Research project for a PhD student from China Scholarship Council

Title: New bio-based polymers useful in food packaging: synthesis, thermal, mechanical and transport properties.

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Description:

At the Paris climate conference (COP21) in December 2015, 195 countries adopted the first-ever universal, legally binding global climate deal. The agreement sets out a global action plan to limit global warming with the reorientation of the world economy towards a low carbon model. Among the proposed solutions, one would be to prepare natural, biodegradable materials made only from renewable resources.

This Ph-D will investigate a new generation of bio-based eco-friendly polymers, using molecules obtained from biomass by a green chemistry approach.

Biopolymers currently used for industrial applications are poly(hydroxyalkanoate) (PHA) and poly(lactic acid) (PLA) (for packaging, clothing (PLA) and as biomaterials). However, these materials show mechanical properties often lower than petroleum-based polymers.

The preparation of new bio-based materials, semi-crystalline, with high molecular weight and with better mechanical properties than PLA and PHA is scientific, industrial and environmental challenges. The progresses in green chemistry science suggest to synthesize new polymers [1,2]. However, physical properties, thermal and hydrolytic aging of these new biopolymers must be studied before considering the replacement of conventional polymers [3].

Nontoxic bifunctional biodegradable and thermally stable molecules can be extracted from biomass. Some molecules can be used as monomers for polymerization. For example, isosorbide can be used as a monomer for synthesizing poly (ethylene furanoate) (PEF), which is intended to replace in the future poly (ethylene terephthalate) (PET) for water and soda packaging [4].

Many other polymers of the same family can be obtained by green chemistry [5]. For this thesis, new polyesters will be synthesized. The microstructure, the mechanical and the thermal properties of these new materials will be studied. We will focus particularly on the transport and sorption properties towards gases and water. The studies should allow to establish relationships between microstructure, morphology, physico-chemical and functional properties of the biopolymers.

Keywords: bio-based polymers, structure-properties relationship

Applicant profile:

The project requires strong skills in molecular and macromolecular organic synthesis, and in polymer physico-chemical characterization. The applicant must be fluent in English (or in French).

[1] A Wroblewska et al., Polymer Chemistry, 2015, 6, 4133-4143
[2] J.-P. Pascault et al., Polymer Science: A Comprehensive Reference, 2012, 10, 59-82
[3] G. Stoclet et al., Polymer, 2015, 72, 165-176
[4] S. Burgess et al., Polymer, 2014, 55, 4748-4756
[5] J. Wu et al., Chemsuschem Communications, 2015, 8, 67-72