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Abstract

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TRANSITION OF PLANAR STRUCTURES OF ISOTACTIC POLYSTYRENE INTO SPHERULITES

Isotactic polystyrene belongs to the class of polymers that crystallize with difficulty, since it consists of chain molecules that are flexible, though strongly interacting. In such systems relaxation processes proceed slowly and, consequently, crystallization of the polymer must be hindered. This circumstance makes it possible to investigate in greater detail the processes of structure formation occurring in this polymer.

The first crystals of isotactic polystyrene were obtained from its solution in xylene under very slow cooling ([1]) and from toluene solutions upon evaporation of the solvent above the glass-transition temperature ([2]). According to the literature, amorphous isotactic polystyrene crystallizes in the form of spherulites in the temperature range 110–175° ([3],[4]).

We investigated structure formation in amorphous isotactic polystyrene with the aid of an electron microscope. The specimens were prepared by applying toluene and xylene solutions, heated to the boiling point, onto a supporting film at a temperature of 110°. Under these conditions, structureless particles of various shapes are formed. Electron-diffraction studies show that these particles have an amorphous structure.

Upon heating amorphous, structureless isotactic polystyrene at temperatures of 140–180°, one can observe profound structural transformations occurring in the solid state.

In Fig. 1a, which shows an electron micrograph of crystallized isotactic polystyrene, the center of formation of a spherulite is visible. Along the edges of the micrograph are typical lamellar crystals, which sometimes grow by a spiral mechanism, analogously to polyethylene and low-molecular paraffins. In the middle part of the micrograph, the entire process of transition of planes into spherulites is visible with remarkable clarity. In isotactic polystyrene the picture of the transition is seen better than in any other objects. The micrograph shows how the edges of the planes, bending, stand on edge, and folds form on the surface.

In Fig. 1b the process of the appearance of spherulites is visible. Here one can observe how the planes that have formed turn over (the angle of rotation reaches approximately 90°) and curl up. It is clearly seen how these turned planes form

Electron micrograph of crystallized amorphous isotactic polystyrene. Samples were heated for 2 hours: a—at 140°, b—at 160°.

Figure 1: Electron micrograph of crystallized amorphous isotactic polystyrene. Samples were heated for 2 hours: a—at 140°, b—at 160°.

several centers of spherulites, with one and the same plane able to enter into two or more spherulites. The bent edges of the planes and the folds give fibrils, of which spherulites usually consist. Thus, it can be observed that the rotation of planes onto edge and fold formation on their surfaces proceed so regularly that this leads to the formation of spherulites.

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Fig. 1. Electron micrograph of crystallized amorphous isotactic polystyrene. Samples were heated for 2 hours: **a**—at 140°, **b**—at 160°.

Note: Figure translations are in progress. See original paper for figures.