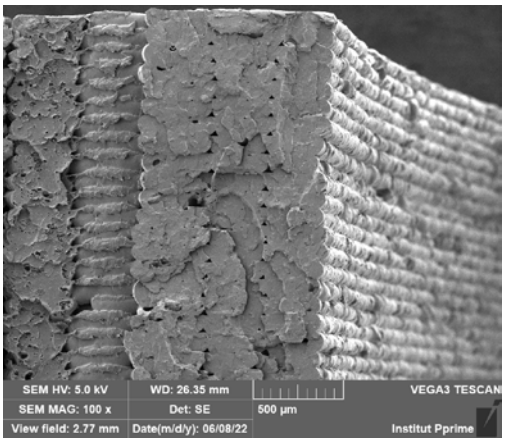

SEM observation of a 3D printed biocomposite

Internship proposal 2023-2024

Laboratory : Institut PPRIME/DPMM/ENDO
(https://pprime.fr/en/research/physics-and-mechanics-of-materials/)

ENSMA – Poitiers (https://www.ensma.fr/en/)

Supervisors : Senior researcher F. Touchard
Prof. H. Naguib (invited researcher)

Funding : internship allowances

3D and 4D printing of biocomposites for deployable structure

Level: with four or five years of post-secondary education, i.e. M1 or M2.
Duration: from 3 to 6 months.
Period: between November 2023 and April 2024.
Required knowledge: Mechanics of Materials, Polymers and Composites, Finite Element Modelling.

Additive manufacturing, or 3D printing, is currently booming and has demonstrated its great potential in many industrial sectors, such as aeronautics, robotics and bio-engineering [1]. In particular, the FDM (Fused Deposition Modelling) process can be used to create structures from polymers and reinforced polymers. Using this technology, it is possible to create intelligent materials integrated directly into the structure, known as 4D printing. This new process, inspired by bio-mimicry, means that 3D printing can be used to create objects capable of changing shape in response to external stimuli: temperature, humidity, light, solvent, etc. [2-4]. 4D printing therefore has great potential for designing intelligent devices such as actuators and sensors. For example, in the space industry, 4D printing is being developed to create self-deploying structures, such as solar panels for satellites, antenna reflectors for communication and surveillance radars, protective domes, flexible and wearable devices [5].

The aim of this internship will be, at first, to characterize the thermo-mechanical properties of different filaments of biocomposites, as hemp/PLA for example, and to study their shape memory capabilities. Next, specimens will be produced by 3D printing and subjected to mechanical testing. The deformation and damage mechanisms of the materials obtained will be analyzed. Actuators will be developed using 4D printing. An in-depth study of the actuation phenomenon will be carried out, based on analytical models and/or numerical simulations. Moreover, an investigation of the recyclability of the studied biocomposite will be performed.

Application: Please send to fabienne.touchard@ensma.fr
- a CV
- your most recent marks and your rank
- a letter of motivation

References:

[1] Darji, V., Singh, S., Mali, HS, 'Mechanical characterization of additively manufactured polymer composites: A state-of-the-art review and future scope.' POLYMER COMPOSITES, 1548-0569, 2023, 10.1002.
[2] K McLellan, YC Sun, T Li, TH Chen, H Naguib, 4D precipitation printing technologies toward sensing devices using microporous structures, Progress in Additive Manufacturing, 2022, 1-12.
[3] K McLellan, T Li, YC Sun, MB Jakubinek, HE Naguib, 4D Printing of MXene Composites for Deployable Actuating Structures, ACS Applied Polymer Materials 2022 4 (12), 8774-8785.
[4] K McLellan, YC Sun, HE Naguib, A review of 4D printing: Materials, structures, and designs towards the printing of biomedical wearable devices Bioprinting 2022 27, e00217.
[5] Kouka, MA, Abbassi, F., Habibi, M., Chabert, F., Zghal, A., Garnier, C., '4D Printing of Shape Memory Polymers, Blends, and Composites and Their Advanced Applications: A Comprehensive Literature Review.' ADVANCED ENGINEERING MATERIALS, 2023, 25,4.