New developments for mass production of Thermoset automotive composites

Jean Philippe Sauvaget
Business Development Director Automotive
Hexion is a **Specialty Chemicals Company** with a leading position in the development and production of **systems, products and services** for **Weight reduction** and **Coatings** in the **Energy, Transportation and Construction markets**.

---

**…at a glance**
- $4.1 billion
- 5100 people
- 65 production sites

**Technology Platforms**
- Epoxy
- Phenolics
- Versatic™ Acids
- Formaldehyde

**Automotive**
- Structural and Exterior Composites
- Under The Hood parts
- Suspension components
- Brake pads
- E-Coat to Clear Coat Coatings
Hexion has global leadership positions across a broad range of technologies and industries.

**Leading Market Positions**

- **Epoxy Resins**
  - Global

- **Phenolic Specialty Resins**
  - Global

- **Versatic™ Acids & Derivatives**
  - Global

- **Forest Product Resins**
  - Global

- **Oilfield Proppant Resins**
  - Global

**Customer Base**

LEADING MARKET POSITIONS IN MORE THAN 80% OF ITS REVENUE BASE

GALM Europe 2017
Hexion continues investing in innovation and collaboration with Automotive customers

Duisburg, Germany
London, ON, Canada
St. Avold, France
Hakusan, Japan
R&D facility, Germany
Innovation and collaboration drives composite component adoption

- Partnerships Through Value Chain
- Materials
  - Epoxy Resins
  - Phenolic Engineering Thermosets
- Optimum Performance and Cost
- Process Capability For OEM Industrialization

WINNER 2014
WINNER 2015
Composites technology innovations offer the industry light-weighting at high build rates
Carbon Fibre Reinforced Plastics (CFRP) has the highest weight reduction potential.


**Typical cost build-up**

- **50% material**
  - 40 - 45% carbon fiber
  - 5 - 10% resin

- **50% processing**
  - Quicker curing matrix
  - Process optimization
  - Near-end-contoured preforms
  - Automation

<table>
<thead>
<tr>
<th>Material</th>
<th>Part weight (% of steel)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steel</td>
<td>100</td>
</tr>
<tr>
<td>HSS</td>
<td>80</td>
</tr>
<tr>
<td>Plastics</td>
<td>80</td>
</tr>
<tr>
<td>Aluminum</td>
<td>60</td>
</tr>
<tr>
<td>Carbon fiber</td>
<td>50</td>
</tr>
</tbody>
</table>
Advanced Thermoset technology shifts in support of higher volume and/or performance

- prepreg
- Epikote™ Resin Prepreg
- Epikote™ Resin RTM
- Epikote™ Resin LCM
- Thermoplastics
- SMC

GALM Europe 2017
Epikote™ TRAC Prepreg
Molding Example of Complex Structural Component

90 seconds Demolding time
## RTM technology allows fast production of highly complex structural parts

<table>
<thead>
<tr>
<th>Process</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lay-up binder stabilized fabric</td>
<td></td>
</tr>
<tr>
<td>Heating and some pressure</td>
<td></td>
</tr>
<tr>
<td>Mould closing and resin injection</td>
<td></td>
</tr>
<tr>
<td>Curing</td>
<td></td>
</tr>
<tr>
<td>Opening and de-moulding</td>
<td></td>
</tr>
</tbody>
</table>

RTM (Resin Transfer Moulding) technology allows for the fast production of highly complex structural parts. The process involves the following steps:

1. Lay-up binder stabilized fabric: The fabric is laid and stabilized using a binder.
2. Heating and some pressure: The mould is heated to the curing temperature and some pressure is applied.
3. Mould closing and resin injection: The mould is closed and resin is injected to fill the cavity.
4. Curing: The resin is cured to form a solid part.
5. Opening and de-moulding: The mould is opened and the part is removed from the mould.
Benefits of Hexion RTM system
EPIKOTE™ Resin TRAC 06170 / EPIKURE™ Curing Agent TRAC 06170

- Short Cycle time <2’
- E-Coat resistance
- Solvent free, Reach compliant
- Easy De-molding
- Complex 3D design
- Low viscosity, long latency, fiber wetting
- Fiber Carbon, Glass, Basalt
- Thermal & chemical resistance
- Tailor made performances

Epikote Resin TRAC EP06170/EK 06170

GALM Europe 2017
Epoxy CFRP with RTM technology for structural applications

BMW 7-Series
CFRP roof arc
EPIKOTE™ Resin 06000 / EPIKURE™ Curing Agent 06130

Benefits
• Designed to the shape of the car body
• Fast curing cycle with HP-RTM
• Outstanding weight / performance ratio

Audi R8 Coupe and Lamborghini Huracan
CFRP Transmission Tunnel
EPIKOTE™ Resin TRAC 06150 / EPIKURE™ Curing Agent TRAC 06150

Benefits
• Weight reduction vs. steel
• Very short cycle time with HP-RTM
• Good overall strength
• Increase of torsional and bending stiffness
Part to part cycle time of less than 1 minute is possible and demonstrated with LCM.

