

Flow-induced crystallization of PP/PE copolymers

Citation for published version (APA):

Housmans, J. W., Peters, G. W. M., & Meijer, H. E. H. (2005). *Flow-induced crystallization of PP/PE copolymers*. Poster session presented at Mate Poster Award 2005 : 10th Annual Poster Contest.

Document status and date:

Published: 01/01/2005

Document Version:

Publisher's PDF, also known as Version of Record (includes final page, issue and volume numbers)

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.

Flow-induced crystallization of PP/PE copolymers.

J.W. Housmans, G.W.M. Peters, H.E.H. Meijer

Eindhoven University of Technology, Department of Mechanical Engineering

Introduction

The major disadvantages of PP are low temperature brittleness and opacity. A way to improve these properties is to use PP/PE random copolymers (RACO's) that also have the advantage of a decrease of the processing temperatures [1]. This study deals with the influence of ethylene content on crystallization behavior and the characterization of these materials for future modeling purposes.

Materials and methods

- A PP homopolymer and three PP/PE RACO's with different ethylene contents (Borealis, Linz).
- All grades have the same molar mass ($M_w \sim 310$ kg/mol) and polydispersity ($D \sim 3.4$) [2].
- Oscillatory experiments to determine the linear viscoelastic response.
- Short term shear experiments, see Fig. 1.

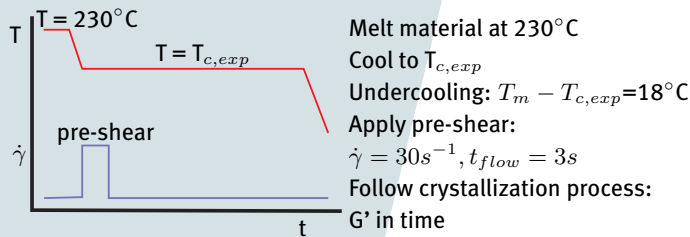


Figure 1 Short-term shear experiment.

Results

The introduction of ethylene monomer in PP leads to:

- a decrease in crystallinity.
- a depression of the glass-transition (T_g), melt (T_m) and crystallization temperature (T_c , Table 1).

Table 1: Basic characteristics of the PP grades.

Type	Ethylene [mol%] ¹⁾	T_g [°C] ²⁾	T_m [°C] ²⁾	T_c [°C] ²⁾	X_c [%] ^{2,3)}
HD234CF	0	-2	163	112	45
RD204CF	3.4	-4	147	105	39
RD226CF	5.2	-5	143	101	37
RD208CF	7.3	-11	138	95	33

¹⁾ From [2], determined using NMR spectroscopy.

²⁾ Determined using DSC, $\dot{T} = 10^\circ\text{C}/\text{min}$

³⁾ $\Delta H_m = 209$ J/g for 100% crystalline PP, [2].

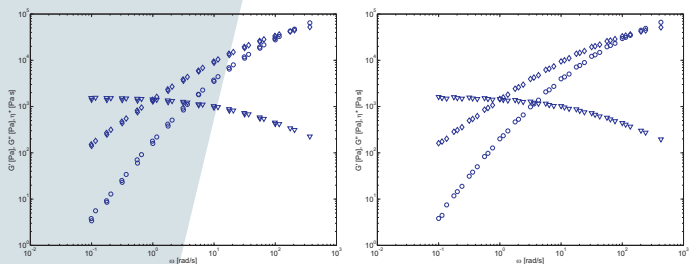


Figure 2 Linear viscoelastic response of HD234CF (left) and RD208CF (right), measured at different temperatures and shifted to $T_{ref} = 220^\circ\text{C}$. $\circ = G'$, $\diamond = G''$, $\triangle = \eta^*$.

Although a clear influence of ethylene is seen on e.g. T_m , the linear viscoelastic behavior is not altered (Fig. 2).

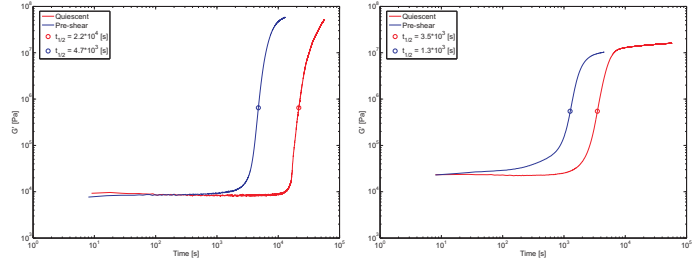


Figure 3 Crystallization behavior for HD234CF (left) and RD208CF (right). Red = without flow, blue = with flow (pre-shear: $\dot{\gamma} = 30\text{s}^{-1}$, $t_{flow} = 3\text{s}$), \circ : defines $t_{1/2}$.

Conclusions

As known from earlier studies [3], the crystallization process is accelerated when shear is applied, Fig. 3 (left). Crystallization of PP is also greatly influenced by the addition of ethylene when compared at the same undercooling, i.e. the half-time of crystallization ($t_{1/2}$) is decreased with almost 1 order of magnitude, Fig. 3.

Future work

A rheological classification of flow induced crystallization is proposed, which identifies different flow regimes [4]. The characteristics can be summarized in a plot (t_{flow} , $t_{1/2}$), see Fig. 4 [5]. How this graph is influenced by the addition of ethylene will be the subject of future research.

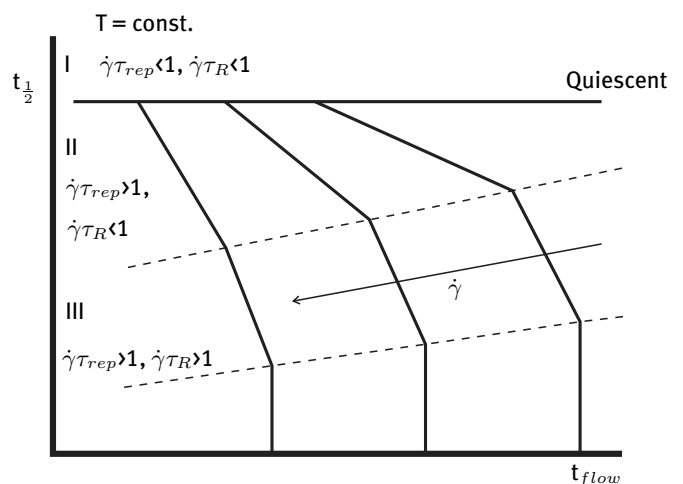


Figure 4 Rheological classification of flow induced crystallization.

References:

- [1] LAIHONEN, S. ET AL.: *Polymer* (1997) 38, 371
- [2] GAHLITNER, M. ET AL.: *J. Appl. Pol. Sci.* (2003) 95, 1073
- [3] VLEESHOUWERS, S. AND MEIJER H.E.H.: *Rheologica Acta* (1996) 35, 391
- [4] VAN MEERVELD, J. ET AL.: *Rheologica Acta* (2004) 44, 119
- [5] VEGA, J.F.. ET AL.: *in preparation* (2005)