Master internship and/or PhD proposal

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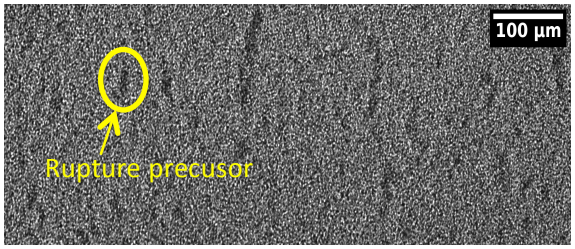
Rupture precursors in colloidal gels

The aim of this internship is to identify rupture precursors in colloidal gels under an oscillatory constraint. Colloidal gels form due to weak attraction between colloidal particles dispersed in a solvent. A gel is structured into a stress-bearing, space-spanning network of colloids at very low volume fraction. The gel displays an elastic modulus and a yield strain, the strain above which the gel breaks and becomes fluid. Upon increasing the strain, the gel undergoes damage and eventually breaks [1-3].

We have recently set up a shear cell that can be placed under a confocal microscope for direct visualization of the gel under deformation. Under repeated strain oscillations, we observe the formation of darker regions within the gel (see figure below), that we interpret as rupture precursors, rapidly followed by gel breakdown. In this experimental internship, we will study the dynamical properties of such rupture precursors through real-time tracking under oscillatory shear. This internship may be followed up by a PhD at Ecole Doctorale PHAST (no funding is secured yet).



Microscopy image of a colloidal gel damaged by accumulation of strain oscillations
(from Thomas Bocquet's M2 intership report, July 2019)

Duration – 3 to 6 month internship at level M1 or M2 between Feb. 2020 and Aug. 2020

Keywords – colloidal gel, rupture, rheology, microscopy, image analysis (Matlab or Python)

References

[1] Saint-Michel, B., Gibaud, T., & Manneville, S. (2017). Predicting and assessing rupture in protein gels under oscillatory shear. *Soft Matter*, **13**(14), 2643-2653

[2] Keshavarz, B., Divoux, T., Manneville, S., & McKinley, G. H. (2017). Nonlinear viscoelasticity and generalized failure criterion for polymer gels. *ACS Macro Letters*, **6**(7), 663-667

[3] Aime, S., Ramos, L., & Cipelletti, L. (2018). Microscopic dynamics and failure precursors of a gel under mechanical load. *Proceedings of the National Academy of Sciences*, **115**(14), 3587-3592