4-17-2024

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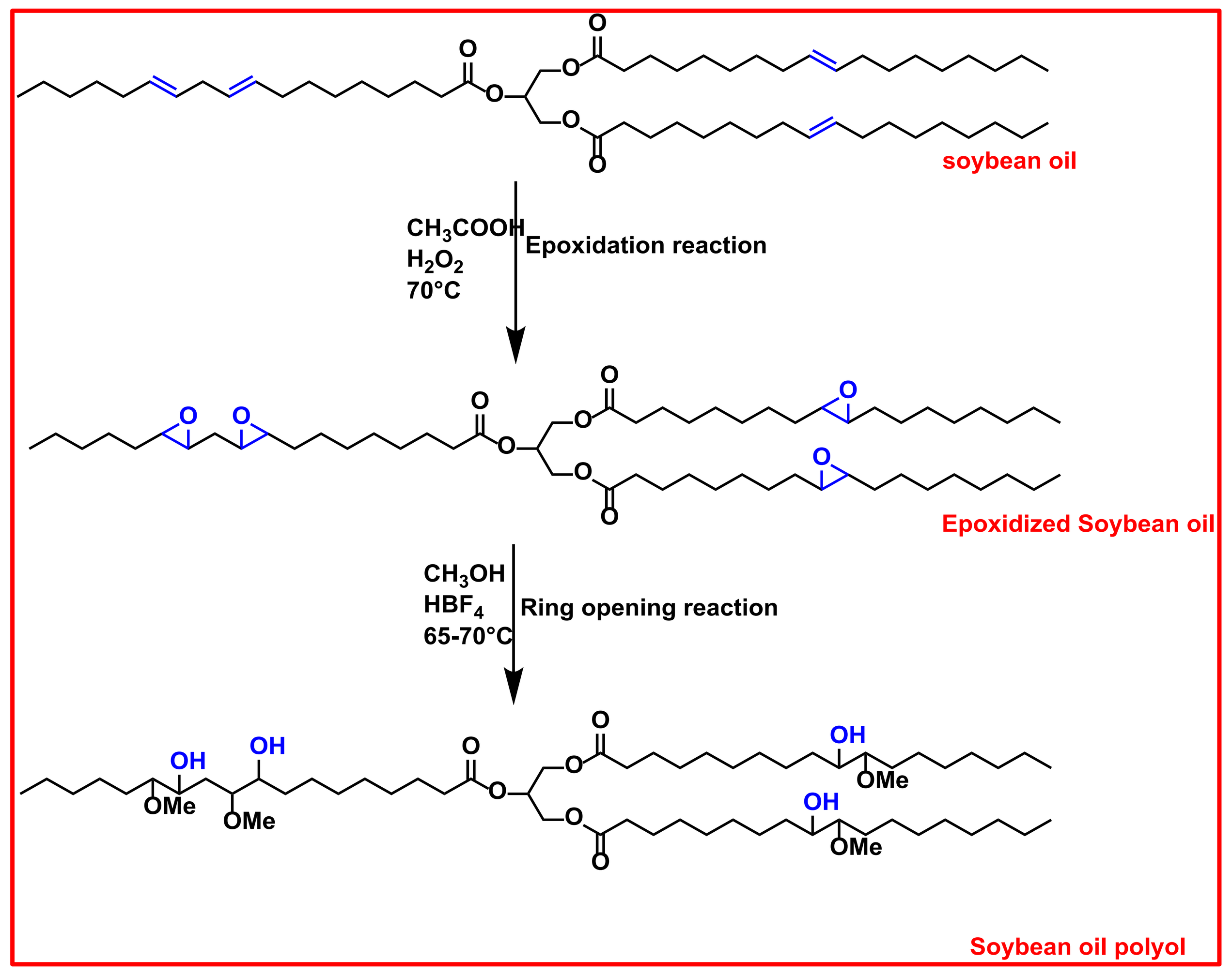
Introduction and Synthesis of the PU-Adhesive

