

Processing-induced properties in glassy polymers : property development in miscible systems

Citation for published version (APA):

Engels, T. A. P., Breemen, van, L. C. A., Govaert, L. E., & Meijer, H. E. H. (2006). *Processing-induced properties in glassy polymers : property development in miscible systems*. Poster session presented at Mate Poster Award 2006 : 11th Annual Poster Contest.

Document status and date:

Published: 01/01/2006

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.

Processing-induced properties in glassy polymers: property development in miscible systems

Tom A.P. Engels, Lambert C.A. van Breemen, Leon E.Govaert and Han E.H. Meijer

Dutch Polymer Institute (DPI), Section Materials Technology (MaTe), Eindhoven University of Technology

Introduction

In previous work [1] we showed that the yield stress of an amorphous polymer, i.e. polycarbonate, can be quantitatively predicted directly from processing conditions. To do so, the kinetics of aging measured well below the glass transition temperature, T_g , are applied to the temperature history received during processing to give a prediction of the distribution of properties throughout a product. In this study we investigate the applicability of this modelling approach to other polymer systems.

Materials

For this purpose a commercially available miscible system of polycarbonate with polyester¹ has been selected, Xylex® (GE Plastics, Bergen op Zoom, the Netherlands). Three compositions are investigated: the pure polycarbonate (Lexan 141R) taken from [2]; a 50/50 weight percent blend of Lexan and Xylex (LX-50/50) and the pure Xylex (Xylex 8300). DMTA results are shown in the figure below.

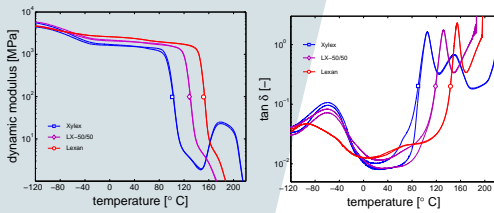


Figure 1 Dynamic modulus (left) and loss angle (right) of the materials used

Modelling approach

The kinetics of the yield stress are captured by the following set of equations:

$$a_T(T) = \exp\left(\frac{\Delta U_a}{R} \cdot \left(\frac{1}{T} - \frac{1}{T_{ref}}\right)\right) \quad (1)$$

$$\sigma_y(t) = c_0 + c_1 \cdot \log(t_{eff} + t_a) \quad (2)$$

$$t_{eff} = \int_0^t a_T^{-1}(T(\xi)) d\xi \quad (3)$$

The evolution of the yield stress is assumed to begin when the glass transition temperature, T_g , taken from the loss angle of the DMTA measurements, is passed.

Experimental

Tensile tests under constant strain rate are performed on samples taken both parallel and perpendicular to the flow direction during processing.

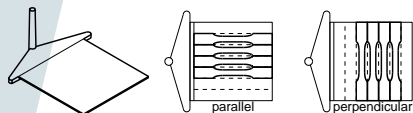


Figure 2 Injection molded part and tensile bars made thereof

¹ exact composition under patent protection

Results

Annealing experiments are performed from which mastercurves can be constructed using time-temperature-superposition, which can be described by Equation (2). Results are shown below.

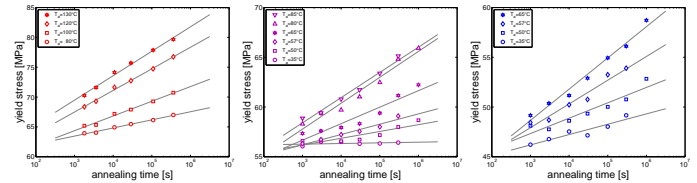


Figure 3 Annealing results for the pure Lexan (left); the LX-50/50 (middle) and the pure Xylex (right)

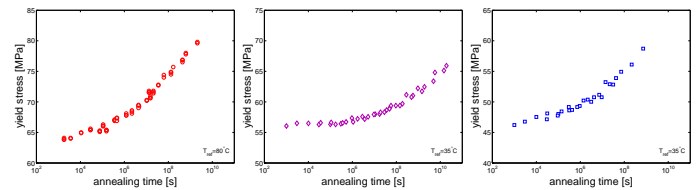


Figure 4 Corresponding mastercurves for the pure Lexan (left); the LX-50/50 (middle) and the pure Xylex (right)

Predictions of the yield stress versus mold temperature are shown below for all materials investigated. Moreover, modelling parameters showed to follow the rule of mixtures.

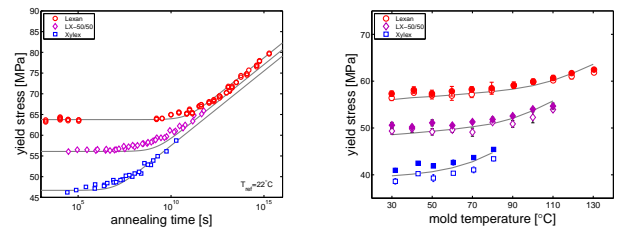


Figure 5 Combined mastercurves (left) and numerical vs. experimental results for the yield stresses vs. mold temperatures (right)

Conclusions

The modelling approach presented in previous work is shown to be applicable to different polymer systems. The experimental versus numerical results are in excellent agreement. The modelling approach follows the rule of mixtures.

References:

- [1] Govaert, L.E., Engels, T.A.P., Klompen, E.T.J., Peters, G.W.M., Meijer, H.E.H.: Processing induced properties of glassy polymers: Development of the yield stress in polycarbonate. (IPP, XX(2), 170-177, (2005))
- [2] Klompen, E.T.J., Engels, T.A.P., Govaert, L.E., Meijer, H.E.H.: Modelling of the post-yield response of glassy polymers: influence of thermomechanical history. (Macromolecules, 38(16), 6997-7008, (2005))