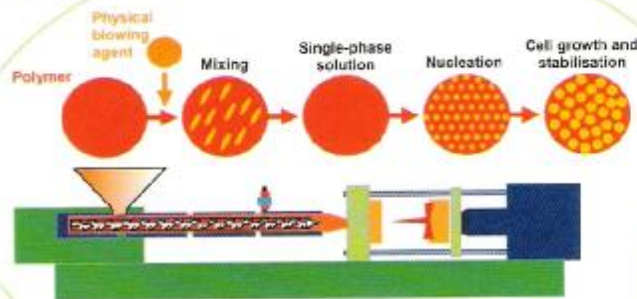


# Predictable Foam

## Foam Injection Moulding of Lightweight Parts

Foam injection moulded parts with 66 % density reduction: a) linear PP and b) branched PP (Photos: Neue Materialien Bayreuth)



Schematics of the physical foam injection moulding process



To study the physical foaming process Neue Materialien Bayreuth use a fully equipped injection-moulding machine (Engel ES1800/250HL) equipped with MuCell technology.

Neue Materialien Bayreuth GmbH currently develops the knowledge of correlating melt properties and resulting foam structures. The present research activities aim to overcome the trial and error experiments and predict the foamability. Therefore, it is important to know, that the foam structure can be optimised by using different PP grades, e.g. containing glass fibres or talc. Contrary to expectations, optimizing the foam injection moulding process does not mean increasing processing costs. Understanding the physics and material properties leads to well-defined integral foam structure of the injection-moulded parts.

Besides current aims towards weight reduction of compact injection-moulded components by decreasing the wall thickness, there is a trend towards injection-moulded thermoplastic foams for automotive applications. Such foamed components include improved thermal properties as well as enhanced specific mechanical properties such as bending stiffness and impact resistance.

The integral foam structures not only lead to a high bending stiffness of the part but also to a significant reduction of processing costs. This decrease in manufacturing costs is related to the possible reduction of the clamping force and cycle time.

The foaming process is made complicated by the specific conditions typically

encountered during injection-moulding such as high injection speeds and the temperature difference between melt and mould. For example, the pressure drop in the cavity leads to an almost immediate foaming of the melt.

### Melt properties are significant

As in other thermoplastic foaming processes the polymer melt properties have a significant influence on the resulting foam morphology. For instance, PP with a high melt strength as a result of polymer branching leads to enhanced density reduction as well as a small average cell size and a uniform cell size distribution in comparison to linear PP. The polymer melt strength rather than the drawability appears to dominate the cell growth and stabilisation process. A lower melt strength leads to a more inhomogeneous foam structure with large variations in the average cell diameter.

The common foam injection moulding process focuses on microcellular foam structures with about 20 % density reduction, whereas low-density parts can be achieved using the breathing mould technique. In this case the gas-laden polymer melt is injected into the cavity, where such cavity is filled nearly completely. After end of injection no parking pressure is applied and the clamping force is reduced almost completely so that a maximum part thickness during the expansion process can be reached. For example a mould with 2 mm wall thickness and opening the mould up to 6 mm causes a density reduction of about 66 %.

The higher melt strength of the branched polypropylene is reflected in a significantly more homogeneous cell size distribution,

as well as a higher cell density. However, the density reduction of the linear PP was coupled with a pronounced anisotropy of the cellular morphology.

### Limited temperature increase

The potential approach of further increasing the mould temperature in order to maximise the density reduction is limited in case of the linear PP. The insufficient melt strength leads to gas losses at higher mould temperatures and does not allow the stable formation of an integral foam at elevated mould temperatures. Additionally, in contrast to this behaviour, the high melt strength PP can be foamed at mould temperatures up to 75 °C which leads to a density reduction of about 85 %.

It should be highlighted that polymer melt properties are of great influence on the resulting foam morphology in foam injection-moulding process. Optimised melt properties can be exploited to reduce the anisotropy of the resulting cellular morphology. Furthermore, the maximum density reduction achievable using the breathing mould technique can be enhanced for such modified polymers by adapting the mould temperatures.

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