MuCell® Injection Molding: Unique Process Solutions for Light Weighting Plastic Parts

Brent Strawbridge, Vice President Sales

Lightweighting Custom eNewsletter
AGENDA

• Technology Overview
• MuCell Benefits and Design Rules
• Light Weighting Applications
• Unique Implementations
What is MuCell

- MuCell is a foaming technology
  Putting small cells into a thin wall (< 3mm) plastic parts
- Primarily using nitrogen as the foaming agent
  Sometimes carbon dioxide

MuCell Processes
TREXEL INC
**Basic Steps**

- Melt plastic prior to SCF injection
- Inject SCF during screw rotation
- Dissolve SCF into the polymer melt (single phase solution)

**MuCell® FOAMING**

Inject SCF → Dissolve SCF → Diffusion Complete
MuCell® FOAMING

Complete Cross-Section

Skin
Foam core
Skin
STRATEGIC BENEFITS with MuCell®

Weight Reduction via foaming /density
Cycle time/Capacity use

Lower tonnage/Increased cavitation
Reduces mold wear and tear

Time to market/Mold conformance
Weight Reduction via Design freedom

Geometry/Warpage
Substitute materials

Project requirements, goals

Long Term Reduction in Design and Manufacturing Costs
WEIGHT REDUCTION

• Typical weight reductions 8% to 12%
  • Key factors are:
    • Flow Length: Thickness Ratio
    • Flow Balance
    • Venting

• Weight reductions implementing design for MuCell
  • Up to 25%
    • Combination of density reduction and design changes
Designing for Function

• Weight reduction by designing part for function and not process
  – Wall thickness optimized for performance requirements not for packing requirements
    • Means thinner nominal wall and higher L/t ratios
      – Viscosity reduction due to SCF
      – Pack pressure is applied through foaming
    • How is this applied
      – 2.5 mm wall thickness at 150:1 (375 mm flow)
        » 8-10% density reduction
      – 2.0 mm wall at 375 mm flow (188:1 L/t)
        » 20% wt red (design) / 6–8% density red.
DESIGNING FOR MuCell®

- Filling from “thin to thick“

  - Recommended injection with Microcellular Foam
  - Injection in solid (with MuCell® still possible)

- Wall to rib ratio 1:1 possible

  - Conventional design
  - Microcellular design
# APPLIED DESIGN
## Interior Trim Volkswagen Touran

### Design Drivers:
- Energy absorption on impact
- No visible sink marks through PVC layer
- Deletion of “plug-in-module”

### Comparison of MuCell Design vs. Conventional Design

<table>
<thead>
<tr>
<th>Conventional Design:</th>
<th>MuCell-Design:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base thickness: 4.4 mm</td>
<td>Base thickness: 2.2 mm</td>
</tr>
<tr>
<td>Plug in module: 65 g</td>
<td>Rib thickness: 2.2 mm</td>
</tr>
</tbody>
</table>

- Equivalent or better energy absorption
- Approx. 40 % reduction in part weight
  - 20 % through wall thickness reduction
  - 14 % through deletion of “plug-in-module“
  - 6 % through density reduction
APPLIED DESIGN
Fan Shroud BMW

Design Drivers:

- Mechanical strength for hubs and stators
- Minimal wall thickness for air deflection
- Hub and stators 2 mm
- Reduced wall to 1 mm

Conventional Design:
- Base thickness: 2.0 mm

MuCell-Design:
- Hub & stators: 2.0 mm
- Air deflection: 1.0 mm

WEIGHT SAVINGS PER SHROUD: 410 GR / 0.9 LBS.
Designing for Function

- 15% weight reduction through wall thickness optimization

1.75 mm at top of front wall
1.55 mm at base of front wall
1.11 mm at tip of ribs
1.31 mm
1.49 mm at base
1.12 mm
1.22 mm
1.12 mm
1.2 mm

Gate Location
Margarine Tub Wall Thickness

Film thickness
0.025 mm

0.40 mm
0.56 mm
0.40 mm
0.36 mm
(includes film)
0.40 mm
(includes film)
LIGHTWEIGHTING APPLICATION

Mercedes – Benz Door Carrier

- Thinner general wall (1.8 mm to 2.0 mm)
- 30% weight reduction using expansion molding
- 1:1 wall to rib ratio
- > 50 % cycle time reduction (MuCell + Tandem-Mold)
- High dimensional stability
LIGHTWEIGHTING APPLICATION

HVAC Systems

Key MuCell Objectives
• Avoidance of warpage
• Machine size reduction
• Weight savings

Key MuCell Results
• 9-12% weight reduction
• Machine size reduction from 1000 tons to 600 tons
• Cycle times savings of 10-15%
• Improved product assembly
• Fewer mold corrections
INJECTION EXPANSION MOLDING

- Combining the MuCell process with a secondary expansion process

- Fill mold cavity close to solid weight with SCF laden polymer
- Increase mold cavity volume to allow for uniform expansion

6 mm
SUMMARY

• The MuCell process incorporates small amounts of physical foaming agent into the polymer melt to create a microcellular foam structure
  ➢ Reduction in material viscosity
  ➢ Gas expansion replaces the function of the pack/hold phase
    ☐ Reduced residual stress results in improved dimensions
    ☐ Improved contact with the mold surface shortens cooling

• This leads to part design for function not process
  ➢ Flow can be from thin to thick
  ➢ Wall thickness variations are more easily tolerated
  ➢ Larger part weight reduction then can be achieved from MuCell foaming alone

• The MuCell process can be combined with other processes to achieve very unique part and cost structures
THANK YOU!

Brent Strawbridge, V.P. Sales
b.strawbridge@trexel.com, Ph: 717-940-8662