Influence of extrusion screw designs and speeds on the mechanical properties of melt-blended nylon 6-graphene nanoplatelet nanocomposites

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Abstract

Melt processing is a technique commonly used for the preparation of nanocomposites. However, achieving a high level of dispersion of nanoparticles using this method, for improving the mechanical properties of nanocomposites, is still considered a challenging task despite extensive research efforts. In order to further advance the existing knowledge, this work investigated the influence of different screw designs and speeds, of an extruder, on the mechanical properties of melt-blended nylon 6/graphene nanoplatelet (GnP) nanocomposites. Nanocomposites were prepared using 3wt% GnPs with a twin-screw extruder having three screw designs designated as high, medium and low shear screws and screw speeds of 100, 200 and 300 rpm. Different screw designs and speeds impart different shear stresses and shear rates hence affecting the dispersion and mechanical properties. Tensile and Charpy impact tests were carried out to investigate the influence of processing conditions on the mechanical properties of the nanocomposites. An increase in the Young's modulus of all the nanocomposite samples was observed as compared to pure nylon 6 with the highest increase of approximately 30% using high shear screw design, while tensile strength was reduced. It was also observed that nanocomposites had lower strain at break which was likely due to the constraining effect of GnPs on the polymer chains which restricted their movement. Furthermore, nanocomposites exhibited lower impact strength compared to pure nylon 6 samples, however, an influence of various screw designs and speeds on the variation of impact strength was observed. The lowest reduction in impact strength was observed for the case of high shear screw design while low shear screw design samples had the highest reduction in impact strength.

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