Internship on 4D printing of bioinspired Flax fibre reinforced hygromorph biocomposite

"Relation between slicing parameters and morphing energy"

Co-directed by: Antoine LE DUIGOU, Mickael CASTRO and Sofiane GUESSASMA

Starting date: February 2022

This internship will be mainly developed at Institut de Recherche Dupuy de Lôme (IRDL) located in Lorient (France). The main research question deals with the structuration of biocomposites thanks to 4D printing to produce large morphing displacement but also force/energy.

Context:

This internship will be developed in the framework of the ANR project Redesign4D: "Adaptive composite materials fabricated by 4D-printing and machine learning". Taking advantage of the hygromorphic properties of flax fibers [1], the project Redesign4D will deal with the fabrication of composite materials containing flax fibers capable of developing actuation (motion/force) in response to humidity and electricity.

Actually biological structure like pine cone can exhibit large displacement during moisture change while keeping an important stiffness. This allows these structures to exhibit amazing energy density (power/mass) which can be a source of inspiration for our materials [2].

The goal will be therefore to understand the relation between the numerous slicing parameters (layer height, raster angle…), the printed architecture and the morphing properties in term of displacement but also force generation.

This internship can be continued in a PhD work as funds have already been obtained.

Internship project:

This internship aims at designing and fabricating programmable materials from flax fibers reinforced polymer to provide hygromorph biocomposites with high energy density.

For this purpose, we propose the following objectives :

1. To print flax /polymer samples and evaluate their microstructures
2. Characterization of mechanical properties during immersion
3. Simulation of hygro-mechanical coupling to propose design parameter
4. Characterize the blocking force generation and the subsequent damages mechanism

Candidate profile:

We look for a candidate having a strong team working ability, with education in mechanics, composite materials and additive manufacturing. Knowledge of at least one of the following topics is particularly welcome: natural fibre, physical chemistry of biopolymers, FE simulation

Application procedure: Send a brief CV (maximum 2 pages), master grades and a cover letter to Antoine le Duigou (antoine.le-duigou@univ-ubs.fr), Mickael Castro (mickael.castro@univ-ubs.fr) and Sofiane Guessasma (sofiane.guessasma@inrae.fr) including two references for possible recommendation.

References :

[1] A Le Duigou, S Requile, J Beaugrand, F Scarpa, M Castro,. Natural fibres actuators for smart bio-inspired hygromorph biocomposites. Smart Mater Struct 2017;26.

[2] Le Duigou A, Castro M. Evaluation of force generation mechanisms in natural, passive hydraulic actuators. Sci Rep 2016;18105.