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Reprocessable Humins Thermosets and Composites

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PURPOSE OF THE ABSTRACT

The need to establish effective solutions to reduce the consumption of non-renewable fossil products and to develop innovatively green and environmentally friendly products have become the main focus of worldwide research. In this general trend and scientific effort, we recently work on developing epoxy resins and composites based on bio-based and renewable products (e.g., vegetable oils, vegetal fibers) or industrial by-product streams (e.g., humins, chicken feathers), that can be used in a wide range of industrial sectors.

To fulfil the concept of circular economy, three different strategies such as reuse, recycling and remodeling were considered. For this purpose, humins (side products from biorefineries) were valorized by developing (flexible) thermoset resins through copolymerization of the humins with epoxy compounds such as resorcinol diglycidyl ether (RDGE), a bio-based epoxide, or trimethylolpropane triglycidyl ether (TMPTE). These humins-based thermoset resins were used as matrices in the development of bio-composites being reinforced with non-woven fabrics made from chicken feathers (food industry waste) or vegetable fibers (bio-renewable resources). To the optimal formulations for composites manufacturing, the thermodynamic parameters of curing, the reactivity of the mixtures but also the ability of the final materials to be recycled were developed. Thereafter, the physico-chemical and thermomechanical properties of the bio-based composites were analysed using various techniques. Comparison of the results showed that the reinforcement led to an increase of glass transition (Tg) region in the range 26?58 °C. The stiffening of the developed materials by reinforcement with the bio-fillers was confirmed by Shore hardness tests, the measured values (74 - 85 SD) being comparable with those of commercial materials (e.g., epoxy/glass fibers and epoxy/carbon fibers composites). The tensile properties of the designed materials were also determined, showing that the reinforcement of humins-based resins with chicken feathers or vegetable fibers non-woven led to the improvement of the tensile strength and the elongation at break of the bio-composites. Also, the matrix/filler interface and the adhesion between compounds was investigated by Scanning electron microscopy (SEM) revealing a proper adhesion and a good interaction between matrix and filler without any prior physical or chemical treatment of the fillers or matrix.

Finally, the study showed, maybe surprisingly, that the humins-based thermoset bio-composites reinforced with natural fibers could be successfully recycled using thermo-mechanical methods without affecting their properties.

FIGURES

FIGURE 1

FIGURE 2

KEYWORDS

humins | composites | chicken feathers | jute and flax fibers

BIBLIOGRAPHY

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