A Global Leader In Specialty Chemicals & Materials

Momentive Specialty Chemicals GmbH.

Automotive Road Show

November 2011

Agenda

- Momentive Specialty Chemicals
  - Company Overview and Composite Applications capabilities
- Epoxy Resin Composites in Automotive Applications
- Presentation of Momentive Specialty Chemicals “Fast Cure Epoxy RTM System”
- Discussion
- Questions & Answers

The New **Momentive**
Transformational Merger Forges An Industry Leader

Combination of Momentive Performance Materials
(formerly GE Silicones / Bayer Silicones/ Toshiba Silicones)

&

Hexion Specialty Chemicals

(formed in 2005: Shell Epoxy Resins, Bakelite, MGS, Borden)

MOMENTIVE™

Pro forma Revenue $7.8 Billion
Pro forma Adjusted EBITDA $1.3 Billion

Combination of Technology leaders into one company makes Momentive unique Globally and in Epoxy Resins

The "New Momentive" Creates One of the Largest Global Specialty Chemical and Materials Growth Platforms

US$ in millions

Momentive Performance Materials
Craig Morrison

Revenue: $7.8 bn
EBITDA: $1.3 bn

Epoxy, Phenolic & Coating Resins Division
Jody Bevilaqua

Revenue: $3,413 mm
EBITDA: $593 mm

- Base Epoxy Resins
- Specialty Epoxy Resins
- Versatic™ Acids & Derivatives
- Specialty Phenolic Resins
- Oilfield
- Powder Coatings
- Global Dispersions
- Acrylic Monomers

Silicones & Quartz Division
Steve Delarge

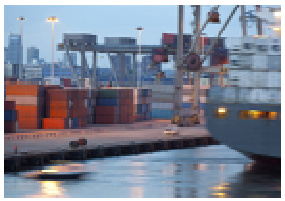
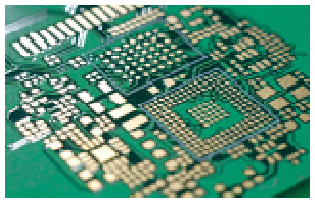
Revenue: $2,720 mm
EBITDA: $480 mm

- Silicone Fluids
- Silanes and Resins
- Silicone Intermediates
- Silicone Elastomers
- Silicone Engineered Materials
- Urethane Additives
- Consumer Sealants and Adhesives
- Fused Quartz and Ceramic Materials

Forests Products Resins Division
Dale Plante

Revenue: $1,713 mm
EBITDA: $180 mm

- Forest Products Resins
- Formaldehyde
- Formaldehyde Derivatives
- Wax Additives

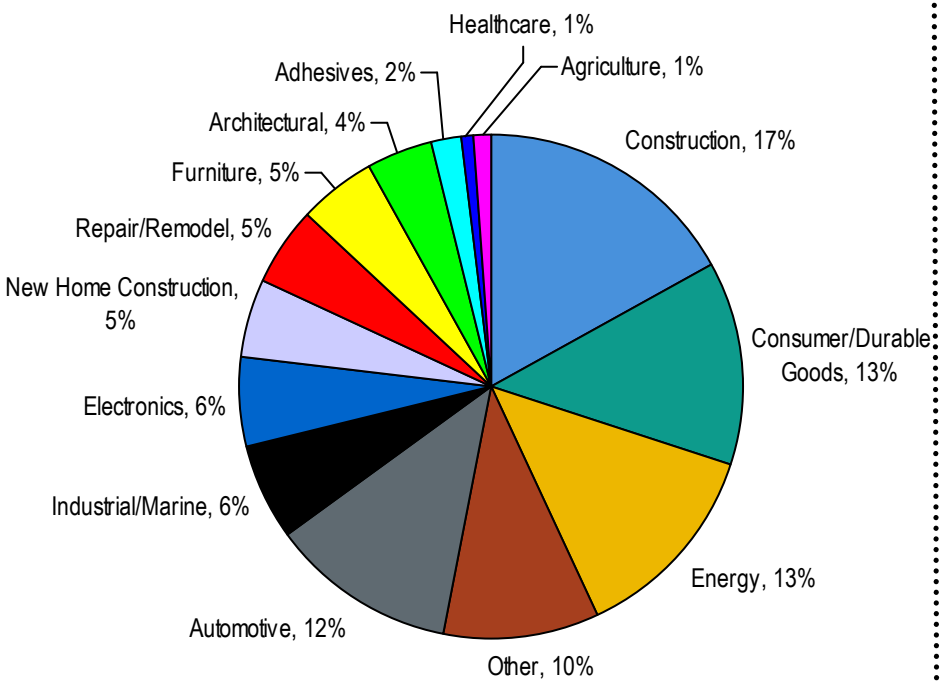
Serving More Than…

- 20,000 customers
- 117 production facilities around the world
- With 10,000 Momentive associates

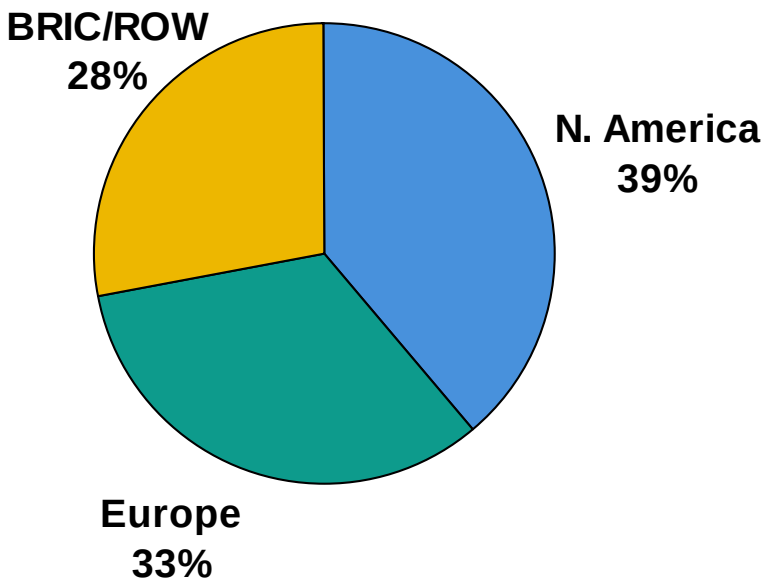
- Balanced geographic portfolio
- With sales of over $7 billion
- Ability to serve global customers in all major regions worldwide
- New Product Development opportunities across a range of technologies in shared end use markets
  - Automotive, Fiber sizing, Construction, Electronics, Tires, Silicons / Quarz, Phenolic Resins, Coatings Resins (solvent borne, Waterborne), Wind Energy, etc. among others

