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Electrically conductive graphene/polymer nanocomposites

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A unique combination of excellent electrical, thermal, and mechanical properties enable grapheme as a multi-functional reinforcement for polymer nanocomposites. However, poor dispersion of graphene in non-polar polyolefins limits its applications as a universal filler. In this presentation, we discuss our research on improving the dispersion of graphene in polyolefins to produce electrically conductive nanocomposites. Highly non-polar nature of polyethylene (PE) was altered by blending it with a polar polymer, called oxidized polyethylene (OPE). Blends of PE with OPE were synthesized via solution blending method. Inclusion of OPE in PE produced miscible blends, but the miscibility decreased with increasing OPE loading. Meanwhile, the Young's modulus of blends increased with increasing OPE concentration, attributed to decreased long period order in PE and increased crystallinity. In addition, the miscibility of OPE in PE substantially reduced the viscosity of blends. Electrically conductive nanocomposites were manufactured by incorporating raphene in PE/OPE blends via solution blending. The rheological and electrical percolations ecreased substantially to 0.3 and 0.13 vol% in blend/graphene nanocomposites compared to 1.0 and 0.3 vol% in PE/graphene nanocomposites. Improved dispersion of graphene in blends was attributed to increased graphene/polymer interactions, leading to high aspect ratio of the dispersed graphene. A universal Brownian dispersion mechanism for graphene was oncluded similar to that of carbon nanotubes, following the Doi-Edwards theory. Furthermore, the improved dispersion of graphene correlated with the formation of surface fractals in blend/graphene nanocomposites, whereas the poor dispersion of graphene in PE led to the formation of only mass fractals.

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