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Rubber Seed Oil-Based UV-Curable Polyurethane Acrylate Resins for Digital Light Processing (DLP) 3D Printing

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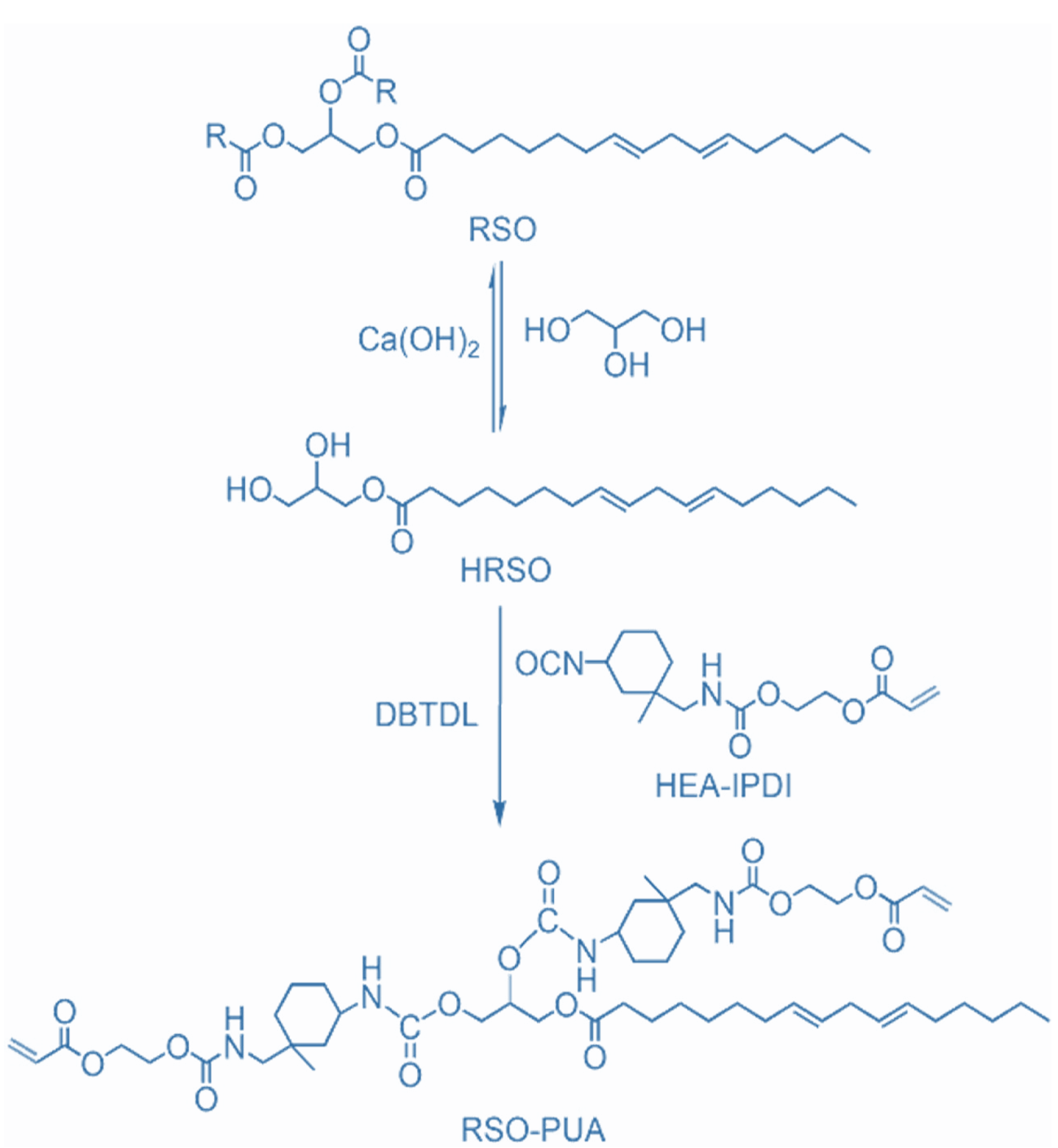
Introduction

