

Structure of Polypropylene Crystallized in Confined Nanolayers

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Films with a thousand alternating layers of isotactic polypropylene (PP) and polystyrene (PS) were prepared by layer-multiplying coextrusion. The crystal structure of extremely thin PP layers confined between PS layers was studied by optical light microscopy (OM), atomic force microscopy (AFM), differential scanning calorimetry (DSC), small angle X-ray scattering (SAXS) and wide angle X-ray scattering (WAXS). Changes in structure were observed as the PP layer thickness decreased to the nanoscale. The thin PP discoids were largely composed of edge-on lamellae with (040) planes lying flat on the interface. In layers 65 nm and 10 nm thick, compressed d-spacings in the directions perpendicular to the chains and loss of registry along the chain axis were suggestive of smectic packing of conformationally distorted chains. Even so, crystalline lamellae were distinguishable in AFM images. In addition to the crystal population with (040) planes parallel to the interface, WAXS from layers 65 nm thick revealed another crystal fraction with (110) planes parallel to the interface and (040) planes perpendicular to the interface. This fraction was more evident in layers 10 nm thick, where it accounted for approximately 10-20% of the crystallinity. Decreasing layer thickness resulted in a change of crystal growth plane from the usual (110) to the more rare (010). Possibly the new crystal structure served to fill-in the radial structure of dendritic discoids when limitation to the thickness of the layer left little space for secondary nucleation of cross-hatched lamella.