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RESEARCH ARTICLE

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Synthesis and characterization of hard copolymer polyurethane/functionalized graphene nanocomposites: Investigation of morphology, thermal stability, and rheological properties

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Abstract

Improving the performance of polyurethane is a crucial endeavor due to its versatile properties that make it suitable for various uses, especially as a matrix in the field of composite materials. The current work investigates the influence of the addition of two types of graphene derivatives, graphene oxide (GO) and reduced graphene oxide (rGO), to hard copolymer polyurethane (HCPU). HCPUs as nanocomposites were synthesized using melt-mixing approaches with different weight ratios of nanofiller additives. The transmission electron microscopy and scanning electron microscopy displayed the morphology through the incorporation of nanofillers within the HCPU structure. Thermogravimetric analysis (TGA) testing showed an increase in the thermal stability of HCPU with the addition of GO and rGO. Herein, the overall HCPU crystallinity/microphase separation decreased after the addition of GO and rGO compared to unfilled HCPU samples. The thermal stability test showed significant enhancement with increasing GO and rGO incorporated weight ratio due to the barrier and tortuous path effects of nanofillers. A clear increase in thermal and electrical conductivity is found, in particular at greater content of addition (5 wt%) of rGO in comparison with neat HCPU. The rheological behavior showed that the storage modulus of HCPU nanocomposites increased from that of pure HCPU, proving the formation of a filler-polymer network interaction within the HCPU chain structure. Dispersion and physical and/or chemical interaction of the GO and rGO within polyurethane chains plays a major role in enhancing the morphology and thermal and rheological properties, and thus represents a significant improvement for the final properties of HCPU nanocomposites.

KEYWORDS

microscopy, polyurethane, rheology, spectroscopy, structure–property relationships