This special issue of the Journal of Materials Research contains articles that were accepted in response to an invitation for manuscripts.

Introduction

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Polymers are found in a plethora of applications that exploit the unique structural capabilities, light weight, thermal stability, chemical stability, smart features (such as shape memory and biodegradability), electrical conductivity of polymer-based components. Polymers are nanomaterials, having characteristic lengths (such as the radius of gyration, the size of crystallites) in the nanometer scale. Polymer-based nanocomposites represent a rapidly growing component of the nano-revolution. The simplest polymer-based nanocomposite is an amorphous crystalline polymer, where the amorphous and crystalline phases define the composite, and the characteristic length (dimensions of crystallites, radius of gyration, thickness of the interface between crystalline and amorphous domains, etc.) is at the nanometer scale. Polymer blends and block copolymers are also polymer-based nanocomposites. However, the classical perception of a polymer-based nanocomposite is that of a polymeric matrix loaded with nanofiller(s). With few exceptions (100% crystalline polymers or completely amorphous polymers), all polymeric materials can be classified as polymer-based nanocomposites.

Phase transitions in polymer-based nanocomposites are complex; the goal of this *JMR* Focus Issue is to consider the theoretical and experimental study of the crystallization process in polymeric materials with an emphasis on polymer-based nanocomposites, in which there is already a rich literature. The authors examine the limits of theoretical approaches to the crystallization/melting processes in polymeric materials, the limitations of existing experimental techniques, the effect of nanoconfinement, and the influence of nanoparticles on the crystallization of polymeric materials. There are many issues and difficulties connected with the analysis of crystallization in polymer-based nanocomposites. The Avrami analysis of isothermal crystallization of polymers, and generalized later for non-isothermal crystallization, provides an acceptable framework for the study of polymer crystallization. However, the correlation between theory and experiment is not trivial; in the case of differential scanning calorimetry investigations, it is important to recognize that thermodynamic quantities scale with the mass of the sample while Avrami theory is based on volume. Diffraction techniques should complement thermodynamic data in combined investigations aiming at a better understanding of polymer-based nanocomposites.

We believe that these articles can be used as a productive starting point in future research on crystallization processes in polymeric materials and polymer-based nanocomposites.

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