Master 2 Internship in Soft Matter Physics

Interfacial dynamics of suspensions

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Inorganic geopolymer-type materials (suspensions of calcined clays in a basic solution) are studied at the CEA for various applications, particularly in the field of radioactive effluent decontamination. Given their physical-chemical properties, their rheological behavior, and by adjusting formulation parameters, they can be easily shaped into foams, beads, or even processed by additive manufacturing. The shaping of these suspensions takes place in the liquid/pasty state, and several phenomena and mechanisms are involved, such as suspension stability (drainage effects in the case of foams) or the breakup of geopolymer droplets, which involves interfacial and viscous phenomena that must be properly characterized and distinguished depending on the particle volume fraction in the suspension. In this context, the aim of this study is to acquire baseline data to improve the synthesis of these materials according to the shaping process involved.

The dynamics of wetting is a complex problem due to the multiple scales involved (from microscopic to macroscopic), the diversity of possible motions (steady or unsteady), and the wide range of contact line velocities, which can vary from a few µm/s to several m/s. The dynamics of the contact line has been extensively studied in the literature under various conditions: evaporating water droplets, impacting droplets, and droplets sliding on a surface [1]. The complexity introduced by the liquid itself—particularly in the case of particle suspensions—also alters these wetting properties, involving, for example, unsteady interfacial phenomena such as stick-slip behavior during the spreading of a colloidal suspension droplet [2].

In the MIMIC team, we have developed an experimental setup, inspired by the design originally proposed by Restagno *et al.* [3,4], which is particularly well-suited for studying interfacial properties (wetting, surface tension) both in static and dynamic regimes. This method, known as the capillary bridge technique, and illustrated in Figure 1, allows us to explore contact angles, dewetting velocities, and the rapid dynamics of the rupture of a liquid bridge formed between a test liquid bath and a curved solid surface.

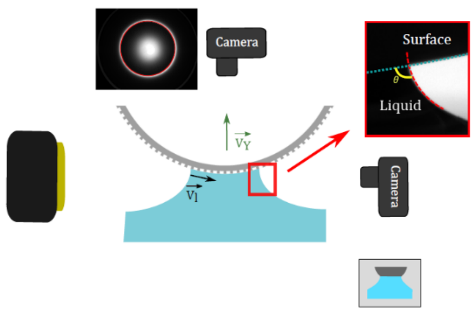

Figure 1. Dispositif du pont capillaire.

Internship Focus:

We propose to use this setup to evaluate the influence of microparticle volume fraction on interfacial properties such as surface tension, drainage, and stability.

Benefits of the Internship:

- Research project combining both fundamental issues and constraints of practical applications.
- Hands-on experience with advanced experimental techniques involving ultra-fast imaging
- Project contributing to environmental challenges related to soil decontamination.

References

[1] Snoeijer *et al.* (2013). *Annual review of fluid mechanics*, vol. 45, no 1, p. 269-292.
[2] Rio *et al.* (2006). *Langmuir*, vol 22, 3186-3191.
[3] Restagno *et al.* (2009). *Langmuir*, vol. 25, no 18, p. 11188.
[4] Cohen et al. (2019). *Soft Matter*, 15(14), 2990-2998.

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