ABSTRACT

Developing low-cost bio-based formaldehyde-free adhesives has aroused widespread interest in the wood adhesive industry. The usage of adhesives that contain urea-formaldehyde or phenol formaldehyde leads to environmental issues. Therefore, biobased renewable resources are a better option to use for polyol (a starting material for making adhesives) instead of petroleum-based polyols. Among all renewable resources, plant oils are the most popular biobased resource for replacing such polyols. In this research, soybean oil polyol was used to prepare a polyurethane (PU)--based adhesive. For studying adhesion strength, three different aliphatic diols (EDO, BDO, and HDO) with increasing chain length were used as a crosslinking reagent. For studying mechanical strength, different wt.% of diols were used in adhesives. Oakwood and stainless steel were used to study adhesive strength. On oakwood, the mechanical strength was increased from 3 MPa to 6.36 MPa after incorporating BDO which showed the highest adhesive strength among all the other samples. After being immersed in different solvents for 24 hours, no notable changes were observed in the FT-IR spectra of these PU materials. This work provides a sustainable alternative to petroleum-based adhesives with good mechanical and physical properties.



Scheme 1: Reaction scheme of soybean oil polyol

INTRODUCTION

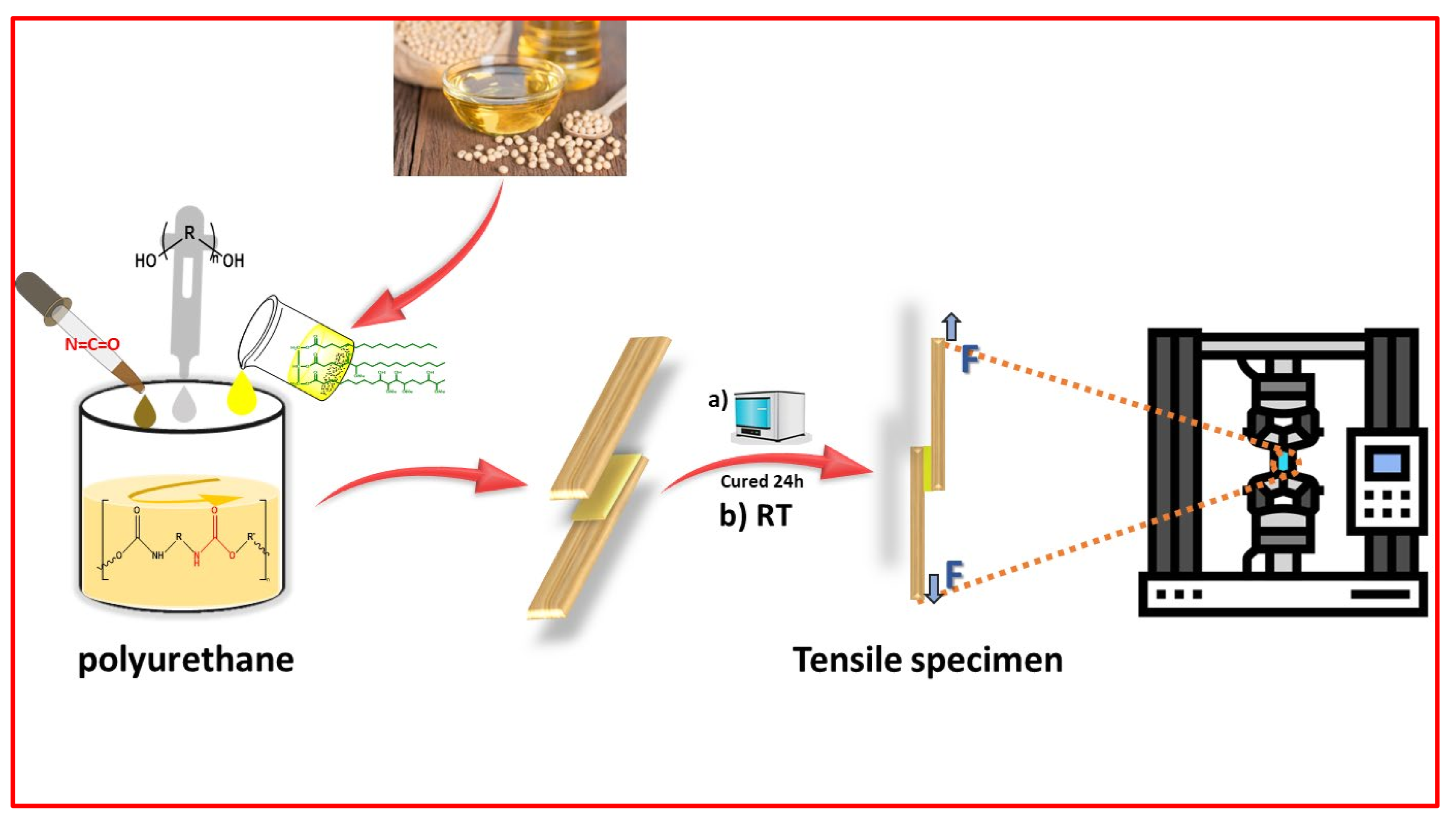
Composites manufactured from wood have a significant role in contemporary applications and find widespread usage in the furniture, ornamental, and architectural industries.