The Scale and Diversity of Momentive Creates Significant Opportunities

PF Revenue by Industry



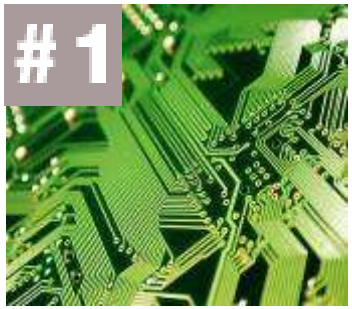
PF Geographical Revenue



DIVERSIFICATION OF END USE MARKETS AND GEOGRAPHIES PROVIDE STRONG GROWTH OPPORTUNITIES

Global Leadership Positions Across a Broad Range of Technologies and Industries

Epoxy Resins
Global



Quartz
Global

Silicones
Global

Phenolic Specialty Resins
Global

Versatic™ Acids & Derivatives
Global

Forest Product Resins
Global

Oilfield Proppant Resins
Global

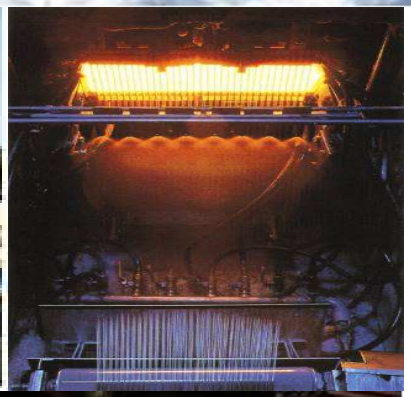
THE COMBINED COMPANY WOULD HAVE LEADING MARKET POSITIONS IN MORE THAN 80% OF ITS REVENUE BASE

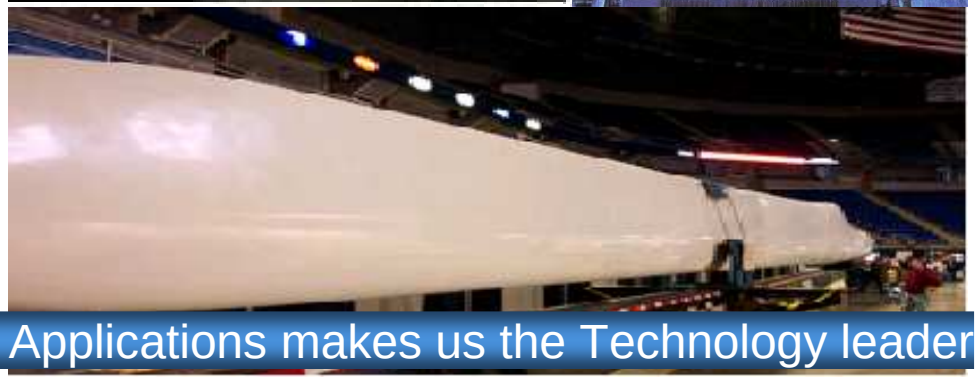
Broad Geographic Footprint Creates Platform for Growth

THE NEW MOMENTIVE SERVES MORE THAN 20,000 CUSTOMERS FROM 93 GLOBAL SITES

Epoxy Market / Applications

- **Composites**
  - **•Automotive**
  - **• Aerospace**
  - **• Wind Energy**
  - **• Pipe &Tanks**
  - **• Recreation**
- **Fibers**
  - **•Sizing of glass and carbon fiber reinforcements**
  - **•Sizing of Non Woven Products**
- **Textiles**
  - **• Adhesives, saturants and binders**



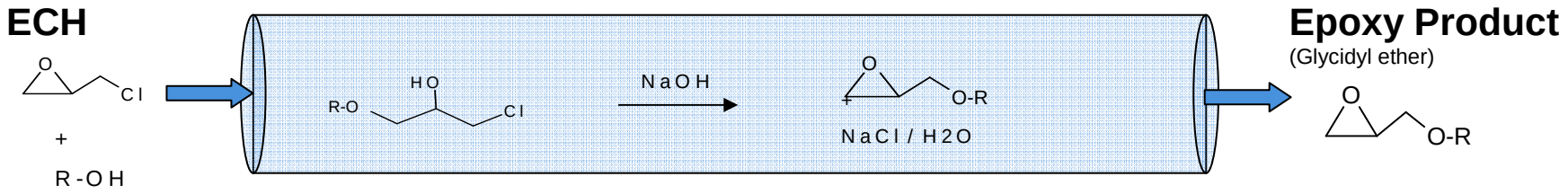


Expertise in diverse Composites Applications makes us the Technology leader

Epoxy Market / Applications

- **Protective Coatings**
  - **Transportation**
  - **Industrial Maintenance & Marine**
- **Civil Engineering**
  - **Polymer flooring**
  - **Sealants**
  - **Adhesives**
  - **Grouts**
  - **Chemical Anchoring**
  - **Construction (E.Q.) damage prevention**
- **Electronics/Electrical Equipment**
  - **Transformers (High and Low Voltage)**
  - **Switch gear**
- **Electrical Laminates**
  - **Printed Circuit Boards**

