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Multi-Walled Carbon Nanotubes as Nucleating Agents

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Abstract : Nucleating agents are widely used to modify the properties of various polymers. The rate of crystallization and the size of the crystals have a strong impact on mechanical and optical properties of a polymer. The addition of nucleating agents to the semi-crystalline polymers provides a surface on which the crystal growth can start easily. As a consequence, fast crystal formation will result in many small crystal domains so that the cycle times for injection molding may be reduced. Moreover, the mechanical properties e.g., modulus, tensile strength, heat distortion temperature and hardness may increase. In the present work, multi-walled carbon nanotubes (MWNTs) as nucleating agents for the crystallization of poly (e-caprolactone)diol (PCL). Thus nanocomposites of PCL filled with MWNTs were prepared by solution blending. Differential scanning calorimetry (DSC) tests were carried out to study the effect of CNTs on on-isothermal crystallization of PCL. The polarizing optical microscopy (POM), and wide-angle X-ray diffraction (WAXD) were used to study the morphology and crystal structure of PCL and its nanocomposites. It is found that MWNTs act as effective nucleating agents that significantly shorten the induction period of crystallization and however, decrease the crystallization rate of PCL, exhibiting a remarkable decrease in the Avrami exponent n, surface folding energy σe and crystallization activation energy ΔE. The carbon-based fillers act as templates for hard block chains of PCL to form an ordered structure on the surface of nanoparticles during the induction period, bringing about some increase in equilibrium temperature. The melting process of PCL and its nanocomposites are also studied; the nanocomposites exhibit two melting peaks at higher crystallization temperature which mainly refer to the melting of the crystals with different crystal sizes however, PCL shows only one melting temperature.

Keywords : poly(e-caprolactone)diol, multiwalled carbon nanotubes, composite materials, nonisothermal crystallization, crystal structure, nucleation

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