Continuing Evolution of Low Density SMC for the Automotive Market

Presentation at SPE Automotive Composites Conference & Exhibition

Novi, MI

Presented by

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Market Manager- Automotive
Core Molding Technologies, Inc.

September 13, 2013
Low density SMC in current automotive. . .

Honda Ridgeline Spare Tire Pan – 1.3 sp.gr.
Supplied by Magna Exteriors & Interiors
Low density SMC in current automotive. . .

Lincoln MKS Decklid – 1.5 sp.gr.
Supplied by Continental Structural Plastics
Low density SMC in current automotive... 

Fiat 500e Battery Cover – 1.43 sp.gr. 
Supplied by Core Molding Technologies
Low density SMC in current automotive... 

- Class A Applications
- Structural and Robust Applications
- Dimensionally Stable
- Chemically Resistant
- Low permeability
- Self-Extinguishing
- Electric Insulator
Background on SMC & automotive

1945  First automobile developed with a fiberglass composite body
1953  MFG launches the Corvette fiberglass body
1954  Thunderbird has a composite hardtop
1960  Sheet molding compound (SMC) invented
1968  Chrysler station wagon introduced with an SMC rear air deflector
1970  Pontiac Tempest one-piece grille opening showcases SMC’s ability to consolidate parts and reduce weight
1972  Corvette body panels are converted to SMC
1981  Composite leaf spring introduced on the Corvette
1987  Mercury tracer bumper beam becomes the first SMC structural part on an automobile in North America
1996  Ford introduces SMC front-end system on Taurus and Sable
1998  Ford introduces SMC underbody shields on Crown Victoria
2003  General Motors introduces Cadillac XLR with SMC intensive design (hood, decklid, pillars, etc.)
2008  Dodge introduces Journey with SMC liftgate

Sources: Automotive Composites Alliance website; Plastics Technology, Oct. 2005
My only CAFE slide...
The point is... We have to do **more** for the Automotive industry!
It is worth mentioning:

- SMC reinforced with chopped carbon fiber will likely be an important material in future automotive design.

- There are still many unanswered questions about economics and processing limitations which need to be explored.

- There is still more to be gained from traditional glass reinforced SMC

- My focus today is on SMC reinforced with glass fibers.
Typical “standard density” SMC has three components*

<table>
<thead>
<tr>
<th>Component</th>
<th>Density (g/cm³)</th>
<th>Composition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glass</td>
<td>2.6</td>
<td>30%</td>
</tr>
<tr>
<td>Resin</td>
<td>1.0</td>
<td>25%</td>
</tr>
<tr>
<td>Filler</td>
<td>2.7</td>
<td>45%</td>
</tr>
</tbody>
</table>

*Densities and composition represent a “generic” SMC for illustrative purposes. In practice, density of individual components varies, and SMC compositions can differ markedly from the generic mix shown.
Resin-to-Glass Adhesion

- In a standard density formulation, glass and filler pack together more tightly, therefore the resin has less surface area to coat.

- In a low density formulation, glass and filler have greater spacing, and the resin must coat a greater surface area. If there is an ineffective interface with resin the resulting matrix is weaker.
Low density challenges...

Water absorption

• Standard density SMC’s usually average less than 0.5% water absorption.

• Low density SMC’s have been historically challenged to go less than 1% water absorption, due to their more porous structure.

• At 1% or greater dimensional stability is difficult
Low density challenges...

**Finishing and paint-ability**

- A traditional approach to achieve lower densities has been the addition of hollow glass microspheres to SMC formulations.

- Sanding and fabrication after molding can create pits in part surfaces, where microspheres are cracked or sheared open.

before sanding

after sanding
Our challenge...

- Further reductions in density
- Overcome glass-to-resin adhesion challenges
- Create a formulation with less than 1% water absorption
- Maintain a paintable surface finish – suitable for visible applications
- Created within a density neutral cost structure

Standard SMC (1.9 sp.gr.)

Featherlite™ SMC (1.43 sp.gr.)

New SMC (?? sp.gr.)
How low can we go???

