MASTER 2, PhD Project
Imbibition in reactive fibrous media

This internship/PhD is part of the project IDeFuTe (imbibition, deformation and functionalization of textiles) between the LadHyX (Ecole polytechnique), Institut Jean le Rond d'Alembert (Sorbonne Université) and GemTex (ENSAIT Roubaix). The objective is to characterize the interactions between a liquid and a reactive textile.

Context:

A textile consists in an assembly, woven or non-woven, of natural (cotton, cellulose...) or synthetic (polymer, glass...) fibers. Textiles are versatile and highly functional materials; due to their efficiency in filtration, thermal insulation, liquid adsorption, they are used in a large variety of domains such as clothing, construction, energy, environment, or medicine. In addition, many biological tissues are non-woven textiles (blood clots, collagen networks, feathers, plant walls) that share many of their properties with industrial non-wovens. Textile research is currently an active field, with the creation of innovative textiles with novel materials, the development of advanced composites and the renewal of fabrication processes aimed at optimizing energy and resource consumption. In particular, the interaction of fibrous materials with liquids (through adsorption, wetting, drying, imbibition) is a very common yet complex phenomenon (e.g. washing, composite manufacturing, filtration, liquid retention and release, long distance diffusion) which remains poorly understood. These phenomena involve a complex interplay of various physical mechanisms, including elasticity, capillarity, and geometry/topology. A creative interaction between these three fields of research has emerged from recent advances in soft matter and the growing interplay between mechanics and physics.

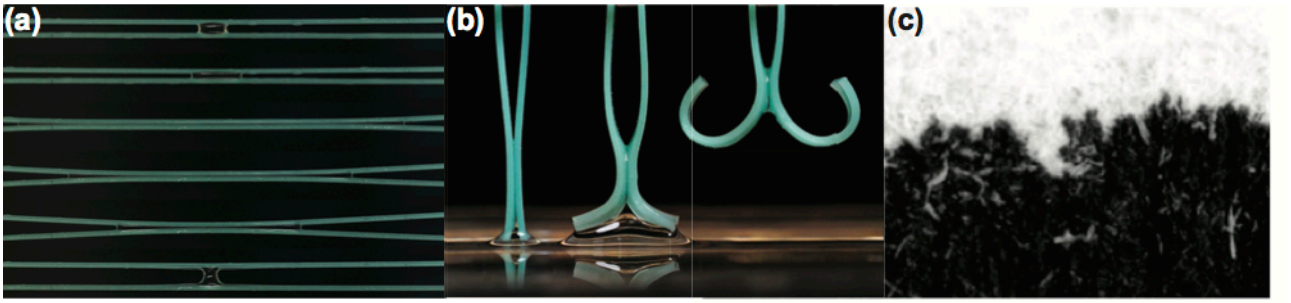

Fig: Model experiment on (a) the wetting of flexible fibers and (b) the swelling of elastomeric plates. (c) imbibition front in paper.

Objectives:

In most realistic situations imbibition into fibrous media is coupled with swelling (e.g. cellulose fibers in papermaking, cotton fibers...). Moreover the type of liquid used in industrial or natural systems is never perfectly newtonian (glue, resin, blood, paint, soap etc.). We wish to study experimentally the effect of swelling and rheology on the imbibition of model systems (from array of parallel fibers to yarns and non-woven textiles) and to develop the theoretical tools to characterize the observed behaviors. This internship may be followed by a PhD.

Contacts:

Suzie Protière (Institut Jean le Rond d'Alembert, Sorbonne Université Paris)
protiere@ida.upmc.fr,
01 44 27 87 22

Camille Duprat (LadHyX, École polytechnique)
camille.duprat@ladhyx.polytechnique.fr,
01 69 33 52 57
Site web