Development of strain induced crystallisation modeling using the SCORIM process

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Introduction

For semi-crystalline polymers different (flow induced oriented) crystalline structures cause anisotropy in the final product. Accurate prediction of the structure is essential to influence the product properties.

Objective

- conformation of strain induced crystallisation (SIC) modelling by predicting layered structures.

Theory

Dependent on the amount of strain experienced during processing, different crystalline structures will be present in the solidified polymer product (fig.1).

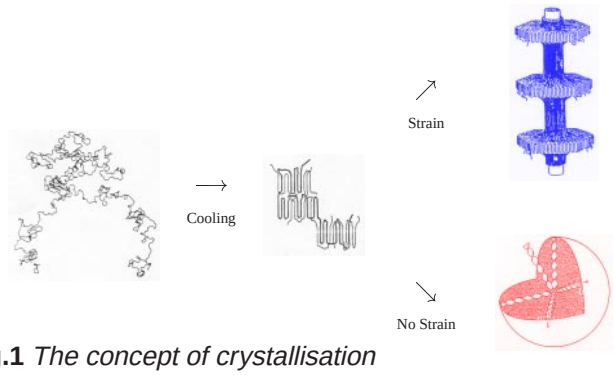

fig.1 *The concept of crystallisation*

While the SCORIM process (Shear Controlled Orientation Injection Moulding) is suited to create extreme situations of the injection moulding process, it is used as a test case for the modelling of crystallisation kinetics during injection moulding.

SCORIM

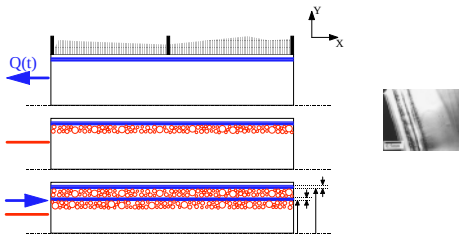

fig.2 *A representation of the layered structure in the SCORIM process.*

In the SCORIM process a flow is maintained in the mould after it has been filled, during solidification/crystallisation of the polymer. SIC is enhanced by flow and results in layers of different crystalline structures (fig.2). As the interesting part of the mould is the region where polymer is present that has not re-entered the runner system, the analysis is restricted to the central region. The procedure for a process is visualised by the pressure distribution (fig.3).

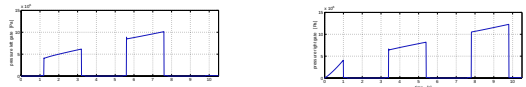

fig.3 *The pressure at both sides of the flow domain.*

Calculation of the strain is done using the Leonov model [1]. Due to the filling of the cavity the strain peak develops near the wall. After the flow is reversed, it decreases to zero and starts increasing again, although it is frozen in partly by the solidified layer, resulting in a layered structure (fig.4).

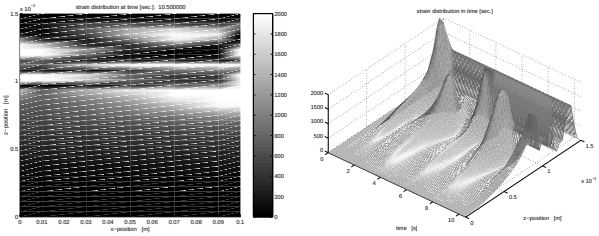

fig.4 *The resulting distribution of the strain (left) and in time at x = 0.05 [m] (right).*

Discussion

In most models used for the calculation of the flow-induced crystallisation kinetics the number of nuclei depends on the amount of strain/stress. For the SCORIM process this would mean that after reversal of the flow, all nuclei will disappear! This is not a realistic result.

Conclusions

Another type of modelling will be used in the future, for instance, the number of nuclei dependent on the invariants of the strain.

References:

[1] ZUIDEMA ET. AL.: *Progress report and update on the contribution of the TUE to the Decrypo project.* (Intern. report, Eindhoven University of Technology, MT 98.015, 1998).