cbecimat26
26° Congresso Brasileiro de Engenharia e Ciência dos Materiais
22 a 26 de novembro de 2026
Costão do Santinho
Florianópolis-SC

Synthesis and Characterization of Biobased Resins Derived from Limonene Epoxide

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Introduction

Problem 1: epoxides from bisphenol A (BPA) are harmful when ingested as contaminants[1];
Problem 2: waste byproducts, often rich in essential oils, require adequate destinations[2];
Solution: transform these waste byproducts into biobased epoxy alternatives.

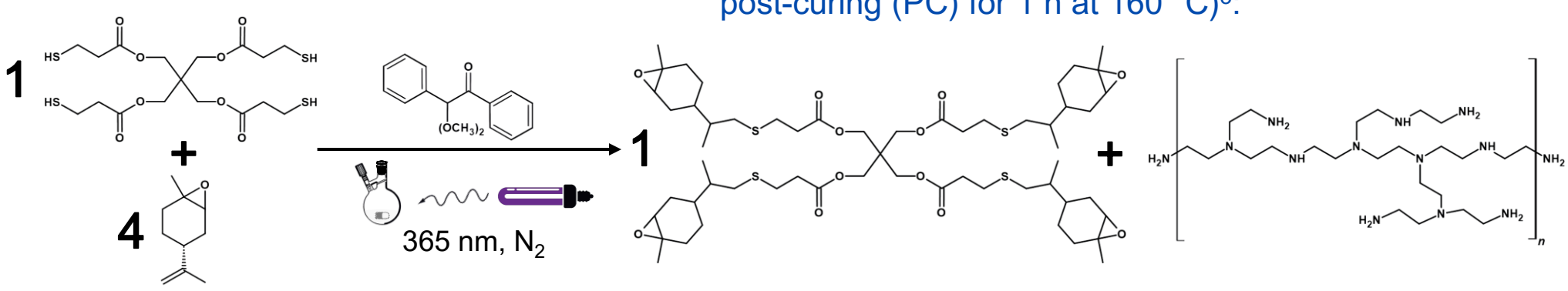
Objectives

Analyze the influence of amine/epoxy proportion in the conversion of oxirane rings from the epoxy resin, and its influence on the thermomechanical behavior of its thermosets.

Keywords: Biobased epoxy resin, Branched polyethylenimine, Photoinitiated thiol-ene reaction, Thermosetting polymers, Sustainability, DMA.

Methodology

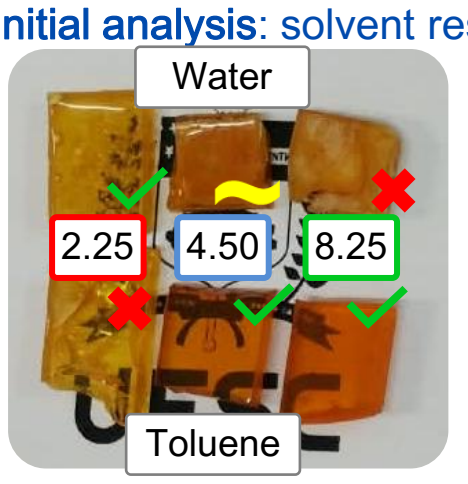
Photoinitiated thiol-ene synthesis of resin[3]:



Curing with polyamine $BPEI_{600}$ (24 h at 130 °C, optional post-curing (PC) for 1 h at 160 °C)[3]:

Results and Discussion

Initial analysis: solvent resistance[3]



Sorbed mass (M_s) after 2 days of swelling (g/g):

	Water	Toluene
■	0.036	0.095
■	0.121	0.029
■	0.466	0.028

Figure 1. Thermosets samples after 56 days of immersion in water (above) and toluene (bellow).