Epoxy Resins:
Epoxy Chemistry and the Resin Chain



Chlorohydrin

Dehydrochlorination

Produced by Hexion

Epichlorohydrin

Bisphenol A

Bisphenol F

Novolacs

Amines

Epoxy Resins

Chemical Modification

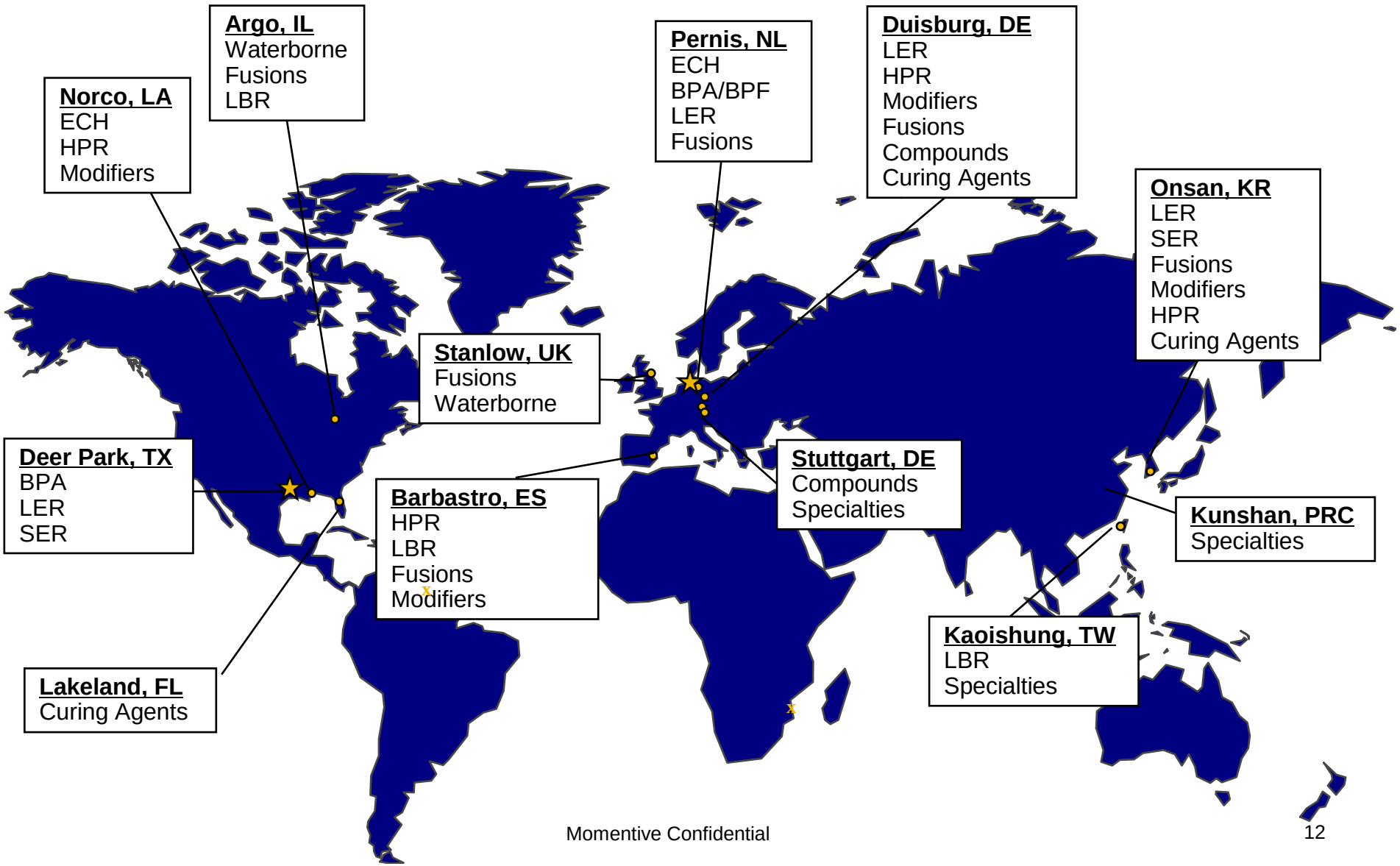
Blending

Compounding

Physical Modification

Strength in Making RM's ensures Consistent Quality

Global Epoxy Manufacturing Network



Epoxy R&D: Global and Regional Focus

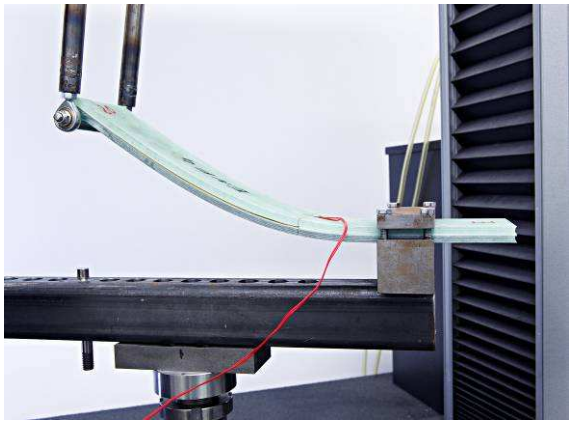
	Adhesives	Coatings	Civil Engineering	Wind and Composites	Fibers / Textiles	Electronics	Electrical
Duisburg Germany	Regional		Regional	**Global**			Global
Houston	Global	Regional	Regional	**Regional**	Global	Global	
Louvain La Neuve		Global			Regional		
Esslingen Germany				**Global Wind Energy**			
Onsan		Regional		**Regional**	Regional	Regional	Regional

Employ Best Expertise to achieve Rapid Implementation

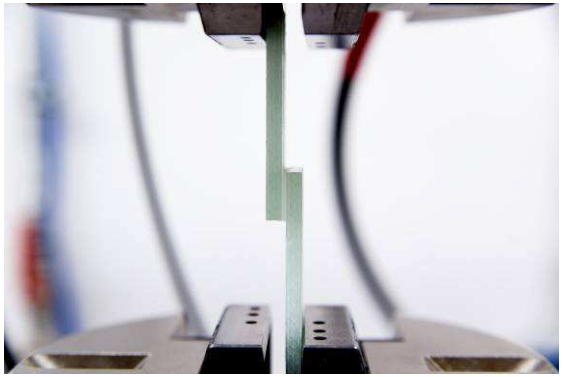
Epoxy Specialties
Composite Laboratory Equipment

Infusion testing

Epoxy Specialties
State-of-the-Art Testing Equipment



Static & dynamic (servo-hydraulic 100kN) test systems



Epoxy Specialties
Pilot Laboratory Equipment

Chemistry and
Application Development for

Vacuum Pressure Impregnating,
Vacuum Casting,
Automatic Pressure Gelation,
Casting, Potting,

Technology Centre - Germany

Please visit us in Germany !!

Esslingen Test Laboratory approved by Germanischer Lloyd

- **following DIN EN ISO/IEC 17025: 2005**
- **Mechanical Testing**
- **Analytical Testing**

Statement

Approval No. GL-LZ 2111 HH

In recognition of a successful inspection carried out by Germanischer Lloyd

Momentive Specialty Chemicals Stuttgart GmbH
Prüflabor
Fritz-Müller-Strasse 114
73730 Esslingen
Germany

is approved as laboratory for technical competence in the field of

Mechanical and Analytical Testing

The certification covers the specific tests and types of tests listed in the annex. This laboratory meets the requirements of the rules of Germanischer Lloyd for Non-metallic Materials.
A laboratory inspection was carried out from 2011-03-22 – 2011-03-23. All facilities and the qualification of the personnel in charge of the above mentioned company was found in good order.

This statement consists of this page and a two-page annex which are integral part of the approval.

