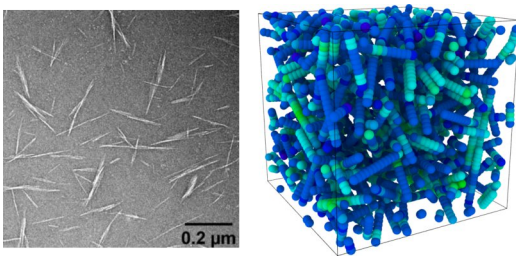
PhD Position

Modeling the rheological properties of rod-like cellulose nanocrystal gels

Location: **3SR Lab**, CoMHet team, Grenoble, France

Project summary

Cellulose nanocrystals (CNC) have emerged as captivating nanoparticles primarily extracted from plant biomass. These biosourced nanocrystals are akin to slender rod-like bio-polymers of about 10 nm in diameter and 100 nm in length with tunable surface chemistry. When dispersed in a fluid such as water, they can self-assemble into micro- and meso-structures that percolate to form a rigid network with small pores that trap water, creating a hydrogel.



Left. SEM image showing cellulose nanocrystals extracted from wood pulp. Right. Snapshot of simulation of rod-like colloidal gel.

These environmentally friendly soft materials have numerous potential applications in civil engineering, healthcare, food science, electronics, and robotics. Additionally, CNC hydrogels serve as precursor materials for other innovative biosourced nanomaterials, such as nanopapers with desirable barrier and optical properties, nanocomposites, and architected materials such as ice-templated or 3D-printed cellular structures with tailored mechanical properties for structural applications.
To effectively use CNC hydrogels for these applications, significant research efforts are required to better understand their complex mechanical behavior. Thus, we will examine the rheological behavior of these gels and analyze changes in their microstructure using shear and compression rheometers and/or our in situ micropress combined with small-angle X-ray scattering imaging to scrutinize flow-induced structural evolutions. Additionally, we will combine our findings with coarse-grained molecular dynamics simulations of colloidal rods to gain quantitative statistical insights into the fundamental microscopic mechanisms governing CNC network formation and their rheological properties under shear and compression.

Location and practical aspects

The successful candidate will benefit from the international outreach of the University of Grenoble Alpes and CNRS. The core of the thesis will be on computational modeling at **laboratory Soils, Solids, Structures, Risks** (3SR, www.3sr-grenoble.fr/) in the "CoMHet" team gathering renowned experts in the physics and mechanics of soft architectured and bio-mimetic materials. In parallel, the PhD student will also contribute to rheometry and X-ray experiments.

Starting date: October 2025 for a period of 3 years.

Profile and required skills

Candidates with academic backgrounds in statistical physics, soft matter, material science, mechanical engineering or physico-chemistry are expected. Specific skills in numerical modeling will be strongly appreciated. Additional knowledge in polymer physics, colloidal materials and rheology will be interestingly examined. Interested candidates should send their **CV**, a **cover letter** and **official transcripts of the last two years** before **2025, May the 6th** to M. Bouzid, mehdi.bouzid@3sr-grenoble.fr, A. Naillon antoine.naillon@univ-grenoble-alpes.fr and L. Orgéas laurent.orgeas@cnrs.fr.