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Entitled

THERMAL CHARACTERIZATION OF GRAPHENE/POLYETHYLENE NANOCOMPOSITES

by

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Abstract

Practically, almost all polymers are solidified from the melts for product-forming purposes. Therefore, the evolution of solid structure (crystallization behavior) from their molten form has prime importance in manufacturing high performance materials. Polyethylene (PE) is one of the most commonly used semicrystalline polymers all over the world. In this thesis, nanocomposites of PE with thermal reduced graphene (TRG) (PE/TRG) were prepared via solvent blending and the crystallization of PE has been investigated using a differential scanning calorimeter (DSC). The nanocomposites were crystallized from the melts under both isothermal and dynamic conditions, and evolution of crystal formation is studied using kinetic analysis. The kinetic data obtained from isothermal crystallization experiments showed excellent fit with the Avrami kinetic theory whereas the dynamic data was better described via Ozawa kinetic model. The parametrization of crystallization process was carried out using various models in order to understand energetics involved during crystallization (solidification) of PE/TRG nanocomposites. The Hoffman-Lauritzen energetic theory further confirmed that inclusion of graphene reduced work required for crystallization, thus facilitating the kinetic growth of the crystals. The graphene nanosheets acted as nucleating agents by substantially decreasing the time to reach 50% of crystallization. The quantitative results from the kinetic analysis were consistent with other nanocomposites where the nanofillers acted as nucleating agents. Since inclusion of nanofillers increases the viscosity of the nanocomposites, PE was blended with oxidized PE in order to reduce its viscosity and nanocomposites were prepared by the same protocol. A detailed analysis of the energetics involved during crystallization of these nanocomposites has also been investigated and compared with neat PE/TRG nanocomposites. The blended PE composites showed similar behavior as that of PE/TRG nanocomposites with even faster crystallization. However, no change in crystal structure was observed.

Keywords: Polyethylene, Graphene, Nanocomposites, Crystallization, DSC.