Thermal modelling of the multi-stage heating system with variable boundary conditions in the wafer based precision glass moulding process

In the precision glass moulding process, the heat transfer and the resulting transient temperature distributions of the molten glass are of great importance because they significantly affect the productivity as well as the thermally induced residual stresses in the final product. Thermal modelling of the heating system in the glass moulding process considering detailed heating mechanisms therefore plays an important part in optimizing the heating system and the subsequent pressing stage in the lens manufacturing process. The current paper deals with three-dimensional transient thermal modelling of the multi-stage heating system in a wafer based glass moulding process. In order to investigate the importance of the radiation from the interior and surface of the glass, a simple finite volume code is developed to model one dimensional radiation–conduction heat transfer in the glass wafer for an extreme case with very high temperature difference considering temperature dependant thermal conductivity and heat capacity. Afterwards, by using three-dimensional FEM modelling along with a predefined experimental test, the equivalent glass–mould interface contact resistance is determined for two different pressures. Finally, the three-dimensional modelling of the multi-stage heating system in the wafer based glass moulding process is simulated with the FEM software ABAQUS for a particular industrial application for mobile phone camera lenses to obtain the temperature distribution in the glass wafer. In the numerical modelling, the interface boundary conditions for each heating stage are changed according to the determining heat transfer mechanism(s). Numerical results are compared with experimental data to show the validity of the numerical modelling. The obtained results show that the right thermal modelling is highly dependent on the proper choice of thermal boundary conditions in different stages according to the real physical phenomena behind the process.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Kaleido Technology ApS
Contributors: Sarhadi, A., Hattel, J. H., Hansen, H. N., Tutum, C. C., Lorenzen, L., Skovgaard, P. M.
Pages: 1771-1779
Publication date: 2012
Peer-reviewed: Yes

Publication information
Journal: Journal of Materials Processing Technology
Volume: 212
Issue number: 8
ISSN (Print): 0924-0136
Ratings:
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Scopus rating (2017): CiteScore 4.15 SJR 1.695 SNIP 2.678
Web of Science (2017): Impact factor 3.647
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 3.62 SJR 1.717 SNIP 2.646
Web of Science (2016): Impact factor 3.147
BFI (2015): BFI-level 1
Scopus rating (2015): CiteScore 2.9 SJR 1.385 SNIP 2.463
Web of Science (2015): Impact factor 2.359
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): CiteScore 3.43 SJR 2.112 SNIP 3.708
Web of Science (2014): Impact factor 2.236
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): CiteScore 2.87 SJR 1.702 SNIP 3.455
Web of Science (2013): Impact factor 2.041
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1