Creating morphologies at your demand

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Introduction

The material rheological behaviour, processing conditions and part geometry define a thermal-mechanical environment that determines the final microstructure and properties of an injection-moulded product. The development of new experimental setups in which flow conditions can be manipulated are of interest to study resulting microstructures and macroscopic properties.

Objectives

√ Define new experiments capable of inducing different flow histories.

√ Develop a numerical tool to predict the developed morphologies.

Methods

An innovative moulding tool, RCEM (Rotation, Compression and Expansion Mould) [1] is used to control the structure development ofinjection-moulded materials (see fig.1). One wall can rotate or translate during the filling stage, i.e combine pressure driven, drag and squeezing flow. A finite-element model for injection moulding is used to simulate the resulting deformation and thermal history.

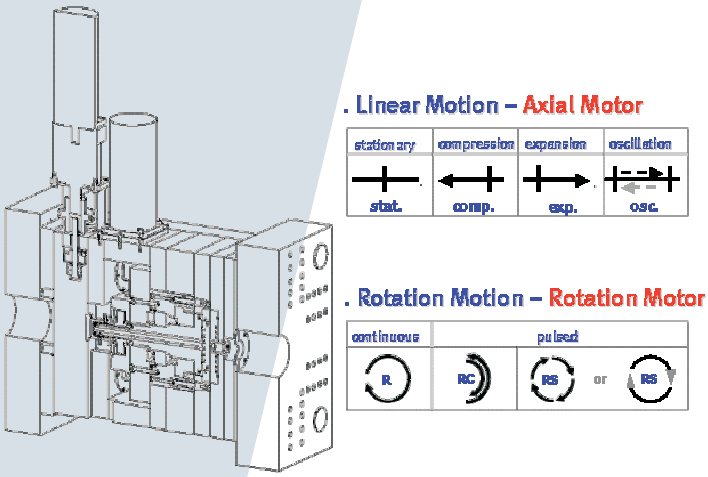

Figure 1. *RCEM mould and the possible operating conditions.*

Isotactic polypropylene samples are injection-moulded at constant temperature and injection speed. The different mould operating parameters are given below. Part geometry: centre gate circular plates ϕ =150 mm.

Conditions	Rotation(rpm)	Compression(mm)
1	-	-
2	450	-
3	900	-
4	900	2

Samples are taken from three different positions and microtomed in two flow directions (fig.2) for Polarized Optical Light Microscopy (POLM) measurements (fig.3).

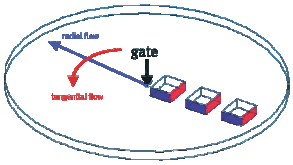

Figure 2. *Layout for microtoming procedure.*

Experimental Results

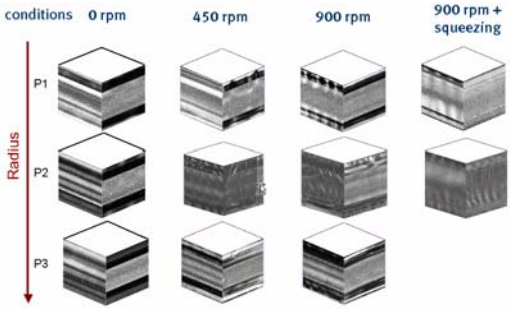

Figure 3. *Polarized optical light microscopy results.*

Molecular orientation is determined for conditions 1, 2 and 3, using FT-IR dichroic ratio measurements (fig.4).

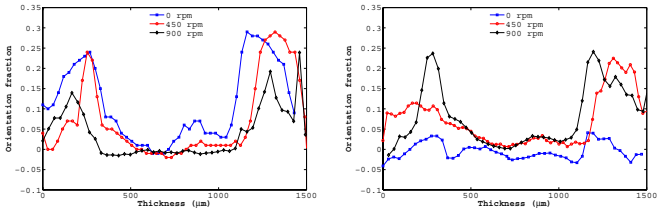

Figure 4. *Orientation fraction calculated in radial direction (left) and tangential direction (right).*

Simulations/Front capture technique [2]

Radial disc filling for standard conditions.

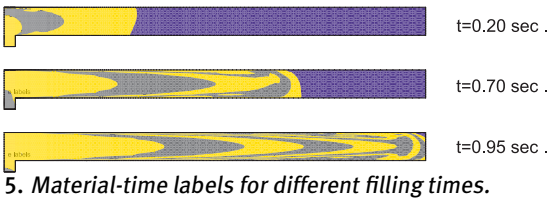

Figure 5. *Material-time labels for different filling times.*

Conclusions/Future work

The RCEM mould is capable of creating different morphologies. Large differences in molecular orientation have been found. A numerical tool to predict the flow kinematics has been validated, still resulting morphologies are to be predicted.

References:

[1] SILVA, C., ET AL.: *International Polymer Processing, Vol. XX, n.1, p.27-34.* (2005)

[2] HAAGH, G.: *Ph.D. thesis, Eindhoven University of Technology* (1998)

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