Durability and Crystallinity changes in PP - LDH nanocomposites upon thermal / photo-irradiation

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Abstract

The effect of layered double hydroxide (LDH) nanolayers on the crystallization behavior of polypropylene (PP) was studied based on the preparation of nanocomposites by a melt intercalation method. Experiments confirmed the nanocomposite formation with exfoliated/intercalated layered double hydroxides well distributed in the PP matrix. The isothermal crystallization kinetics and subsequent melting behavior of PP/LDH hybrids were studied with differential scanning calorimetry (DSC), polarized optical microscopy (POM), and wide-angle X-ray diffraction (WAXD). Studies revealed that the LDH promoted heterogeneous nucleation, accelerating the crystallization of PP. The Avrami equation successfully describes the isothermal crystallization kinetics of PP/LDH hybrids and signifies heterogeneous nucleation in crystal growth of PP. The varying values of Avrami exponent (n) and half crystallization time ($t_{1/2}$) of PP and PP/LDH hybrids describes overall crystallization behavior. The crystallite size (D_{hkl}) and distribution of different crystallites in PP varied in presence of LDH. A significant increase in melting temperature is observed for PP/LDH hybrids. The POM showed that smaller and less perfect crystals were formed in nanocomposites because of molecular interaction between PP chains and LDH. The results revealed that very small amounts of LDH (1%) could accelerate the crystallization process relative to the pure PP and increase in the crystallization rates was attributed to the nucleating effect of the nanoparticles The value of fold surface free energy (σ_e) of PP chains decreased with increasing LDH content. Finally, the overall results signify that LDH at nano meter level acted as nucleating agent and accelerate the overall crystallization process of PP.