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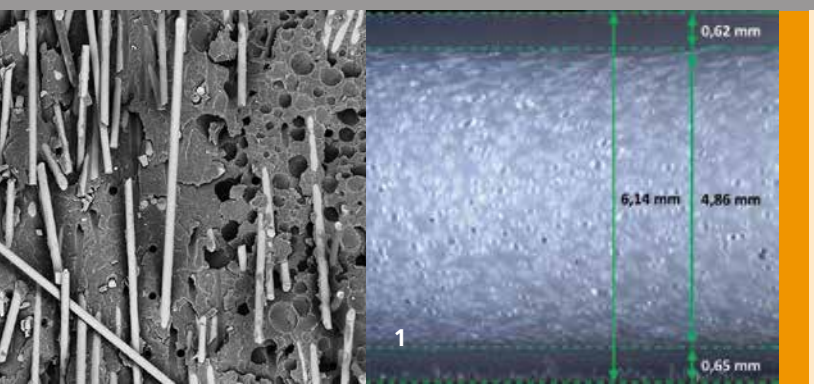

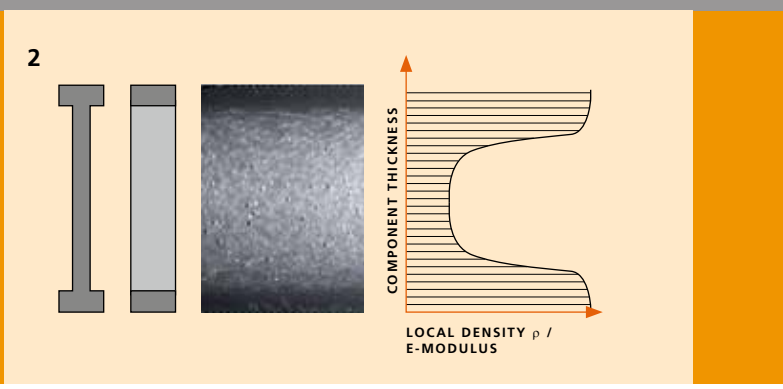

1 SEM micrograph of a microcellular structural foam (PP/LGF30) (left) and micrograph of a fine-celled structural foam (HMS-PP) (right).

2 Density and elastic modulus distribution (right) within a cross-section of a typical integral foam structure (center); simplified representation as a sandwich structure or double-T-beam (left).

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FOAM INJECTION MOLDING (FIM)

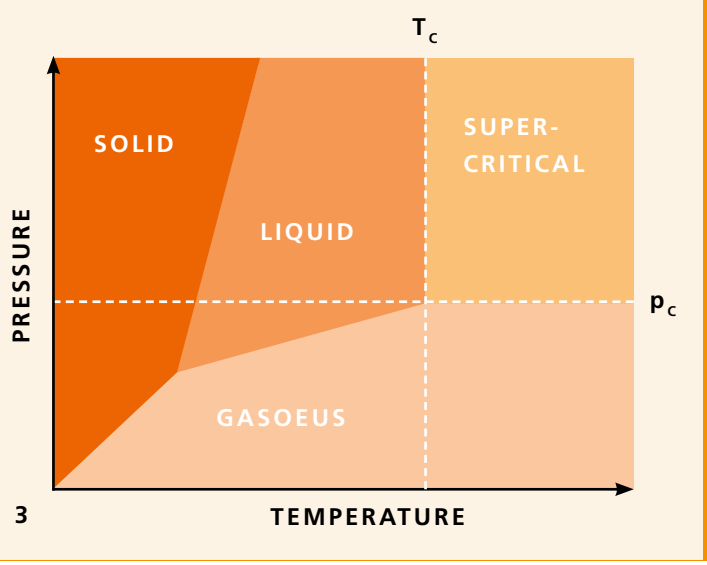
In foam injection molding (FIM), a blowing agent is added to the polymer melt which makes the molding compound expand after injection into the cavity. An integral foam structure is formed (2 center) with a foamed core and a compact skin layer. On examination of the cross-section, different local densities and elastic moduli can be observed (2 right). Foamed components can also be conceptualized as sandwich structures or double-T-beam (2 left). In principle foams can be created in an injection molding process using chemical or physical blowing agents. In some cases a combination of both types of blowing agents produces the best results.

Chemical blowing agents (CBAs)

Chemical blowing agents (powders or granules) are added to the base polymer during processing. The CBAs decompose above certain processing temperatures and give off gases which dissolve in the polymer melt. Beside these gases, solid decomposition residues are formed in this reaction, and their compatibility (e.g. color, corrosion, odor etc.) must be taken into account when the CBA is chosen.

Physical blowing agents (PBAs)

Unlike CBAs, physical blowing agents do not undergo a decomposition reaction. The PBA is introduced directly into the polymer melt during the foam molding process. A gas dosing station is needed to dissolve larger quantities of gas in the polymer. No decomposition residues are produced.



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Where a gas dosing station is used, the PBA can be brought into a supercritical state above certain temperatures (T_C) and pressures (p_C) (3). In this state gases show a particularly favorable solution and diffusion behavior.

Advantages FIM

Foam injection molding (FIM) has a variety of advantages over conventional injection molding:

- Weight and material savings
- Lightweight construction effect due to
  - Negative embossing ("Breathing Mold")
  - Reduction of wall thickness
- Increased dimensional stability due to
  - less residual stress
  - less warpage
- Injection from thin to thick
- Fewer sink marks
- Longer flow path / lower injection pressure
- Lower cavity pressure and clamping force
- Improved design freedom
  - Increased wall thickness without sink marks
  - Extreme jumps in wall thickness
- Shorter cooling times (cycle times)
  - No / shorter packing phase
  - Lower processing temperatures
  - Improved contact to cavity wall

Machine equipment

- MuCell with fiber preserving screw

Technical details		
Screw diameter	mm	80
L/D		25
Max. dosing volume	ccm	1,402
Max. injection pressure	bar	1,401
Max. injection speed	ccm/s	442
Max. cylinder temperature	°C	450
Clamping force	kN	7,000
Blowing agent		N_2, CO_2

- MuCell with standard screw

Technical details		
Screw diameter	mm	60
L/D		23
Max. dosing volume	ccm	792
Max. injection pressure	bar	2,057
Max. injection speed	ccm/s	848
Max. cylinder temperature	°C	450
Clamping force	kN	5,500
Blowing agent		N_2, CO_2

- LFT-D-foam

Technical details		
Screw diameter TSE	mm	40
L/D TSE		48
Diameter of injection screw	mm	105
Max. dosing volume	ccm	4,106
Max. injection pressure	bar	1,650
Max. injection speed	ccm/s	945
Max. cylinder temperature	°C	450
Clamping force	kN	7,000
Blowing agent		N_2, CO_2, CBA

- FIM using CBA

Technical details		
Max. dosing volume	ccm	4,106
Max. injection pressure	bar	1,650
Max. injection speed	ccm/s	945
Max. cylinder temperature	°C	450
Clamping force	kN	7,000
Blowing agent		N_2, CO_2, CBA

- Special processes
  - negative embossing ("breathing mold")
  - Dolphin-Prozess

Our offer

In this research area we offer the following services:

- Feasibility studies
- Material developments
- Benchmark tests
- Process developments
- Consultancy in process, mold and component design
- Construction of prototypes

3 PBAs such as CO_2 or N_2 reach a supercritical state above certain temperatures (T_C) and pressures (p_C).
4 Continuous-fiber-reinforced foam sandwich.