Researchers propose 3D printing of high-performance elastomers through vat photopolymerization

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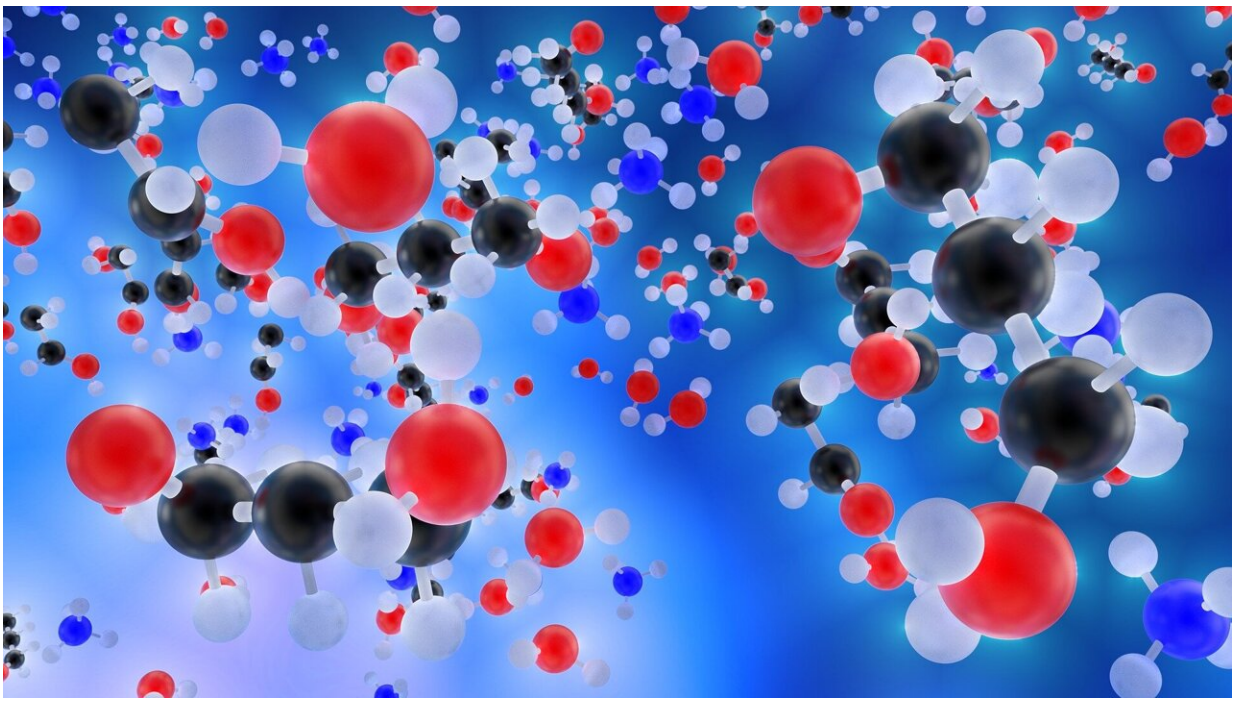

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Acrylate-based ultraviolet (UV)-curable resins are currently used as raw materials to obtain desired performance by adjusting the types and ratios of oligomer and reactive monomers in the resin system. However, due to low degree of free-radical polymerization, the elastomers prepared by

vat photopolymerization (VPP) technology show low strength, poor resilience, and unsatisfactory mechanical properties.

In a study published in *Advanced Materials* , the research group led by Prof. Wu Lixin from Fujian Institute of Research on the Structure of Matter of the Chinese Academy of Sciences proposed 3D printing of high-performance elastomers through vat photopolymerization.

The researchers analyzed the structure-property relationship between molecular weight and mechanical properties, and selected polytetramethylene ether glycols (PTMGs) with different molecular weights (M_n=1000, 2000, 3000 g mol^{-1}, respectively) as reactants to react with isophorone diisocyanate (IPDI). The obtained polyurethane blocked oligomers (PUBs) exhibited high viscosities.

To increase the polymerization degree, increasing the proportion of oligomer is the most direct and effective way. However, the viscosity of the resin system also increases dramatically. The previously developed linear scan-based vat photopolymerization (LSVP) can effectively solve this problem by direct 3D printing the high-viscosity resin.

By the merit of the broadened process windows, the researchers synthesized oligomers containing tert-butyl hindered urea bonds (HUBs), which would deblock at high temperatures and re-block at room temperature. During the printing process, the HUBs and viscous compounded oligomers underwent cross-linking via a free radical polymerization mechanism to produce green parts.

With the wide process window capability of the LSVP system, which allows for 3D printing of high-viscosity resin, the researchers replaced the conventional monomer with a high-viscosity oligomer compounded with the as-prepared PUB to create the 3D printable UV-curable resin.

Corresponding mechanical tests revealed that PUB2000-HMDA showed the highest ultimate engineering stress of 25.9 ± 1.6 MPa, along with the highest strain of 1605 ± 63%. The tensile toughness, measured as the integral area beneath the strain–stress curve, was 142.3 MJ m^{-3}, indicating an overall superior mechanical performance.

Besides, to further investigate the structure-property relationship between the chain extender and mechanical properties, the researchers employed three different types of chain extenders to evaluate the corresponding mechanical properties. Experimental results showed that the HMDA-extended samples exhibited the highest tensile strength and elongation at break among the three chain extenders.

This study systematically investigates the mechanical properties of high-viscosity PUB-dominated UV-curable resin upon thermal treatment.

More information: Xianmei Huang et al, 3d Printing of High Viscosity UV-curable Resin for Highly Stretchable And Resilient Elastomer, *Advanced Materials* (2023). DOI: 10.1002/adma.202304430

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