Laboratoire Rhéologie et Procédés

R·MeS Regenerative Medicine and Skeleton - Nantes

I-MEP² École Doctorale
Ingénierie — Matériaux, Mécanique, Environnement, Énergétique, Procédés, Production

PhD Student (M/W): Orthotropic cellulosic based composites for bone and cartilage tissue engineering

At Laboratoire Rhéologie et Procédés (UMR 5520)

In collaboration with the RMeS laboratory: Regenerative Medicine and Skeleton (INSERM U1229)

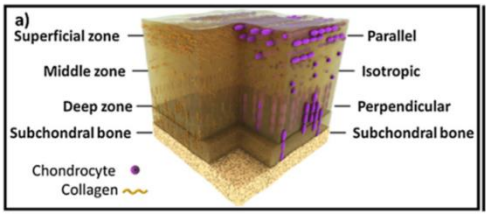
To apply (before 27 May 2022): Application file, selection process, and timeline: Ecole-doctorale I-MEP2- UGA

Applicant should provide an e-application file combining a curriculum vitae, a letter of motivation, a summary of their research experience. A single pdf should be addressed by email to: **frederic.pignon@univ-grenoble-alpes.fr** and **Vianney.Delplace@univ-nantes.fr**

Research Objectives:

The aim of this project is to develop multilayer cellulosic-based composites that can recapitulate the main structural features of cartilage to improve cartilage tissue engineering (Fig. 1). Typical multilayer structures of the cartilage are targeted, combining cellulose nanocrystals (CNCs) with collagen fibrils and/or self-assembled alpha-lactalbumin amyloid fibers, suspended in a synthetic extracellular matrix (ECM) made of photopolymerized hyaluronic acid or aginate. Novel processing methods that combine an innovative ultrafiltration/ultrasound (UF/US) process with hydrogel photocrosslinking will be implemented in order to reproduce the well-known orthotropic organization of the cartilage, comprising: (i) a superficial zone composed of tightly packed and aligned objects parallel to the articular surface; (ii) an intermediate transitional zone with obliquely organized objects; and (iii) a deep zone with objects arranged perpendicular to the articular surfaces. This orthotropic organization should increase the material resistance to shear, tensile and compressive forces, which will be studied by in-situ SAXS, SALS, and ex-situ MEB, XRD and tensile/compression tests. Cytocompatibility tests will be performed at RMeS to assess the compatibility of the designed biomaterials and that of the UF/US process for CNC orientation. The optimization of the different processes (filtration, ultrasound, photopolymerization) and the evaluation of their cytocompatibility will open these novel cellulosic based composites to tissue engineering applications.

Orthotropic multi-layer lamellar structure of cartilage



S. Camarero-Espinosa and J. Cooper-White, Tailoring biomaterial scaffolds for osteochondral repair, International Journal of Pharmaceutics 523 (2017) 476–489

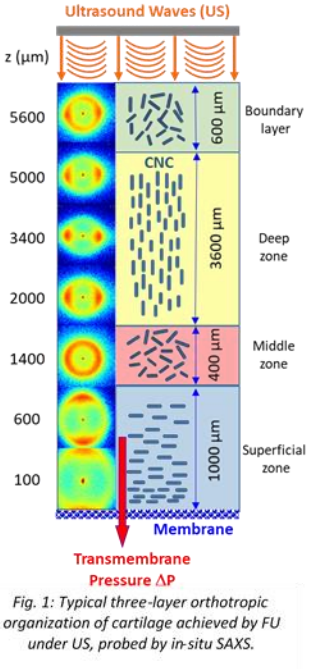


Fig. 1: Typical three-layer orthotropic organization of cartilage achieved by FU under US, probed by in-situ SAXS.

Profile of the PhD expected: The candidate must hold a Master 2 with skills in fluid mechanics, soft matter and/or processes. Experience in the structural/mechanical characterization of colloids and polymers, in hydrogel design and/or cell culture, would be appreciated.

References

- Semeraro, E. et al. Colloids Surf. A, 584, 124030 (2020) – doi.org/10.1016/j.colsurfa.2019.124030.
- Pignon, F. et al. Carbohydrate Polymers, 260, 117751 (2021). doi.org/10.1016/j.carbpol.2021.117751
- Jin, Y. et al. Carbohydrate Polymers, 124, 66–76 (2015). doi.org/10.1016/j.carbpol.2015.01.073
- Domingues, R.M.A. et al. Biomacromolecules 15, 2327–2346 (2014) doi.org/10.1021/bm500524s
- *S. Camarero-Espinosa and J. Cooper-White, International Journal of Pharmaceutics 523 (2017) 476–489 doi.org/10.1016/j.ijpharm.2016.10.035*