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The humins: from side-stream product to auto-crosslinked rigid foams and added value materials

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PURPOSE OF THE ABSTRACT

Humins are a side-stream product of the industrial acidcatalyzed dehydration of C6-sugars during the production of levulinic acid, 5-(hydroxymethyl)furfural and derivatives. During the biorefinery process, a random and so far uncontrollable polymerization between several intermediates present in the acidic media occurs, generating a black viscous mixture of oligomers called humins. Their formation not only reduces the efficiency of the process but also leads to engineering challenges. The development of cost-effective valorizations of humins and their application in the preparation of high value products has become a priority for an economical and environmental point of view.

Recently, we proved that these humins possess an auto-crosslinking and self-foaming behavior, and when heated above 180 °C lead to rigid porous thermosets called humin foams. The humin foams can be produced from crude humins without any purification or chemical modification step, by a simple and cheap straightforward thermal process. The foams can be obtained with high control over the product morphology, porosity and carbon content (up to 95%). Chemico-physical properties and application of these humin foams have been investigated in terms of surface chemistry, stability, conductivity and reactivity. Humin foams have also been tested as sacrificial template in the preparation of 3D-networked metal porous catalysts, as well as in activated carbon monoliths preparation using CO₂ activation. High BET surface areas could be achieved for these monoliths (1300-1500 m²/g), and have been tested in CO₂ storage and water decontamination applications. Furthermore, using humins thermoset behavior it was possible to prepare composite materials with improved mechanical properties as compared to the pure humins thermosets.

FIGURES

FIGURE 1

FIGURE 2

KEYWORDS

Humins | lignocellulosic biomass | thermoset | waste valorization

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