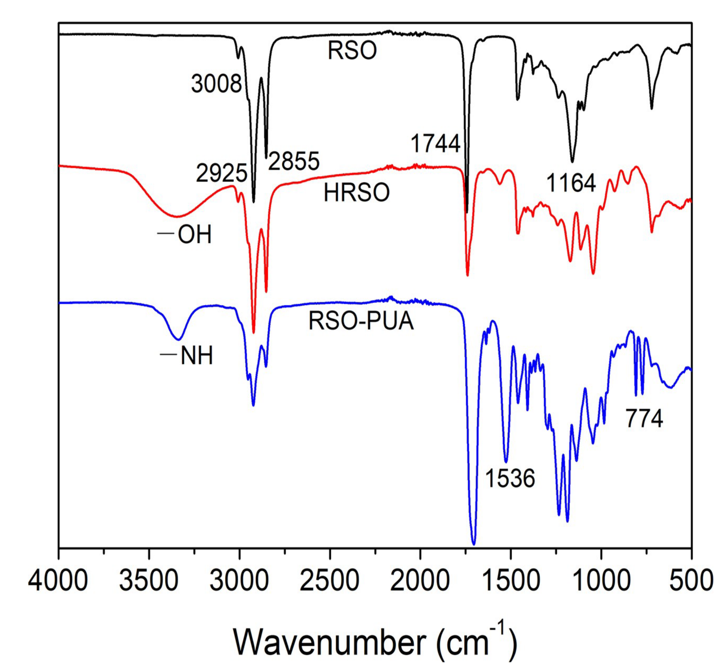
❑ Abstract

➢ Novel UV-curable polyurethane acrylate (PUA) resins were developed from rubber seed oil (RSO). Firstly, hydroxylated rubber seed oil (HRSO) was prepared via an alcoholysis reaction of RSO with glycerol, and then HRSO was reacted with isophorone diisocyanate (IPDI) and hydroxyethyl acrylate (HEA) to produce the RSO-based PUA (RSO-PUA) oligomer. FT-IR and 1H NMR spectra collectively revealed that the obtained RSO-PUA was successfully synthesized, and the calculated C=C functionality of oligomer was 2.27 per fatty acid. Subsequently, a series of UV-curable resins were prepared and their ultimate properties, as well as UV-curing kinetics, were investigated. Notably, the UV-cured materials with 40% trimethylolpropane triacrylate (TMPTA) displayed a tensile strength of 11.7 MPa, an adhesion of 2 grade, a pencil hardness of 3H, a flexibility of 2 mm, and a glass transition temperature up to 109.4 ◦C. Finally, the optimal resin was used for digital light processing (DLP) 3D printing. The critical exposure energy of RSO-PUA (15.20 mJ/cm2) was lower than a commercial resin. In general, this work offered a simple method to prepare woody plant oil-based high-performance PUA resins that could be applied in the 3D printing industry.

❑ Synthesis:



Results & Discussion



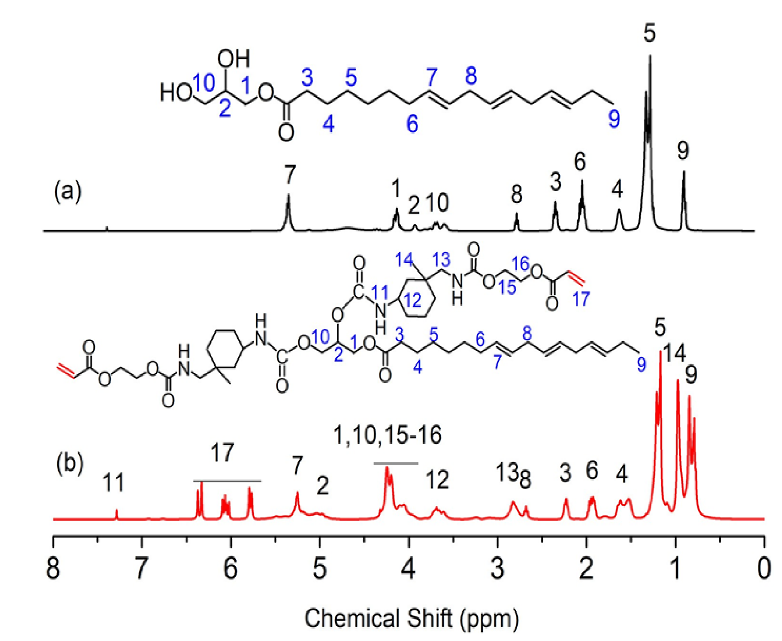


Figure 1. FT-IR spectra of RSO, HRSO and RSO-PUA.
Figure 2. 1H NMR spectra of (**a**) HRSO and (**b**) RSO-PUA..

