

Abstract No. phil579

Comparative Study of Morphology Development During Isothermal Crystallization of Alpha- and Beta-Form Isotactic Polypropylene

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Beamline(s): X27C

Introduction: The beta-form of isotactic polypropylene (iPP) has been extensively studied and reviewed [1,2,3]. While normally a minority phase relative to the alpha-form, very high percentages of the beta-form can be obtained with the addition of selected additives depending on crystallization conditions. The lamellar microstructure of the beta-form exhibits much greater similarity to the "conventional" microstructure of semicrystalline homopolymers than does the alpha-form with its unique tendency for cross-hatch formation [1]. Simultaneous synchrotron small-angle and wide-angle x-ray scattering (SAXS/WAXS) measurements allow for in-situ comparisons of lamellar/crystallinity development during isothermal crystallization. Recent comparative results of iPP (alpha-form) and syndiotactic PP, which also exhibit different lamellar microstructures, showed that the sPP long spacing changed to a greater extent during crystallization relative to the "compact" microstructures of the alpha-form of iPP [4]. This study examines whether a similar situation exists for the alpha- and beta-forms of iPP.

Methods and Materials: Stabilized Ziegler-Natta iPP formulations (Mw~200,000) were studied without nucleator, with sodium benzoate nucleator (a strong nucleator for the alpha-form) and with the calcium salt of suberic acid (a strong nucleator for the beta-form). The suberic acid salt was synthesized at Basell USA. The activity of the nucleator for the beta-form has been discussed previously [5]. The formulations were melt-mixed in a Haake mixer and the product compression molded into plaques, from which samples were cut for the synchrotron experiments. Simultaneous SAXS/WAXS measurements were conducted at beamline X27C using two linear position-sensitive detectors (European Molecular Biology Laboratory) with simultaneous data acquisition. Isothermal crystallization measurements were carried out with a dual-chamber temperature jump apparatus described elsewhere [6]. Melt temperatures were 200 C, and crystallization temperatures ranged from ~115-140 C.

Conclusions: At the same crystallization temperature, the long spacing of the beta-nucleated iPP is greater than both the neat and nucleated alpha-forms of iPP dependent on the extent of conversion to the beta-form (crystallization temperature dependent). The beta-nucleated iPP showed a greater decay of the long spacing during crystallization than the alpha-form samples.

Acknowledgments: The author thanks A.A.Marchione (formerly Basell USA) for assistance in synthesizing the beta-nucleating compound, Deborah Morgan (Basell USA) for sample preparation, and Dr. F.Yeh (State University of New York-Stony Brook) for invaluable support of the synchrotron measurements.

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