

Creating morphologies at your demand

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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 of injection-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.

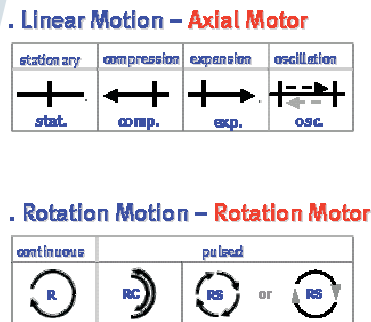
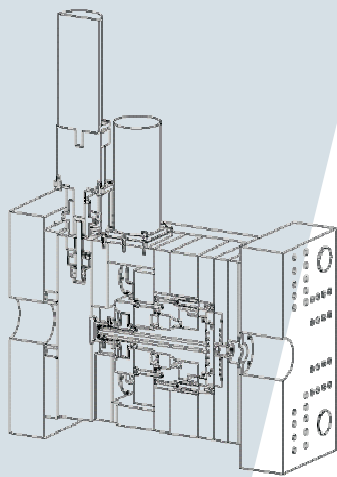


Figure 1. RCEM mould and the possible operating conditions.

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 $\phi = 150$ 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).

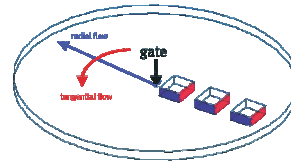


Figure 2. Layout for microtoming procedure.

Experimental Results

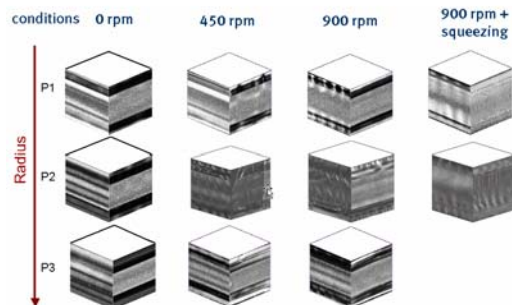


Figure 3. Polarized optical light microscopy results.

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

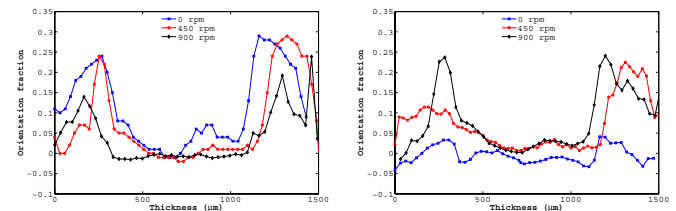


Figure 4. Orientation fraction calculated in radial direction (left) and tangential direction (right).

Simulations/Front capture technique [2]

Radial disc filling for standard conditions.

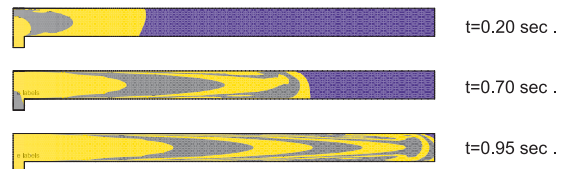


Figure 5. Material-time labels for different filling times.

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)