Title : Development of a green composite for packaging.

Programme : PhD in Mechanical Engineering

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Description :

The last few years have seen a great industrial and academic interest on the development of **green composites** that use **polymers from renewable sources and plant based fibers**, due to the reduction of fossil sources together with the increase for environmental concerns. Cellulose is the most abundant biomass product on Earth. It is a biodegradable macromolecule with a semi-crystalline structure that is extensively used for the fabrication of paper. **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. At the same time, polymers such as high density polyethylene (HDPE) and polypropylene (PP) that were before solely obtained from petroleum can be obtained from renewable sources **and HDPE cellulose nanofibrils composites** have been identified as interesting materials for the **packaging industry.** 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. In the case of polyethylene, obtaining a proper dispersion by melt mixing still remains a challenge as most polyethylene is highly hydrophobic and CF is hydrophilic. 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 as well as increase the heat deflection temperature and impact strength, as well as processing conditions to obtain these materials still need to be optimized. Furthermore, it was shown that the addition of nanofillers may affect greatly the crystalline structure of polymers which in turns will affect the functional properties of the resulting composite. However, this phenomenon is not properly understood and needs to be investigated further.

This PhD project aims at developing HDPE cellulose filaments nanocomposites for packaging.

It will require

- The optimization of processing parameters to obtain cellulose filaments HDPE nanocomposites by melt-mixing with optimized properties (thermal, mechanical and barrier)
- The understanding of formation of composite morphology during processing and its influence on the functional properties of the materials obtained.
- The evaluation of the influence of addition of cellulose nanofibrils on the crystalline structure of polyethylene and its consequence on the 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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