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Study of the Non-isothermal Crystallization Kinetics of Polypropylene Homopolymer/Impact Copolymer Composites

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Abstract : Polypropylene (PP) is an essential material of numerous applications in different industrial sectors, including packaging, construction, and automotive. Because the application of homopolypropylene (HPP) is limited by its relatively low impact strength and high embrittlement temperature, various types of impact copolymer PP (ICPP) that incorporate elastomers/rubbers into HPP to increase impact strength have been successfully commercialized. Crystallization kinetics of an isotactic HPP, an ICPP, and their composites were studied in this work understand the composites' behaviors better. The Avrami-Jeziorny model was used to describe the crystallization process. For most samples, the Avrami exponent, n, was greater than 3, indicating the crystal grew in three dimensions with spherical geometry. However, the n value could drop below 3 when the ICPP content was 80 wt.% or higher and the cooling rate was 7.5°C/min or lower, implying that the crystals could grow in two dimensions and some lamella structures could be formed under those conditions. The nucleation activity increased with the increase of the ICPP content, demonstrating that the rubber phase in the ICPP acted as a nucleation agent and facilitated the nucleation process. The decrease in crystallization rate after the ICPP content exceeded 60 wt.% might be caused by the excessive amount of crystal nuclei induced by the high ICPP content, which caused strong crystal-crystal interactions and limited the crystal growth space. The nucleation activity and the n value showed high correlations to the mechanical and thermal properties of the materials. The quantitative study of the kinetics of crystallization in this work could be a helpful reference for manufacturing ICPP and HPP/ICPP mixtures.

Keywords : polypropylene, crystallization kinetics, Avrami-Jeziorny model, crystallization activation energy, Nucleation activity
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