

Family matters

Citation for published version (APA):

Roozmond, P. C., Ma, Z., & Peters, G. W. M. (2012). *Family matters*. Poster session presented at Mate Poster Award 2012 : 17th Annual Poster Contest.

Document status and date:

Published: 01/01/2012

Document Version:

Accepted manuscript including changes made at the peer-review stage

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.

Family Matters

Peter C. Roozmond, Zhe Ma, Gerrit W.M. Peters



Introduction

The microstructure of semi-crystalline polymer products can be fascinating and extremely complex. For example, chains that have been extended by flow can act as nucleation sites for lamellae that grow radially outward. This morphology was aptly named shish-kebab (Fig 1).

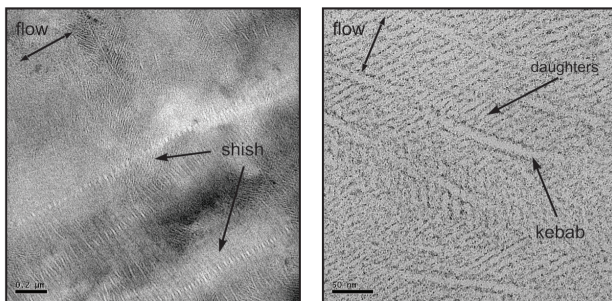


Figure 1: TEM picture of shish-kebab morphology¹

On the imperfections in the kebab, so-called daughter lamellae nucleate (Fig 2). The aim of this work is to investigate the crystallization kinetics of both parent (kebabs) and daughter lamellae.

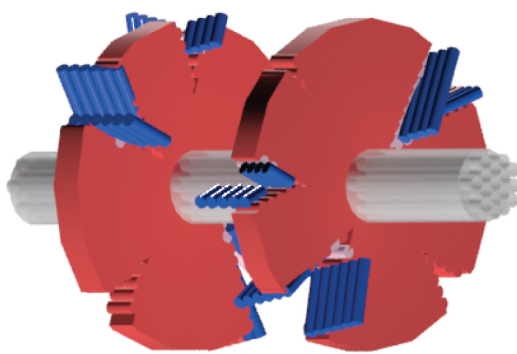


Figure 2: Schematic representation of shish-kebab structure with parents (red) and daughters (blue).

Experiments

Slit flow experiments combined with in-situ synchrotron x-ray experiments were performed at the ESRF, Grenoble.² Recently, a detector with an unprecedented sample rate of 30 Hz became available, allowing us to probe structure formation for extremely strong flows.

Simulations

A novel crystallization model was developed that considers parents as cylindrical domains growing radially outward and daughters nucleating homogeneously in this volume. Furthermore, crystal growth rate was taken time-dependent due to both deformation during flow and heat release during crystallization.

Results

Simulations and experimental results are compared in Fig 3. The area under 110 reflection peak is shown, which directly correlates to crystalline volume fraction.

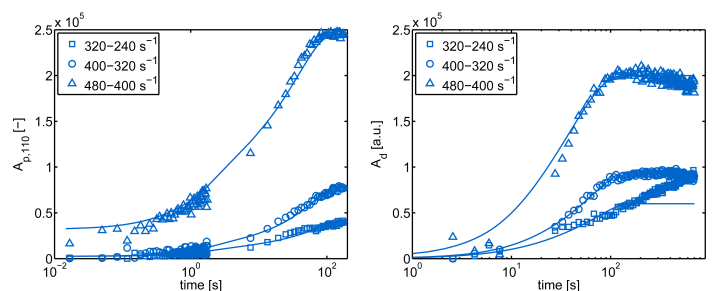


Figure 3: Area of 110 reflections in WAXD signal for parents (left) and daughters (right). Symbols show measurements, lines show simulations.

Conclusions

Simulations and experiments show excellent agreement, validating key assumptions in our modeling:

- Nucleation rate of daughter lamellae is proportional to the radius of parent crystals, indicating a nucleating mechanism as shown in Fig 2.
- Crystal growth rate of kebabs is increased during flow, which in strong flows is of paramount importance for the final crystal structure.
- Locally, temperature can increase by as much as 6 °C in a matter of seconds due to heat of crystallization.

References

- [1] T. van Erp. Ph.D. thesis, Eindhoven University of Technology (2012).
- [2] Z.Ma, et al. *Macromolecules* 45 (2012), 4216–4224.