IOWA STATE UNIVERSITY

Materials Science & Engineering Department

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Final Oral Examination
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"Bio-Based Thermosetting Copolymers of Eugenol and Tung Oil"

There has been an increasing demand for novel synthetic polymers made of components derived from renewable sources to cope with the depletion of petroleum sources. In fact, monomers derived vegetable oils and plant sources have shown promising results in forming polymers with good properties. The following is a study of two highly viable renewable sources, eugenol and tung oil (TO) to be copolymerized into fully bio-based thermosets. Polymerization of eugenol required initial methacrylate-functionalization through Steglich esterification and the synthesized methacrylated eugenol (ME) was confirmed by ^{1}H-NMR. Rheological studies showed ideal Newtonian behavior in ME and five other blended ME resins containing 10 – 50 wt% TO. Free-radical copolymerization using 5 mol% of tert-butyl peroxybenzoate (crosslinking catalyst) and curing at elevated temperatures (90 – 160 °C) formed a series of soft to rigid highly-crosslinked thermosets. Crosslinked material (89 – 98 %) in the thermosets were determined by Soxhlet extraction to decrease with increase of TO content (0 – 30%). Thermosets containing 0 – 30 wt% TO possessed ultimate flexural (3-point bending) strength of 32.2 – 97.2 MPa and flexural moduli of 0.6 – 3.5 GPa, with 3.2 – 8.8 % strain-to-failure ratio. Those containing 10 – 40 wt% TO exhibited ultimate tensile strength of 3.3 – 45.0 MPa and tensile moduli of 0.02 GPa to 1.12 GPa, with 8.5 – 76.7 % strain-to-failure ratio. Glass transition temperatures ranged from 52 – 152 °C as determined by DMA in 3-point bending. SEM analysis on fractured tensile test specimens detected a small degree of heterogeneity. All the thermosets are thermally stable up to approximately 300 °C based on 5% weight loss.