Matière et Systèmes Complexes, UMR CNRS 7057

Internship / PhD research project

Collective effects in soft glasses : dynamical heterogeneities in the out-of-equilibrium states

Supervisor : **Bérengère ABOU (CR CNRS)**, Matière et Systèmes Complexes (MSC)
berengere.abou@univ-paris-diderot.fr

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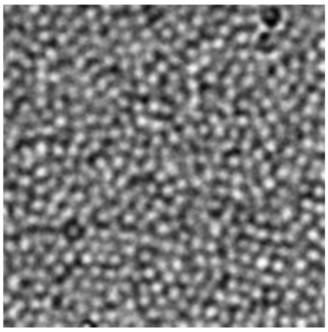
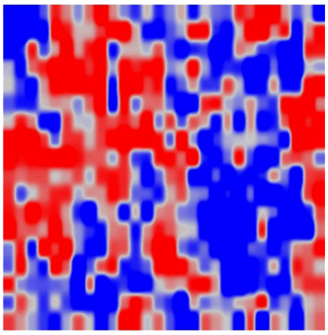
Take a liquid and quench it sufficiently fast: the crystallization will be avoided. Below the melting point, a glass (disordered arrangement, no crystalline, slow dynamics) is observed! Understanding the glass transition in materials and their slow dynamics remains a challenge in condensed-matter physics. When dealing with this generic state of matter, several fundamental questions emerge, the more obvious one being: what causes the dramatic slowing down of the dynamics observed in the glass, with nearly no structural changes compared to the liquid?



In practice, the glass transition is observed in various systems, such as molecular liquids, colloids or granular materials. Among all, **dense colloids** are powerful model systems with a glass transition at ambient temperature when increasing volume fraction. Besides, colloids display slow accessible timescales and can be probed with simple optical techniques (**Figure 1: dense soft thermosensitive colloids (~1 µm) under the microscope**).



Recently, a promising lead to follow up to understand slow relaxation in glasses has been provided by dynamical heterogeneities (DHs). They are characterized by fast and slow clusters of dynamically correlated particles, coexisting in the material. The idea is that the clusters size would diverge when approaching the glass transition, which would explain the drastic slowing down of the dynamics in glasses (**Figure 2: fast (red) and slow (blue) clusters coexisting in our dense soft thermosensitive colloids**).

Our project aims to investigate DHs, and the associated collective effects, in soft thermosensitive colloids near the glass transition. We aim to explore the link between microscopic aspects, such as the size and intensity of collective rearrangements, and macroscopic aspects, such as the visco-elastic properties. We will vary soft repulsive interactions between colloids to generate a wide variety of behaviors which, we believe, will lead to a better understanding of the relevant features of the glass transition.

R. Colin, A. M. Alsayed, C. Gay & B.Abou, Soft Matter **11** 9020 (2015).