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Experimental Approach

- Controlled-pressure slit flow coupled with in-situ time-resolved WAXD/SAXS.
- 16 combinations of different pressures and flow rates.

Outcome

- Quantitative data on crystal phases and morphology.
- Rheology via pressure drop at the transducers.

Results

Pressure increases relaxation times and crystal growth rates, shish form early during flow, affecting the rheology of the material. Crystallinity happens at shorter times and reaches higher levels for increasing pressure and flow rate. The total amount of γ-phase formed is promoted by pressure and reduced by flow.

In polymer products, especially those made of isotactic polypropylene, different crystal forms and different morphologies can be present. The classical example is injection moulding: the combination of high cooling rates, shear flow and high pressure results in 4 different crystal phases (α, β, γ and a meso-phase) and complex morphologies, including shish-kebab (parents) with α- and γ-lamellar branching (daughters). The effect on final properties can be tremendous [2]. Therefore, quantifying the amount of different phases and their morphology as a function of processing conditions (flow, pressure) is indispensable for understanding and fully model the process and resulting properties.

Conclusions and outlook

For the first time the complex morphological and structural behavior found in crystallization of isotactic polypropylene after flow at different pressure level is fully characterized. The results will be used to validate a crystallization model [2] that includes the effects of flow and pressure, incorporated in a finite element code, permitting the prediction of the final structure in parts made by complex processing operations such as injection molding.

References