Modelling the injection moulding process of semi-crystalline polymers

Citation for published version (APA):

Document status and date:
Published: 01/01/1997

Please check the document version of this publication:

• A submitted manuscript is the version of the article upon submission and before peer-review. There can be important differences between the submitted version and the official published version of record. People interested in the research are advised to contact the author for the final version of the publication, or visit the DOI to the publisher’s website.
• The final author version and the galley proof are versions of the publication after peer review.
• The final published version features the final layout of the paper including the volume, issue and page numbers.

Link to publication

General rights
Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

• Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
• You may not further distribute the material or use it for any profit-making activity or commercial gain
• You may freely distribute the URL identifying the publication in the public portal.

If the publication is distributed under the terms of Article 25fa of the Dutch Copyright Act, indicated by the “Taverne” license above, please follow below link for the End User Agreement:
www.tue.nl/taverne

Take down policy
If you believe that this document breaches copyright please contact us at:
openaccess@tue.nl
providing details and we will investigate your claim.
Modelling the Injection Moulding Process of Semi-Crystalline Polymers

Eindhoven University of Technology, Faculty of Mechanical Engineering, Section Materials Technology, P.O. Box 513, NL 5600 MB Eindhoven

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

☐ development of a numerical model for flow-induced crystallisation of semi-crystalline polymers.

Theory

Depending on the amount of molecular strain during processing, different crystalline structures (fig.1) will be present in the solidified product (fig.2).

![The concept of crystallisation](image1)

![A cross section of an injection moulded product](image2)

Modelling

Models for the development of different structures:

☐ One for the degree of crystallinity for the spherulitical structure \( \xi_g \) [1]:

\[
\frac{\xi_g}{1-\xi_g} = \phi_0 \quad \phi_i = G^{i-1} \phi_{i-1} \quad \phi_3 = 8\pi\alpha
\]

Solving these together with the energy equation for a 1D-problem (\( T_i = 478[K] \), \( TW = T(t) \) (low)) gives results (center/wall, in between) comparable with the predictions of Schneider (*) (fig.3).

![Simulation results using Schneider's rate equations](image3)

☐ One for the degree of crystallinity for the shish-kebab structure \( \xi \) [2]:

\[
-ln(1-\xi) = \psi_0 \quad \psi_0 = 2\pi \int_0^1 dL_{tot}(\int_0^1 G(u) du)^2
\]

\[
\psi_1 = \frac{\psi_0}{G} \quad \psi_2 = \frac{\psi_1}{G} = 4\pi L_{tot}
\]

\[
\psi_3 = \frac{\partial\psi_2}{G^2} + \frac{\psi_2}{G} = 8\pi N \quad \psi_3 = 8\pi(\gamma_n^2 g_n - \frac{\psi_3}{\gamma_n})
\]

Solving these for a non-isothermal flow clearly shows the influence of the solidified layer (fig.4).

![Simulation results for shear induced crystallisation](image4)

Conclusions

The models shown are a good starting point. However, strain calculations have to be incorporated.

References:
