Integration of industrial by-products into bio-sourced resins and composites

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Abstract

The RECYSITE project aims to develop bio-sourced composite materials based on vegetal fibers and resins based on humins and epoxidized linseed oil (ELO). In turn these materials will be used as parts in the transportation and constructions sectors.

Humins are a by-product of bio-refineries in the production of furan-based monomers. As a by-product, they can represent as much as 30% w/w in the industrial process[1]. From a chemical standpoint they are complex mixtures of furan derivatives, in various degrees of polymerization[2,3]. This aspect offers perspectives towards higher value applications such as polymers[4]. ELO is an epoxidized vegetable oil containing 5.5 oxirane moieties per molecule. It is regarded as a bio-sourced, renewable alternative to classical, synthetic epoxides[5,6].

Resins were produced from humins, ELO and Capcure 3-800 and characterized through ATR FT-IR. Based on formulation, a wide array of materials was obtained with Shore hardness varying from 56A to 66D. The thermal behavior of the resins was evaluated through differential scanning calorimetry and thermogravimetric analysis.

Composites, employing as reinforcement, five types of vegetal fibers were obtained. The adherence of the resin to the reinforcement was evaluated through scanning electron microscopy (SEM) and was found to be optimal. Figure 1 displays the results of the project.

The obtained composites present a bio-based content up to 85%. The mechanical properties of the materials can be adjusted by adapting the formulation. The good compatibility between the resin and the reinforcement proposes the materials as candidates to replace classical materials in applications. At this moment, the materials are tested as parts for the transportation and constructions sectors.

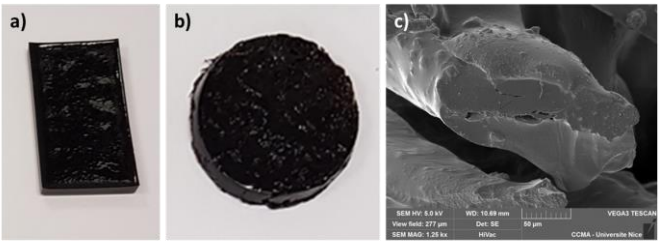


Figure 1: a) Humins/ELO/Capcure resin; b) composite made from humins/ELO/Capcure resin and hemp fibers reinforcement; c) scanning electron microscopy (SEM) micrograph of resin/hemp composite

Recent Publications

1. Pin J.M, Guigo N, Mija A., Sbirrazzuoli N., van der Waals J.C, de Long E. (2014) Valorization of Biorefinery Side-Stream Products: Combination of Humins with Polyfurfuryl Alcohol for Composite Elaboration. ACS Sustainable Chem. Eng., 2 (9), 2182–2190.
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3. Cheng Z., Everhart J.L., Tsilomelekis G., Nikolakis V., Saha B., Vlachos D.G. (2018) Structural analysis of humins formed in the Brønsted acid catalyzed dehydration of fructose. Green Chem., 20, 997-1006.
4. Mija A., van der Waal J.C, Pin J.M, Guigo N, de Jong E. (2017) Humins as promising material for producing sustainable carbohydrate-derived building materials. Construction and Building Materials 139, 594-601
5. Pin J.M., Sbirrazzuoli N, Mija A. (2015) From epoxidized linseed oil to bioresin: an overall approach of epoxy/anhydride cross-linking. ChemSusChem. 13;8(7), 1232-43.
6. Pin J.M, Guigo N., Vincent L, Sbirrazzuoli N, Mija A. (2015) Copolymerization as a Strategy to Combine Epoxidized Linseed Oil and Furfuryl Alcohol: The Design of a Fully Bio-Based Thermoset. ChemSusChem 8, 4149-4161.

Biography

Erol-Dan Licsandru received his diploma in chemical engineering in 2009, with a focus on organic synthesis. He followed a master's program for two years in advanced synthesis. During his PhD at Insitut Europeen des Membranes Montpellier he focused on supramolecular chemistry applied to the field of molecular transport. In 2017 he joined the RECYSITE project and its goal of designing bio-sourced thermosetting resins and composite materials.

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