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Ph.D. thesis (2022-2025)
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Comprehension and characterization of the impregnation and drying of bio-based hydrogel for self-folding of architectured paper structures

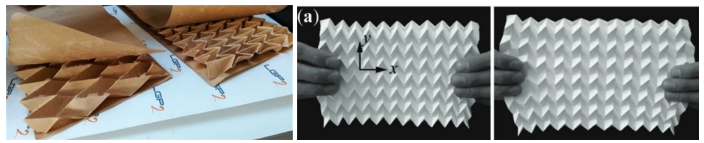
Compréhension et caractérisation de l'imprégnation et du séchage d'un hydrogel biosourcé pour l'autopliage de structures papier architecturés

MatBio / ComHet (3SR)

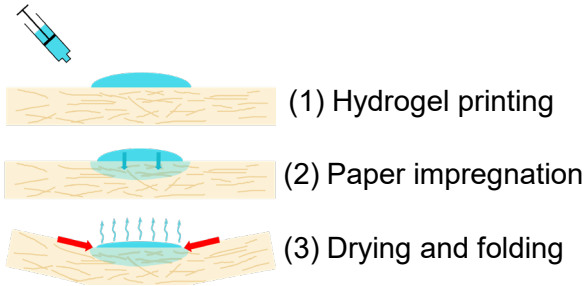
Context / Objectives

Architectured paper structures

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



Self folding mechanism using a cellulose hydrogel



- 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

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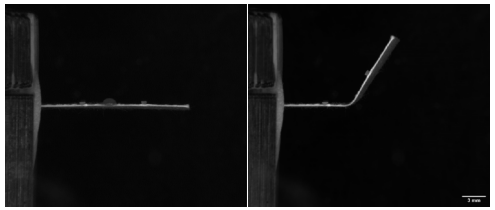
Methods

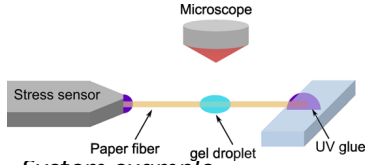
Macro-scale experimentations

Using lab paper and automatic gel dispenser



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

- **Model system approach**



System example

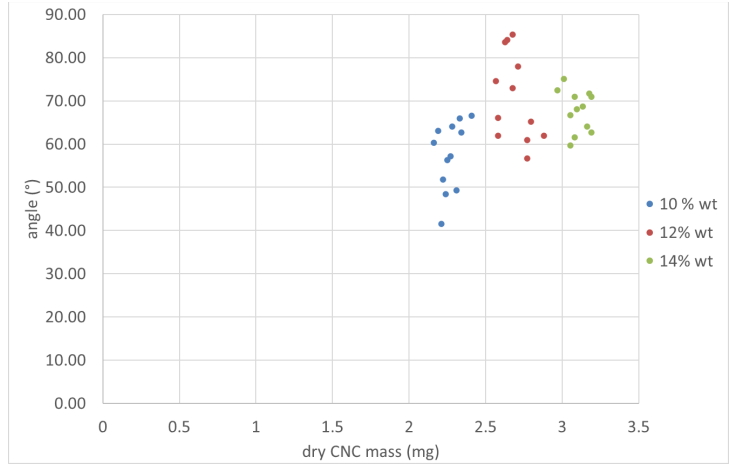
- Separate impregnation and drying phases
- Characterise separately gel and paper behavior
- **Determine specific physical law**

- **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 10%, 12%, 14% concentrated CNC gels
- Measuring angle and curvature of samples



- The mechanism works on high basis weight papers (150g/m²)
- High result variability under the same experimental conditions
- Explaining variability requires local caractérisations of paper heterogeneities