Deformation of Fractal Clusters under Mixed Shear Flows

Marco Lattuada*, Zhiqiang Ren

Adolphe Merkle Institute, University of Fribourg

Chemin des Verdiers 4, 1700 Fribourg, Switzerland

*Marco.lattuada@unifr.ch

In this work Stokesian Dynamics was used to investigate the deformation of fractal colloidal clusters under a flow field characterized by a special mixed linear shear flow, in which the ratio between the strain rate and the vorticity was adjusted. Interparticle interactions are accounted for using DLVO theory as well as tangential forces to allow particle bonds to sustain bending moments. Different deformation patterns were obtained for clusters under different strain/vorticity ratios. Clusters were shown to deform to highly elongated and nearly linear structures when the strain rate is higher than the vorticity, while they undergo periodic deformations when the vorticity is higher than strain rate. The frequency of the periodic deformation can be analyzed through Fourier transform and can be fitted by an ellipsoid model. In the case where the strain rate is equal to vorticity, the mixed shear becomes a simple shear. The deformation of clusters under simple shear was found to be independent of the shear stress if a cluster size and its fractal dimension are fixed. The strength of DLVO interactions does not show a direct influence on cluster deformation, but can change the role played by tangential forces among particles, thus indirectly affecting the cluster deformation. In the final part of the work, the influence of the deformation of clusters the fluid viscosity is investigated. A semi empirical relationship between the cluster fractal dimension and the system stresslet, which determines the cluster contribution to the suspension viscosity, was derived and verified by simulations.