Léopold Oudinot
Thèse, 2022 – 2025
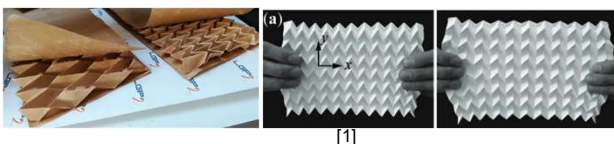3SR : F. Dufour, A. Naillon, L. Orgeas
LGP2 : J. Viguié
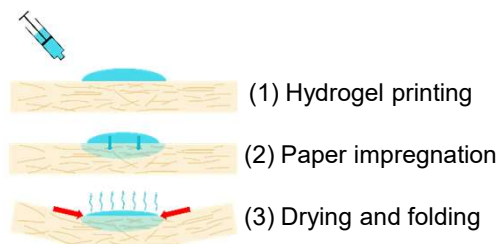
Compréhension et caractérisation de l'imprégnation et du retrait induit par séchage d'un hydrogel biosourcé pour l'autopliage de structures papier architecturées

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

Equipe CoMHet

Context

Architectured paper structures

- Develop new paper based sandwich pannel (folded core improving mechanical performances)
- Industrial production via self folding technologies

[1]

Self folding mechanism using a cellulose hydrogel

(1) Hydrogel printing

(2) Paper impregnation

(3) Drying and folding

- Understand non-Newtonian fluid impregnation in fibrous media (2)
- Characterize stress and strain during drying (3)
- Find key physical parameters to predict angle and local curvature of fold

[1] S. Li, H. Fang, S. Sadeghi, P. Bhovad, et K. Wang, 2019, doi: 10.1002/adma.201805282.

Method

Macro-scale experiments
Using lab papers and automatic gel dispenser

6 mm
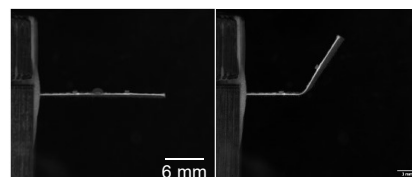
- Different papers/gels/printing parameters
- Measuring angle and curvature of fold

Model system approach

4mm

Capillary tube in a CNC gel

- Separate impregnation and drying phases
- Characterise separately gel and paper behavior : *Gel ability to flow by capillary, tensile stress imposed by shrinking during its drying*

Meso-scale observation

- Using X-ray tomography
- Observe impregnation phase and characterize impregnated area
- Measure strain field during drying

Results

Macro-scale expérimentations: influence of gel concentration

- 150 g/m² bleached soft wood paper
- Dispenser delivers 0.9 mm³ of gel with 1.37mm nozzle
- Using [0%wt ; 18%wt] concentrated CNC gels
- Measuring angle and curvature of samples
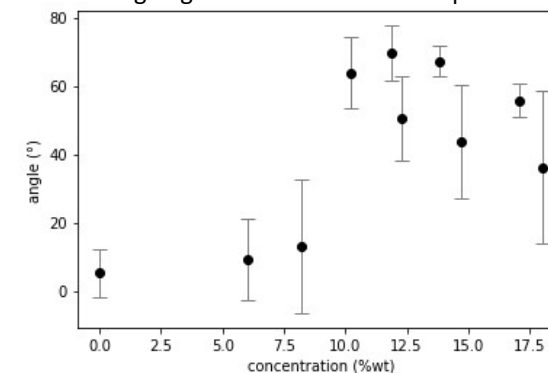
- The mechanism requires minimal gel concentration to occur
- High result variability under the same experimental conditions
- Explaining variability requires local characterisation of paper and gel line heterogeneities