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Master Thesis Defense

Entitled

Graphene/Polypropylene Nanocomposites

by

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Abstract

Graphene has been regarded as a multifunctional nanofiller for manufacturing polymer nanocomposites. A small amount of graphene nanosheets is expected to significantly improve the properties of base polymers. The property enhancement, however, is a function of the degree of exfoliation and dispersion of graphene as well as its compatibility with the polymer. The non-polar nature of polyolefins such as polyethylene (PE) and polypropylene (PP) restricts the homogeneous dispersion of graphene, leading to significant agglomeration of the nanosheets and thus, limiting the expected property improvements in polyolefins. Currently, more efforts are focused on finding strategies to improve graphene dispersion in polyolefins. In this thesis, two strategies were followed to improve the dispersion efficacy of graphene in PP: (1) using compatibilizers, and (2) covalent functionalization of graphene. First part of thesis discusses a new compatibilizer (ethylene butyl acrylate (EBA)) for graphene/PP nanocomposites, and compares it with a conventional compatibilizer (polypropylene-grafted-maleic anhydride (PP-g-MA)). The nanocomposites were prepared by varying graphene concentrations and compatibilizer/graphene (C/G) ratio using the conventional melt blending approach. Increasing C/G reduced the %crystallinity of EBA-compatibilized nanocomposites whereas slight decrease in %crystallinity was observed for MA-compatibilized nanocomposites. The compatibilized nanocomposites showed marked increment in the tensile modulus where EBA-compatibilized nanocomposites exhibited 44% increment and MA-compatibilized nanocomposites showed 32% increment at 5 wt% graphene. However, elongation at break increased significantly with increasing the compatibilizers compared to neat PP/graphene nanocomposites. Higher values of elongation at break for EBA-compatibilized nanocomposites is attributed to lower %crystallinity in nanocomposites. In the second approach, various types of amine-functionalized graphenes have been used to prepare PP/graphene nanocomposites. The nanocomposites were prepared by melt and solution blending methods. The x-ray diffraction and transmission electron microscopy confirmed exfoliated and sheet-like morphology of functionalized graphene. Interestingly, both solution and melt blended nanocomposites exhibited equivalent tensile moduli. The tensile strength of solution-blended nanocomposites was lower than that of melt-blended nanocomposites. However, the elongation at break increased to 3 times in solution processed nanocomposites.

Keywords: Graphene, exfoliation, dispersion, polyolefins, polypropylene, compatibilizers, covalent, functionalization.