SPECIFIC POLYMERS

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Ecoxy Project

ECOxy

Introduction

For more than 15 years, SPECIFIC POLYMERS is involved in collaborative projects whether at the National or European level. In this scope, we are involved in the Ecoxy project since its inception in June 2017. The project gathers together a consortium of 13 partners from 8 different European countries to meet the following objective: the development of bio-based fibres with improved properties.

The establishment of such project arises from major concern about the significant part of epoxy-based materials worldwide which are prepared from the DiGlycidyl Ether of Bisphenol A (DGEBA). Indeed, Bisphenol A (BPA) has been classified as a chemical of very high concern by the European Chemicals Agency (ECHA) due to its toxicity. That is why nowadays, many industrial and collaborative projects are ongoing to find industrially viable bio-based breakthrough alternatives to fossil resources.

Bio-based, recyclable, reshapable & repairable (3R) thermoset composites

Among thermosetting materials, epoxy polymers are widely used in many industrial fields due to their good adhesion to many substrates, good chemical resistance, and excellent thermal and mechanical properties. Hence the importance of bio-based epoxy polymers which could thus have the double positive effect of Bisphenol A replacement and renewable and non-harmful epoxy monomers.

Within the ECOXY H2020 project, innovative bio-based epoxy resins are synthesized in order to produce new sustainable thermoset composites exhibiting reparability, reprocessability and recyclability properties (3R). A key challenge is to reach targeted 3R properties while meeting end-users' specifications in terms of processability and final mechanical properties. In this way, SPECIFIC POLYMERS research efforts are mainly dedicated to:

(i) Bio-based alternative building-blocks to substitute toxic and petro-based precursors (Bisphenol-A, Formophenolic, Isocyanates, etc.) in thermoset resins and composites

(ii) The end-of-life phase of corresponding thermoset materials that suffer from a lack of reprocessability, reparability and recyclability

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Bio-based alternatives in epoxy materials

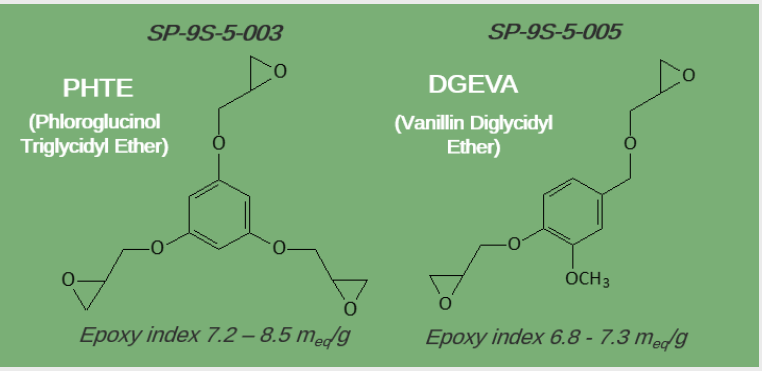
To develop suitable biobased epoxy resins, a particular attention was given to the influence of the epoxy index, the molecular weight and the chemical nature of synthesized precursors on resins processability and thermomechanical properties. Two range of biobased epoxies were developed:

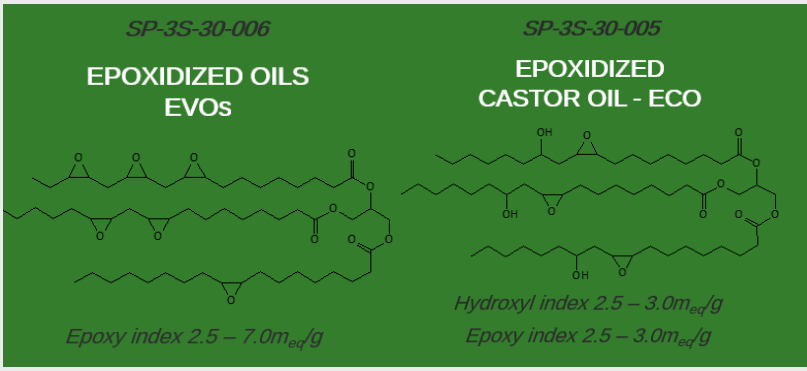
Aromatic Bio-based Precursors:

We realised the synthesis of aromatic resins bearing multi-functional glycidyl ether moieties. Our study was based on the chemical modification of vanillyl alcohol which can be extracted from Lignin and Phloroglucinol, which can be extracted from Algae. Both epoxy resins are aromatic multifunctional glycidyl ethers that can be combined to reach a range of thermomechanical properties.

Epoxidation of vegetable oils:

We focused on the epoxidation of unsaturated vegetable oils. The degree of unsaturation and their chemical nature have a great influence on reachable epoxidation degree and final epoxy resin properties. Most interesting oils were analyzed to determine their unsaturation content to adapt the epoxidation process accordingly. A wide range of epoxidized vegetable oils exhibiting an epoxy content from 2.5 to 7.0 meq/g were synthesized.





Epoxidized vegetable oils allow to reach Tg in between 15°C and 90°C using the reference hardener. Resins formulated on the basis of DGEVA and PHTE allow to reach Tg in between 90°C to 180°C. Thus, from both these bio-based precursors, it was possible to find a sustainable alternative to DGEBA in epoxy resin formulations. As a consequence, DGEVA and PHTE was retained as the most promising materials for ECOXY project. An in-depth development work was achieved to enhance the synthetic protocols of both these epoxy precursors and we are working in close collaboration with its toll-manufacturer to scale up the production of these resins to 25 kg by the end of the project. The 3R functionalities are achieved by combining aforementioned SP bio-based epoxy building-blocks with suitable dynamic hardeners. Compatibilization with flax fibers or PLA fibers is currently being studied to prepare corresponding 3R composite materials.