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Biopolymer nanocomposites for engineering applications

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Nanocomposites of poly-L-lactide (PLA), bio-polyamide (PA) and poly butylene adipate-coterephthalate (PBAT) with varying amounts of thermally reduced graphene were generated by melt mixing. Structural characterization of nanocomposites was performed in order to analyze the effect of graphene on polymer chain conformations, crystallinity, interfacial interactions as well as properties. Free amide bonds in the amorphous phase of PA were observed to undergo chemical reaction with the surface groups of graphene, resulting in better interfacial interactions. PA nanocomposites had exfoliated morphology, whereas PLA nanocomposites had least filler exfoliation. Tensile modulus of PA nanocomposite with 5% filler content was 1.8 times higher than pure polymer, whereas the increment was 1.4 and 1.1 for PLA and PBAT nanocomposites. The yield strength for PA composite with 5% filler was also enhanced by 40%. At 60 °C, the extent in increase of storage modulus for the PA nanocomposite with 5% graphene was 1.8 times higher than pure polymer, as compared to 1.3 and 1.1 for respective PBAT and PLA nanocomposites. A significant increase in the melt enthalpy of PA was observed on graphene incorporation which confirmed the findings from structural studies. PA nanocomposites also exhibited maximum thermal stability owing to better filler dispersion in the polymer. The peak degradation temperature in PA composite with 5% graphene content was enhanced by 10 °C and was also a function of the filler content. The findings confirm the use of graphene as a functional filler to enhance the properties of biopolymers and also indicate the role of filler-matrix interactions in achieving filler dispersion and superior nanocomposite properties for engineering applications such as pipelines for fluid transmission.

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