Internship 3A / 4A / M1 / M2: Soft Matter & Physical colloidal chemistry

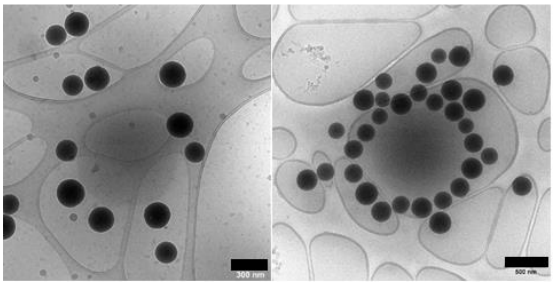
Laboratoire de Physique de l'ENS de Lyon
Laboratoire d'Ingénierie des Matériaux Polymère (UJM, Saint-Etienne)

Gelation of binary colloidal mixtures with tunable interactions

Formulated products from the pharmaceutical and food industries are often made up of mixtures of rigid particles, polymers of various architectures, or droplets. These complex systems can gel, i.e., form a percolated network that imparts viscoelastic solid behavior to the material, depending on the total colloid volume fraction and the nature of their physicochemical interactions [1]. Understanding the gelling mechanisms of colloidal mixtures is important for controlling and predicting the rheological properties of many everyday products [2].

Context: In recent work, we have developed a model binary system involving soft colloids (polyacrylamide microgels, Am) and hard colloids (silica particles), with modular attractive interactions [3]. A series of systems have been studied, successively exhibiting repulsive, attractive colloidal gel behavior and gelling by arrested phase separation by adding either a small amount of a "sticky" co-monomer to the microgels or a co-solvent, such as glycerol.

Objective: The aim of this internship is to **modulate the attractive interactions of this binary colloidal system via a "solvent" route**. The state diagrams will be studied by formulating different mixtures to identify the gelling conditions and the behavior of these binary mixtures under concentrated flow. Next, the reinforcing effects of attractive interactions on rheological properties will be investigated.



Cryo-TEM photos of binary suspensions of silica particles (black spheres) and microgels (gray spheres), with different interactions. Scale bar ~300nm.

Candidate: The ideal candidate should demonstrate an interest in physical chemistry, rheology, and experimental work. This internship will last **4 to 6 months and be hosted at ENS de Lyon** in the Physics Laboratory. There is also potential for pursuing this research project **through a Ph.D. thesis, with funding supported by the ANR under the ANR "MS3AC" project**.

To apply, please send a CV and a letter of motivation to the following contacts:

- *Dr. Thibaut DIVOUX - thibaut.divoux@ens-lyon.fr*
- *Dr. Fabien DUTERTRE - fabien.dutertre@univ-st-etienne.fr*
- *Pr. Jean-Charles MAJESTE - majeste@univ-st-etienne.fr*

[1] T. Gibaud, T. Divoux & S. Manneville, In: Meyers R. (eds) *Encyclopedia of Complexity and Systems Science*. Springer, Berlin, Heidelberg (2020). [link]

[2] M. Bantawa, B. Keshavarz, M. Geri, M. Bouzid, T. Divoux, G.H. McKinley & E. Del Gado, *Nature Physics* **19**, 1178–1184 (2023). [link]

[3] A. Mungroo, J.-C. Majesté, F. Dutertre, *Polymer* **296**, 126811 (2024) [link]