VORTICITY-ALIGNED FLOCS IN CARBON BLAK GELS

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Colloidal gels of carbon black particles in a mineral oil are studied. When such gels are sheared between parallel plates with a narrow gap (smaller than about 500 micron) the particles do not remain homogeneously distributed but instead arrange into highly anisotropic structures perpendicular to the shear direction. A similar behavior has been reported in other attractive systems (flocculated emulsions, carbon nanotube suspensions and clay gels). Here we investigate this structuring experimentally through simultaneous rheological measurements and optical observations. We study the formation and stability of those shear-induced structures by varying the particle concentration, the gap width and the shear rate.

We have also performed molecular dynamics simulations of attractive particles in a newtonian fluid. The simulation configuration is the same as in the experiment: the fluid is sheared at constant shear rate between two plates. The interactions between particles are modelled by a Lennard-Jones potential and the fluid is taken into account by assuming a linear velocity profile and simply adding a viscous drag force on the particles. We observe a critical shear rate under which structuring into vorticity-aligned flocs occurs. This critical shear rate scales as a power-law of the gap width with an exponent -2.4. We have checked that several attractive potentials combined with hard-sphere repulsion qualitatively yield the same results.