

One Company. One Culture. One Future.



# Composite Leichtbau in der automobilen Großfertigung

AluMag Lightweight Technology - Roadshow 2014

July 14-18, 2014

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## Agenda

- **Momentive Company Overview**
- **Epikote™ Epoxy resin systems for mass production of light weight composites for structural and exterior parts**
- **Bakelite™ Engineering Thermoset compounds for mass production of light weight under-the-hood parts**

Shell Epoxy Resins & Versatics  
Bakelite AG  
MGS  
Borden Chemical  
Eastman Chemicals

GE Silicones  
Bayer Silicones  
Toshiba Silicones

**HEXION**<sup>TM</sup>  
Specialty Chemicals



  
**MOMENTIVE**  
performance materials  
The science behind the solutions.

**MOMENTIVE**<sup>TM</sup>

- Turnover ≈ 7.8 \$US Billion
- With 10,000 Momentive associates
- And approximately 90 Manufacturing facilities around the world
- Ability to serve global customers in all major regions worldwide

# Global Leadership in Thermoset Technologies & Markets

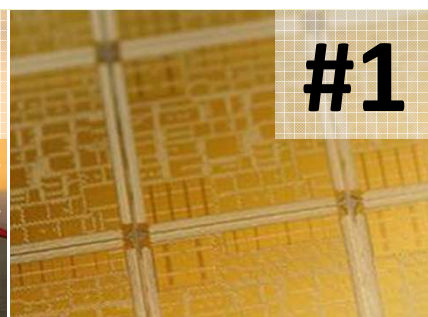


## First Epoxy resin

Epoxy Resins  
Global



Quartz  
Global



Silicones  
Global



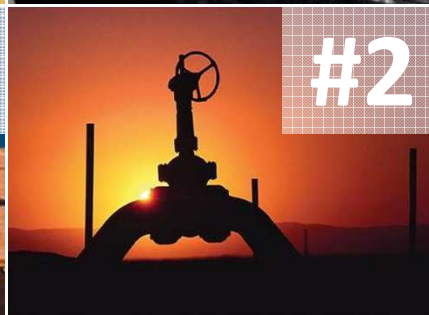
Phenolic Specialty Resins  
Global



Versatic™ Acids & Derivatives  
Global



Forest Product Resins  
Global



Oilfield Proppant Resins  
Global

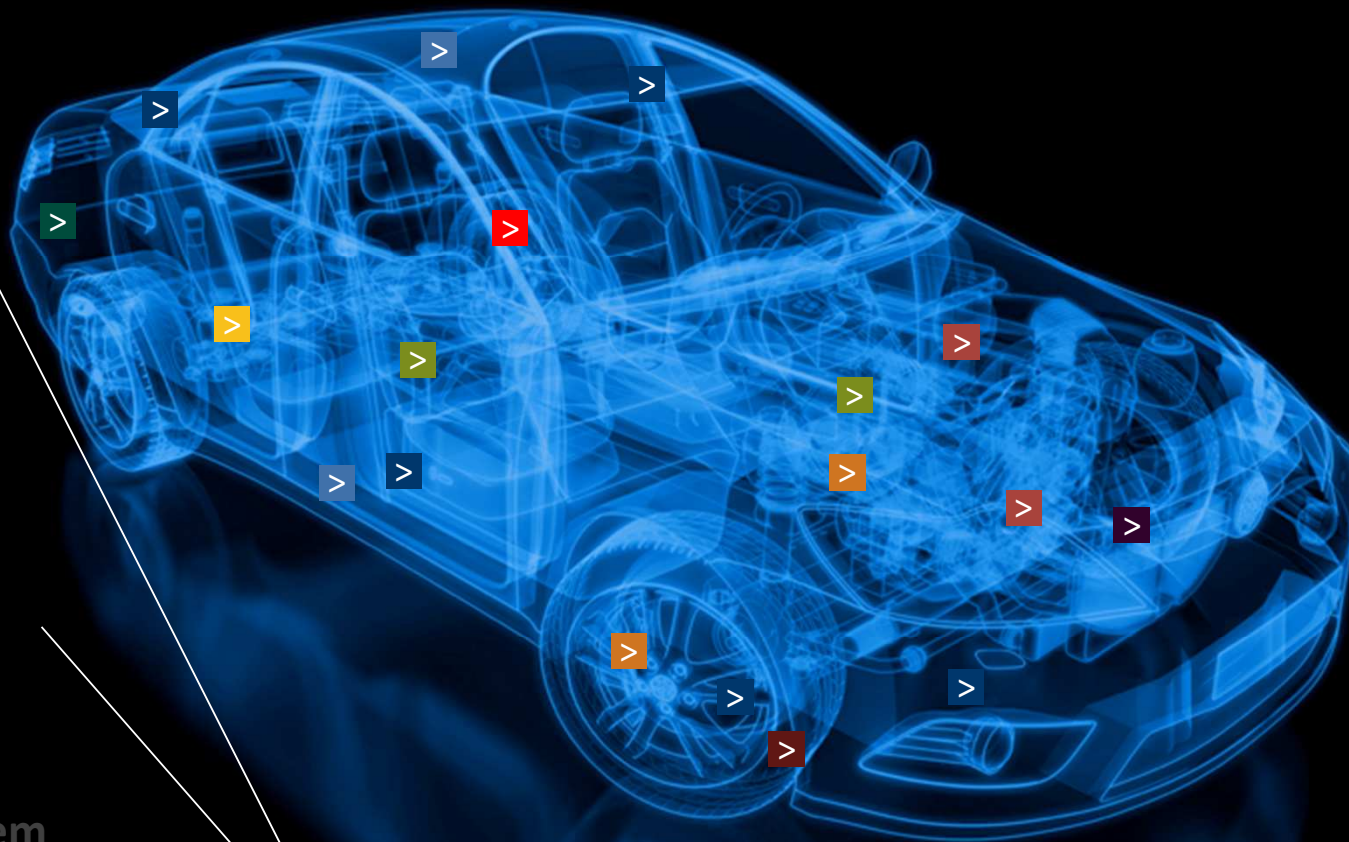
Worlds' First Plastic =  
Bakelite® Thermosets



# Thermoset Solutions for a Broad Range of Automotive Applications



- > Structural
- > Exterior
- > Coatings
- > Cooling System
- > Fueling System
- > Drivetrain
- > Braking System
- > Rubber Goods
- > Lubrication System
- > Suspension System



## Composites Material Solutions

Long-Fiber Composites = Matrix Resins

Short-Fiber Composites = Matrices & Molding Compounds

# Automotive Light Weight Material Application Centers

## Capabilities in Application Technologies

Preforming  
RTM (LP-/HP-RTM)  
Prepreg  
Compression Molding  
Prototyping  
Tooling