FT-IR: groups conversion:

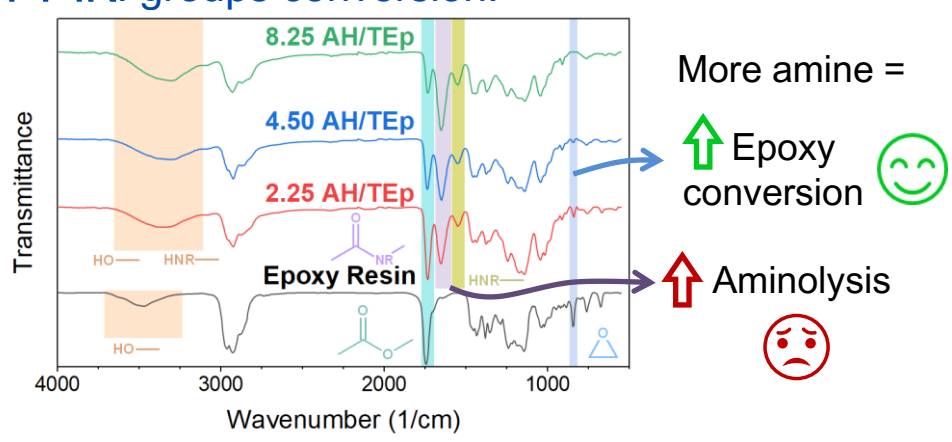
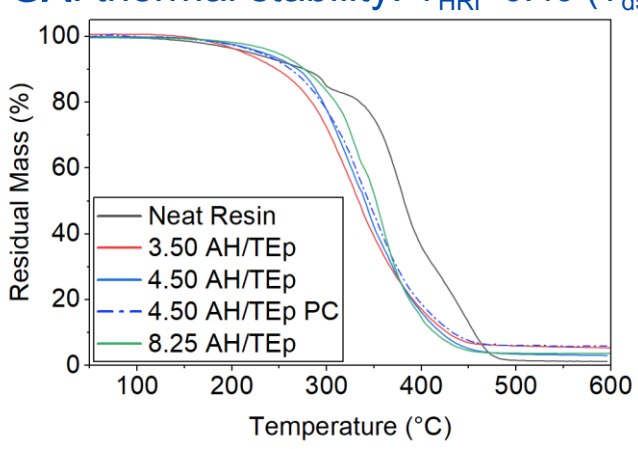


Figure 2. FT-IR of the epoxy resin, and corresponding thermosets.

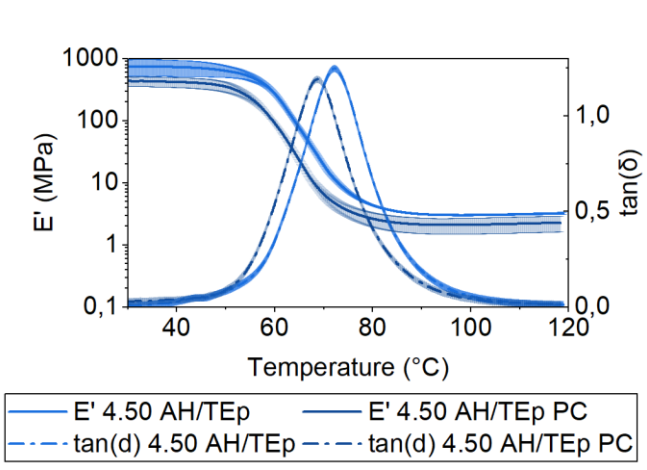
TGA: thermal stability: $T_{HRI}=0.49\cdot(T_{d5}+0.6\cdot(T_{d30}-T_{d5}))$



T_{HRI}:
148 °C
131 °C
138 °C
138 °C
144 °C

Figure 3. TGA of the neat epoxy resin, and corresponding thermosets.

DMA: thermomechanical behavior



T_g
72 °C
69 °C

Crosslink density (υ):
$\upsilon = E'/3RT$
323 mol/m³
229 mol/m³

Figure 4. DMA of the chosen thermosets.

Conclusions

The newly proposed biobased thermosets from limonene oxide show great thermal stability up to 130 °C and remain rigid in temperatures as high as 72 °C, making them candidates for use as food contact materials.

References and Acknowledgements

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3 ERBE, D. *et al.* Synthesis of biobased resin from limonene epoxide. *In*: CONGRESSO BRASILEIRO DE POLÍMEROS, 18, 2025. Campos do Jordão. **Anais** [...]. São Paulo: Aptor Software, 2025.

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