Highly Efficient Thermal Conductivity of Polyarylene Ether Nitrile Composites Via the Introduction of Hybrid Fillers and Tailored Cross-Linked Structure

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Abstract:

A polymer alloy with balanced thermal conductive and dielectric properties was successfully prepared by polyarylene ether nitrile(PEN), bisphthalonitrile-microsphere@boron nitride nanosheets(Bm@BNNS), and silicon carbide whisker (SiCws). Specifically, introduction of Bm@BNNS fillers with core-shell structure into PEN resins results in heterogeneous interfaces, which effectively reduces the agglomeration and dosage of BNNS and synergistically improves the λ and dielectric performance. Besides, it has high breakdown strength (Eb) and high energy storage density (242.26 kV/mm, 1.66J/cm^3) when filled with only 4.37 vol% BNNS. Furthermore, effects of one-dimensional SiCws at different scales on formation of heat-conduction pathways and electrical insulation properties of PEN/Bm@BNNS composites were investigated. The findings display that PEN/Bm@BNNS/SiCws composites with large size SiCws (7.81 vol%) achieved a high λ of 2.376 W/(m.K), which was 135.24 % and 87.09 % higher than pure PEN and PEN/Bm@BNNS composites, respectively. Thus, the thermal conductive pathways are constructed by line-plate structure (SiCws-BNNS), and insulating performance primarily on the core-shell structure (Bm@BNNS). Besides, the novel PEN/Bm@BNNS/SiCws hybrid materials are together with a low coefficient of thermal expansion of 38–89 ppm/°C and high Tg of 220 °C. Thus, it gives a promising insight to achieve highly λ polymer-based insulating film materials used for high-temperature-resistant fields.

Keywords:

Polymer-based composites, Thermal conductivity, Insulating properties, Boron nitride nanosheets, Silicon carbide whisker.