By synthesizing a PU-adhesive from SOP and incorporation ethane-1,2-diol, 1,4-butanediol, and 1,6-hexanediol were ensured to apply to join the wood surface. The incorporation of the hydroxyl group from the diols enhances the adhesive bonding strength.

Modifying our plant-based oil into a polyol helps to reduce the use of non-renewable sources. Which directly contributed to the healthy economy.

The adhesive was created with a few goals:

- environmentally friendly
- easy, one-step synthesis
- solvent and catalyst-free
- higher bonding strength
- solubility and hydrophobicity



Scheme 2: The schematic describes the preparation and curing method of the adhesive sample.

Results and Discussion

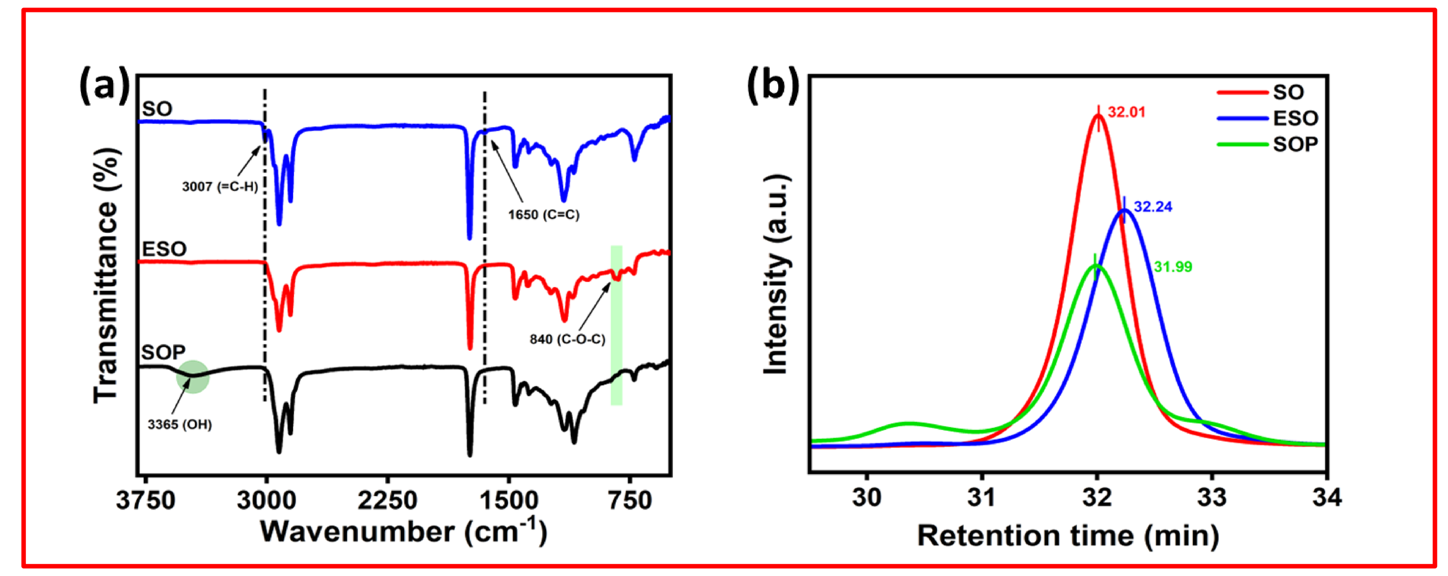


Figure 1: (a) FT-IR spectra and (b) Molecular weight distribution of SO, ESO, and SOP.

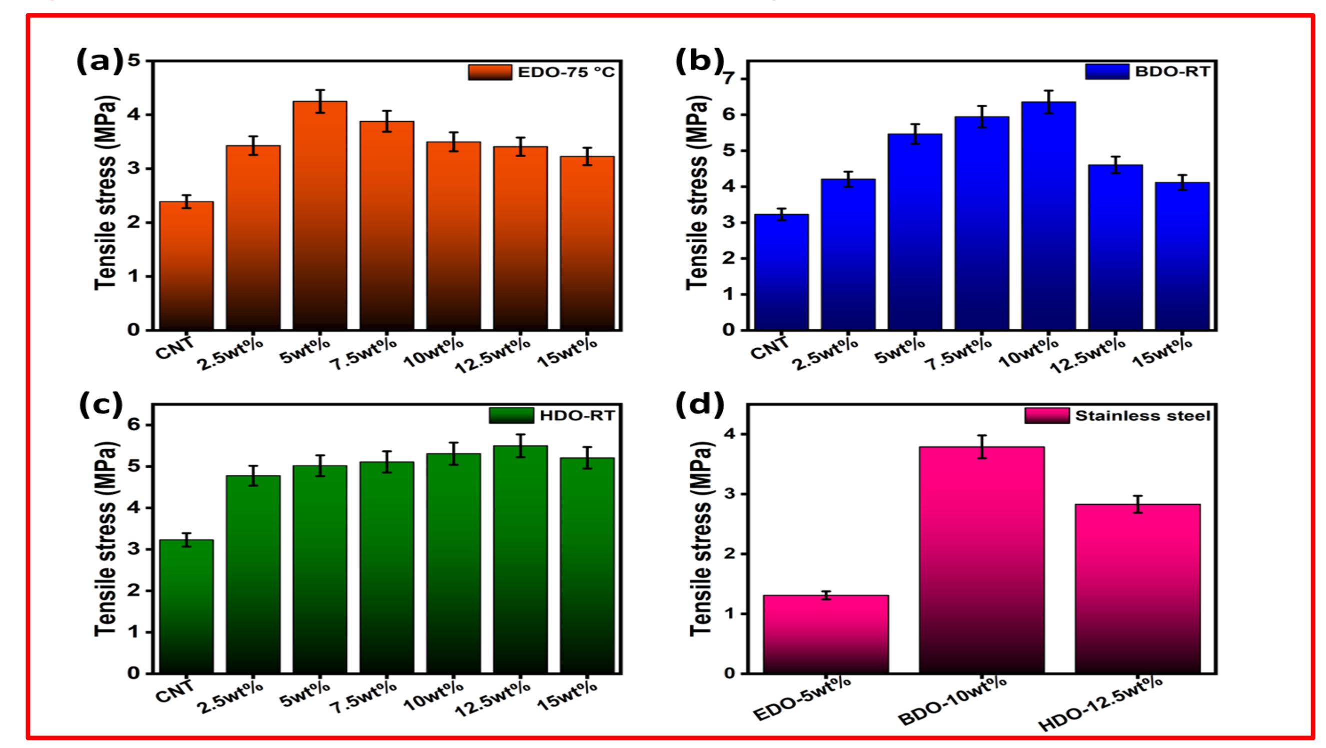


Figure 3: Tensile strength of (a) varying wt.% of EDO containing (b) (a) varying wt.% of BDO containing (c) varying wt.% of HDO containing PU adhesive materials (d) EDO-5 wt.%, BDO-10 wt.% and HDO-12.5 wt.% on stainless steel metal coupon

