

Structural and Morphological Studies of Isotactic Polypropylene Fibers during Heat/Draw Deformation by *in situ* Synchrotron SAXS/WAXD

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Introduction: There have been many studies on the structure, morphology, mechanical property and their relationships in isotactic polypropylene (iPP). However there are still many more unresolved issues. For example, the nature of the mesophase and its relationships with the crystal phase in iPP fibers have not been completely developed^[1], which is the focus of this work.

Methods and Materials: Simultaneous synchrotron WAXD/SAXS method. The polypropylene fibers obtained from Montell USA were spun from a Hills Model REM-3MP-25 spinning unit at a temperature of 216 °C and a take-up velocity of 1000 m/min. The resultant fiber was a 41 filament yarn with ~5 denier/filament. The resin was a commercial Ziegler-Natta resin (Montell PF-304) with M_w of $\sim 1.8 \times 10^5$ g/mol, M_w/M_n of ~ 3 and melt flow rate index of 40 g/10 min.

Results: A novel image analysis method was used to deconvolute the quantitative information of the mass fractions of the crystalline, mesomorphic and amorphous phases from the 2D WAXD patterns^[2]. The results indicated that defective α -form crystals were present in the initial iPP fibers. These α -form crystals were completely converted into the mesomorphic form at a draw ratio of 2.5 at room temperature. The corresponding 2D SAXS pattern showed that there was no obvious lamellar structure in the mesophase of the iPP fibers.

Conclusions: We speculate that the dominant constituent of the mesophase in iPP fibers may be oriented bundles of helical chains with random helical hands in addition to the oriented chains with no helical structures, with both having only partial packing ordering, but no short range three-dimensional orders.

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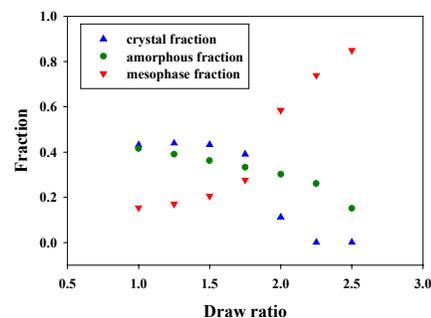


Figure 1. Fractions of crystal, mesomorphic and amorphous phases as a function of draw ratio at room temperature