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Evaluation of optical, thermal and hydrophobic properties of sustainable stilbene-based benzoxazines for high-performance utilization

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Highlights

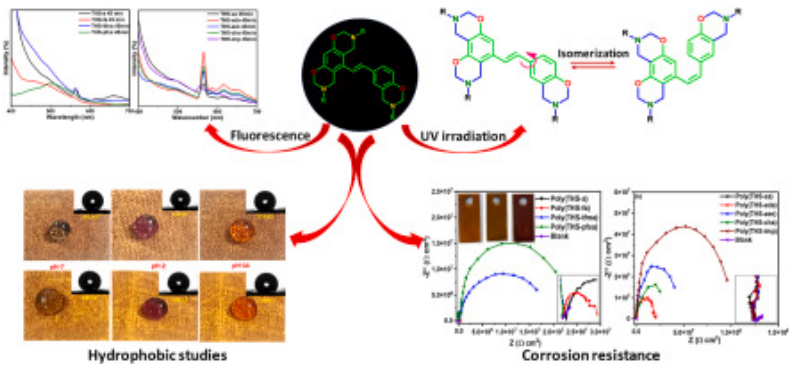
- Stilbene based trifunctional benzoxazines were synthesized.
- Using optical studies band gap values were calculated for benzoxazines.
- Trifunctional stilbene based polybenzoxazines exhibited superhydrophobic behavior.
- Photosensitive benzoxazines exhibited both photocrossliking and photodimerization.
- Polybenzoxazines exhibited corrosion resistant property of 99% efficiency.

Abstract

Currently there is a growing interest in the field of photosensitive benzoxazines synthesized from sustainable raw materials. An attempt has been made to synthesize nine structurally different benzoxazines through Mannich condensation reaction. The formation of the expected structure of

the synthesized benzoxazine monomers were ascertained using spectroscopic methods. The ring-opening polymerization of benzoxazines was studied using DSC and found that THS-imp benzoxazine monomer exhibits the lowest value of curing temperature (T_p) of 179°C than the rest of the benzoxazine monomers. Thermal stability of polybenzoxazines were analyzed using thermogravimetric analyzer. Among the different polybenzoxazines studied, poly(THS-a) possesses the higher thermal stability with char yield of 53% than that of other benzoxazines. The band gap values of benzoxazines calculated from optical studies are ranged between 3.92 and 4.71 eV. The hydrophobic behavior of the polybenzoxazines assessed using the water contact angle obtained from goniometer for both neat polymer matrix and benzoxazine coated cotton fabric. Results from the water contact angle infer that the benzoxazines coated cotton fabric exhibited 152°, which shows the superhydrophobic behavior. The corrosion resistant properties of all the polybenzoxazines coated over MS specimen has been tested. Among them poly(THS-pfsa) and poly(THS-imp) have higher I_{corr} value and corrosion inhibition efficiency of 99%. Data obtained from different studies indicate that the benzoxazines developed from sustainable stilbene can be utilized in the form of coatings, adhesives, sealants, and matrices for composites for wide range of industrial and engineering applications, where high thermal stability and are required.

Graphical abstract



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Introduction

In the recent past, the quest for innovative materials that exhibit multifunctional properties has intensified and driven by the demand for advanced materials in diverse industrial applications. Among the promising classes of compounds, benzoxazines have gained attention due to their unique chemical structure and versatility [1]. Polybenzoxazines have been developed to replace conventional phenolic resins. Their ring-opening polymerization method significantly reduces the limitations associated with the traditional condensation chemistry approach [2,3]. Nevertheless, it is currently acknowledged that polybenzoxazine should not merely be viewed as a substitute material for traditional phenolic resins; rather, it is recognized as a distinct class of materials that surpasses conventional options like phenolics, epoxies, and bismaleimides [[4], [5], [6]]. The molecular design adaptability of polybenzoxazines enables the properties of the polymerized materials to be