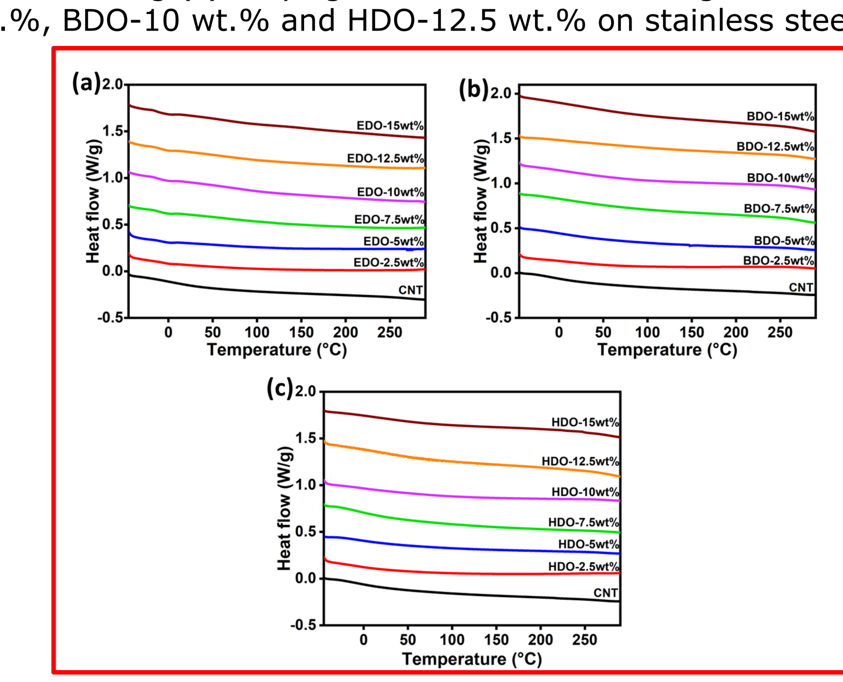


Figure 4: DSC spectra of PU adhesive materials with varying wt.% of (a) EDO (b) BDO and (c) HDO

