PhD Position

« Comprehension and characterisation of the impregnation and drying of bio-based hydrogel for self-folding of architectured paper structures »

Project summary

In order to reduce the ecological footprint of structural materials in packaging, housing or transports, paper-based material is a relevant alternative to plastic, being a bio-based material, recyclable and biodegradable. Several processes have already been developed to provide good barrier properties to paper. Nevertheless, reaching a stiff enough paper structure for practical use is an issue, since its fabrication process does not allow to obtain homogeneous paper layers thicker than 180 µm. The solution considered in this project is the design of architectured paper by self-folding in order to form paper-based structures with enhanced mechanical properties (in terms of bending stiffness, shear resistance or deployability) while limiting the amount of matter used and the final cost.

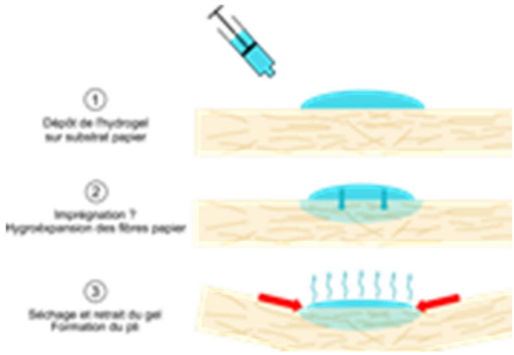

Illustration of different mechanisms yielding to the paper folding by hydrogel deposit and drying

Preliminary works have shown that fold and architectured structures can be obtained by depositing and drying an hydrogel on a paper sheet. This uses the hygro expansion properties of paper fibres, and the hydrogel shrinkage during drying. This promising technic opens the way to form complex structures, difficult to make by mechanical process, while being adaptable, low cost, and decreasing the shaping environmental impact.

Thus, the goal of this project is to understand and characterize the mechanisms leading to paper folding after the deposit and the drying of an hydrogel. The project will centre on a fine characterization of the two main mechanisms involved: (i) the hydrogel impregnation in a paper, and (ii) the hydrogel shrinkage yielding to fold formation. These mechanisms will be characterized locally, with model-systems, and at the material scale using X-Ray microtomography and mechanical tests. To this end, the project will rely on the skills of LGP2-lab, expert on paper, bio-based hydrogel and their shaping, and on the ones of 3SR-lab, expert on multiscale characterization and multiphysics coupling in heterogeneous media, included fibrous media, and 3D Imaging.

Results will give fundamental insights to understand the gel impregnation in a porous or fibrous media, and the stress development in the solid matrix induced by gel shrinkage. They also enable to do recommendation to manage technology transfer towards industrial processes.

Location and practical aspects

The successful applicant will be hosted by the laboratory 3SR in the “COMHET” team. He/she will work under the supervision of Pr Dufour F., Dr Naillon A. from Laboratory 3SR and Dr Viguie J. form Laboratory LGP2. The gross salary will be 1975 €/month, equivalent to a net salary of 1580 €/month.

Qualifications of the applicant

Strong background in fluid and solid mechanics for complex materials is expected, especially fibrous media. However, profiles within the fields of material science with focus on the transfer in porous media will also be regarded with interest. Motivation for original and advanced experimental testing is required.

Applications

Interested candidates should send their CV and cover letter to frederic.dufour@3sr-grenoble.fr, antoine.naillon@univ-grenoble-alpes.fr and jeremie.viguie@lgp2.grenoble-inp.fr.

Deadline for the application: 15th of May 2022