IFPRI Project Abstract

Dynamic and structural investigation of capillary suspensions

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Project Objective:

Structure and function and inherently related. Using a model system for dense and capillary suspensions, we will investigate the microstructural changes during interesting rheological transitions, e.g. yield, using confocal microscopy. Capillary suspensions, particles suspended in a bulk fluid with a small amount of immiscible secondary fluid added to form a percolating network of capillary bridges between the particles are of particular interest as they show a wide range of rheological behavior.

Approach:

We investigate changes to the microstructure of capillary (nano)suspensions containing fluorescently labeled silica spheres and glass micro-rods using a confocal microscope. By using particle detection and semi-local measures, we compare the structure of the samples with their bulk rheological response.

Recent Results:

This year, we finalized the work on the investigation of nanoparticles on capillary suspension structures. In capillary suspension precursor systems, the deposition of silica nanoparticles varies with their hydrophobicity; hydrophilic nanoparticles coat microparticle surfaces, while more hydrophobic ones aggregate and adsorb to the liquid-liquid interface. The nanoparticles located on microparticles decrease the storage modulus G' by reducing the Hertzian contact forces and easing the contact line pinning effect, facilitating easier restructuring during compression experiments. This work is published as an open-access paper in the *Journal of Colloid and Interface Science* (DOI:10.1016/j.jcis.2024.03.103). In addition to capillary nanosuspension, we have also studied the recovery rheology of the capillary (nano)suspension which predicts that the local network has a softer structure in comparison to the macroscopical gel network. However, our main focus is the study of anisotropic capillary suspension structural change during shearing. The optimized index-matching system has been developed. We discovered that by applying a minimal amount of secondary liquid we are able to eliminate the biased orientation of micro rods in pure suspensions. For both experiments, extensive rheo-confocal experiments are to be done.

Next Steps:

The rheo-confocal setup will now give us more information on the dynamic changes to the network. Recovery rheology requires confocal data to visually verify the measured particle displacements and thus, correlate it to the recovery of the whole network. For anisotropic capillary suspensions, experiments will be conducted to visualize sample rearrangement (rods rotate/flip) during shear and its yielding mechanism is of great interest of ours.