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● Polyurethane adhesives based on oxypropylated lignin via reaction with propylene carbonate

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Abstract content

Polyurethanes (PUs) are usually synthesized via a reaction between polyol and diisocyanate, mostly petroleum-based raw materials. Due to social concerns regarding sustainability and the imminent depletion of fossil resources, renewable precursors have been investigated in the last decades. In this context, lignin emerged as a potential candidate, based on its thermomechanical properties and chemical structure. Despite its potential, lignin presents some limitations: low reactivity, structural heterogeneity, and brittleness. In several works, lignin oxypropylation with alkylene oxides (AO) was used as the main strategy used to overcome these limitations. However, AO are flammable, toxic, and carcinogenic. Kühnel et al.[1] investigated the lignin oxypropylation via reaction with propylene carbonate (PC) as an alternative to AO, due to its low toxicity and high boiling point. In our work, for the first time, polyurethane adhesives were synthesized based on lignin oxypropylated with PC (HKL_PC). Chemical modifications were confirmed by FTIR-ATR spectroscopy (Figure 1.a), DSC, and 1H NMR. HKL_PC was mixed with castor oil (CO) under different mass ratios (HKL_PC/CO = 15/85 and 30/70). Afterward, 4,4'-Diphenylmethane diisocyanate (MDI) was added to polyol mixtures (NCO:OH = 1:1). Curing kinetics was studied by Temperature Modulated Optical Refractometry (TMOR) at 60 °C (Figure 1.b). Thermomechanical properties and tensile mechanical behavior were investigated by DMA analysis and tensile tests, respectively. Furthermore, the practical adhesion was evaluated by single-lap shear tests. Results confirmed the development of HKL-containing adhesives, with mechanical properties and practical adhesion similar to commercial polyurethanes adhesives.

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References
[1] I. Kühnel, J. Podschun, B. Saake, R. Lehnen, Holzforschung. 69 (2015) 531–538.

Figure 1.a and Figure 1.b