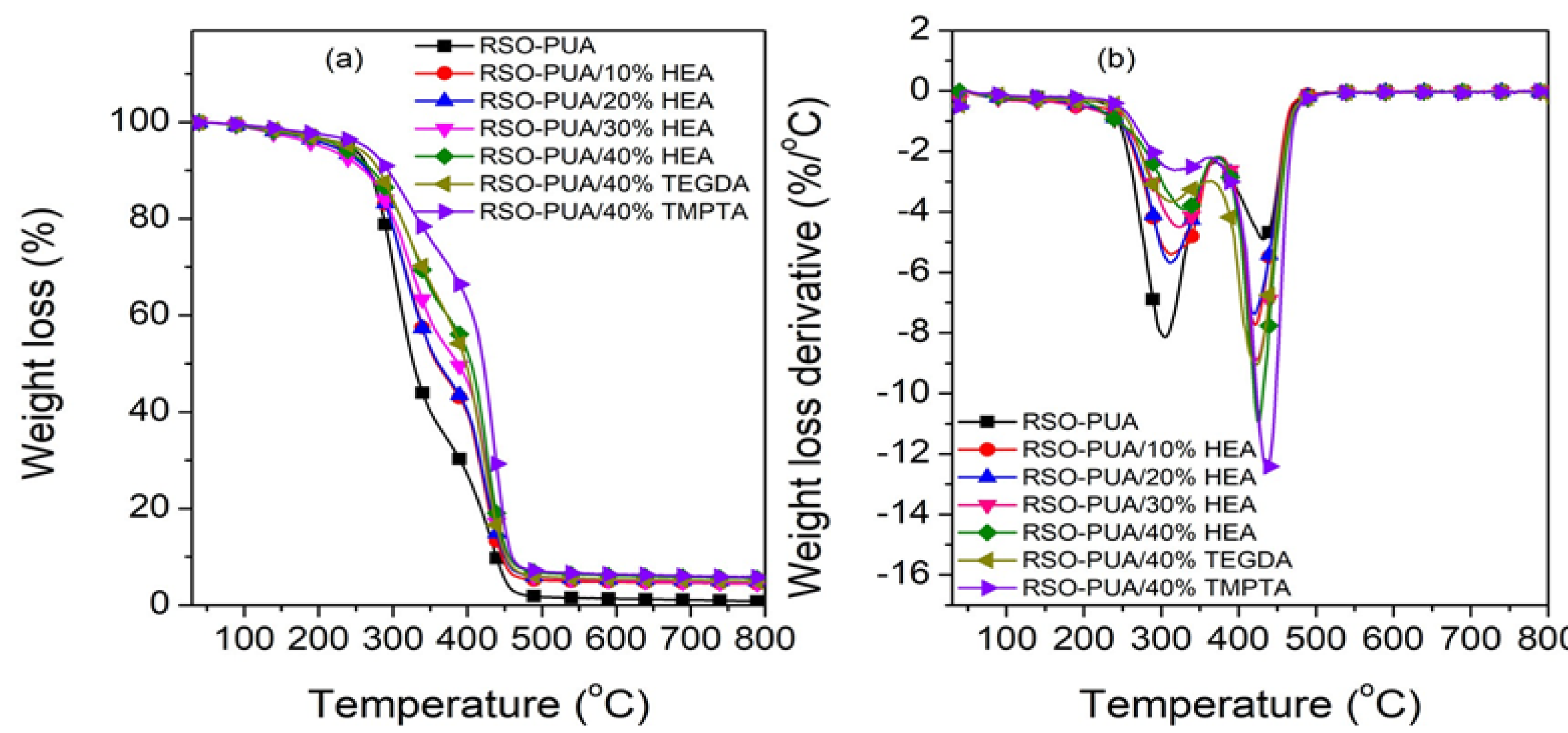


Figure 3. (**a**) TG and (**b**) DTG of the UV-cured RSO-PUA materials.

