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Polyhydroxyurethane thermosets from partially carbonated epoxidized soybean oil

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PURPOSE OF THE ABSTRACT

Non-isocyanate polyurethanes (NIPUs) and more precisely polyhydroxyurethanes (PHUs), obtained by reaction between cyclic carbonates and amines, are considered today as realistic alternatives to common polyols/isocyanate-based polyurethanes.

In the present work, the reaction of partially carbonated epoxidized soybean oils with two different diamines, Priamine 1075 and 1,8-octanediamine respectively, was investigated. The relative reactivity of carbonate and epoxide functions with respect to amines was studied to understand the role of each function in the crosslinking reaction.

At first, epoxidized soybean oil (ESBO) was converted into carbonated soybean oil (CSBO) through the reaction of the epoxide functions with carbon dioxide catalyzed by tetrabutylamonium bromide (TBABr). After optimization of the experimental conditions of this reaction, partially carbonated soybean oils, with a carbonation ratio ranging from 45 % (CSBO45) to 99 % (CSBO99), were synthesized.

The reactivity of both reactive functions of CSBO45, i.e. carbonates and epoxides, was then monitored through in-situ infrared and Raman spectroscopy with either Priamine 1075 or 1,8-octanediamine at various temperatures comprised between 60 °C and 150 °C. Those experiments demonstrated that carbonates react with amines at a much faster rate than epoxides but also showed the importance to reach the completion of both the carbonate-amine and epoxy-amine reactions to effectively crosslink this hybrid system. Indeed, rheological measurements confirmed that the reaction of carbonates only is not sufficient to observe the gelification of the system. Furthermore, swelling tests in toluene complemented the previous results as soluble fractions decreased drastically when high conversion degrees for both carbonates and epoxides are achieved.

In the end, two-step reactions were carried out with the aim of improving the crosslinking of the polymers by taking advantage of the reactivity difference between carbonates and epoxides. Hence, the first step at 80 °C led mainly to the conversion of carbonates thus increasing the viscosity of the medium, while the second step at 120 °C triggered the reaction of epoxides with residual amine moieties leading to the gelification of the system.

FIGURES

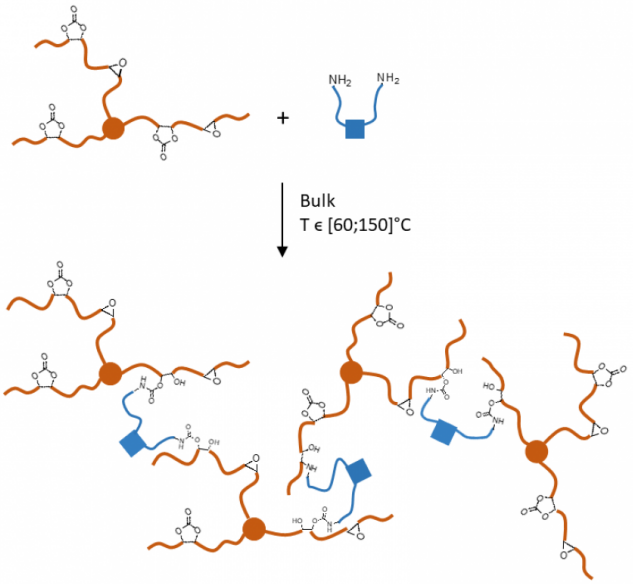

FIGURE 1

Synthesis of polyhydroxyurethane thermosets

Scheme of the reaction of partially carbonated epoxidized soybean oil with a diamine

FIGURE 2

KEYWORDS

Polyhydroxyurethane | Soybean oil | Thermoset

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