This statement is valid until 2014-03-31

Hamburg, 2011-04-11

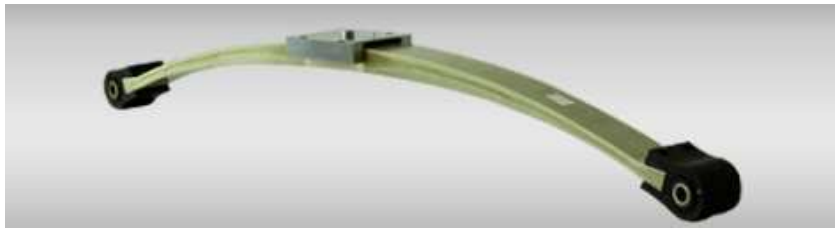
Germanischer Lloyd

i. A. Stefan Röhr

i. A. Guido Michalek

Market Segment **Automotive / Transportation**

- Significant weight reduction in comparison to metals and alloys.
- Short cycle time with high mechanical performance secures competitiveness.
- Systems:
  - ***Filament Winding***
  - ***Prepreg***
  - ***Pultrusion***
  - ***Infusion (RTM)***
  - ***Tooling and Prototyping***



Weight savings in all applications contributes to overall efficiency

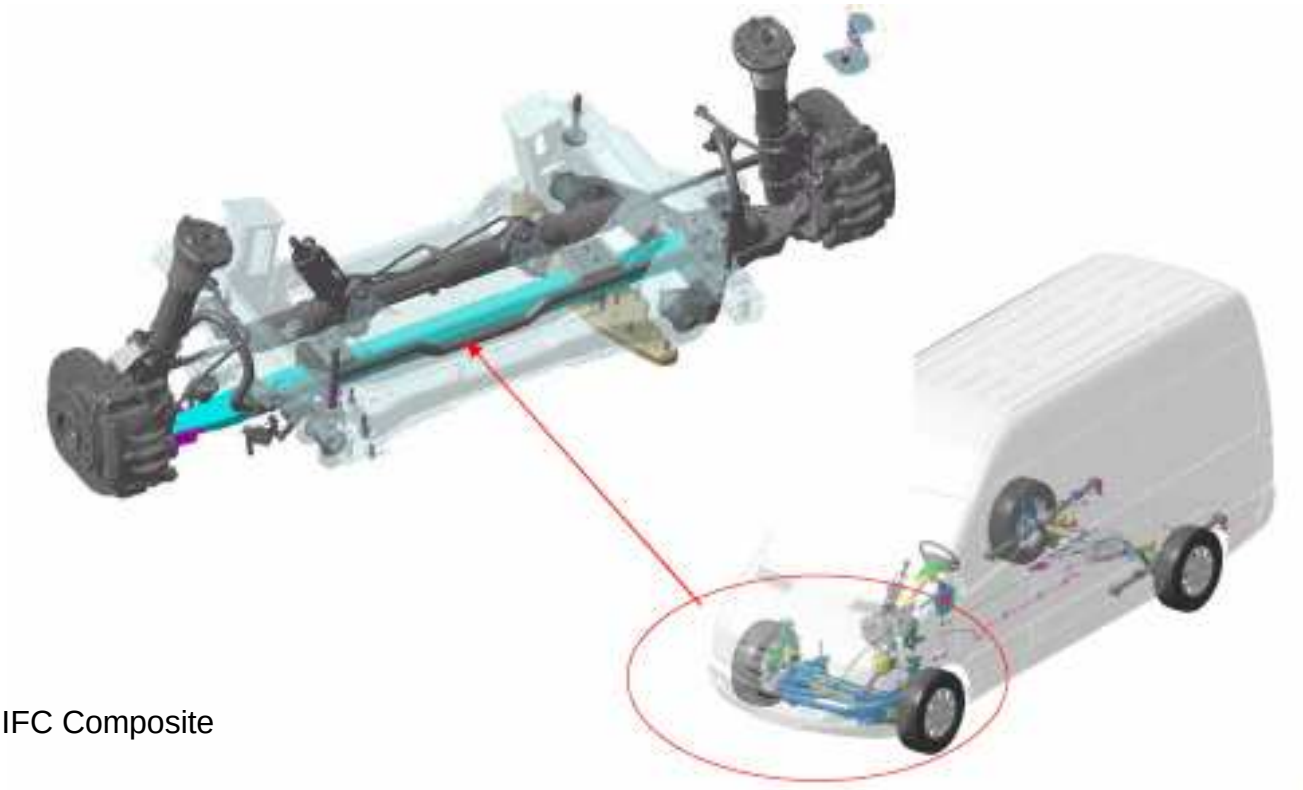
Glass fiber Epoxy Composite Leaf Springs for Light Trucks – Daimler Sprinter : Prepreg Technology

Source: IFC Composite

Leaf spring data:

ca. 1400 mm long,
ca. 75 mm wide,
ca. 30 mm thick and
ca. 160 mm high.
ca. 5.5 kg weight compared to 25 kg steel front leaf spring

Composite Leaf Springs for Trucks
Leaf Spring stacking arrangement in Mercedes Sprinter



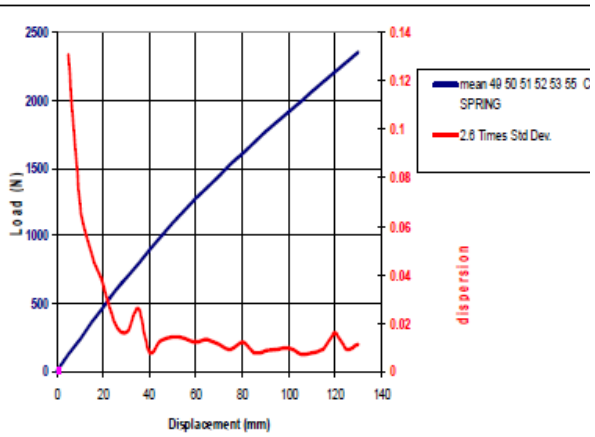
Source: IFC Composite

Outlook in Terms of Requirements and Epoxy Resin Technology Deliverables

New growing applications for epoxy glass or carbon fiber reinforced structures

**Composite coil springs have been known for a few years.
Static mechanical and fatigue performance as well as
thermo mechanical (Tg) values are fulfilling all requirements.**

Now it's time for implementation of mass production.

