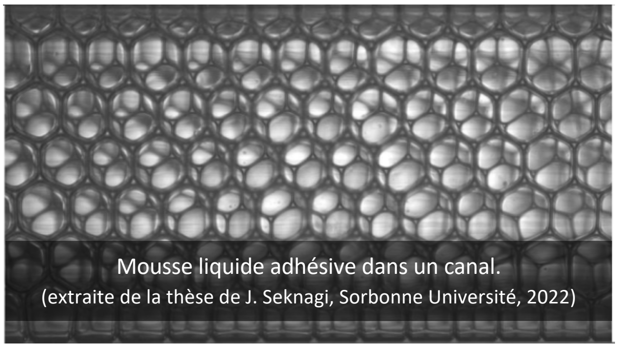
Master thesis proposal (2024-2025)

Flow of adhesive liquid foams

Liquid foams play a crucial role in the ecological and energy transition. With their excellent thermal insulation properties, they enhance the energy efficiency of buildings and infrastructure. They have various applications, such as cleaning and decontaminating surfaces and confined spaces, capturing and controlling dust on construction sites or industrial areas, wastewater remediation, and separating finely divided materials through flotation. Furthermore, new processes are emerging that utilize the properties of foams for extracting precious metals from recycled electronic devices (urban mining), promoting a more sustainable management of resources and urban waste. Other potential applications include soil improvement and rehabilitation, as well as underground CO_2 storage. Liquid foams are multifunctional materials referred to as "complex" because they consist of an assembly of bubbles in varying concentrations within a liquid. To fully exploit their advantages, it is crucial to master their production methods, control their aging process over time, and predict their physical properties, both in their liquid and solid (hardened) states. Despite significant research advances over the past twenty years, many aspects still need to be mastered.

We are exploring a completely new type of liquid foam, in which the bubbles adhere to each other when they come into contact, remaining attached until a sufficient force is applied to separate them. These adhesive bubble foams (as opposed to classical repulsive liquid foams) have not yet been studied, thus opening up an entirely new field of research with the potential to discover novel properties and develop new applications. We will focus specifically on their flow properties. Indeed, the adhesive forces are likely to significantly alter the way bubbles reorganize under the effect of an imposed shear flow. The objective will be to determine the adhesive contact formation time in comparison to the contact time imposed by the flow. This study with carefully controlled 'collision' parameters will be conducted both at the scale of two bubbles using videomicroscopy, and at the scale of the flowing foam, using a rheometer.



Mousse liquide adhésive dans un canal.
(extraite de la thèse de J. Seknagi, Sorbonne Université, 2022)

Techniques/methods in use: Microfluidic, videomicroscopy, image analysis (AI machine learning models), rheometry.

Applicant skills: Background in condensed matter physics, or material science (physics/chemistry) or fluid mechanics. A taste in experimental work is expected.

Internship supervisor(s): sylvie.cohen-addad@insp.upmc.fr , olivier.pitois@univ-eiffel.fr

Internship location: Institut des NanoSciences de Paris (Sorbonne Université, Paris, https://w3.insp.upmc.fr/recherche-2/equipes-de-recherche/physico-chimie-et-dynamique-des-surfaces/mousses-bulles-et-films-de-savon/) et/ou Laboratoire Navier (Champs-sur-Marne, https://navier-lab.fr/la-recherche/rheophysique-et-milieux-poreux/).

Possibility for a Doctoral thesis: Yes, Funding secured.