Phd offer
Colloids, Soft Matter, Material Sciences.

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LABORATOIRE NAVIER

Effect of adjuvants on the contact properties of colloidal particles

Colloidal suspensions are ubiquitous in our environment (cosmetics, foods, fresh building materials, environmental fluids, ...). When the solid volume concentration is high enough (30% or more) the rheology of these materials is controlled by the interactions between particles, whether they are contact or short range. In many practical applications, polymers are added (adjuvantation) to the suspension to adapt its rheology to its implementation or use.

Our understanding of the physics of these adjuvanted suspensions remains limited because of the experimental difficulties to overcome to characterize the interactions between particles: these suspensions are dense and opaque and the forces between particles can be of the order of a few piconewtons for separations of a few angstroms. The rheology of colloidal suspensions is thus a very active multidisciplinary research field.

By combining optical tweezers measurements, rheometry tests and confocal microscopy observations, our team has recently shown that the particular rheology of silica particle suspensions in a saline solution is due to the existence of aging adhesive contacts between the particles [1, 2].

The objective of this experimental thesis is to build on these results to study the effect of the addition of a polymeric additive on the properties of a suspension of silica particles. To do so, experiments combining rheometry, particle manipulation with optical tweezers and various physico-chemical characterizations will be carried out to access the macroscopic properties (elastic modulus, yield stress, flow laws) of the suspension and measure the properties of the contacts between particles. Two types of polymers will be studied: PEG phosphonates and polycarboxylates grafted with polyethylene glycol chains.

In practice, the thesis work will consist in:

- characterize the adsorption of polymers on the particle surface by TOC (Total Organic Carbon),
- measuring by rheometry the elastic modulus, the yield stress and the flow law of the suspensions as a function of the concentration and the properties of the added polymer,
- characterize the properties of contact between particles using optical tweezers as a function of the concentration and properties of the added polymer,
- analyze the link between the rheological properties of the suspension and the properties of contact between particles.

The results will be compared to the results already obtained for the non-adjuvanted system [3].

1. Contact and macroscopic aging in colloidal suspensions, F. Bonacci, X. Chateau, E.M. Furst, J. Goyon and A. Lemaitre, Nature Materials, 19, 775-780 (2020)
2. Yield stress aging in attractive colloidal suspensions, F. Bonacci, X. Chateau, E.M. Furst, J. Goyon and A. Lemaitre, Physical Review Letters 128, 018003 (2022)
3. Rheology signature of flocculated silica suspensions, J. Fusier, J. Goyon, X. Chateau and F. Toussaint, Journal of Rheology 62, 753 (2018)

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