Master 2 internship and Ph.D. proposal

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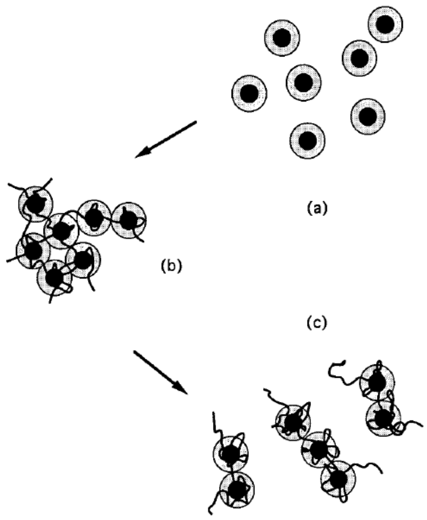
Shear-induced aggregation in colloid-polymer suspensions

Soft Glassy Materials (SGMs) are ubiquitous in major industries, i.e., foodstuff, personal care, and oil. These soft solids consist of disordered assemblies of subunits such as particles or polymers, whose interaction and volume fraction control their viscoelastic properties. Under external shear, their microstructure is usually broken, which allows these materials to flow like liquids, whereas they behave as soft solids at rest [1]. However, Otsubo et al. reported in a seminal series of work [2,3] that shear can surprisingly lead to forming a permanent percolated network with solid-like behavior, which raises crucial fundamental issues about the physics at play during flow-microstructure interactions.



A pictorial representation of different situations encountered with particles and adsorbed polymers. The particles are represented as dark disks, and their ionic clouds as shaded disks: (a) no polymer, electrostatic stabilization, (b) unsaturated surfaces, bridging to three-dimensional flocs, (c) boundary region, bridging to one-dimensional ''necklaces.'' [4]

The internship aims to investigate the local scenario associated with the shear-induced gelation of nanoparticle suspensions flocculated by polymer bridging. For example, nanometric silica particles dispersed in water can bridge into long necklaces by adsorbing macromolecules (see Figure). It was evidenced through small-angle neutron scattering that such necklaces display shear-induced flocculation and gelation. Above a critical shear rate, the necklaces connect to form threadlike objects, aligning with the velocity. At higher shear intensities, these objects associate sideways to form a three-dimensional floc [4]. In practice, the candidate will perform rheometry coupled with ultrasonic imaging [5] to unravel the local scenario associated with the formation of such gels for different shear intensities and durations. Light scattering and nano-indentation will help to determine the microstructures of these shear-induced gels.

Duration – 4 to 6 months at Master 2 level between February and August 2022. Possibility to apply for Ph.D. funding at the Lyon Physics & Astrophysics graduate school.

Keywords – Shear-induced gels, Rheology, Colloids, Polymers, Nanoindentation, Light Scattering

References

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