Lignin-Based Polybenzoxazine Derived from Empty Fruit Bunch Fibers with Good Thermal and Mechanical Properties

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Abstract:
In this study, a renewable phenolic component was synthesized using empty fruit bunch fibers via microwave-assisted liquefaction known as Liquefied Empty Fruit Bunch (LEFB). LEFB can be used as phenolic derivative to replace petroleum-based phenol as it contains aromatic group in lignin that can be used as starting materials to synthesis polybenzoxazine resins. A Lignin-based benzoxazine (L-PBz) has been synthesized using a solventless approach from the reaction of LEFB, furfurylamine as the amine component and paraformaldehyde via Mannich condensation reaction. Two different ratios of LEFB:furfurylamine:paraformaldehyde which are 1:1:1 and 1:1:2 were investigated. The thermal properties and polymerization behavior of the L-PBz were analyzed using thermogravimetric analysis (TGA) and differential scanning calorimetry (DSC), respectively. In addition, cured-polybenzoxazine composites were also prepared by hot-pressing the uncured L-PBz at 250 °C for 4 hours, and the mechanical properties of the composites were assessed through Izod impact strength test. TGA analysis showed that, L-PBz with ratio of 1:1:1 exhibit a high char yield compared to 1:1:2 which is 47% vs 43%, respectively, after being heated until 900 °C. However, L-PBz with ratio of 1:1:2 showed good polymerization behavior compared to 1:1:1 which indicated by the curing temperature 215 °C vs 238 °C. L-PBz composites, which added with cellulose nanocrystal (CNC) fillers have better strength compared with the absence of fillers. As a conclusion, the aromatic structure of lignin in empty fruit bunch fibers has presented a promising alternative to replace petroleum-based phenol in polybenzoxazine synthesis.

Keywords: Bio-Based Polybenzoxazine; Composites; Empty Fruit Bunch; Lignin; Thermoset

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