Laboratoire de Glycochimie et des Agroressources d'Amiens UR 7378
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6-months Internship Proposal

3D-biopolymers printing

3D printing, also known as additive manufacturing, enables objects with complex geometries to be built quickly, accurately and cost-effectively. As a result, this technique is widely used in aerospace, the automotive industry, robotics and automation, industrial tooling and, more recently, in healthcare for tissue engineering and organ reconstruction. In recent years, in response to environmental challenges and the depletion of fossil fuels, major efforts have been made to develop 3D printing materials based on renewable resources such as cellulose or lignin, mainly because they are generally abundant and biodegradable. In this project, we would like to develop new 3D materials based on silk fibroin or chitin/chitosan. Silk fibroin is a natural protein with good biodegradability and biocompatibility properties, as well as excellent mechanical properties with high tensile strength. Chitin, the second most abundant polysaccharide on Earth, and its deacetylated derivative, chitosan, also have excellent mechanical and biological properties. Therefore, these biopolymers are excellent candidates for 3D printing, and their extraction/characterization/modification are well known in our laboratory. In collaboration with the ***Mécanique et Ingénierie des Matériaux*** Team from **Laboratoire des Technologies Innovantes** (**LTI**) at the university of Picardie Jules Verne, specialized in the development of innovative materials using modern manufacturing processes and high-performance digital tools, we will integrate these biopolymers into 3D printing techniques:

- **DLP (stereolithography)** in which the biopolymers will be combined with biocompatible light-curing resins traditionally used in dentistry.
- **Binder jetting** in which a binder is sprayed onto a powder bed consisting of biopolymers and PVA or PEG powder.
-**FDM (Fused Deposition Modelling)** in which biopolymers are combined with a low-melting thermoplastic such as PCL.

The student will have access to a wide range of instruments for the characterization of biopolymers and 3D scaffolds (FTIR, XRD, TGA, 13C NMR, SEM, etc.).
The candidate should have strong skills and experience in organic chemistry, polymer chemistry or materials chemistry (MASTER or engineering schools). Organized, reliable, reactive, the candidate must show initiative, innovation and have good integration skills. Around 650 €/month is provided for 5-6 months internship.

Candidates who are interested in this subject are requested to send a CV, a letter of motivation and transcripts of their Bachelor's and Master's degrees to the following addresses: albert.nguyen-van-nhien@u-picardie.fr , caroline.hadad@u-picardie.fr

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References LG2A :

1. Active coatings based on oxidized chitin nanocrystals and silk fibroins for the control of anthracnose in 'Hass' avocados. Funes, C. F.; Larach, A.; Besoain, X.; Serrano, D. D.; Hadad, C.; Pedreschi, R.; Van Nhien, A. N.; Fuentealba, C. *Int. J. Biol. Macromol.* **2023**, 253, 126673.

2. CHAPTER 4 Carbon Nanostructures and Polysaccharides for Biomedical Materials González-Domínguez, J. M.; Álvarez-Sánchez, M. Á.; Hadad, C.; Benito, A. M.; Maser, W. K. *Carbon Nanostructures for Biomedical Applications* **2021**, 98-152.

3. L versus DES: Impact on chitin pretreatment to afford high quality and highly functionalizable chitosan Huet, G.; Hadad, C.; González-Domínguez, J. M.; Courty, M.; Jamali, A.; Cailleu, D.; van Nhien, A. N. *Carbohydr. Polym.* **2021**, 269, 118332.

4. Straightforward extraction and selective bioconversion of high purity chitin from Bombyx eri larva: Toward an integrated insect biorefinery. Huet, G.; Hadad, C.; Husson, E.; Laclef, S.; Lambertyn, V.; Araya Farias, M.; Jamali, A.; Courty, M.; Alayoubi, R.; Gosselin, I.; Sarazin, C.; Van Nhien, A. N. *Carbohydr. Polym.* **2020**, 228, 115382.

5. Conversion of Chitin in Ionic Liquids. Hadad, C.; Husson, E.; Van Nhien, A. N. *Encyclopedia of Ionic Liquids* **2019**, 1-6.

6. Synthesis of high molecular weight chitosan from chitin by mechanochemistry and aging. Di Nardo, T.; Hadad, C.; Nguyen Van Nhien, A.; Moores, A. *Green Chem.* **2019**, 3276-3285.

7. The effect of room temperature ionic liquids on the selective biocatalytic hydrolysis of chitin via sequential or simultaneous strategies. Husson, E.; Hadad, C.; Huet, G.; Laclef, S.; Lesur, D.; Lambertyn, V.; Jamali, A.; Gottis, S.; Sarazin, C.; Nguyen Van Nhien, A. *Green Chem.* **2017**, 19, 4122-4131.

References LTI:

8. Toward High Resolution 3D Printing of Shape-Conformable Batteries via Vat Photopolymerization : Review and Perspective. Maurel, A., Martinez, A., Grugeon, S., **Panier, S.**, Dupont, L., Cortes, P., Sherrard, C., Small, I., Sreenivasan, S. and MacDonald, E., *IEEE Access,* , **2021,** *9*, 140654-140666.

9. Considering Lithium-ion Battery 3D-printing via Thermoplastic Material Extrusion and Polymer Powder Bed Fusion. Maurel, A., Haukka, M., MacDonald, E., Kivijärvi, L., Lahtinen, E., Kim, H., Armand, M., Cayla, A., Jamali, A., Grugeon, S., Dupont, L. and **Panier, S.** *Additive Manufacturing,* **2021**, *37*, 101651.