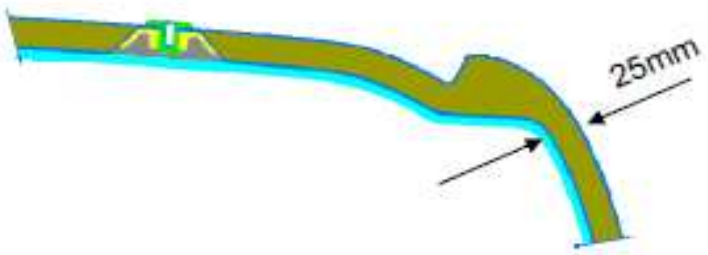


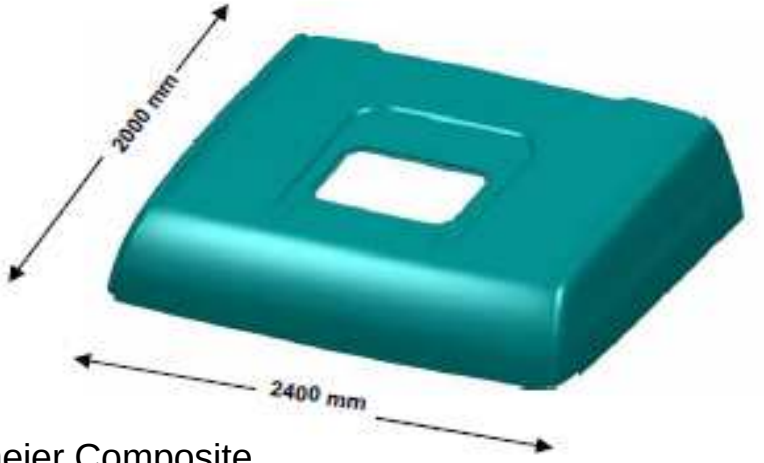
Glassfiber epoxy coil spring model, source: Sardou S.A.

Epoxy System for Truck Roofs and Wind Deflectors
RTM Technology
By Way of Illustration: MAN TG-X Roof

Single-section roof shell

with 6-part PUR foam core





Source: Fritzmeier Composite

Epoxy System for Glass Fiber Reinforced Truck roofs and Wind Deflectors – RTM Technology

RTM mold and truck roof while demolding, source: Fritzmeier Composite

Thermolatent (Fast Cure) Epoxy RTM Systems

for

Automotive Structural Parts suitable for mass production

November 2011

Project Target and Objectives

Development of a thermolatent RTM Epoxy Systems for Automotive Structural car body applications suitable for automotive mass production

A novel Fast Cure System (FC-RTM)

Internal set targets:

Injection time:	*> 1 minutes (variable)*
Curing time:	*≤2 minutes*
Injection & curing temperature:	*80 - 125 ° C*
Tg onset, first run	*> 95° C min.*
Total cycle time:	*< 5 minutes*

Targeted Product Performance and Standard Methods

Product performance	Unit	Target value	Method
Tg onset, DSC, first run, 10K/min, N_2 gas	°C	> 100	ISO 11357
Curing degree, DSC conversion	%	>98	ISO 11357
Tensile test Tensile modulus Tensile strength Elongation at break	 MPa MPa %	 3000 ± 10% > 75 > 5	DIN EN ISO 527
E-modulus DMA	MPa	$E'_{90°C} > 0.8 * E'_{23°C}$	GS 97036
Linear thermal expansion coefficient	/K	$< 80*10^{-6}$	DIN 53752-A
Water uptake (7 days at 23 °C, specimen 4x10x80 mm)	%	< 0.2	DIN EN ISO 62
Volumetric reaction shrinkage	%	< 6	ISO 3521
Fracture toughness G_{IC}	 J/m^2	 200 ± 20	 ISO 13586
Burning rate	mm/min	< 100	GS 97038

Targeted Product Performance and Standard Methods

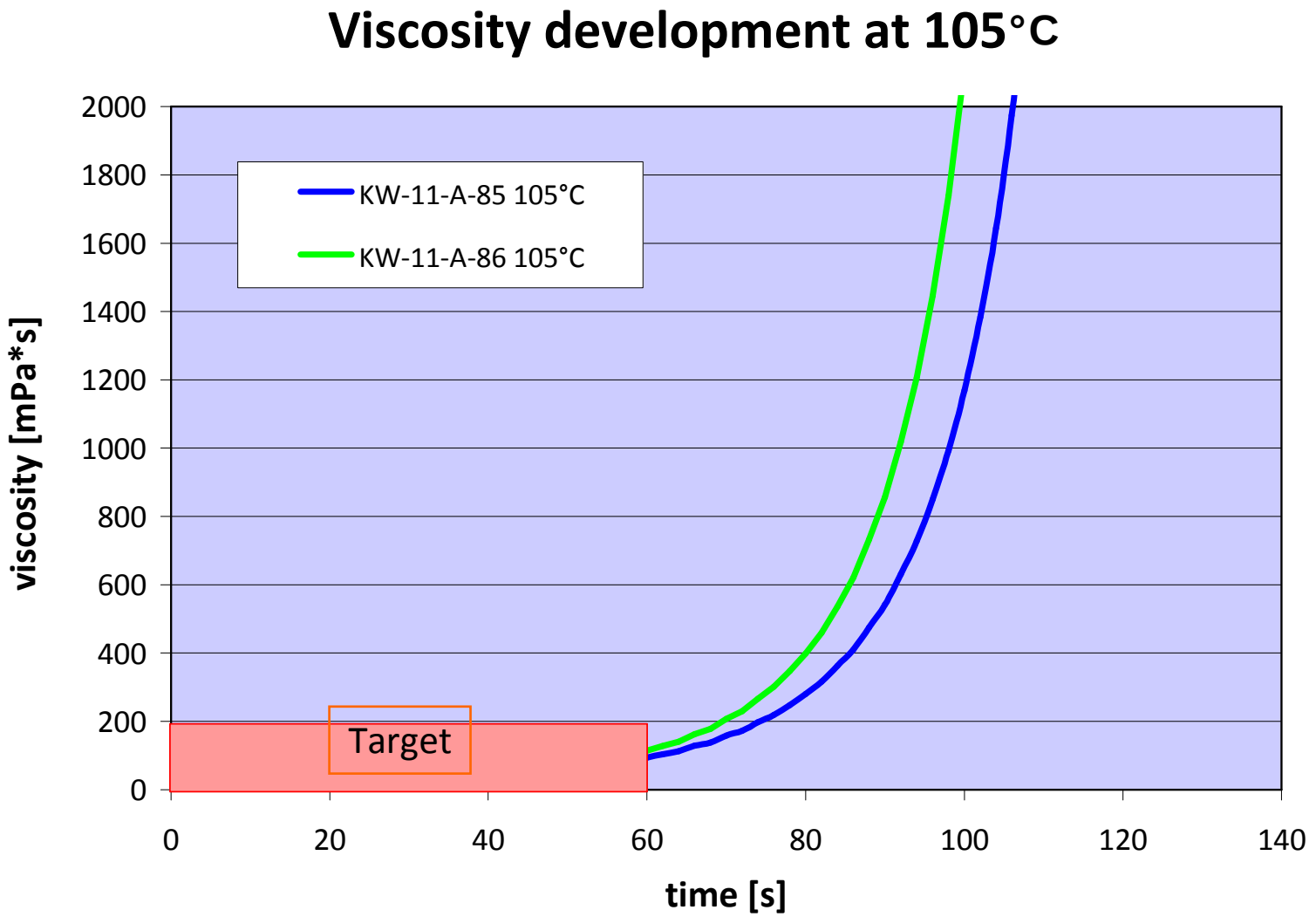
Process parameters	Unit	Targeted value	Method
Working tool temperature	*°C*	*80- 125*	-
Injection time at 80- 125 °C	*sec.*	*> 60*	-
Start formulation viscosity at 80- 125 °C	*mPa*s*	*< 150*	*DIN 53019*
Viscosity development of system **after 60 sec.** *infusion time at 80- 125 °C*	*mPa*s*	*< 300*	*DIN 53019*
Mixing ratio	*pbw*	*100/5 – 100/30*	-
Internal mould release	*% mass*	*< 2*	-
Mixing tolerance of the components	*Pbw*	*±2*	-
Curing time at 80- 125°C **conventional system** **accelerated system**	*Min*	*< 5* *< 2*	-
Fiber volume content (glass + carbon)	*% Vol*	*55*	-

