

Review

of the Ph.D. Thesis of Esther Ramakers-van Dorp

entitled:

Process-Induced Thermal and Viscoelastic Behavior of Extrusion Blow Molded Parts

Presented Thesis deal with investigation of bulk as well as local process-dependent thermo-mechanical viscoelastic properties and corresponding morphologies of extrusion blow molding (EBM) parts. Majority of study is devoted to high-density polyethylene (HDPE) which is a polymer widely used in that manufacturing process and therefore data and results in Thesis might be attractive to a wide range of users both from academia and industry.

In order to be able to determine viscoelastic properties locally, new microindentation system was implemented to a conventional dynamic mechanical analyser (DMA). Furthermore, a model providing anisotropic coefficients of thermal expansion as a function of process dependent crystallinity was developed to predict thermal expansion and shrinkage along and perpendicular to the flow or extrusion direction which is insufficiently considered within EBM simulation tools until today.

The role of many technological parameters such as flow direction, draw ratio and mold temperature were proven to be statistically significant studying storage moduli of process-induced polymer structures. Results of microindentation method with DMA, namely complex viscoelastic moduli, for variety polymers such as HDPE, PBT, PC etc. were compared with available data from literature and it was found that coincide well.

Thesis is divided into several parts beginning with well-arranged State of Art followed by Aims of the Work, description of used methods and important results and finishing with Contribution to Science and Practice. These chapters are written in a very legible way, good English with the help of appropriately selected Figures and Tables. For Thesis author used 111 references. In whole this section very careful approach is evident and deep knowledge of topic introduced. I found only a few imperfections such as "... above Tg in the molten state" in page 33 at the bottom.

Most of the results are already published in 3 original scientific papers (included as Appendix A - C) and others in 2 prepared manuscripts submitted for publishing recently. Results are published in respected journals in the field of Polymer Science representing Q1 group according to Web of Science database and submitted manuscripts follow the same strategy. The last Appendix D is devoted to detailed derivation of a model describing thermal expansion behaviour of lamellar polymer structures.

Newly developed microindentation method implemented to DMA instrument, precise collection of data on samples prepared at well-defined conditions and implementation of model provides insight to anisotropic thermal expansion and corresponding structural changes within the polymer and leads to better understanding of processes present during EBM as well as to predict properties of manufactured products during their application. The effects of investigated processing parameters can be implemented in simulation software modelling thermo-mechanical behaviour of parts produced by extrusion blow molding.

In order to stimulate discussion I propose following questions:

- 1) Why only published papers are included in Annex?

- 2) Data in figure 35 and some others are fitted by quadratic models. Do regression parameters have some physical meaning?
- 3) In Chapter 3 methods used excluding TMA are described. Can you provide information about the preparation of test specimens for TMA and introduce operating conditions, please?

The comments and questions introduced above do not diminish the quality of the scientific level of Esther Ramakers-van Dorp and her contribution to the field of Process Engineering. On the basis of the reviewed Thesis and after successful defence I recommend her to be awarded as Philosophiae Doctor (Ph.D.).

Otrokovice, 26.11.2019

Assoc. Prof. Vladimír Pavlínek, Ph.D.

