Past and Recent Advances in Low Density SMC for Automotive Class A and Structural Applications

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AOC TECHNICAL SERVICE SPECIALIST | 2/17/17
Low Density SMC

OUTLINE

- Class A 1.2 SPG Low Density
  - Development of Current Low Density Class A SMC
  - Properties of Low Density Class A SMC
  - Status of Current Low Density Class A SMC
  - Current Usage

- Next Steps
  - High Mechanical Property Class A 1.25 SPG
  - 1.0 Specific Gravity Class A

- Summary
Development of Current Low Density Class A SMC

• Low Density SMC mostly used in non-appearance applications
  • Heat shields
  • Body panel supports; etc.

• New Low Density Class A Body Panels
  • Requirement is for a 1.2 specific gravity or lower
  • Surface aesthetics comparable to standard density (1.9 SPG) Class A SMC
  • Physical Properties
    • Must meet current low density SMC specifications
    • Better if they could meet the standard density SMC specifications
Development of Current Low Density Class A SMC

- Achieving both required mechanical properties and Class A surface aesthetics has been a challenge.

- Now low density systems of 1.2 specific gravity offer comparable performance in both respects to standard density (1.9) Class A systems at up to a 46% weight savings vs steel.
Development of Current Low Density Class A SMC

- Demand for Better Fuel Efficiency
  - Improvement of mileage
  - Lower carbon emissions

- High Strength Steel
  - Low cost/readily available
  - Stampable - Fits the existing infrastructure
  - At the point of diminishing returns in terms of weight reduction

- Aluminum
  - Lighter but more expensive than steel
  - Stampable
  - Requires major re-tooling of the forming & assembly processes

- Carbon Fiber
  - Offers excellent strength/weight ratios
  - Slow process / High cost raw materials
  - Limited carbon fiber availability
  - Di-electric & repair concerns
  - Likely (future) material of construction
Properties of Current Class A 1.2 Low Density
## Surface Properties

<table>
<thead>
<tr>
<th>Description</th>
<th>LORIA</th>
<th>OP</th>
<th>DOI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Typical Structural LD</td>
<td>104</td>
<td>6.4</td>
<td>70</td>
</tr>
<tr>
<td>Standard Density Class A 1.9 SPG</td>
<td>87</td>
<td>9.3</td>
<td>94</td>
</tr>
<tr>
<td>Current Class A Low Density 1.2 SPG</td>
<td>50</td>
<td>9.6</td>
<td>97</td>
</tr>
</tbody>
</table>
Mechanical Properties
Tensile Strength (MPa)

<table>
<thead>
<tr>
<th></th>
<th>Minimum Specification</th>
<th>Typical Structural LD</th>
<th>Current LD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tensile Strength (MPa)</td>
<td>40</td>
<td>70</td>
<td>80</td>
</tr>
</tbody>
</table>

Ford LD Specification WSS-M3D188-A
## Mechanical Properties

### Tensile Modulus (GPa)

<table>
<thead>
<tr>
<th></th>
<th>Minimum Specification</th>
<th>Typical Structural LD</th>
<th>Current LD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Value</td>
<td>6.2</td>
<td>7.0</td>
<td>8.0</td>
</tr>
</tbody>
</table>

*Ford LD Specification WSS-M3D188-A*
Mechanical Properties

Tensile Elongation (%)
Mechanical Properties
Flexural Strength: (MPa)

![Bar chart showing flexural strength (MPa) for Minimum Specification, Typical Structural LD, and Current LD.](image)
Mechanical Properties

Flexural Modulus: (MPa)

Minimum Specification: 5 MPa
Typical Structural LD: 7 MPa
Current LD: 8 MPa

Ford LD Specification WSS-M3D188-A
## Other Properties

<table>
<thead>
<tr>
<th>Structural Low Density Properties*</th>
<th>Typical Structural LD</th>
<th>Current 1.2 SPG Class A LD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specific Gravity (1.0-1.4) (ISO 1183, Method A)</td>
<td>1.19</td>
<td>1.19</td>
</tr>
<tr>
<td>Water Absorption (max 1.3%) No blisters</td>
<td>1.14</td>
<td>0.58</td>
</tr>
<tr>
<td>Glass Fiber Content (33-45%) By weight</td>
<td>38</td>
<td>38</td>
</tr>
</tbody>
</table>

*Ford LD Specification WSS-M3D188-A
Status of the Current Class A 1.2 Low Density
Current Usage of Class A Low Density SMC

• This material is currently in production on the GM C7 Corvette and has been so for over a year.

• It has been pointed out that the material processes very well.

• Molding of the low density 1.2 SPG Class A goes very well with minimal if any paint pops.

• Customers are very happy with the overall performance of the system.
Status of Class A Low Density SMC

- *It has now been approved at two other OEMS.*

- *The low density 1.2 SPG Class A SMC is targeted for a new production application with a major OEM later this year.*
Opportunities for Low Density SMC
Opportunities

• Explore the boundaries of the current 1.2 SPG system.
  
  • Current progress on improving the mechanical properties of the current system.

