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NANOCOMPOSITES FOR SPACE APPLICATIONS: CARBON NANOTUBES ENHANCED CYANATE ESTER COMPOSITE HAVING EXCELLENT THERMAL PROPERTY, HIGH DIELECTRIC CONSTANT AND LOW PERCOLATION THRESHOLD

Abstract

Materials for space applications especially space electronics and circuitry need to have dimensional stability at extreme temperatures, robust adhesion to conductors, and low dielectric loss property in addition to high strength-to-weight ratio.

This study revolves around preparation of cyanate ester (CE) composites with carbon nanotubes (NT) for space electronics and circuitry applications, exhibiting high dielectric constant, low percolation threshold and excellent thermal property. Surface nature of the functionalized nanotubes was investigated to examine the morphology of the composite prepared. Two types of CE/NT composites, tagged as CE/NT (non-functionalized) and CE/NTf (functionalized), in order to gauge the effect of surface treatment of NT. Up-to-date the investigations on NT/polymer composites has mainly focused on thermoplastics and made great progress. However, many problems still need to be deeply investigated.

The interface is a critical component of a nano-composite which, in most cases, is the decisive factor for the properties of the composite; however, the effect of the interface on the dielectric properties of composites is still needs to be investigated comprehensively. Some research studies have proved that when CNTs as the conductive fillers are added into the matrix system, it is facile to induce the space polarization due to the charge accumulation at the interfaces, which results in high electrical conductivity and which will affect the dielectric behavior extremely near the percolation threshold.

Our results show that increasing the content of NT or NTf, the dielectric constant of both kinds of composites initially rises until reaches the maximum value, and then declines. Additionally, when the percolation occurs, dielectric constant and loss of both types of composites decrease rapidly with the increase of the tested frequency. The addition of MWCNTs into CE decreases the glass transition temperature and thermal stability, while the incorporation of NTf considerably develops the thermal stability of CE resin. The surface functional groups of NT after surface treatment can improve the interfacial adhesion between NT and CE matrix system. Both types of composites show elevated dielectric constant when the percolation happens. Comparing to CE/ NT composites, the dielectric constant of CE/NTf composite is greater, owing to the different surface nature of NT. Besides this, the improved dispersion and the stronger interfacial adhesion of NTf with CE matrix improve the thermal stability of composite and the final product. This nano-composite can be used effectively in space electronics and circuitry where these properties are required.