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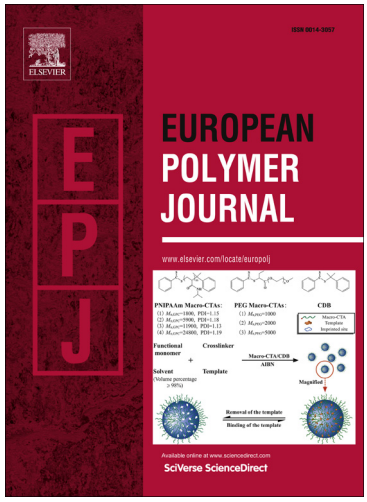

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Green synthesis of flexible polyurethane foams from liquefied lignin

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ABSTRACT

One of the targets of the research activity in the EC project FORBIOPLAST grant agreement no. 212239 was focused on the use of by-products from wood as raw materials for the production of soft polyurethane foams by innovative sustainable synthetic processes with reduced energy consumption. The present paper reports the green synthesis of soft foams from Kraft lignin. In an attempt to produce flexible foams, two types of chain extenders were used in combination with liquefied lignin: polypropylene glycol triol and castor oil. The samples were produced with the "one shot" technique and the only blowing agent used was water. All samples were produced with a NCO/OH ratio less than one, because it is well known that it significantly reduces the degree of crosslinking, resulting in higher flexibility of the material. Samples were produced in free and controlled rise expansion. Lowering the glass transition temperature of the polyol phase was determined to be the most important issue in order to increase the content of liquefied lignin in foam formulation, and ultimately achieving the goal of making soft foam with liquefied lignin.

Keywords: polyurethane, lignin, soft foam, microwave, renewable resources

1. Introduction

Polyurethanes (PU) are a broad class of polymers having urethane as a common group. They are known for their versatility, but one of the problems related to the production of PU nowadays is their dependence on petroleum-derived products.

Foams represent one of the most important commercial products of PU. These foams are commonly classified as flexible, semi-rigid, or rigid, depending on their mechanical performance and core densities. The main field of polyurethane application is in the furniture industry followed by automotive applications for flexible and semi-flexible polyurethanes (seat cushioning, bumpers, sound insulation, etc.).

Flexible PU foams are block copolymers that owe their elastic properties to the phase separation of so-called “hard blocks” and “soft blocks.” Hard blocks are rigid structures that are physically cross-linked and give the polymer its firmness; soft blocks are stretchable chains that give the polymer its elasticity. By adapting the composition and the ratio of the hard and the soft blocks, PU can be customized to its application.

Polyurethanes are prepared from the polyol component and isocyanates. At present, for foam applications, only the production of polyol from renewable resources is reported. Although aliphatic di-isocyanates from dimerized fatty acids are commercial, they do not have sufficient reactivity for application in foams, but they could be used for coatings and other applications [1]. Thus, isocyanates for foams must be aromatic. On the other hand, vegetable oil polyols have an excellent