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Remarkable Mechanical and Solvent Resistance Properties of Polyurethane Elastomers Based on Betulin Prepared without Need of Catalyst

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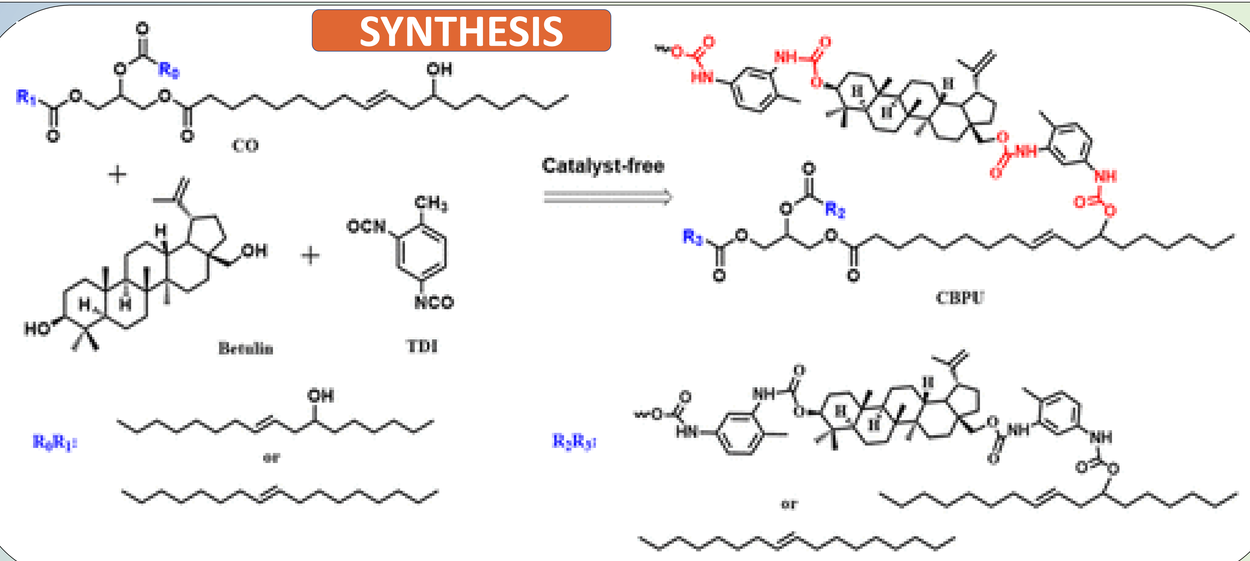
ABSTRACT

Using sustainable biomass feedstock to prepare biobased chemical products is attracting increasing attention. Betulin is a natural cyclic aliphatic diol that can be extracted in large quantities from the bark of birch trees. In this study, a series of bio-based polyurethane (PU) elastomers with excellent mechanical properties, solvent resistance, and thermal stability were synthesized under catalyst-free conditions using betulin and castor oil (CO) as the bio-based polyols. The chemical structure and properties of the bio-based PU elastomers were systematically investigated according to the effect of the hydroxyl ratio between betulin and CO. Due to the presence of abundant hydrogen bonds and rigid ring planes in the PU structure, and a higher cross-link density, the obtained PU elastomers had excellent mechanical properties. They achieved a maximum tensile strength of 31.6 MPa with the tensile strain reaching more than 200% and were able to withstand 1 × 105 times their weight. The thermal decomposition temperature of the betulin-derived PUs was over 300 °C. This study showcased a strategy to synthesize sustainable high-performance PU materials with a high biomass content (>75%).