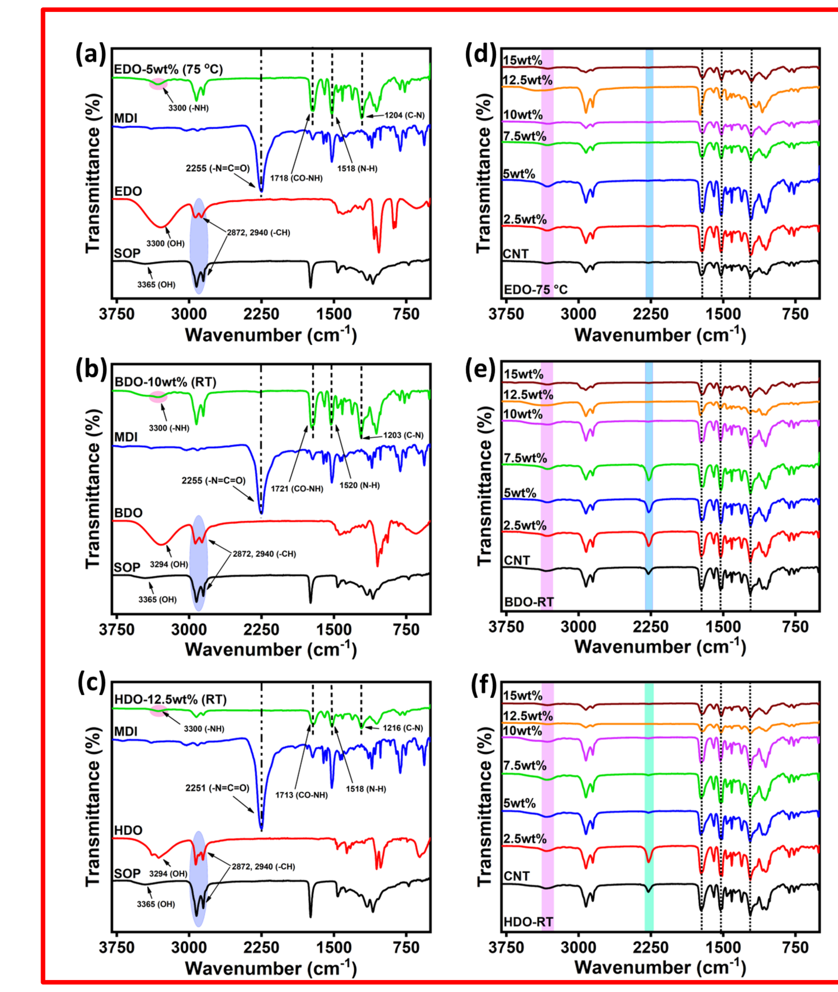


Figure 2: FT-IR spectra of PU adhesive materials with (a-c) comparison to the monomers (d-f) varying wt.% of EDO, BDO, and HDO crosslinker.

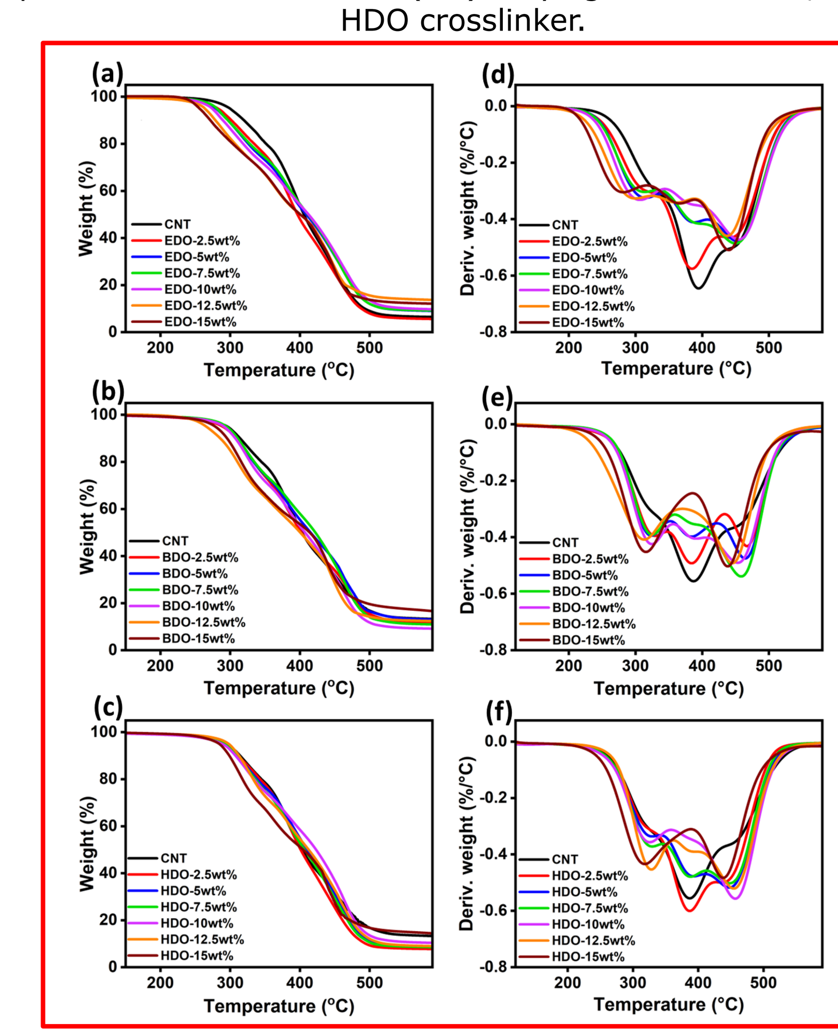


Figure 5: (a-c) TGA and (d-f) DTG thermograms of PU adhesive materials with varying wt.% of EDO, BDO and HDO