The leader in fast RTM/LCM processing of CFRP automotive parts.
Benefits of Hexion LCM system
EPIKOTE™ Resin TRAC 06170/ EPIKURE™ Curing Agent TRAC 06170

- Solvent free, Reach compliant
- E-Coat resistance
- Easy De-molding
- No Pre-forming
- Simpler 2,5D Parts
- Short Cycle time <1’
- Fiber Carbon, Glass, Basalt
- Thermal & chemical resistance
- Tailor made performances

Epikote Resin TRAC EP06170 / EK 06170

GALM Europe 2017
Epoxy CFRP with LCM technology for **structural** applications

**BMW 7-Series**
CFRP tunnel reinforcement
EPIKOTE™ Resin 06000 / EPIKURE™ Curing Agent 06130

**BMW 7-Series**
CFRP Windshield Frame
EPIKOTE™ Resin 06000 / EPIKURE™ Curing Agent 06130

**Benefits**
- Weight saving
- Local reinforcement enhances torsional stiffness
- 2.5D part without pre-forming
- Fast curing cycle with LCM

**Benefits**
- Weight reduction vs. steel
- Short cycle time in LCM
- Good overall strength
Advanced Thermoset technology shifts in support of higher volume and/or performance

GALM Europe 2017
SMC is a cost efficient process due to net shape moulding without preforming step

- Component mixing
- SMC compounding
- SMC Cutting & moulding
- Pressing
- Part de-moulding
Benefits of the Hexion SMC system
EPIKOTE™ Resin TRAC 06605/ EPIKURE™ Curing Agent TRAC 06608

- Short in mold Cycle time 3’
- Low viscosity systems
- Thermal and Chemical resistance
- High flow and mold ability
- Net-shape Easy de-molding
- Low reinforcement scrap rate
- E-Modulus up to 40 GPa (CF)
- Tensile strength up to 300 Mpa (CF)

Epikote Resin TRAC EP 06605 / EK 06608

GALM Europe 2017
Hexion epoxy SMC is easily processed on existing SMC infrastructure
Advanced Thermoset technology shifts in support of higher volume and/or performance.
Short fiber engineering thermosets have a favorable price/performance ratio

*Based on typical resin pricing and glass transition temperatures. Size of balloon represents the fact that pricing/properties for a given class of resin vary according to the specific formulation.
Phenolic Engineering Thermosets for under-the-hood applications

**Confidential**
Toothed belt sprocket  
BAKELITE® PF 1110

**Benefits**
- High precision
- 70% weight reduction compared to steel
- Higher efficiency and longer lifetime
- Noise reduction

**Various European OEMs**
Solenoid switch cap  
Bosch  
BAKELITE® PF 1110

**Benefits**
- Meeting tight tolerances
- Good mechanical performance
- High dimensional and thermal stability
Phenolic Engineering Thermosets for under-the-hood applications

Ford Motor Company
Cam Carrier Demonstrator for Ford Fox EcoBoost Engine
BAKELITE® PF 1110 containing CF

Benefits
- Weight reduction of 30% versus cast aluminum
- Reduced part cost by elimination of several manufacturing steps
- Maintains mechanical properties at above 200°C

Ideal target Parts
- Aluminum with significant post machining
- Continuous service temperature between 100-200°C
- Critical tolerances
- Chemical resistance
- Flame resistance
- Surface friction and wear

Source: Ford Motor Company
Optimum CFRP performance and cost is complemented with good design

Partnerships Through Value Chain
- Equipment suppliers
- Part Design and Modeling
- Process Design and Modelling
- Tool Building
- Reinforcements

Materials
- Epoxy Resins:
  - Liquid resins
  - Hot melts
  - Perform Binders
  - Mould Release Agents
  - Prototyping systems
- Phenolic Engineering Thermosets

Optimum Performance and Cost

Process Capability For OEM Industrialization

- HP-RTM
- Injection Moulding
- LCM - Compression Moulding
- Towpreg
- Performing
- SMC
- Prepreg
- FiWi
Key takeaways

Epoxy Fibre Reinforced Composites:
Offer the highest weight saving potentials

New generation resin systems:
Have faster cure cycles, easier de-moulding and manufacturing process versatility

Design and consolidation of component:
Will continue to decrease cost per kg weight saving

Phenolic Engineering Thermosets:
Enable cost efficient weight saving in under-the-hood applications
Thank you!
Innovation Built on Collaboration
Your Partner in Composite Resin solutions

Jean-Philippe Sauvaget
Director Business Development Automotive
jeanphilippe.sauvaget@hexion.com

Alain Leroy
Senior Automotive Applications Engineer
alain.leroy@hexion.com

DISCLAIMER
The information provided herein was believed by Hexion Inc. and its affiliated companies ("Hexion") to be accurate at the time of preparation or prepared from sources believed to be reliable, but it is the responsibility of the user to investigate and understand other pertinent sources of information, to comply with all laws and procedures applicable to the safe handling and use of the product and to determine the suitability of the product for its intended use. All products supplied by Hexion are subject to Hexion's terms and conditions of sale. Hexion makes no warranty, express or implied, concerning the product or the merchantability or fitness thereof for any purpose or concerning the accuracy of any information provided by Hexion, except that the product shall conform to Hexion's specifications. Nothing contained herein constitutes an offer for the sale of any product. © 2015 Hexion Inc. All rights reserved.
® and ™ denote trademarks owned or licensed by Hexion Inc.