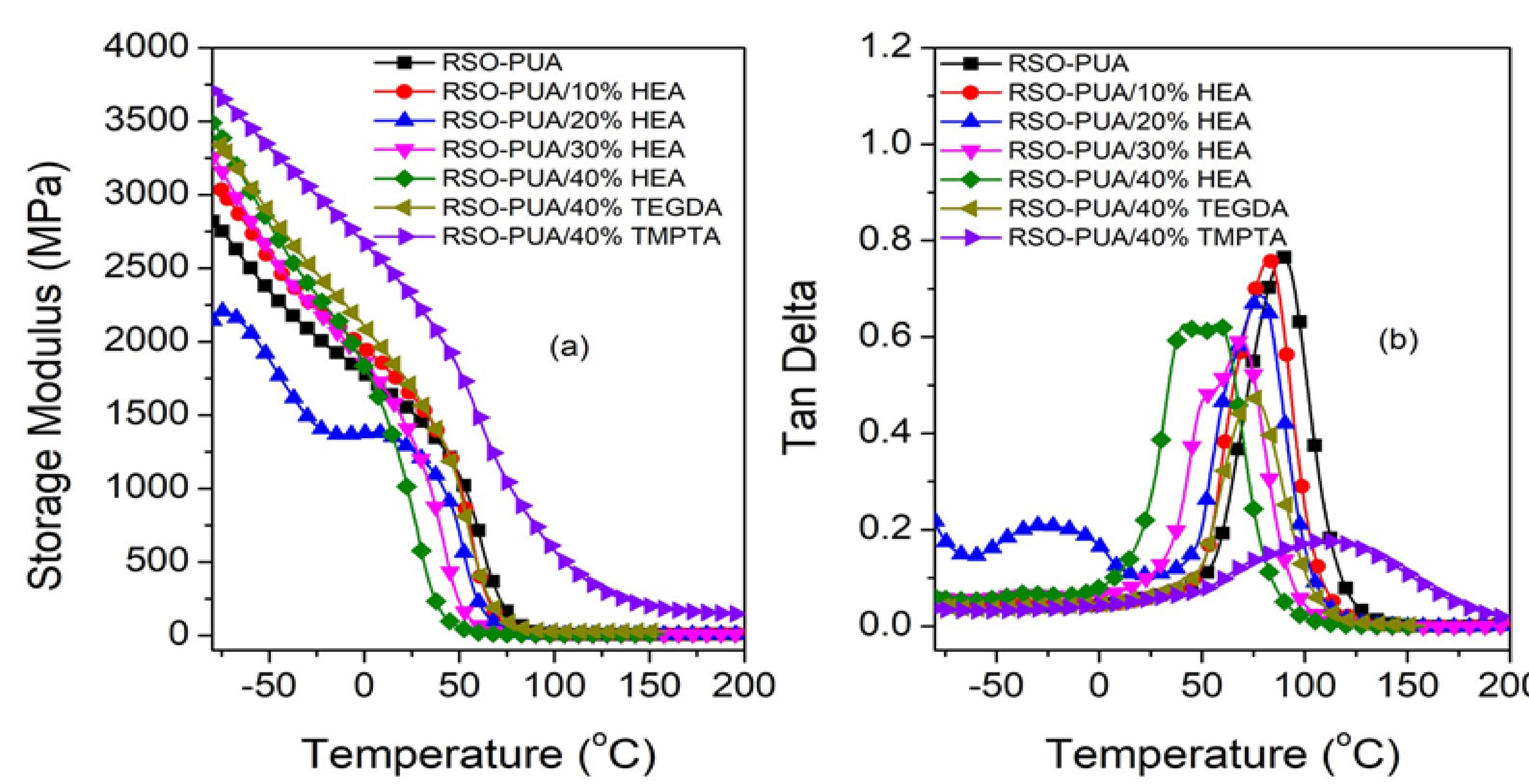
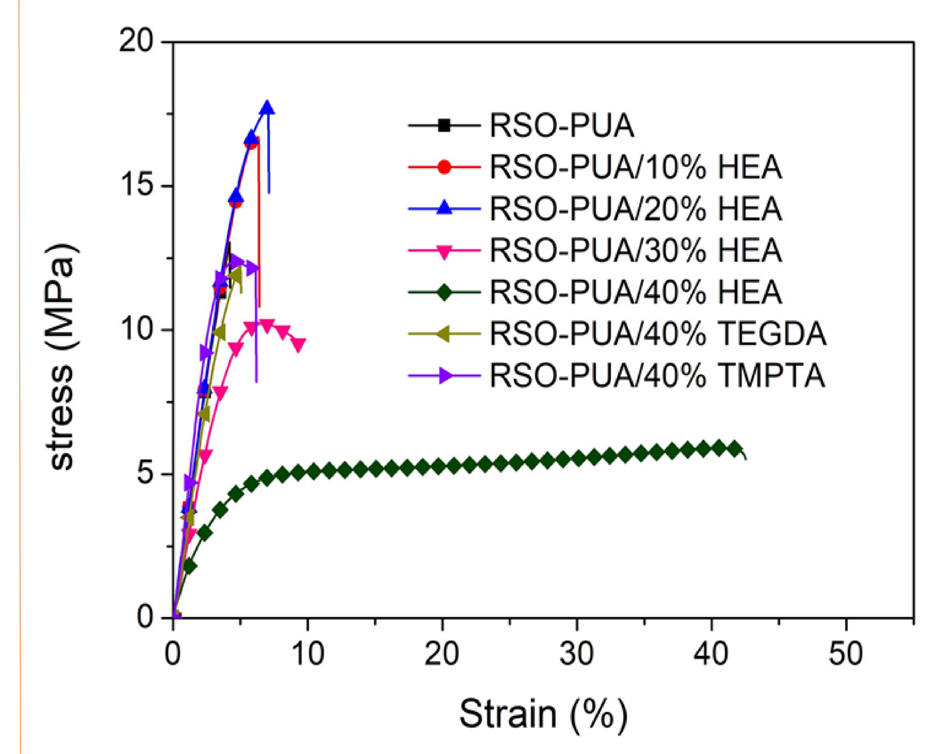


