Foam injection molding of Styrene based polymers – Optimization of surface properties and processing behavior

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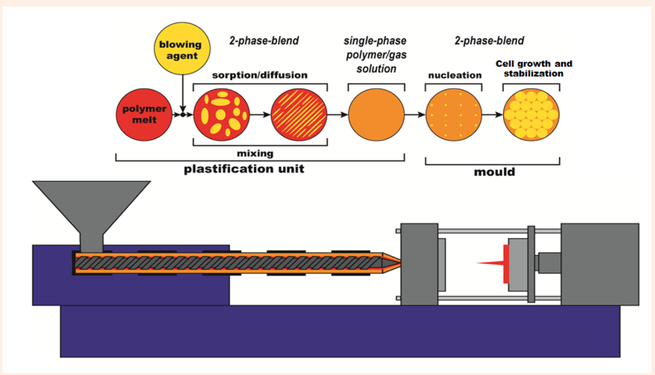
Abstract

The constant interest of the polymer processing industry in weight reduction and material savings lead to the processing of thermoplastic polymers by foam injection molding. Especially foamed polypropylene (PP) and polyamide (PA) are often used in automotive or household foam injection molded parts, as a weight saving in the order of magnitude of 10 % can be achieved in a drop in process. With further optimization and special mould technologies such as a 'breathing mould' concept, the density can be reduced up to 20 - 30 %. Within this work a wide range of styrene based themoplastic polymers was investigated according to their foaming behavior.

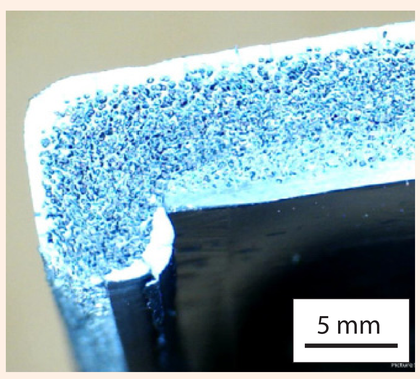
Motivation and Objectives

As styrene-based polymers are commonly known for their good surface appearance in injection molding, this study investigated the foamability of styrene-based thermoplastic polymers, such as acrylonitrile butadiene styrene (ABS), styrene acrylonitrile (SAN), polystyrene (PS), acrylonitrile styrene acrylate (ASA) and various other blends of polymers produced by Styrolution. The major aim is to position these polymers in visible and foamed automotive interior applications. This requires good surface appearance, but also good mechanical properties and a simple processing. Therefore special technologies like Variotherm® e.g. won't be considered in this work.

Processing: Foam injection moulding with chemical blowing agent



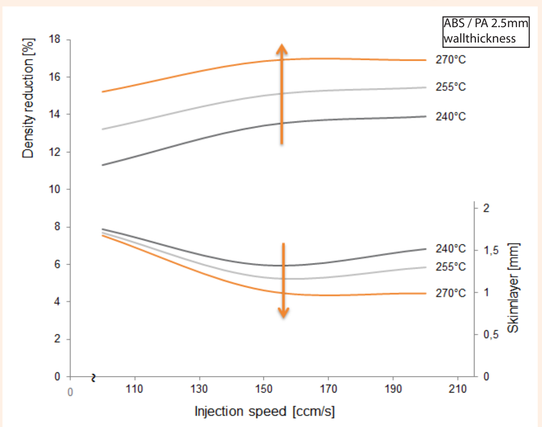
Process description foam injection moulding

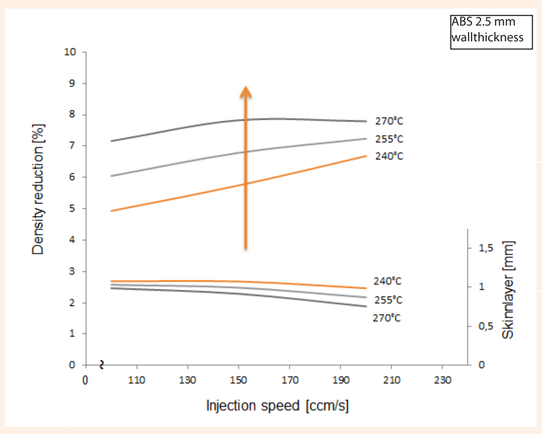


Foamed Luran S778T (mould opening)

- 450 to hydraulic injection molding machine with 60 mm screw (Engel DUO 1350H/ 1350M/ 450 Combi M)
- Size of specimen 200 x 400 mm wallthicknes 2.5 - 5 mm

