ISGC 2019
May 13th - 17th

N°638 / PC
TOPIC(s) : Polymers / Industrial chemistry

Reparable, Reprocessable and Recyclable Thermoset Epoxy Resins

AUTHORS

Samuel MALBURET / SPECIFIC POLYMERS, 150 AVENUE DES COCARDIÈRES, ZAC VIA DOMITIA, CASTRIES
Chiara DI MAURO / UNIVERSITÉ CÔTE D?AZUR, UNIVERSITÉ NICE-SOPHIA ANTIPOLIS, INSTITUT DE CHIMIE DE NICE, UMR CNRS 7272, NICE CEDEX 02
Alice MIJA / UNIVERSITÉ CÔTE D?AZUR, UNIVERSITÉ NICE-SOPHIA ANTIPOLIS, INSTITUT DE CHIMIE DE NICE, UMR CNRS 7272, NICE CEDEX 02
Sarah MONTES / CIDETEC, PASEO DE MIRAMÓN, 196, DONOSTIA-SAN SEBASTIÁN (GIPUZKOA)
Aratz GENUA / CIDETEC, PASEO DE MIRAMÓN, 196, DONOSTIA-SAN SEBASTIÁN (GIPUZKOA)
Alain GRAILLOT / SPECIFIC POLYMERS, 150 AVENUE DES COCARDIÈRES, ZAC VIA DOMITIA, CASTRIES
Cédric LOUBAT / SPECIFIC POLYMERS, 150 AVENUE DES COCARDIÈRES, ZAC VIA DOMITIA, CASTRIES

PURPOSE OF THE ABSTRACT

SPECIFIC POLYMERS (SP - www.specificpolymers.fr) is a SME with 17 employees acting as R&D service provider and scale up producer in the field of functional building-blocks, polymers and materials with high specificity. The main goal of the innovative product developed by SPECIFIC POLYMERS is to validate proof of concepts and develop tomorrow's materials. In this context, green material chemistry biomass valorization and circular economy are the main aspect of SP research and development activities. Many industrial and collaborative projects are ongoing to find bio-based breakthrough alternatives to fossil resources having an industrial viability. In this scope, SP research effort is mainly dedicated to (i) bio-based alternative building-blocks (Figure 1) to substitute toxic and petro-based precursors (Bisphenol-A, Formophenolic, Isocyanates, etc.) in thermoset resins and composites and (ii) the end-of-life phase of corresponding thermoset materials that suffer from a lack of reprocessability, reparability and recyclability.

Among thermosetting materials, epoxy polymers are used in many industrial fields such as aerospace or automotive for instance. This is mainly due to their good adhesion to many substrates, good chemical resistance, and excellent thermal and mechanical properties. Currently, 75% of the epoxy polymers worldwide are prepared from the DiGlycidylEther of Bisphenol A (DGEBA). However, its manufacturing is based on Bisphenol A, a reprotoxic substance that is under close monitoring and which use might be restricted in certain applications in the future. The bio-sourcing of epoxy polymers could thus have the double positive effect of Bisphenol A replacement and renewable and non-harmful epoxy monomers is a hot topic and a challenge that needs to be addressed. For these reasons, the bio-sourcing of epoxy polymers received a great deal of attention.

ECOXY H2020 project (www.ecoxy.eu) is an integral part of this innovation work. Indeed, in this project, innovative bio-based epoxy resins are synthesized in order to produce new sustainable thermoset composites exhibiting reparability, reprocessability and recyclability properties (3R). The 3R functionalities are achieved by combining SP bio-based epoxy building-blocks with suitable dynamic hardeners[1]. A key challenge of the project is to reach targeted 3R properties while meeting end-users specifications in terms of processability and final mechanical properties. To do so, SP developed the synthesis of bio-based epoxy precursor exhibiting a set of properties that can be adjusted depending on the application. A significant part of the work was dedicated to (i) the synthesis of Vanillin DiGlycidylEther (DGEVA) prepared from vanillyl alcohol that can be extracted from

lignin[2] and to (ii) Phloroglucinol TriGlycidylEther (Phloroglucinol-TGE) that can be extracted from algae[3]. Both epoxy resins are aromatic multifunctional glycidyl ethers that can be combined to reach a range of thermomechanical properties. On the other hand, epoxidation of various vegetable oils was also studied[4]. The degree of unsaturation and the chemical nature of vegetable oils have a great influence on reachable epoxidation degree and thus final epoxy resin properties. Overall, particular attention was given to the influence of the epoxy index, the molecular weight and the epoxy reactivity of synthesized precursors on resins processability and thermomechanical properties. Indeed, the ultimate goal of the project is to produce 50 to 100 kilograms of the most suitable resins for their evaluation in both automotive and construction sectors.

FIGURES

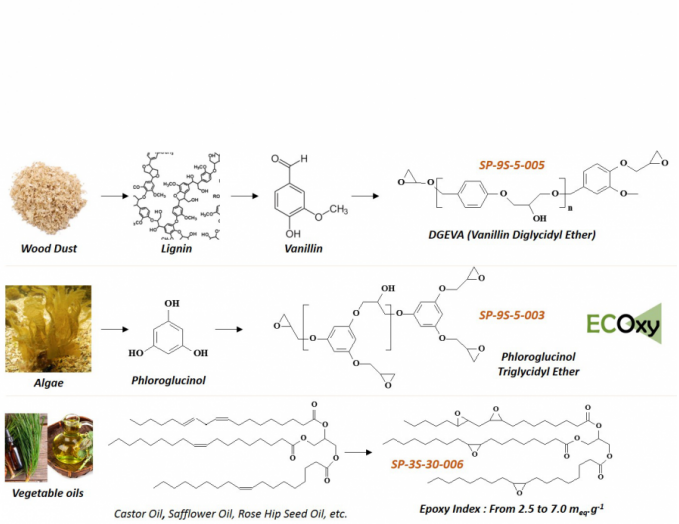

FIGURE 1

Figure 1

Bio-based Building-Blocks for Thermoset Epoxy resins

FIGURE 2

KEYWORDS

DGEBA Alternatives | Bio-based Epoxy | Thermoset Materials | Recyclable Thermoset Resins

BIBLIOGRAPHY

[1] A. Ruiz de Luzuriaga, R. Martin, N. Markaide, A. Rekondo, G. Cabañero, J. Rodríguez and I. Odriozola, Epoxy resin with exchangeable disulfide crosslinks to obtain reprocessable, repairable and recyclable fiber-reinforced thermoset composites, Mater. Horiz., 2016, 3, 241-247

[2] M. Fache, B. Boutevin and S. Caillol, Epoxy thermosets from model mixtures of the lignin-to-vanillin process, Green Chem., 2016, 18, 712

[3] J. Ding, O. ur Rahman, W. Peng, H. Dou and H. Yu, A novel hydroxyl epoxy phosphate monomer enhancing the anticorrosive performance of waterborne Graphene/Epoxy coatings, Applied Surface Science 427 (2018) 981–991

[4] S. M. Danov, O. A. Kazantsev, A. L. Esipovich, A. S. Belousov, A. E. Rogozhin and E. A. Kanakov, Recent advances in the field of selective epoxidation of vegetable oils and their derivatives: a review and perspective, Catal. Sci. Technol., 2017, 7, 3659