Results - Typical data and reactivity

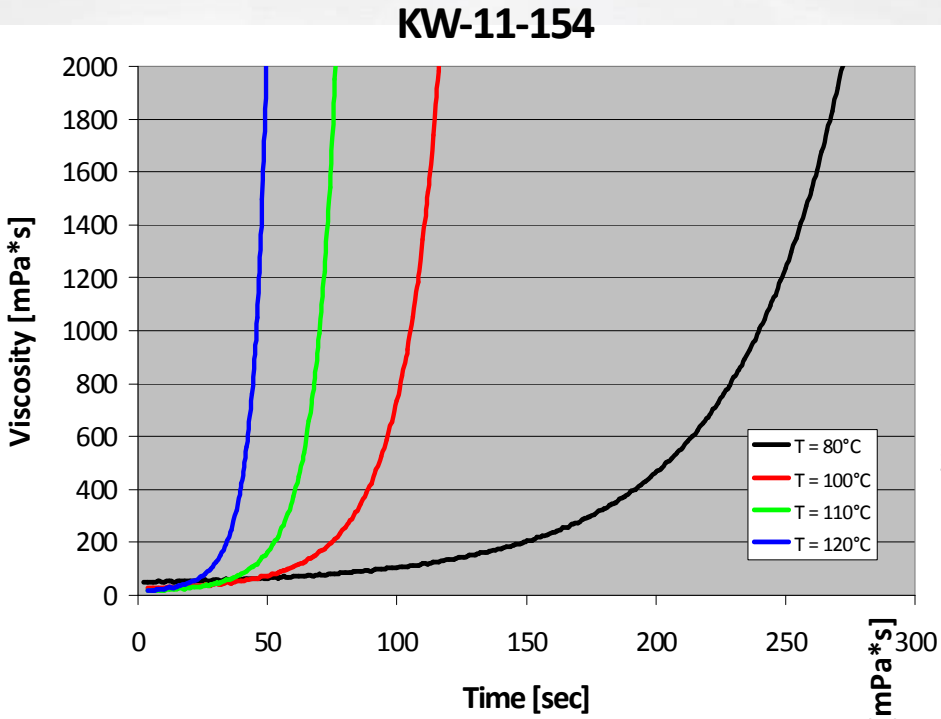
Performance	Unit	Target	KW-11-154	KW-11-86
Mixing ratio resin / hardener	pbw	-	100 / 16	100 / 16
Start formulation viscosity at: 105°C 110°C	mPa*s	< 150	 20 ± 3 15 ± 2	 25 ± 3 16 ± 2
Viscosity development of system at 110°C after: 30 sec 60 sec	mPa*s	 - < 300	 55 ± 5 250 ± 30	 29 ± 3 169 ± 10
Pot life (100g sample) at 25°C	min	-	45	40
Gel time (hot plate) 110°C*	sec.	-	50	53

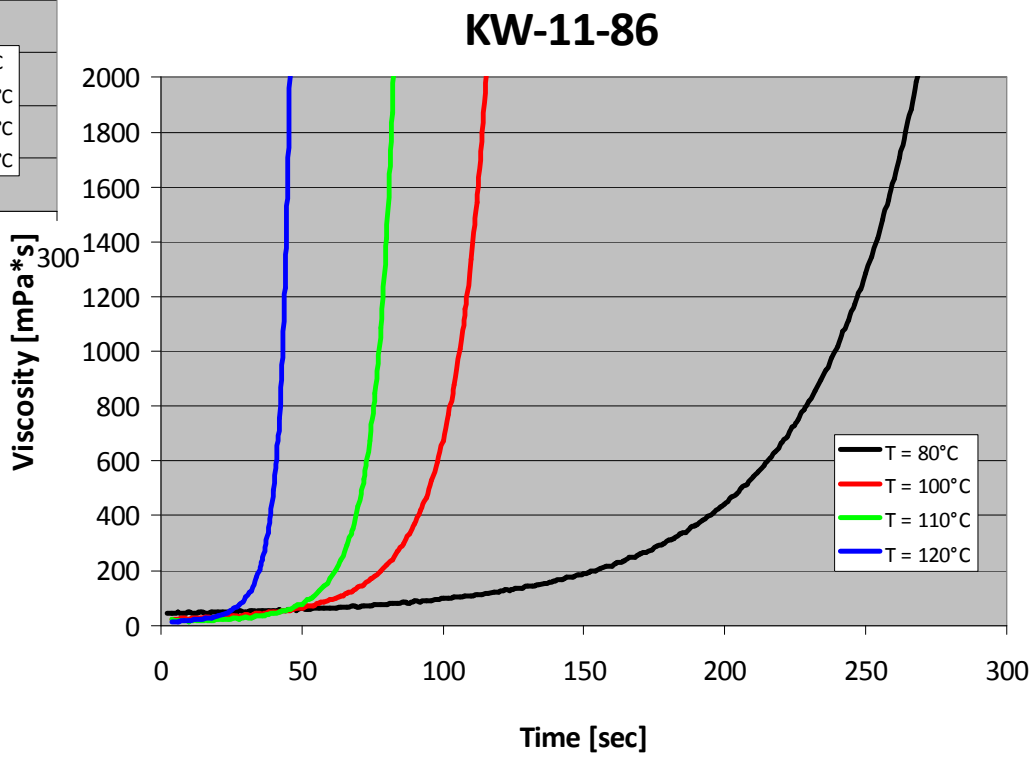
* Gel times measured on the RTM mould at Cannon Italy

