INEOS Next Generation
Arotran™ Structural Technology
ACCE Conference 2019
Outline

- Sheet Molding Compound (SMC) Overview
- Development Objectives
- Next Generation Arotran™ Structural Technology (NGAST) for Battery Enclosures
- Next Generation Arotran™ Structural Technology (NGAST) for Truck Boxes
Background
History Of INEOS Composites

- Our transportation brands, like Arotran™ and Derakane™, are used for long list of automotive and heavy truck BMC and SMC applications

- Part of the INEOS family

- Constantly creating new resin systems and families to meet the industry’s newest applications, like battery enclosures and truck boxes
What Is SMC?
Benefits - Why Do We Use SMC?

- SMC’s Advantages in Automotive Applications = Cost and Flexibility
  - Lower tooling cost when compared to aluminum or steel
  - Lower scrap rates over other composite techniques
  - Corrosion resistant
  - Fast button to button cycle times
  - Excellent strength to weight ratio
    - Lighter weight parts as compared to metals
  - Ability to consolidate multiple parts
  - Increased part complexity possible ex. - difficult compound curves
Research Goal

- Develop Advanced Resin Systems for Battery Enclosures and Truck Box Applications
  - That have vinyl ester like high performance mechanical properties without the vinyl ester cost
  - That have the ability to accommodate a wide range of reinforcement, additives, and fillers
  - That can be used for high strength, light weight, and weatherable applications
  - That retain all the traditional SMC benefits
Next Generation Arotran™ Structural Technology (NGAST) For Battery Enclosures
Advanced Resin System - Applications-Battery Enclosures

- Electric Vehicle Battery enclosures
  - Emerging market, but composites appear to be the material of choice
    - Electrical insulation
    - Flame resistant
    - Light weight

- INEOS is working on developing resin systems for highly filled applications for flame resistances and low part specific gravity

Source: CSP
V0 Testing of Experimental Battery Enclosure Resin

<table>
<thead>
<tr>
<th>Base Resin</th>
<th>SMC Panel Testing</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Parts Flame Resistant Filler</td>
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<tr>
<td>Experimental</td>
<td>100</td>
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<tr>
<td>Experimental</td>
<td>150</td>
</tr>
<tr>
<td>Industry Standard</td>
<td>100</td>
</tr>
<tr>
<td>Industry Standard</td>
<td>150</td>
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</tbody>
</table>

- Battery Enclosures require a large addition of dense filler to meet flame requirements
- NGAST technology allows for this to be offset by adding low-density filler, which would traditionally not be processable
Viscosity Testing of Experimental Battery Enclosure Resin

- These high filler levels are achievable by designing a resin system that can incorporate a large amounts of solids.

- When the paste viscosity reaches a certain maximum, it is not processable with traditional SMC lines.
Next Generation Arotran™ Structural Technology (NGAST) For Truck Boxes
Advanced Resin System - Applications - Pickup Bed

- **Composite Truck Boxes**
  - Lighter weight than their metal counterparts
  - Provide design freedom and part consolidation
  - Can be painted or use weatherable in-mold color
    - In-mold color provides mar resistance and manufacturing advantages

- **INEOS has developed two new advanced resins for this market**
  - Arotan™ 502 – painted applications
  - Arotan™ 808 – in-mold color applications

Source: CSP
### Arotran™ 502 - SMC Benchmarking vs Commercial Products

- **For painted truck box applications**
- **Provides higher properties than a current vinyl ester hybrid based truck box in SMC mechanical testing**
- **Over 22 % improvements in strength, modest gains in modulus**

<table>
<thead>
<tr>
<th>1.55 Specific Gravity Truck Box Testing</th>
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<tbody>
<tr>
<td>Flexural Strength</td>
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<td>122</td>
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</tbody>
</table>

- Vinyl Ester Hybrid Resin
- Arotran 502
**Arotran™ 808 for High Strength, Mid Density Applications**

- In-mold color applications
- Control is not processable at 1.55 specific gravity and 37% fiber volume fraction
- Arotran™ 808 can process higher amounts of solid materials
- 1.52 SG part represents an estimated 35% weight savings over metal
Standard Density, High Strength Truck Boxes

- Alternatively, larger amounts of fiber reinforcement for increased mechanical performance can be used

- This allows for more durable or thinner and lighter parts
  - Estimated 38% weight savings over metal

<table>
<thead>
<tr>
<th>Base Resin</th>
<th>Part Specific Gravity</th>
<th>Fiber Glass (Volume %)</th>
<th>Engineered Filler (Volume %)</th>
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<tbody>
<tr>
<td>Control</td>
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<td>37.5</td>
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<tr>
<td>Arotran 808-1</td>
<td>1.64</td>
<td>41.4</td>
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<td>Arotran 808-3</td>
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<table>
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<th>Normalized Tensile Strength</th>
<th>Normalized Tensile Modulus</th>
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<tr>
<td>Arotran 808-3</td>
<td>128</td>
<td>112</td>
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</table>

- Estimated 38% weight savings over metal
Accelerated weathering testing is a key parameter for in-mold color resins. Arotran™ 808 can exceed or meet the current industry standard in performance.
Conclusions

- INEOS has developed a new series of resins designed for battery enclosures and truck box applications
  - Arotran™ 502 for structural systems and Arotran™ 808 for in-mold color applications

- They deliver vinyl ester like high performance properties at a lower cost

- They provide significant formulation advantages, like the ability to add high amounts of filler at high volume fractions of reinforcement

- While retaining the traditional advantages of SMC
Acknowledgements

- **Collaboration Partners**
  - IDI Composites International
  - Continental Structural Plastics

- **INEOS SMC Development Team**
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