Densities in gm/cm³

<table>
<thead>
<tr>
<th>Density</th>
<th>Material</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.8</td>
<td>Aluminum</td>
</tr>
<tr>
<td>1.9</td>
<td>Standard SMC</td>
</tr>
<tr>
<td>1.8</td>
<td>Magnesium</td>
</tr>
<tr>
<td>1.6</td>
<td>Carbon Fiber</td>
</tr>
<tr>
<td>1.4</td>
<td>Core Featherlite™ SMC</td>
</tr>
<tr>
<td>1.1</td>
<td>Nylon</td>
</tr>
<tr>
<td>1.1</td>
<td>ABS</td>
</tr>
<tr>
<td>1.0</td>
<td>Water</td>
</tr>
</tbody>
</table>
Chosen Approach

Guidelines for development

• Re-examine microspheres
  - New technologies made available for fabrication

• Focus on processing parameters of filler systems
  - Overcome detrimental effect of high sphere loading

• Reevaluate the sequence and interaction in compounding
  - Known to have dramatic effect on performance
Hollow Glass Microspheres

- Thin wall Soda-Lime Borosilicate
- 17-20 μm diameter
- Density of 0.46 gm/cc

Recent breakthroughs…

Increased
Crush Strength
-Mixing
-Fabrication

Decreased
Diameter
Cost
"I think you should be more explicit here in step two."
### Property Table

<table>
<thead>
<tr>
<th>Property</th>
<th>Std. SMC</th>
<th>Featherlite™</th>
<th><strong>placeholder</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Specific Gravity</td>
<td>1.91 gm/cm³</td>
<td>1.43 gm/cm³</td>
<td>1.18 gm/cm³</td>
</tr>
<tr>
<td>Glass Reinforcement</td>
<td>28%</td>
<td>28%</td>
<td>36%</td>
</tr>
<tr>
<td>Tensile Strength</td>
<td>90 Mpa</td>
<td>76 Mpa</td>
<td>70 Mpa</td>
</tr>
<tr>
<td>Flex Strength</td>
<td>190 Mpa</td>
<td>165 Mpa</td>
<td>165 MPa</td>
</tr>
<tr>
<td>Flex Modulus</td>
<td>11,800 Mpa</td>
<td>8,500 Mpa</td>
<td>8,700 Mpa</td>
</tr>
<tr>
<td>Water Absorption</td>
<td>&lt; 0.50%</td>
<td>&lt; 0.50%</td>
<td>&lt; 0.40%</td>
</tr>
<tr>
<td>Izod Impact Strength</td>
<td>940 J/m</td>
<td>900 J/m</td>
<td>810 J/m</td>
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<tr>
<td>ALSA Surface Index</td>
<td>55-65</td>
<td>95-105</td>
<td>90-100</td>
</tr>
</tbody>
</table>
Conclusions & Lessons Learned

1. Achieved another 18% reduced density over previous best
   -1.18 gm/cm³ is lowest commercially available value for SMC

2. Overcame detrimental impact to physical properties
   -70% improvement in resin-to-glass strength over previous LD formulations

3. New microsphere technology provides significant advantage
   -Stronger and smaller spheres enable new processing/performance

4. Are we reaching the density limit on glass reinforced SMC?
Core Molding Technologies

Creative • Reliable • Composites

founded in 1996 • stock symbol CMT

Composite Capabilities

<table>
<thead>
<tr>
<th>• Compression Molding SMC &amp; LFTP</th>
<th>• Resin Transfer Molding (RTM)</th>
<th>• Vacuum Assisted Resin Infusion Molding (V-RIM®)</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Hand Spray Up (HSU)</td>
<td>• Hand Lay Up (HLU)</td>
<td>• Reaction Injection Molding (RIM)</td>
</tr>
<tr>
<td>• Compounding</td>
<td>• Design &amp; CAD Optimization</td>
<td>• Machining &amp; Assembly</td>
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About us

<table>
<thead>
<tr>
<th>Location</th>
<th>Size</th>
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<tbody>
<tr>
<td>Columbus, OH</td>
<td>331,000 ft²</td>
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<tr>
<td>Cincinnati, OH</td>
<td>107,000 ft²</td>
</tr>
<tr>
<td>Gaffney, SC</td>
<td>111,000 ft²</td>
</tr>
<tr>
<td>Matamoros, MX</td>
<td>437,000 ft²</td>
</tr>
</tbody>
</table>
Thank You!

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