INTERNSHIP PROPOSAL

Laboratory name: LadHyX, Ecole Polytechnique / Institut Jean le Rond ∂'Alembert, Jussieu
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Thesis possibility after internship: YES

IMBIBITION AND SWELLING IN TEXTILES

Fibrous media are ubiquitous in natural and engineered systems, due to their versatility, flexibility and functionality. Nonwovens (i.e. entangled fibrous networks), and especially natural fibre -based materials such as paper or flax mats, are heavily used for a variety of applications, and could be largely developed as a sustainable alternative for fossil-based plastics. The first limitation of their widespread use is their response to humidity, wetting or drying, which is unavoidable in many applications, and is a key step of their manufacturing processes. The ElCapiTex project aims at characterizing and modelling the specific behaviour and properties of wet non-woven textiles and of their manufacturing processes.

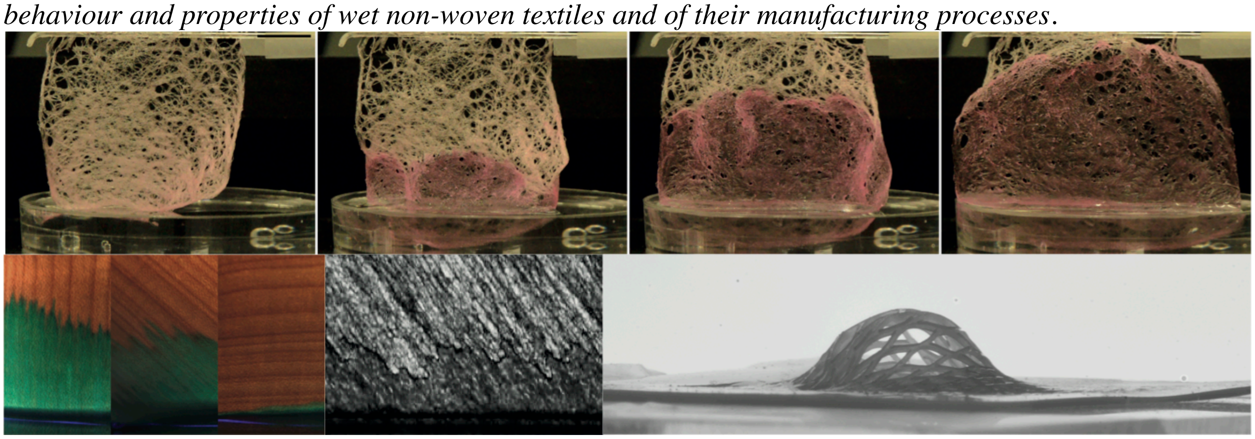

Figure: Imbibition and swelling of a hydrogel non woven (top row), imbibition in wood, imbibition in a non woven, swelling and deformation of a model elastomeric mesh.

When a textile is placed in contact with a liquid, the liquid can spontaneously wick in between or inside the fibres; the liquid advances in the pores owing to a reduction of pressure at a curved front meniscus, or within the fibre through swelling, with imbibition and absorption rates depending on the specific materials (fibre type) and geometry (density, weave and knit pattern, yarn tension...). Liquid imbibition can occur in large-scale interyarn or interfibre pores, in finer intra- yarn or intrafibre pores, in film flows along fibres, and as swelling inside fibres. These mechanisms are associated with different timescales that depend on the materials and structure of the textile, leading to a wide variety of dynamics. The goal is to characterize the imbibition dynamics using model systems, from pore-scale models of a few fibres to lab-produced model fibrous sheets, but also with large scale industrially produced nonwovens. We can also study the effect of swelling of individual fibres on the imbibition dynamics. We expect different dynamics depending on the ratio of the characteristic swelling time to the capillary imbibition timescale. Furthermore, the swelling can lead to large scale deformation that strongly depend on the orientation and arrangements of the fibers, which we can study with model systems.

The work will be mostly experimental. From these results, we will look for simple theoretical models. The internship is part of a collaboration between LadHyX at École Polytechnique (Palaiseau) and Institut Jean le Rond ∂'Alembert (Sorbonne Université, Site Jussieu). The internship can be continued with a PhD thesis (funding available).