Figure 5. (**a**) Storage modulus and (**b**) loss factor versus the temperature of the UV-cured RSO-PUA materials.



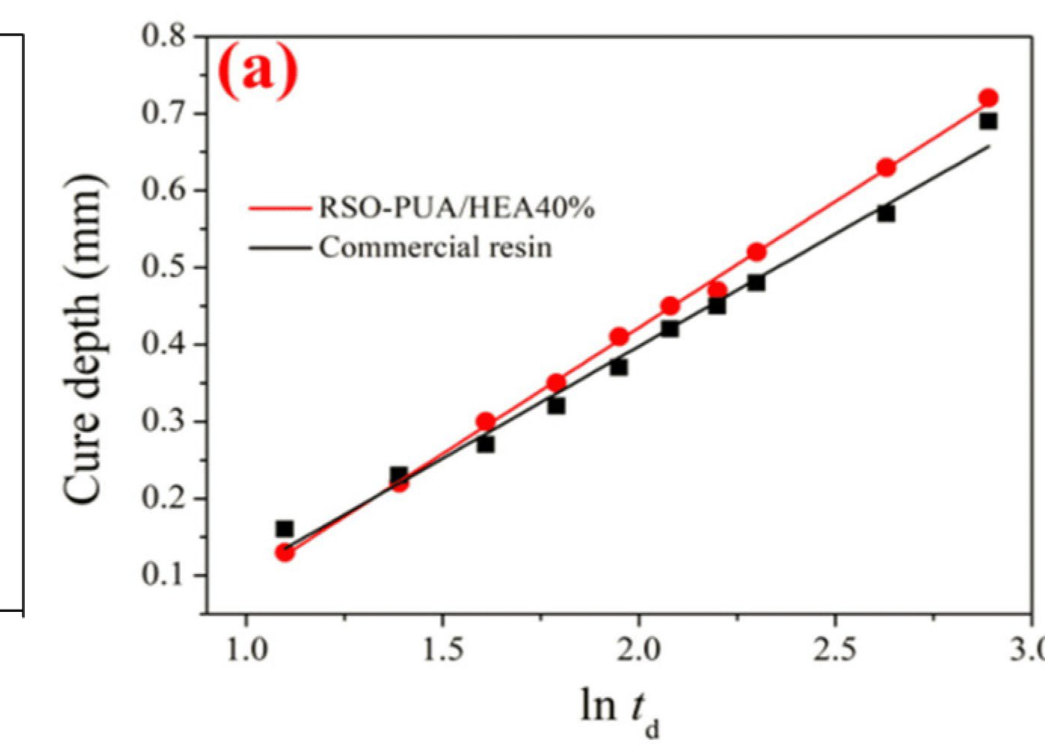
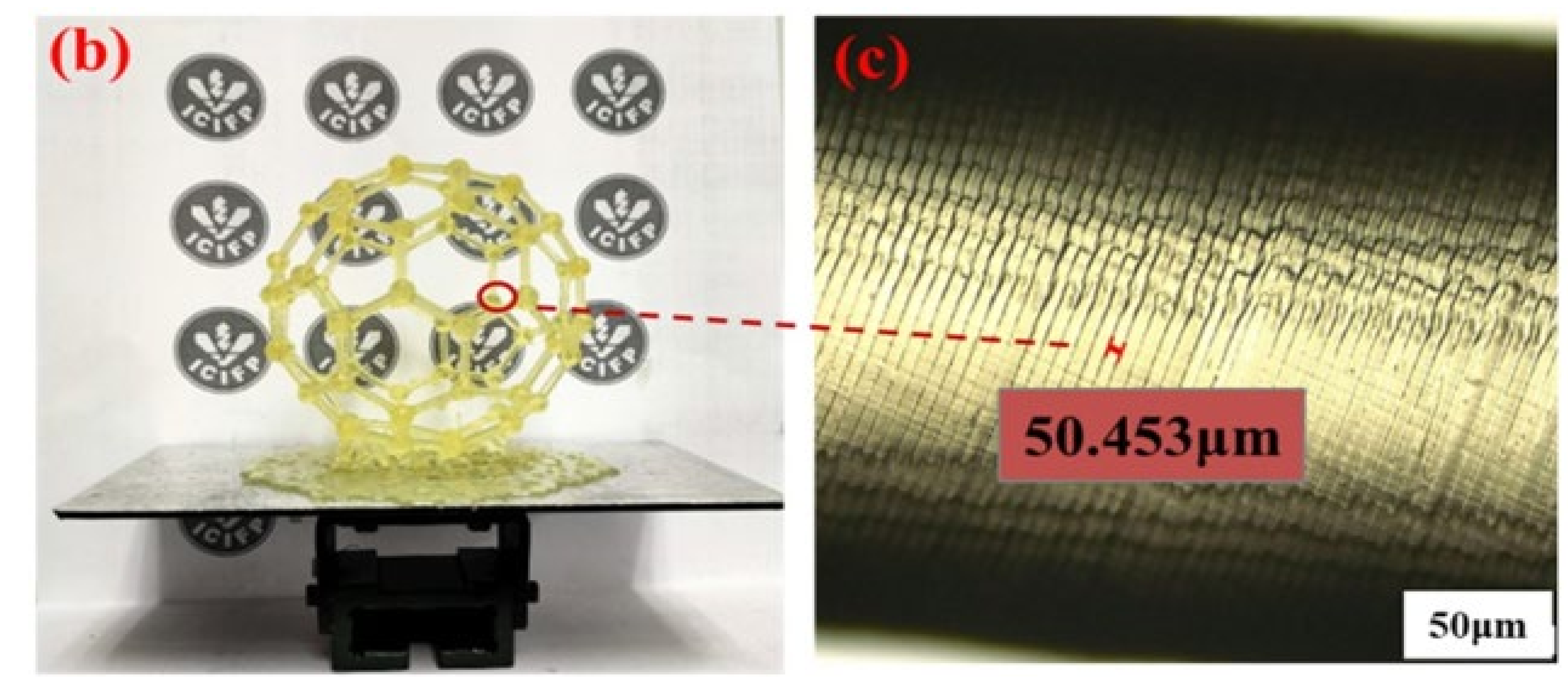


Figure 4 . Tensile stress−strain curves of the UV-cured RSO-PUA resins.



(**a**) Working curves of the UV-curable RSO-PUA/HEA40% resin and commercial resin; (**b**) the printed model of football-ene ; (**c**) the surface image of the football-ene model

Acknowledgment

❑ National Institute For Materials Advancement
❑ Pittsburg State University

Conclusions

- ❑ Synthesized novel RSO-based PUA oligomer
- ❑ Blended with various diluents for UV-curable resin preparation Cured materials demonstrated high gel content (up to 98.5%), elevated Tg (up to 109.4°C), excellent thermal stabilities (T5% up to 270°C), and strong mechanical strength (up to 16.3 MPa)
- ❑ Increased diluent content and functionality improved gel content, Tg, and thermal stabilities
- ❑ Cured resins showed exceptional hardness and flexibility, strong adhesion, and remarkable water resistance
- ❑ Optimal resin exhibited lower Ec compared to commercial resin
- ❑ Enabled DLP 3D printing of football-ene model
- ❑ Offers a facile strategy for woody plant oil-based UV-curable PUA resin fabrication.

References

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