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Abstract

Full Text

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CHEMISTRY

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ON THE POLYMORPHISM OF CRYSTALLINE POLYPROPYLENE

At the present time there is no doubt about the fact that any crystalline polymer can be crystallized in the form of crystals when certain conditions are created ([1–8]). Since the process of crystal formation is a complex multistage process, as has been investigated in detail for polyethylene, we are entitled to expect the appearance of a great variety of morphological forms, which will be the subject of the present communication.

Stereoregular polypropylene of high molecular weight ($M = 100000$) was chosen as the object. Solutions of 0.001-0.1% concentration in xylene and decalin were heated to 10-15° below the boiling point of the solvent and slowly (over the course of 2 weeks) cooled to room temperature. The resulting transparent suspension was applied to a collodion substrate, shadowed, and examined in a GEM-5G electron microscope. Electron diffraction obtained from single crystals (Figs. 1a, b, 2, 3) gives sharp reflections that disappear under the electron beam, which apparently destroys the diffracting capacity of the specimen, while at the same time not affecting its shape.

For the first time for polymers, using polypropylene as an example, we have succeeded in observing polymorphism with such a variety of morphological forms: elongated rods up to 5 μ in size, regular triangles, hexagonal crystals, crystals in the form of "snowflakes," a three-dimensional crystal with distinct lateral faces, and, finally, the rhombs most common for polymers.

By changing the crystallization conditions (temperature, concentration, cooling rate), intermediate crystalline formations were obtained. At low concentrations (less than or equal to 0.001%) and at temperatures close to the boiling point of the solvent, asymmetric formations up to 0.5 μ in size are observed (Fig. 4a), which, with a slight increase in concentration or decrease in temperature, become elongated until linear structural units (threads) are formed, especially long for decalin solutions. The further process is reduced to the appearance of longitudinal formations of crab-like (photograph not shown), needle-like, and dendritic type (Fig. 4b), with transverse ordering of these linear structural units. These preliminary data suggest that Keller' s mechanism of formation

of crystalline structures by layering of planes is apparently not the only one for crystallizing polymers, which will be discussed in the following communication.

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Fig. 1

Fig. 2

Fig. 3

Fig. 4

Fig. 1. Single crystal of polypropylene: *a* –crystallized from a 0.01% solution in decalin, 23,000×; *b* –crystallized from a 0.01% solution in decalin, 13,000×

Fig. 2. Polypropylene crystallized from a 0.005% solution in decalin, 350,000×

Fig. 3. Crystals of polypropylene crystallized from a 0.01% solution in xylene, 88,000×

Fig. 4. Polypropylene: *a* –crystallized from a 0.001% solution in xylene, 60,000×; *b* –crystallized from a 0.01% solution in xylene, 68,000×

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