PhD Proposition – CIFRE Thesis

Development and functionalization of flax shives for injection moulded bio-based composites

Information

Doctoral School: I2S - Information, Structure, Systèmes (University of Montpellier)

Specialization: Mechanical and Civil Engineering

Research teams: DMS et PCH (IMT Mines Alès)

Supervisors: A.S. Caro, M.F. Pucci, N. Le Moigne

Funding: CIFRE scholarship 36 months

Beginning of thesis: 1 October 2021

Deadline for application: 1 June 2021

Keywords

Thermoplastic polymers, flax shives, recycling, bio-based composites, formulation, modeling, functionalization, manufacturing.

Thesis topic

The Material Research Center of Mines Alès (C2MA) is one of the three research centers at IMT Mines Alès. Its expertise concerns the development of materials for transport, building and packaging industry with a focus on bio-based and recycled materials to minimize their impact on the environment. It provides the strategic link between training, research and economic development activities in these areas. The candidate for the proposed CIFRE thesis will work with members of two C2MA teams: the Hybrid Polymers and Composites (PCH) team, whose objective is the development of low-impact multifunctional polymer, composite and hybrid materials, and the Eco-Sustainability of Materials and Structures (DMS) team, which contributes to the development of eco-materials with improved mechanical performance and addressing durability criteria. The main objective of the research teams is to reveal the relationships between processing, microstructure and functional properties of materials [6-9].

The thesis is part of a collaborative research project funded by ADEME. The aim is to propose to the plastics industry new solutions of plant fillers, as flax shives, to reinforce polymers and develop new functional composites while preventing damaging of injection molds. Actually, flax shives are a coproduct from flax fibre production for textile and composite applications. The production of 1 ton of flax fibres results in the production of 4 tons of flax shives, which correspond to the “wood” part of flax straw. However, the commercialization of flax shive based products is not increasing as fast as for flax fibers [1]. Therefore, it is crucial to find new ways of exploiting this coproduct in the industry and the plastic sector could be promising, since it develops polymer composites reinforced with plant fibers (wood, hemp…) for many uses. The extrusion of polymer wood composites (WPC based PVC or

polyolefins) for decking applications can be performed at relatively low temperatures [2]. Wood fibres are interesting and low cost solutions for plastics extrusion, but their thermal degradation at higher temperatures used for injection molding, is likely to damage injection molds that are very expensive. In this context, flax shives could be an interesting alternative for injection moulding applications, due to their better properties in terms of reinforcing, lightening and thermal stability [3,4].

The first part of this thesis will consist in a comparative study of flax shives and wood fibres properties for the injection molding process. Components causing the damage of injection molds will be identified and processing routes to reduce damages will be proposed. The second part will consist in the identification of new functionalities brought by flax shives in thermoplastic compounds, such as the lightening due to their low density and the improvement of mechanical performances due to their relatively high stiffness [4,5]. The choice of raw materials and processing parameters to optimize these properties will be primarily considered. Particular attention will be also paid to the modeling of the mechanical behavior of composites reinforced by flax shives in relation to their microstructure. The last part of this work will focus on the functionalization of flax shives for their compatibilization with polymer matrices. Various treatments will be evaluated considering their cost and up-scaling to industrial pilots. The final goal of this research work is thus to develop flax shives reinforced composites to minimize the damage of injection molds, to maximize mechanical stiffness and strength and/or lighten bio-composite structures. The resulting compounds will be used in industrial demonstrators.

Thesis supervision

Thesis will take place mainly (70%) at the C2MA:

https://www.mines-ales.fr/ecole/imt-mines-ales/les-centres-de-recherche-et-denseignement/c2ma

The remaining part (30%) will take place at the two industrial partners involved in the project. Academic collaborations are also planned. The PhD student will have the opportunity to publish in international scientific journals and to participate to national and international conferences and workshops.

Required profile

- Master 2 / Engineering Degree in Material Sciences (obtained or upcoming);
- Competences in development and adaptation of experimental methods;
- Interest in experimental work, applied research and modeling;
- Competences and interest in polymers and composites, bio-based materials and material processing.

Contacts

Candidates have to send a CV and an application letter describing their research experiences and of interest areas to:

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