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Starch as a source of polyols for bio-based film-forming polyurethanes

Fabiana Aparecida Lobo[1,2], Diego Beltrame Pereira[3], Luiz Antonio Ramos[2], Vagner Roberto Botaro[4], Jane Maria Faulstich de Paiva[5], Elisabete Frollini[2]

[1]Universidade Federal de Ouro Preto (*Departamento de Química*) , [2]Instituto de Química de São Carlos - Universidade de São Paulo, [3]Instituto de Química de São Carlos - Universidade de São Paulo (*Departamento de Físico-Química*) , [4]Universidade Federal de São Carlos - Campus Sorocaba (*Departamento de Física, Química e Matemática*) , [5]Universidade Federal de São Carlos - Campus Sorocaba (*Departamento de Engenharia de Produção*)

e-mail: fabiana@ufop.edu.br

In the context of investigating the utilization of polyols derived from renewable sources[1] for the synthesis of bio-based polyurethanes (PUs-bio), the present study incorporates not only ricinoleic acid triglyceride—the major component of castor oil—but also starches with both high and low average molar masses as hydroxyl group sources (comprising 50 wt% relative to castor oil). The synthesis was conducted without the use of a solvent or catalyst, with the reagent mixture, including hexamethylene diisocyanate, pre-applied to the surface of a glass plate using an extender. Such conditions allowed films to be formed alongside the advancement of the synthesis process. The tensile properties of the resulting films demonstrated that, when using high average molar mass starch as a polyol instead of low average molar mass starch, there was a 50% increase in tensile strength, a 12% increase in modulus, and a 32% enhancement in elongation. Dynamic mechanical analysis revealed that both films exhibited a glass transition temperature (Tg, from the tan delta peak) of approximately 30 °C. The PUs-bio forming the films exhibit a chemical structure combining the rigid structures of amylose and amylopectin (starch components) alongside the more flexible ricinoleic acid triglyceride and diisocyanate moieties. The latter two factors appear to have contributed more to the observed glass transition than the variation in the average molar mass of the starches used as polyols. The prepared bio-based materials have potential for a variety of applications, including packaging, battery separators, and more. The ongoing study plans to explore additional starch percentages and alternative isocyanate sources in the PUs-bio formulations.

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References
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