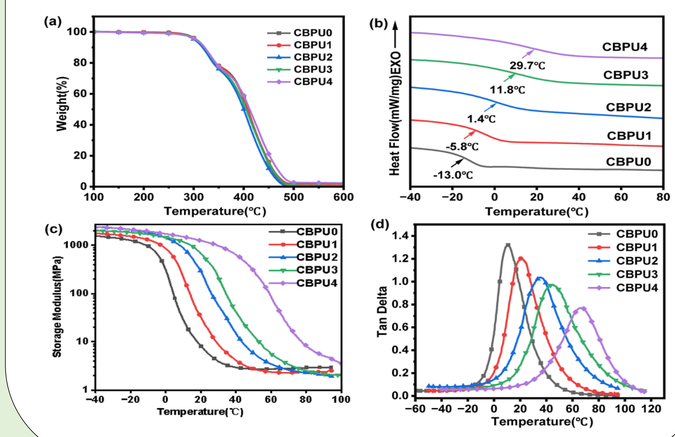
INTRODUCTION

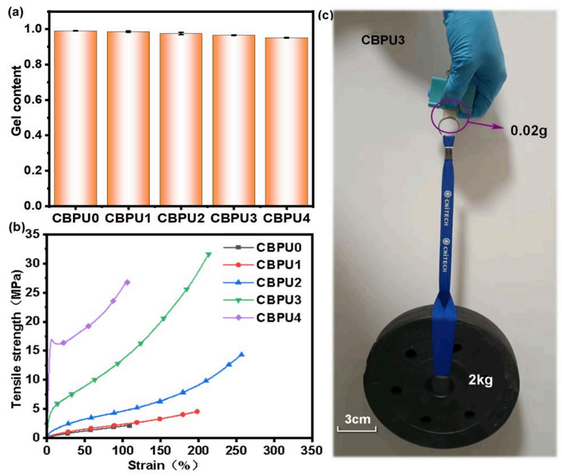
- In particular, PU elastomers have a combination of excellent mechanical, physical, and chemical properties along with exceptional biocompatibility. Therefore, these elastomeric systems are used in a diverse range of indoor, outdoor, underwater, and biomedical application.
- Betulin is a nontoxic aliphatic diol with a five-ring structure, which is mainly found in the bark and leaves of birch trees. About 30% of the dry weight of birch bark extract is botulin and can be easily extracted in large quantities from the bark of birch trees by various methods.

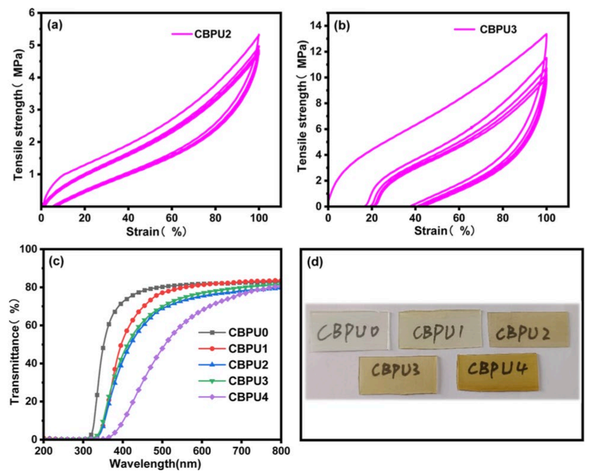
SYNTHESIS

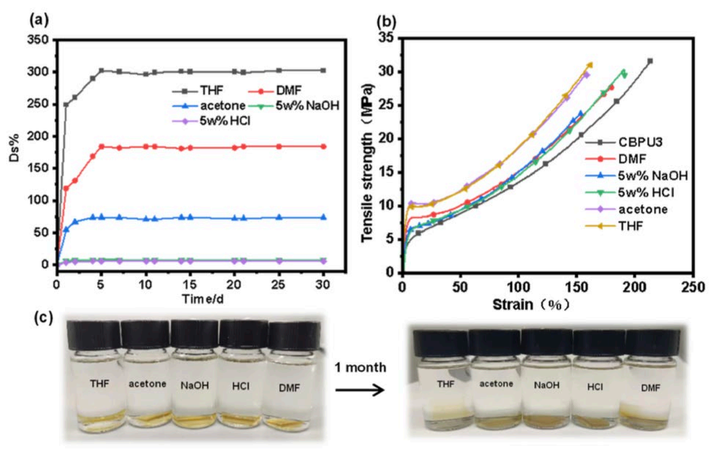


THERMOPHYSICAL & MECHANICAL BEHAVIOUR









CONCLUSION

- In this study, the underutilized biomass resource, betulin, was used to make the bio-based PU network as part of the polyol, and a series of bio-based PU materials with excellent mechanical properties, high thermal stabilities, and strong solvent resistance were developed by adjusting the hydroxyl value.
- A rigid structure also led to a high tensile strength (31.6 MPa) and a high toughness. In addition, the botulin-based PU film shows excellent mechanical reliability, and it was capable of lifting weights more than 1 × 10^5 times its own weight.

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REFERENCES

- Xu, Q.; Lin, J.; Jiang, G. Synthesis, Characterization and Properties of Soybean Oil-Based Polyurethane. *Polymers* 2022, *14*, 2201.
- Hu, S.; He, S.; Wang, Y.; Wu, Y.; Shou, T.; Yin, D.; Mu, G.; Zhao, X.; Gao, Y.; Liu, J.; Li, F.; Guo, M.; Zhang, L. Self-Repairable, Recyclable and Heat-Resistant Polyurethane for High-Performance Automobile Tires. *Nano Energy* 2022, *95*, 107012.
- Usman, A.; Zia, K. M.; Zuber, M.; Tabasum, S.; Rehman, S.; Zia, F. Chitin and Chitosan Based Polyurethanes: A Review of Recent Advances and Prospective Biomedical Applications. *Int. J. Biol. Macromol.* 2016, *86*, 630–645.
- Sharoyan, D. E. Pulping Additives for a Reduction of Resin from Kraft Pulp. November 8, 2011; p 8052840 https://www. freepatentsonline.com/8052840.html (accessed 2023-02-13).
- Dai, L.; Liu, K.-F.; Si, C.-L.; He, J.; Lei, J.-D.; Guo, L.-Q. A Novel Self-Assembled Targeted Nanoparticle Platform Based on Carboxymethylcellulose Co-Delivery of Anticancer Drugs. *J. Mater. Chem. B* 2015, *3*, 6605–6617.