Reactivity at 105°C



Viscosity versus Temperature





RHEOPLUS/32 V2.81
MCR 300
PP 25mm
Gap 1mm

HP-RTM Trials at Cannon (Italy)

Mold dimension:	*500 x 375 mm*
Thickness:	*2 mm*

Processing parameters:	
Resin temperature:	*65°C*
Hardener temperature:	*30°C*
Tool temperature:	*110°C*
Mixing pressure:	*140-170 bar*
Injection time:	*7-10 sec*
Pressure in mould:	*50-70 bar*
Curing temperature:	*110°C*
Curing time:	*2 minutes*

HP-RTM trials of Carbon-reinforced Specimens

Mould:	*500 mm x 375 mm*
Thickness:	*2mm*
Fiber:	*Carbon UD, Toray T 620*
	MA 0°/90°
	MA ±45°
	(with and without epoxy binder)
Layers structure:	*5 layers*
	3x 0°/90°
	2x ±45°
(0°/90° // +/- 45° // 90°/0° // -/+ 45° // 90°/0°)	
FVC:	*45-50%*

Mvi_2719.mpg

Epoxy binder: EPIKOTE™ Resin 05390 (Momentive)

Performance of Carbon-reinforced Specimens

Performance	Unit	KW-11-154	KW-11-86
DSC, 10K/min			
Tg onset first run	*°C*	*not possible**	*not possible**
Conversion (DSC enthalpy)	*[%]*	*> 98*	*> 98*
DMA			
onset	*°C*	*117*	*104*
tan delta	*°C*	*135*	*128*
Tensile test			
tensile modulus	*MPa*	*37000 ± 3000*	*40200 ± 1100*
tensile strength (max)	*MPa*	*400 ± 40*	*460 ± 12*
Elongation at break	*%*	*2 ± 0.1*	*2 ± 0.1*
ILSS (SEBN, DIN EN 2563)			
0°	*MPa*	*52 ± 2*	*52 ± 2*
90°		*55 ± 5*	*60 ± 2*

** overlap residual enthalpy with Tg*

Formulations contain 1% internal mould release (1.2% in the epoxy resin)

Epoxy binder EP 05390: approx. 20g/m²

Conclusion

- *Several high speed RTM systems (2 min. cure cycle) developed*
- *3 Systems selected for HP-RTM trials at Cannon and Krauss Maffei*
- *Successful HP-RTM trials at Cannon and Krauss Maffei (mould problem)*
- *Trials confirmed lab testing results with regard to:*
  - *Thermolatency during infusion (Gel time > 45 sec at 110°C)*
  - *Better fiber wetting*
  - *Fast cure (2 min. at 110°C)*
  - *Good thermal and mechanical performance (Tg > 100°C)*
  - *No post-cure needed*
  - *Good mould release in combination with Internal Release Agent (IMR)*
  - *Compatible with epoxy binder (e.g., Epikote 05390)*
  - *Very good surface quality (surface Class A finish)*

Outlook in Terms of Requirements and Epoxy Resin Technology Deliverables

MOMENTIVE

Current development status with focus on processing and performance

Epoxy chemistry – fiber sizing:

Fiber sizings have significant impact on the performance of the fiber reinforced structure.

Intensive research and development will further lead to new sizing materials which will contribute to improved mechanical performance and consequently to weight reduction of composites.

Outlook in Terms of Requirements and Epoxy Resin Technology Deliverables

MOMENTIVE

Current developments with focus on processing and performance

For example, functionalization of preforms with carbon nano tubes.

CNT are “tools” which can enhance mechanical performance.

Issue in combination with RTM technology = heterogeneous distribution of CNT

Solution: Apply CNT via the preform.

Result: Uniform distribution of particles with
No washout effect
No enrichment of CNT was observed
Expected effect of mechanical enhancement

THANK YOU All for your attention

and last, but NOT least, just a glance where Momentive serves the Automotive Industry….

Automotive Applications within the Momentive group

Momentive Heritage
Underhood

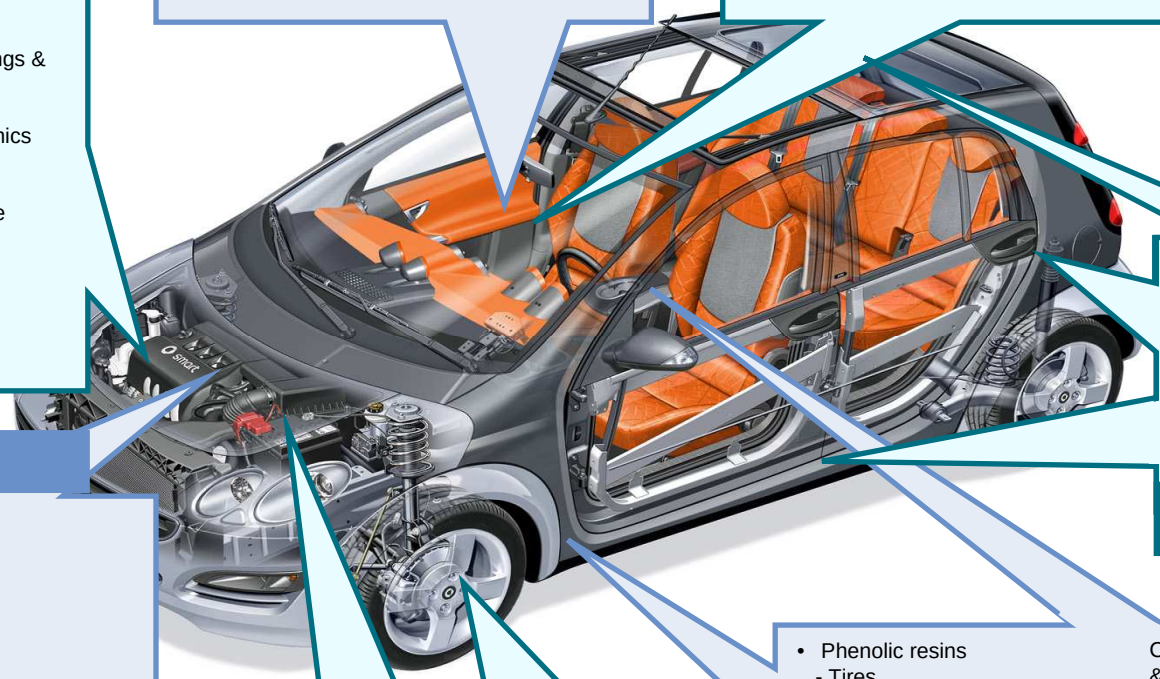
- Sensors, stoppers & seals
- Sparkplugboots
- Ignition cables
- Air systems seals & flaps
- Charge air cooler gasket
- Turbo-hoses
- Powertrain seals 7 gaskets
- Wireharness connectors & cables
- Engine mounts
- Fuel system seals, gaskets, o-rings & membranes
- Exhaust hangers
- Potting materials for sensitive electronics
- Adhesives for engine control units
- Sealing of sensitive areas
- Thermal interface materials to remove excess heat
- Fuel additives

