



Synthesis of SiO₂/epoxy–benzoxazine ternary copolymer via sol–gel method: Thermal and mechanical behavior

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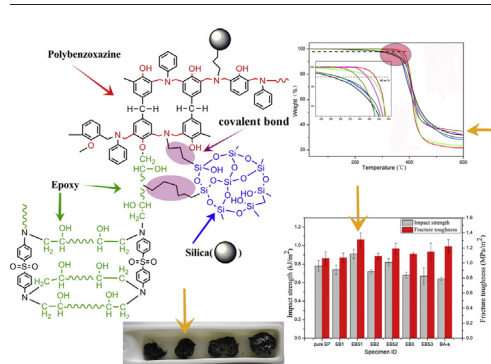
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HIGHLIGHTS

- Silica unit is introduced to the epoxy/benzoxazine copolymer which has covalent bond with both epoxy and benzoxazine.
- Morphology of the decomposition residues are analyzed with both naked eye and SEM.
- There is no particle agglomeration observed in the matrix.
- The ternary copolymer shows improved toughness and thermal stability compared with common epoxy/benzoxazine copolymer.

GRAPHICAL ABSTRACT



ARTICLE INFO

Article history:

Received 1 August 2016

Received in revised form 30 August 2016

Accepted 31 August 2016

Available online 07 September 2016

Keywords:

Epoxy resin

Benzoxazine

Silica

Thermal property

Mechanical behavior

ABSTRACT

Trialkoxy-terminated benzoxazine monomer was synthesized using bisphenol A (BPA), 3-aminopropyltriethoxysilane (KH-550) and paraformaldehyde. Subsequently, bisphenol F epoxy resin (F51) was pretreated with 3-isocyanatopropyltriethoxysilane (IPTS) to covalently introduce trialkoxy group into the epoxy molecular. Sol–gel process was then initiated with tetraethoxysilane (TEOS) as precursor to introduce silica structure into epoxy–benzoxazine hybrid before curing reaction. The synthesized benzoxazine and epoxy resin containing trialkoxysilane group were used as silane coupling agent to connect epoxy–benzoxazine matrix as organic domain and silica units as inorganic domain. Thermal gravimetric analysis (TGA) and dynamic mechanical analysis (DMA) show that the organic–inorganic ternary copolymer possesses promoted thermal stability compared with the unmodified epoxy–benzoxazine matrix. The char residues of the ternary copolymer after decomposition test reveal a dense surface layer and unbroken original dimension which is in accordance with the TGA results. According to the results of the mechanical tests and DMA, the SiO₂/epoxy–benzoxazine copolymer possesses improved toughness and is more capable of absorbing deformation energy under external force.

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1. Introduction

Thermosetting epoxy polymers have been widely used as engineering adhesives and matrices for composite materials due to its high modulus and strength, excellent chemical resistance and simplicity in

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