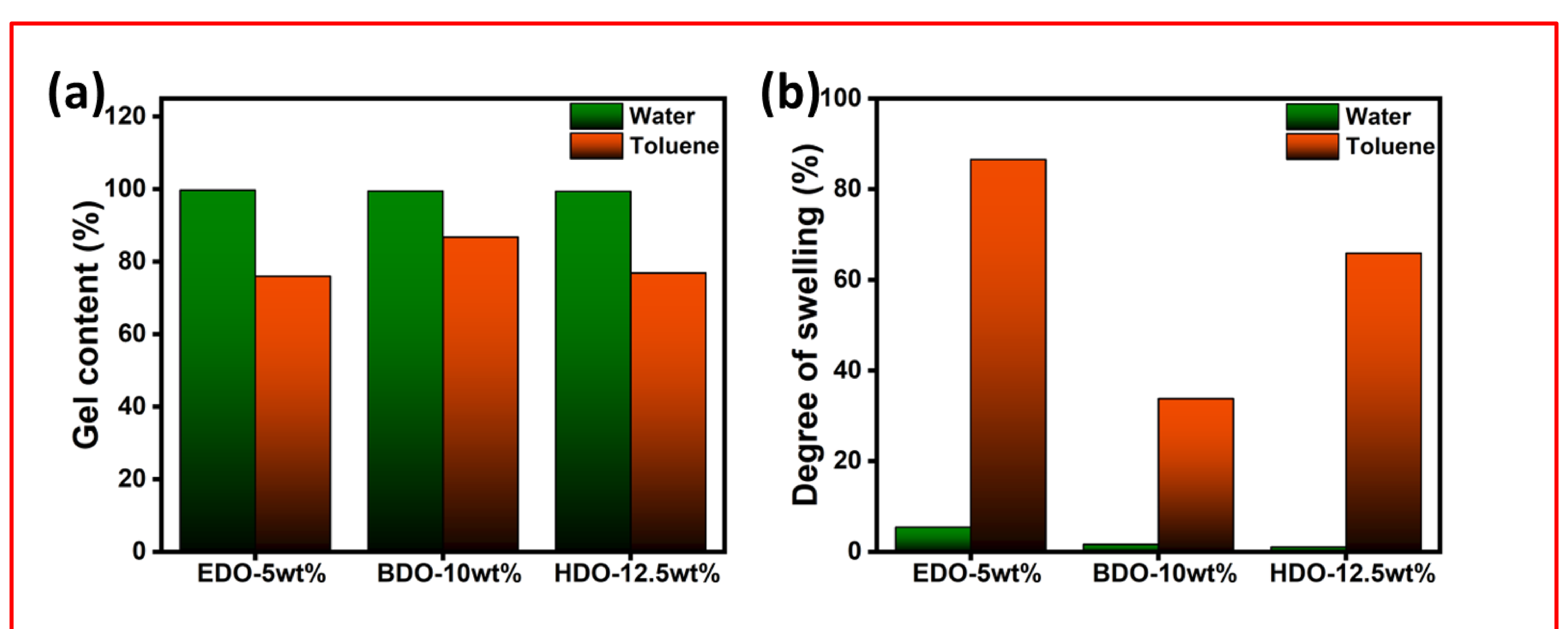


Figure 6: (a) Percentage of gel content and (b) swelling degree of EDO-5 wt.%, BDO-10 wt.% and HDO-12.5 wt.% PU adhesive materials in water and toluene

