INSTITUT PASCAL (UMR6602 UCA/CNRS) - Group M3G/MatInn

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Title of the thesis: Development of flax/thermoplastic composites - characterization of their properties and durability

Summary of the thesis topic:

The thesis aims to develop the use of composite materials based on flax fibers and thermoplastic polymer matrix (TP).

The design of new materials implies more and more to consider some environmental criteria related to the use of natural (water), renewable (plants) or on the contrary fossil (oil) resources, as well as the quantity of energy necessary to the production, the transport, the use and the management of end of life of materials. It is within this framework that a life cycle analysis can be used to compare materials and help in the decision to favour one solution over another.

Composite materials with flax fibers and thermoplastic matrix are very promising candidates for this analysis. Indeed, they are direct competitors of the very widespread composites made with glass fibers and polyester matrix, and this for several reasons: i/ vegetable fibers, in particular flax fibers, present specific mechanical properties comparable or even superior to those of glass fibers; ii/ their production requires 5 times less energy than their synthetic counterparts; iii/ thermoplastic matrices, recyclable contrary to thermosets, are now simpler to process in association with long fibers (by infusion or resin transfer molding in particular). The performance of the resulting materials is therefore much more interesting, in terms of strength, rigidity and even durability.

Nevertheless, this new combination of materials is very little studied in the literature, in comparison with carbon fiber composites (intended for high-tech applications). In this thesis, we propose to fabricate and characterize flax fiber and thermoplastic matrix composites, to compare the properties of these materials with traditional glass/polyester composites and then (if necessary) to optimize their design and/or processing method. The modeling of their behavior will be carried out within the framework of a set of experiments in order to limit the quantity of tests to be carried out and to validate the change of scale, i.e. the transposition of samples to products. The properties that will be evaluated will not only be mechanical (stiffness, resistance, shock resistance...) but also physico-chemical (resistance under humidity and temperature...) and environmental (life cycle analysis, carbon balance…).