  • Studies are in progress to analyze the effects of lowering the specific gravity for Class A to 1.0 SPG.
Higher Mechanical Property Class A LD SMC Progress

• Modifications to the 1.2 SPG system has yielded:
  • A Higher strength Class A SMC
  • System was ELPO bake tested and passed.
  • Good dimensional control – can be used in an “inner” structural application as well.
  • SPG now 1.25
Higher Mechanical Property Class A LD SMC Progress

• High Temperature Performance

  o A key point to keep in mind is the concern for the loss of tensile modulus during high temperature painting.

  o Even though tensile modulus is important at room temperature, it is also important through high temperature painting cycles.
Higher Mechanical Property Low Density
Tensile Strength (MPa)
Higher Mechanical Property Low Density Tensile Modulus (GPa)
Higher Mechanical Property Low Density Flex Strength (MPa)

![Graph showing flex strength at different temperatures for different LD types.](image-url)
Higher Mechanical Property Low Density Flex Modulus (GPa)
## Surface Properties

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</thead>
<tbody>
<tr>
<td>Typical Structural LD</td>
<td>104</td>
<td>6.4</td>
<td>70</td>
</tr>
<tr>
<td>Current Low Density Class A – 1.2 SPG</td>
<td>50</td>
<td>9.6</td>
<td>97</td>
</tr>
<tr>
<td>Higher Property Class A Low Density – 1.25 SPG</td>
<td>56</td>
<td>9.3</td>
<td>94</td>
</tr>
</tbody>
</table>
## Mechanical Properties

<table>
<thead>
<tr>
<th>Structural Low Density Properties*</th>
<th>Higher Property Class A LD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specific Gravity (1.0-1.4)</td>
<td>1.28</td>
</tr>
<tr>
<td>Water Absorption, max. 1.3% no blisters</td>
<td>0.6</td>
</tr>
<tr>
<td>Glass Fiber Content (33-45%) by weight</td>
<td>47.7</td>
</tr>
</tbody>
</table>

*Ford LD Specification WSS-M3D188-A
# Ultra Low Density Class A: Surface Characteristics

<table>
<thead>
<tr>
<th>Description</th>
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<th>O P</th>
<th>DOI</th>
</tr>
</thead>
<tbody>
<tr>
<td>ULD Class A</td>
<td>51</td>
<td>9.5</td>
<td>96</td>
</tr>
<tr>
<td>Latest ULD Class A</td>
<td>57</td>
<td>9.3</td>
<td>95</td>
</tr>
<tr>
<td>Current 1.2 SPG LD Class A</td>
<td>50</td>
<td>9.6</td>
<td>97</td>
</tr>
</tbody>
</table>
# Ultra Low Density Class A:
Mechanical Properties

<table>
<thead>
<tr>
<th>Structural Low Density Properties*</th>
<th>ULD Class A</th>
<th>Latest ULD Class A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tensile Strength at Break, min. 42 MPa</td>
<td>50</td>
<td>55</td>
</tr>
<tr>
<td>Tensile Modulus at Break, min. 6.8 MPa</td>
<td>6.5</td>
<td>6.2</td>
</tr>
<tr>
<td>Tensile Elongation, min. 0.8%</td>
<td>1.08</td>
<td>1.19</td>
</tr>
<tr>
<td>Flexural Strength, min. 115 MPa</td>
<td>109</td>
<td>n/a</td>
</tr>
<tr>
<td>Flexural Modulus, min. 5.2 GPa</td>
<td>6.0</td>
<td>n/a</td>
</tr>
</tbody>
</table>

*Ford LD Specification WSS-M3D188-A
# Ultra Low Density Class A: Mechanical and Physical Properties

<table>
<thead>
<tr>
<th>Structural Low Density Properties*</th>
<th>ULD Class A</th>
<th>Latest ULD Class A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specific Gravity (1.0-1.4)</td>
<td>0.99</td>
<td>0.98</td>
</tr>
<tr>
<td>Water Absorption, max. 1.3% no blisters</td>
<td>0.92</td>
<td>0.91</td>
</tr>
<tr>
<td>Glass Fiber Content (33-45%) by weight</td>
<td>38.4</td>
<td>39.4</td>
</tr>
</tbody>
</table>

*Ford LD Specification WSS-M3D188-A
Low Density SMC: Summary
Summary

• The AOC Low Density resin systems displayed –
  • Mechanical Property results that were favorable to the Ford Low Density Structural Specification for Mechanical Properties WSS-M3D188-A
  • Some were superior to the surface characteristics shown for a standard density Class A system.

• AOC now has a Class A resin system that is currently in production on the Chevrolet Corvette. The Class A system has also been qualified at Ford and Chrysler. Other OEMS are in the process of qualifying the Class A system as well.
Summary

• We believe that the work done affords automotive OEMs the opportunity to immediately reduce the weights of Class “A” closure panels without having to change their manufacturing and assembly processes.

• These materials provide a cost competitive alternative to aluminum and carbon fiber composites and are readily available.

• Additional benefits include: greater design freedom, parts consolidation, lower tooling cost, dent/damage & corrosion resistance and excellent surface aesthetics.

• We are currently focusing on improving the Ultra Low Density versions for mechanical properties.
Thank You

Questions?