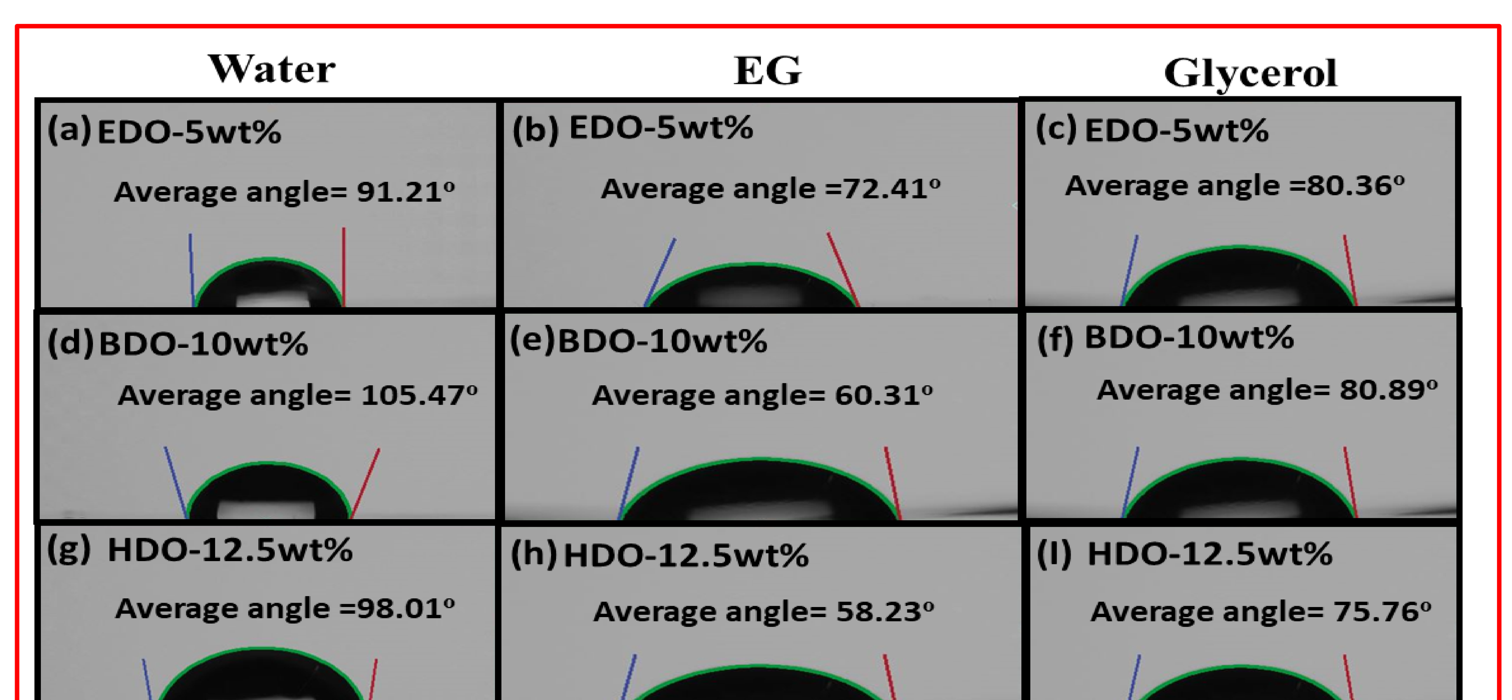


Figure 7: Contact angle of EDO-5 wt.%, BDO-10 wt.% and HDO-12.5 wt.% PU adhesive samples with aforementioned solvents

Conclusions

As shown by this poster presentation, we created a PU adhesive that showed the following properties:

- ✓ A solvent and catalyst-free bio-based wood adhesive is synthesized by using SOP
- ✓ Three different chain lengths of diols have shown different mechanical strengths.
- ✓ BDO 10wt.% has shown 6.3 MPa which is 100% more than the control sample.
- ✓ Thermal study shows that incorporation of the cross-linker can enhance the thermal stability
- ✓ Among the three deals, BDO shows lower swelling and higher gel content which confirms the higher crosslinking of adhesive, it reflects on higher bonding strength.
- ✓ All adhesive samples show above 90° water contact angle, which confirms the hydrophobic nature of PU-adhesives.

Future work

- ❖ The current study could be expanded to examine the impact of various cross-linkers and fillers on the general functionality and commercial aspects of wood adhesives based on vegetable oils.
- ❖ Distinct curing techniques such as hot press can be used.

Acknowledgement

- ➢ National Institute for Materials Advancement
- ➢ Pittsburg State University