Master 2 internship and Ph.D. proposal

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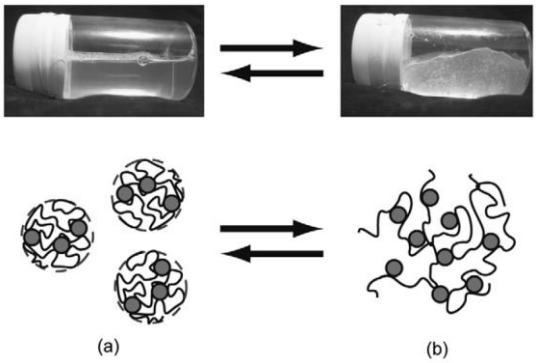
Shear-induced aggregation in colloid-polymer suspensions

Colloidal gels are ubiquitous in major industries with applications such as colloidal crystals, energy storage devices, advanced ceramic materials, and biomaterial. They consist of polymer and/or nanoparticles in attractive interactions that form a percolated space-spanning structure, which confers to the gel solid-like elastic properties [1]. Harnessing the interplay between the building blocks' properties (shape, size, surface chemistry, etc.) and that of the resulting gel remains an outstanding challenge for manufacturing a vast range of applied materials.



Photographs of shear-thickening suspension in a quiescent state (a) and right after violent shaking in horizontal direction (b), and the corresponding structural models. The fluid with low viscosity is converted to gel-like paste by structural changes from discrete flocs to three-dimensional network in shear fields [3].

In a seminal work, Otsubo *et al.* reported that shear applied to colloid polymer mixtures stable at rest leads to forming gels in which the flexible polymer coils bridge particles [2,3]. Such shear-induced flocculation is evidenced at the macroscopic scale by a substantial increase of the suspension viscosity. However, if the phenomenon is robust and well documented, it still raises crucial fundamental issues about the physics at play during flow-microstructure interactions.

The goal of this M2 internship is twofold (*i*) to investigate the local scenario associated with the shear-induced gelation and (*ii*) to determine the microstructural and viscoelastic properties of these suspensions flocculated by polymer bridging. We will investigate silica colloids dispersed in water that bridge into long necklaces by adsorbing polyacrylamide. The candidate will determine the impact of shear history on shear-induced gelation and rationalize the existence of a critical shear rate beyond which the gelation occurs. In addition, the candidate will measure the linear viscoelastic properties of the shear-induced gel through mechanical spectroscopy. The goal will be to link the gel terminal viscoelastic properties to the shear history (intensity, duration, etc.). Finally, rheometry coupled with local measurements, e.g., ultrasonic imaging [4], will be crucial to unravel the local scenario associated with forming such gels, whose microstructure will be studied by Dynamic Light Scattering.

Duration – 4 to 6 months at Master 2 level between February and August 2023. 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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[4] Gallot, Perge, Grenard, Fardin, Taberlet & Manneville, Rev. Sci. Instrum. **84**, 045107 (2013)