Effect of cooling rate on crystal polymorphism in beta-nucleated isotactic polypropylene as revealed by a combined WAXS/FSC analysis

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The efficiency of linear trans γ-quinacridone to nucleate formation of β-crystals in isotactic polypropylene (iPP) at rapid cooling conditions has been evaluated by a combination of fast scanning chip calorimetry (FSC) and microfocus wide-angle X-ray scattering (WAXS). For samples containing different amount of γ-quinacridone, FSC cooling experiments revealed information about a critical cooling rate above which the crystallization temperature decreases to below 105 °C, that is, to temperatures at which the growth rate of α-crystals is higher than that of β-crystals. Microfocus WAXS analysis was then applied to gain information about the competition of formation of β- and α-crystals in samples prepared at well-defined conditions of cooling at rates up to 1000 K/s in the FSC. For iPP containing 1 and 500 ppm γ-quinacridone, the crystallization temperature is lower than 105 °C on cooling faster about 10 and 70 K/s, respectively, which then on further increase of the cooling rate leads to a distinct reduction of the β-crystal fraction. The study may be considered as a first successful attempt to quantify and interpret β-crystal formation in iPP containing γ-quinacridone at processing-relevant cooling conditions in the shed of light of the different temperature-dependence of the growth rates of α- and β-crystals. These conditions can then be applied to mold filling simulations to predict microstructures resulting from the injection molding process.