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Impact of incorporating nanosilica on the properties of bio-based polyurethane films created from cellulose and lignin as polyols during the polymerization process

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The development of new materials from alternative and sustainable sources is essential for promoting a circular bioeconomy aligned with global sustainability goals. In this study, microcrystalline cellulose, kraft lignin, and castor oil were used as polyols, along with a diisocyanate resin, to synthesize bio-based polyurethanes without solvent or catalysis[1,2], with simultaneous film formation. SiO_2 nanoparticles have garnered attention as reinforcing agents and for their potential antibacterial properties[3]. These nanoparticles were synthesized using a biotechnological method and subsequently incorporated into the films by either adding them directly to the reaction mixture or via airbrush deposition onto the film surfaces. The reaction commenced while mixing the reagents. Once the appropriate viscosity was observed, the reaction medium was spread onto a glass plate. The reaction proceeded at room temperature (≈25ºC), resulting in the simultaneous formation of films. Different nanoparticle concentrations and time intervals between mixture spreading and nanoparticle deposition were evaluated. Film characterization was carried out by scanning electron microscopy, infrared and UV/Vis spectroscopies, thermogravimetric analysis, tensile test, dynamic mechanical analysis, surface zeta potential, and antibacterial assays. The addition of SiO_2 nanoparticles resulted in films with improved tensile and antibacterial properties compared to the control films. The deposition of nanoparticles using an airbrush resulted in films with better antibacterial properties compared to those incorporated into the reaction mixture.

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References

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