Hexion Heritage
Interior

- Phenolic resin copper – clad laminates
- Epoxy resin copper – clad laminates
- Epoxy resin multilayer – PWB materials
- Phenolic molding coumpounds – ash trays
- Phenolic resins – interior cushioning felt
- Dispersion for seating applications

Momentive Heritage
Interior

- Switches & light guides
- Rain / camera sensors
- Steering wheels
- Dashboards
- Door Panels
- Headliners
- Seating foams
- Upholstery



- Weatherable & abrasion resistant coatings
- Weatherstrip coating
- Automotive paint & coatings
- Car waxes

Momentive Heritage
Exterior

Hexion Heritage
Underhood

- **Phenolic molding compounds**
  - starter caps & oil caps
  - switches
  - brake booster valve bodies
  - heat insulators
  - fuel pump impellers
  - various pulleys
  - accumulator pistons-AT devices
- Precision molded products
  - heat insulators
  - various pulleys
  - accumulator pistons-AT devices
- Phenolic resins
  - engine shell molds
- Phenolic fuel additives

- Fast cure RTV additives
- High transmission LED lenses
- High light transmission encapsulants for LEDs
- Tire & Rubber coupling agents

Momentive Heritage
Exterior

- Phenolic resins
  - Tires
  - Brake linings & pads
- **Precision molding compounds & Precision molded products**
  - **Brake pistons**
- Epoxy fiber sizing
  - Tire cords

CED coatings, topcoats & refinish systems

- **Epoxy structrual panels & adhesives**
- Expoy primer coatings
- **Composite structural panels**
- **Tackifying resins**

Hexion Heritage
Exterior

All Momentive product codes and names, used in this document are

EPON™, EPIKOTE™ and EPIKURE™

which are registered trademarks of Momentive Chemicals, Inc. or an affiliate of Momentive Specialty Chemicals, Inc.

DISCLAIMER: THE MATERIALS, PRODUCTS AND SERVICES OF MOMENTIVE PERFORMANCE MATERIALS INC., MOMENTIVE PERFORMANCE MATERIALS USA INC., MOMENTIVE PERFORMANCE MATERIALS ASIA PACIFIC PTE. LTD., MOMENTIVE PERFORMANCE MATERIALS WORLDWIDE INC., MOMENTIVE PERFORMANCE MATERIALS GmbH, THEIR SUBSIDIARIES AND AFFILIATES DOING BUSINESS IN LOCAL JURISDICTIONS (collectively "SUPPLIERS"), ARE SOLD BY THE RESPECTIVE LEGAL ENTITY OF THE SUPPLIER SUBJECT TO SUPPLIERS' STANDARD CONDITIONS OF SALE, WHICH ARE INCLUDED IN THE APPLICABLE DISTRIBUTOR OR OTHER SALES AGREEMENT, PRINTED ON THE BACK OF ORDER ACKNOWLEDGMENTS AND INVOICES, AND AVAILABLE UPON REQUEST. ALTHOUGH ANY INFORMATION, RECOMMENDATIONS, OR ADVICE CONTAINED HEREIN IS GIVEN IN GOOD FAITH, SUPPLIERS MAKE NO WARRANTY OR GUARANTEE, EXPRESS OR IMPLIED, (i) THAT THE RESULTS DESCRIBED HEREIN WILL BE OBTAINED UNDER END-USE CONDITIONS, OR (ii) AS TO THE EFFECTIVENESS OR SAFETY OF ANY DESIGN INCORPORATING SUPPLIERS' PRODUCTS, MATERIALS, SERVICES, RECOMMENDATIONS OR ADVICE. AFOREMENTIONED EXCLUSIONS OR LIMITATION OF LIABILITY ARE NOT APPLICABLE TO THE EXTENT THAT THE END-USE CONDITIONS AND/OR INCORPORATION CONDITIONS CORRESPOND TO THE RECOMMENDED CONDITIONS OF USE AND/OR OF INCORPORATION AS DESCRIBED BY SUPPLIER IN ITS PRODUCT DATA SHEET AND/OR PRODUCT SPECIFICATIONS. EXCEPT AS PROVIDED IN SUPPLIERS' STANDARD CONDITIONS OF SALE, SUPPLIERS AND THEIR REPRESENTATIVES SHALL IN NO EVENT BE RESPONSIBLE FOR ANY LOSS RESULTING FROM ANY USE OF ITS MATERIALS, PRODUCTS OR SERVICES DESCRIBED HEREIN. Each user bears full responsibility for making its own determination as to the suitability of Suppliers' materials, services, recommendations, or advice for its own particular use. Each user must identify and perform all tests and analyses necessary to assure that its finished parts incorporating Suppliers' products, materials, or services will be safe and suitable for use under end-use conditions. Nothing in this or any other document, nor any oral recommendation or advice, shall be deemed to alter, vary, supersede, or waive any provision of Suppliers' Standard Conditions of Sale or this Disclaimer, unless any such modification is specifically agreed to in a writing signed by Suppliers. No statement contained herein concerning a possible or suggested use of any material, product, service or design is intended, or should be construed, to grant any license under any patent or other intellectual property right of Suppliers or any of its subsidiaries or affiliates covering such use or design, or as a recommendation for the use of such material, product, service or design in the infringement of any patent or other intellectual property right.