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Bio-origin polybenzoxazines based on sustainable rigid diamines and phenols

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Polybenzoxazines (PBz) are emerging class of polymers, obtained by initiator-free thermally mediated ring-opening polymerization (ROP) of benzoxazine (Bz) monomers. The properties exhibited by PBzs are more superior as compared to traditional commercial polymers epoxies, phenolic, bismaleimides. The attractive thermo-physicomechanical properties, near zero shrinkage upon polymerization, low water absorption, high char yield and further molecular flexibility at a structural level are additional attractive features. Considering the sustainability perspective, the replacement of raw materials with abundantly available bio-based feedstock is the need of the hour. For Bz monomer, the raw materials are phenol and amine which undergoes a Mannich-like condensation reaction with formalin to form Bz monomer. The natural origin of phenol is abundant while renewable amines are scarce in nature. In current work, alternative sustainable route of diamines based on polyols of carbohydrates origin is devised, synthesized and characterized. Fully biobased Bz monomers based on sugar diamines and renewable phenols such as cardanol, guaiacol, and eugenol were synthesized. The monomers were structurally characterized using 1H-, 13C-, 1D NOE, HSQC-NMR, and FTIR spectroscopy. The crystal structure was also determined by X-ray analysis. The temperature of ROP and thermal stability of PBzs was determined by DSC and TGA respectively. The adhesive property of resins was determined by lap-shear strength confirming their potential as solvent-free green adhesives. Current work supports a further step towards substitution for petrol-origin toxic chemicals like bisphenol-A (BPA) and diamines with environmental friendly sustainable materials.

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