Lignin and Glycerol as Bioderived Agents for Films, Foams, and Adhesives: Structure-Property Relationships and Biodegradability Performance

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Polyurethanes (PUs) are the world's sixth highest produced polymer and represent a versatile class of plastics capable of producing adhesives, coatings, elastomers, biomedical materials, and foams. PUs are commercially produced by the reaction of polyols with isocyanates, the reaction being highly exothermic, with short cure times, conducive to manufacturing operations with rapid cycle times. The versatility of PUs stems from the ability to interchange or combine different types of polyols to induce flexibility, elastomeric properties, or rigid materials of high strength. However, isocyanates are an acutely toxic reagent, responsible for the highest cases of workplace asthma, and recognized as carcinogenic, mutagenic, and a reproductive toxin. These hazards have led many to innovate new kinds of non-isocyanate polyurethanes (NIPUs), however, little adoption in high-use applications such as packaging have been made. In addition, little is known about the biodegradability performance of NIPUs in organic composting operations, an end-of-life solution growing in popularity among producers and consumers. To address these issues, we looked to glycerol and sebacic acid, two industrially produced biobased chemicals, to produce a series of films, foams, and adhesives and assessed the effect of adding a biobased crosslinker, lignin. These materials were assessed for the mechanical and barrier properties in packaging applications, while also undergoing aerobic decomposition in simulated composting conditions. The results reveal an interesting platform for NIPU synthesis that combines renewability and biodegradability in a versatile monomer platform similar to commercial PUs.