Supporting Information

Crystalline structure of injection molded β-isotactic polypropylene: Analysis of the oriented shear zone

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Figure S1. SEM micrographs for raw rare earth β-Nucleating Agent (β-NA).

As shown in Figure S1, the single crystal diameter is about tens of nanometers and most of the agglomerates consist of several crystals.

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Figure S2. Schematic of the sample preparation for 2D-SAXS/WAXS measurements. FD: flow direction; RD: wall direction.

Before 2D SAXS/WAXS measurement, a segment with 10 mm length along the flow direction (FD) is cut in the middle of the part, from which a board of 1 mm thickness was grinded along FD-wall direction (RD) plane, which is schematically illustrated in Figure S2. The X-ray beam is perpendicular to FD-RD plane. To determine the position of shear zone for X-ray measurement, the macroscopic hierarchical structure was studied, and a typical example of POM micrograph in thickness direction is shown in Figure S3. Obviously, zones that can be recognized from skin surface to the core of the part are a thin skin zone (1), a shear zone (2) and the core zone. It is clearly that the width of skin zone is about 30 µm for iPP-0 and that of shear zone (2) is about 110µm. For the β-iPP, the nucleating agent lowers the free energy barrier. Thus, it is understandable that the thickness of shear zone is thickening. The details about shear stress and β-iPP influence the thickness of the shear zone can be found in the Ref. [1,2]. Therefore, the shear zone is easily to locate (the scan steps is 100µm from the skin surface) during 2D SAXS/WAXS measurements.
Figure S3 POM micrographs of hierarchical structure of (a) iPP-0, (b) iPP-0.2 and (c) iPP-1.0.

Distinguished zones are the skin zone (1) and shear zone (2).

The random distribution of β-NA by comparison molding has been report in the Ref. [3-6]. In the case of this study, β-NA is oriented parallel to flow direction with the aid of shear flow. To prove this, the ultrathin slices (ca.10µm) were cut from the middle of parts along flow direction; and then they were inserted between two microscope cover-glasses. The morphology of β-NA in the shear zone was investigated by a POM (Leica DMLP) equipped with a hot-stage (Linkam). According to Ref. [3], β-NA cannot be dissolved at 200˚C in the polymer melt and therefore its solid structure cannot be easily destroyed during the process of melting and recrystallization. Figure S4 shows a typical example of POM photographs for iPP-0.2 during the recrystallization. Obviously, β-NA is oriented parallel to flow direction in the melt as shown by the arrows.

Figure S4 The typical POM photographs of β-NA in iPP-0.2.

References


