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Sustainable furfural bis-thymol based benzoxazines: Superhydrophobic, aggregation induced emission and corrosion resistant properties

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Highlights

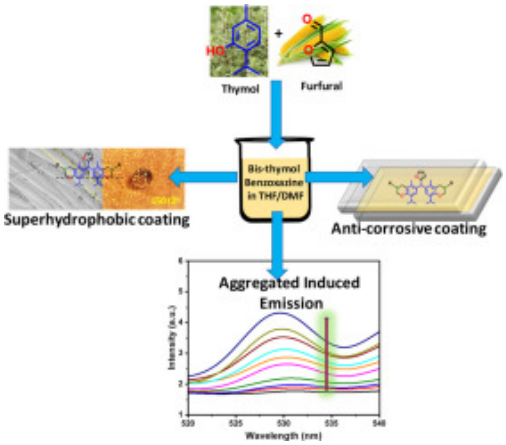
- New kind of furfural core bis-thymol has been synthesized.
- Different nature of fluorine substituted furfural-bis-thymol based benzoxazine have been synthesized.
- Poly(FBT-pfsa) exhibited superhydrophobic behaviour of water contact angle value of 151°.
- The developed material resulted excellent corrosion resistance towards mild steel specimen with 99 % efficiency.
- The developed benzoxazines exhibited aggregated induced emission properties.

Abstract

Sustainable bis-thymol based benzoxazines have been synthesized using furfural bis-thymol (FBT) and paraformaldehyde separately with five different fluorine substituted amines through Mannich condensation process. The molecular structure of the obtained benzoxazines has been verified using spectroscopic analyses. The curing temperature of the synthesized benzoxazines are ranged between 241 °C and 277 °C. Among the synthesized polybenzoxazines, poly(FBT-pfa) exhibits the highest thermal stability of 52 % char yield. All the polybenzoxazines exhibit the value of LOI above the threshold limit of 26 which infers the self-extinguishing property of the polymer. Poly(FBT-pfsa) showed the highest value of water contact angle of 151°, which ascertains that the increased fluorine content contributes to the superhydrophobic nature. Results from hydrophobic durability studies with poly(FBT-pfsa) using coated cotton fabric under acidic and basic conditions indicate its suitability for hydrophobic applications. The corrosion protection ability of polybenzoxazines towards mild steel surfaces was studied and the results obtained suggest that these polybenzoxazines can be used as an excellent coating material. UV–Visible and fluorescence spectroscopic analyses infer that these benzoxazines exhibit aggregation induced emission (AIE) characteristics. Data from different studies suggest that these materials can be conveniently utilized in the form of optical, superhydrophobic and corrosion-resistant coatings.

Graphical abstract

Bis-thymol based benzoxazines have been developed using sustainable furfural and thymol to study the superhydrophobic and anti-corrosive coating applications. Optical behavior also explored for photoluminescence applications.



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Introduction

Phenolic resins, originating from Bayer, have garnered widespread applications in construction and aerospace industries due to their thermal stability, resistance to chemicals and cost-effectiveness [1]. However, their inherent drawbacks, including formaldehyde emissions and processing limitations and need of catalyst for curing, have urged the search for alternative materials [2]. In response, benzoxazines have emerged as a promising alternative, offers significant advantages that overcomes the shortcomings of phenolic resins. Their molecular design flexibility allows for the utilization of different nature of raw materials, endowing them with exceptional properties such as polymerization