Catalytic regeneration and reactive compatibilization of PP/EVOH blends using organometallics anchored by cellulose nanocrystals

M2 – Internship proposal (Feb – June 2025) - 550€/month

Laboratory : Centre de recherches sur les macromolécules végétales (CERMAV)
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The increasing use of commodities polymeric materials as low-biodegradability quick-disposal packaging fosters a scenario of increasing waste generation. Multi-resin materials such as co-extruded multi-layer packing (e.g. PP/EVOH) are part of a challenging scenario due to the difficulty of thermomechanical recycling of such products. As the starting material is a degraded polymeric blend, the addition of usual compatibilizers may not be enough for the regeneration of physical-mechanical properties.

An interesting option is to use specialized additives that can functionalize one (or more) phase(s) of the mixture with organometallic monolayers, to support a "repolymerization bed" by catalytic action.

Nanocellulose-based materials, such as cellulose nanocrystals (CNC), can be used to anchor the organometallic and repolymerize the surrounding phase (PP), reconnecting polymeric chains that suffered previous scission by thermomechanical degradation. Moreover, if the functionalized CNCs are located at the PP/EVOH interface, they can reactively compatibilize the polymeric blend, improving adhesion and reducing interfacial tension.

This internship will focus on the recycling of multicomponent materials with the regeneration of mechanical properties of the degraded matrix, assisted by simultaneous mechanical reinforcement and repolymerization using organometallic additives grafted on nanocellulose fillers. It will open an international collaboration between CERMAV and the Federal University of São Carlos (UFSCar – Brazil) and the intern will present his/her results to both institutions.

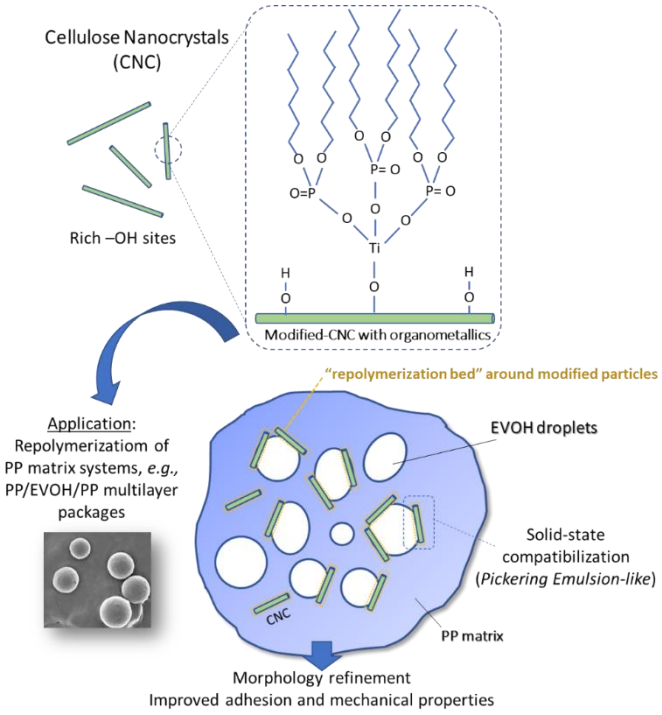

Figure 1. Illustration of the compatibilization mechanism of the PP/EVOH mixture, based on modified-CNC with organometallics.

Objectives:
Preparation of cellulose nanocrystals (CNC from cotton or tunicate) and their surface modification to graft organometallics. Preparation of polymer blends based on recycled polypropylene (PP) and ethylene vinyl alcohol (EVOH) filled with functionalized CNCs. Characterization of the grafted CNCs, blend microstructure, polymer-filler interfaces and bulk mechanical properties.

Approaches & Techniques:
Cellulose nanocrystals extraction/surface modification (FTIR, solid-state NMR, TEM), cellulose nanocrystals dispersion in polymer melt (internal mixer), microstructure and interfaces (SEM, AFM), thermal (DSC) and mechanical properties (tensile tests, DMA).

Candidate profile: Physical chemist with a good background in materials science and engineering.