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Solvent-Aided Dispersion of Tannic Acid to Enhance Flame Retardancy of Epoxy

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Abstract : Background and Significance: Tannic acid (TA) is a bio-based high molecular weight organic, aromatic molecule that has been found to increase thermal stability and flame retardancy of many polymer matrices when used as an additive. Although it is biologically sourced, TA is a pollutant in industrial wastewater streams, and there is a desire to find applications in which to downcycle this molecule after extraction from these streams. Additionally, epoxy thermosets have revolutionized many industries, but are too flammable to be used in many applications without additives which augment their flame retardancy (FR). Many flame retardants used in epoxy thermosets are synthesized from petroleum-based monomers leading to significant environmental impacts on the industrial scale. Many of these compounds also have significant impacts on human health. Various bio-based modifiers have been developed to improve the FR of the epoxy resin; however, increasing FR of the system without tradeoffs with other properties has proven challenging, especially for TA. Methodologies: In this work, TA was incorporated into the thermoset by use of solvent-exchange using methyl ethyl ketone, a co-solvent for TA, and epoxy resin. Samples were then characterized optically (UV-vis spectroscopy and optical microscopy), thermally (thermogravimetric analysis and differential scanning calorimetry), and for their flame retardancy (mass loss calorimetry). Major Findings: Compared to control samples, all samples were found to have increased thermal stability. Further, the addition of tannic acid to the polymer matrix by the use of solvent greatly increased the compatibility of the additive in epoxy thermosets. By using solvent-exchange, the highest loading level of TA found in literature was achieved in this work (40 wt%). Conclusions: The use of solvent-exchange shows promises for circumventing the limitations of TA in epoxy.

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