Title : Additive manufacturing of polylactic acid (PLA) cellulose nanofibrils composites.

Programme : PhD in Mechanical Engineering

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Description :
Additive manufacturing, also referred to as 3D printing, has recently attracted a lot of attention due to its potential applications in various fields such as aerospace, automotive and pharmaceutical industries, among others. Although, initially used for rapid prototyping, AM is now used more and more to obtain custom made structures and devices due to the versatility of the process. Fused filament fabrication (FFF) is one of the process most commonly used for additive manufacturing of thermoplastics. A filament of polymer is introduced into a printing head and deposited layer by layer on a platform to form a printed object. Two of the most important polymers that are used in FFF are polylactic acid (PLA) and Acrylonitrile Butadiene Styrene (ABS). Additive manufacturing of PLA is particularly interesting for biomedical applications due to its biodegradable and biocompatible character. However, due to its crystalline structure, PLA may not always present the mechanical properties needed for some applications. Combining PLA with plant based fibers renewable reinforcement such as cellulose filaments (CF) could be an alternative that still needs to be investigated. **Cellulose filaments (CF)** are nanofibers with a high aspect ratio, which gives them notable mechanical and rheological properties that enable their use as rheology modifiers, mechanical reinforcement of several materials such as paper, thermoplastics, thermosets and concrete. In particular, it was shown, that their addition to polymer resins, at relatively low loading levels, results in a good improvement of the mechanical properties of the resins while maintaining good flow properties and low density. However, as it is the case for all types of nanocomposites, their properties depend on a proper dispersion of the CF within the polymer and a strong interfacial adhesion between the CF and the polymer matrix. Furthermore, cellulose is prone to thermal degradation during processing and water uptake, which both should be avoided. A right combination of additive which will enhance the mechanical reinforcement effect of cellulose filament, reduce the moisture content and water uptake and thermal degradation still need to be optimized

This PhD project aims therefore at studying the fused filament fabrication modeling of PLA nanocomposites for biomedical applications.

It will require

- The identification of a biomedical application of PLA/CNF nanocomposites
- The preparation of a optimal material formulation for fused filament fabrication process. In particular, the rheological properties of the materials will be tailored so that the 3D impression will be possible and their morphology controlled to result in materials with interesting functional properties.
- The optimisation of fused filament fabrication process to result in a material with interesting material functional properties.

Partners:
This project will be carried out in collaboration with Kruger Biomaterials and the Université du Québec en Abitibi-Temiscamingue et du Québec à Trois Rivières.

Scholarship : 21.000,00 $ /year

Student profile: Chemical or Materials Engineer

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