Robust and durable hydrophobic sustainable and eco-friendly bio-based polybenzoxazine coated cotton fabric/paper for effective oil–water emulsion separation and self-cleaning applications

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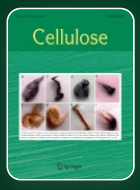

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Abstract

Distinctive challenges in developing oleophilic/hydrophobic membranes through the coating technique for the separation of oil–water mixtures are the lengthy processes, the release of volatile contents, and the decrease in separation efficacy with repeated cycles. In this work, an attempt has been made to develop cost-effective, eco-friendly, bio-based, sustainable, and durable hydrophobic/oleophilic polybenzoxazine (PBZ) matrices coated on the cotton fabric for efficacious separation of oil–water emulsion mixtures. The benzoxazine monomers were synthesized using eugenol, furfuryl amine or stearyl amine, and paraformaldehyde (E-fa and E-sa) by a solvent-less, green synthetic approach. The synthesized benzoxazine monomers were characterized by FTIR and ^{1}H NMR. Trifunctional benzoxazine monomers were synthesized by a simple thiol-ene click reaction using E-fa, E-sa, and trithiocyanuric acid. Later, the hydrophobic cotton fabric or filter paper was prepared by a simple dip coating method using E-fa, E-sa, E-fa/TCA, and E-sa/TCA separately,

followed by thermal curing. The hydrophobic PBZ coated on the fabric/filter paper materials revealed better separation of emulsified oil–water mixtures with a separation efficacy of > 98% even after 15 repeated cycles. The thermal behavior of developed PBZ showed better thermal stability (thermal degradation and higher char yield) than conventional bisphenol A and F based PBZs. The hydrophobic/oleophilic surface on the cotton fabrics/filter paper, altered with the sustainable bio-based eugenol-based benzoxazines, is eco-friendly and easy to scale up, revealing prodigious capacities in several practical applications including oil–water separation and self-cleaning.

Graphical abstract