the size of the gap between the plates are varied in the experiment.

The fluids exhibited different responses to quasi-static shear under various conditions, including overshoot —i.e. non-monotonic stress–strain relationships (Figure 1). These differences are associated with variations in microstructure, such as the morphology of particle aggregates, as well as differences in the interactions between the aggregates and the measuring geometry surfaces. In order to exhibit non-monotonic behaviour, the particles must first form linear aggregates. This can be achieved by using low particle concentrations. Additionally, for micron-sized particles, a specific interaction between the linear particle aggregates and the surface of the rheometer plates is necessary. This can be achieved by either increasing the size of the gap or modifying the surface of the plates in a specific way that involves incorporating large magnetic particles into them. The relevant rheometric measurements are supplemented by observations of the actual microstructure of the microparticle aggregates using X-ray micro-CT.

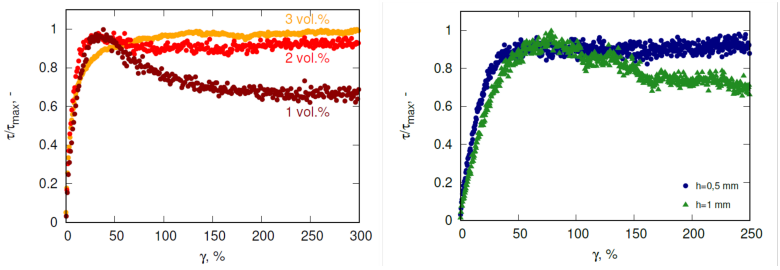

Figure 1:

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