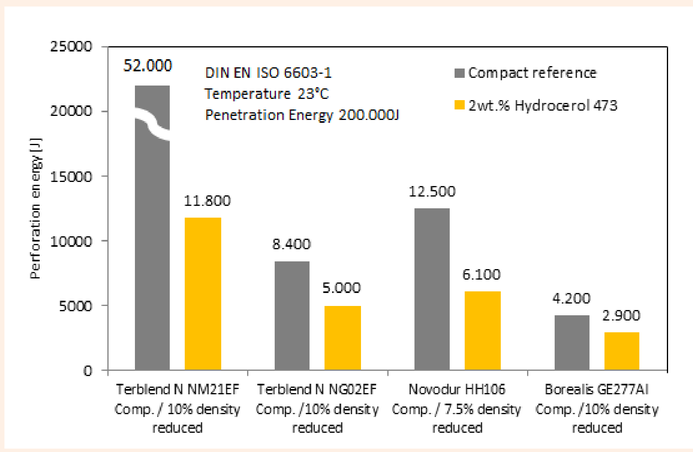
Optimizing processing conditions



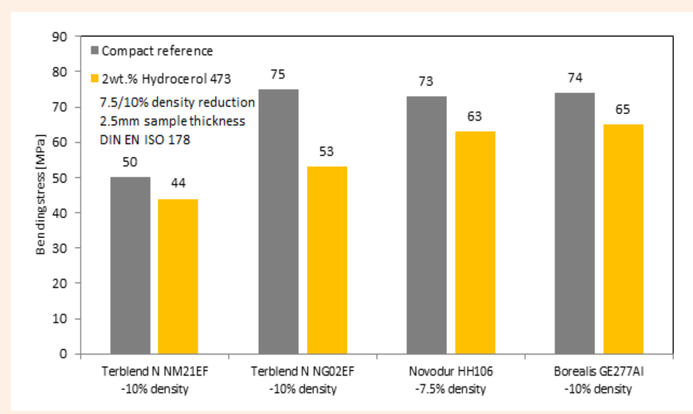


- The shown results refer to ABS & ABS-PA specimens foamed with 2 wt. % chemical foaming agent Hydrocerol 473
- The highest density reduction was found at high melt and mould temperatures
- The injection speed found to be ideal at ca. 165 ccm/s
- With PA/ABS, lower densities can be achieved compared to ABS
- With a breathing mould concept, very fine celled foams can be achieved with Luran S778T

Influence of FIM-Process on Mechanical properties



Falling dart test:
Foamed parts show reduced impact strength.
Nevertheless, the unreinforced styrene polymers show 50-300% higher impact energy absorption compared to a fiber reinforced polypropylene.



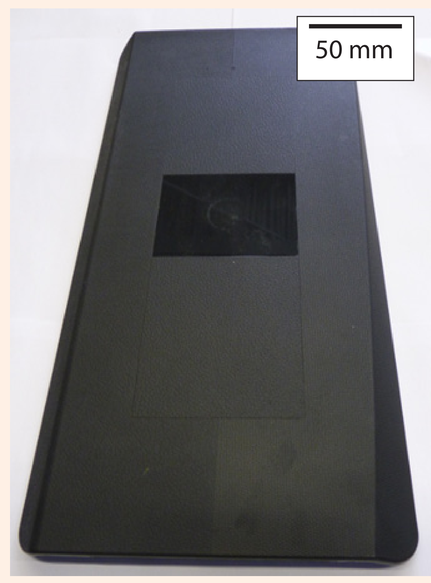
3-point-bending:
The density reduction also leads to a reduction of the bending strength. Compared to a fiber reinforced polypropylene, the unreinforced styrene polymers can achieve 70 - 80% of the bending strength.

Surface properties

Within the foaming trials especially the ASA and ABS/PA grades have been found to provide a good grained surface:

- Luran S778T (ASA)
- Terblend N NG02EF (ABS/PA)
- Terblend N NM21EF (ABS/PA)

The surface quality could be furtherly improved by use of a dynamic tool temperation from 130 °C to 50° C.



Terblend N NG02EF

Acknowledgement

Styrolution Group GmbH

References and Notes

[1] Altstädt, V.; Mantey, A. Thermoplast Schaumspritzgießen, Bayreuth, Germany, 2010.
[2] Eckardt, H.; Alex, K. Advances in Plastics Technology, 1, 40 - 49 1981.
[3] Spörrer, A. N. J.; Altstädt, V., Blowing agents and foaming processes, Frankfurt, Germany, 2007.

Conclusions

Injection moulding of styrene based thermoplastics with chemical foaming agent is possible. Significant density reductions are possible within a narrow processing window, especially with PA/ABS blends. Styrene polymers showed higher impact resistance compared to GF-PP, and grained surfaces could be achieved with high aesthetics."

Outlook

Within the material group there is a great potential for thick wall applications or the processing by special mould technologies, which will be investigated in the future.

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