*Duisburg, Germany*



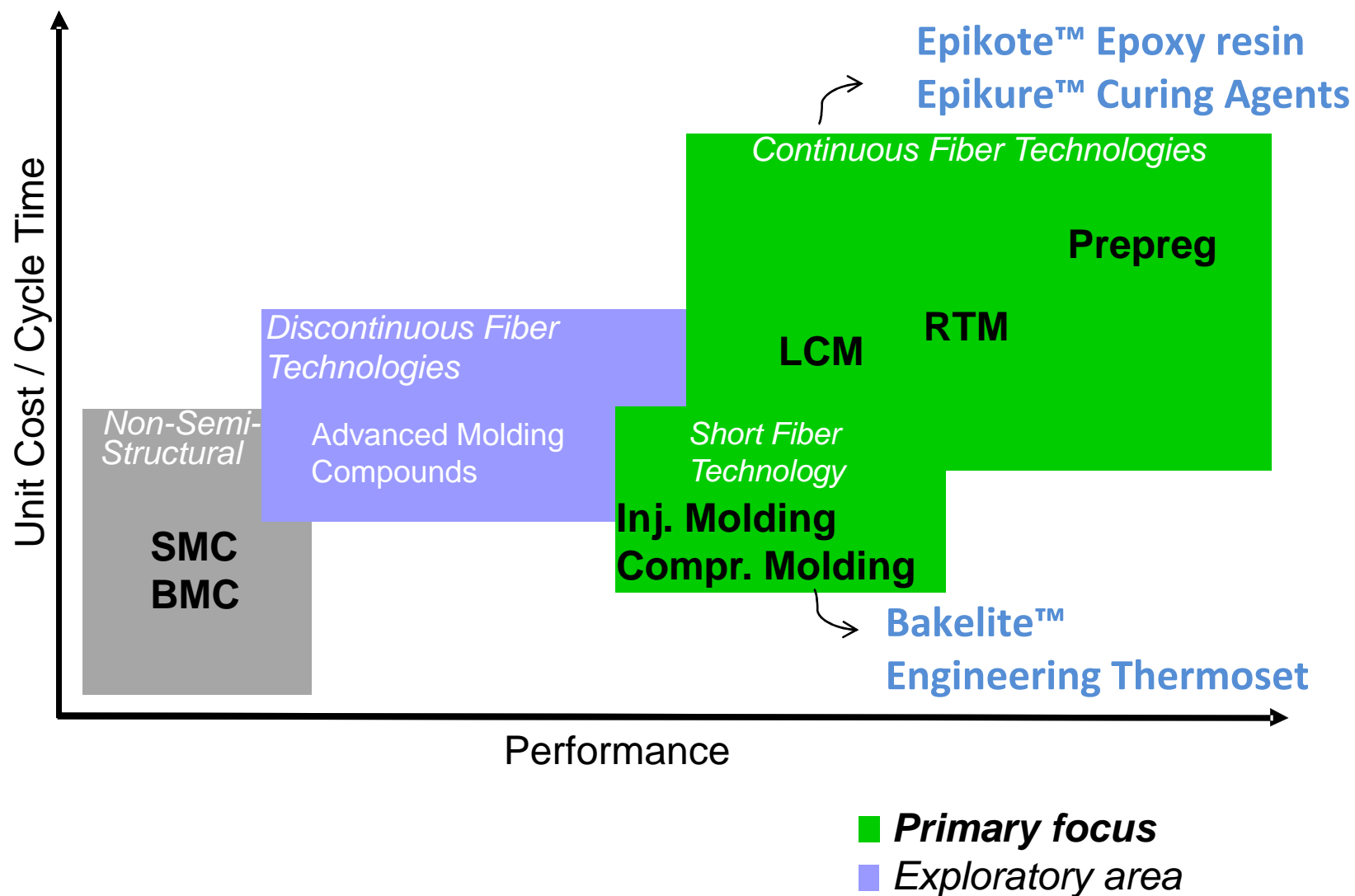
*London, ON, Canada*



*South Hampton, UK*

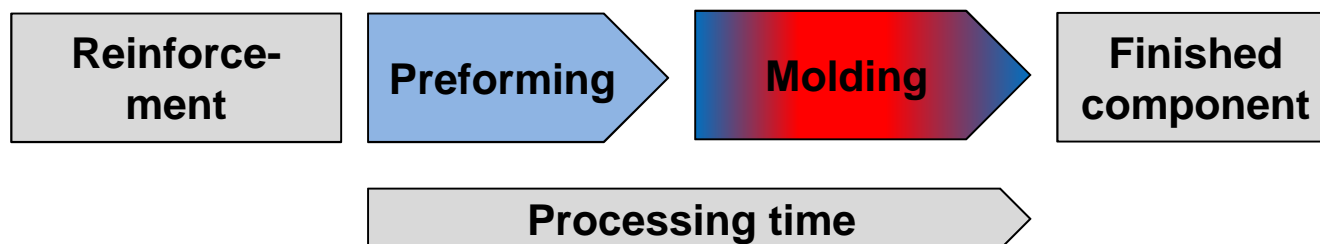
# Light-Weight Composite Solutions

## “Product & Process Technology View”

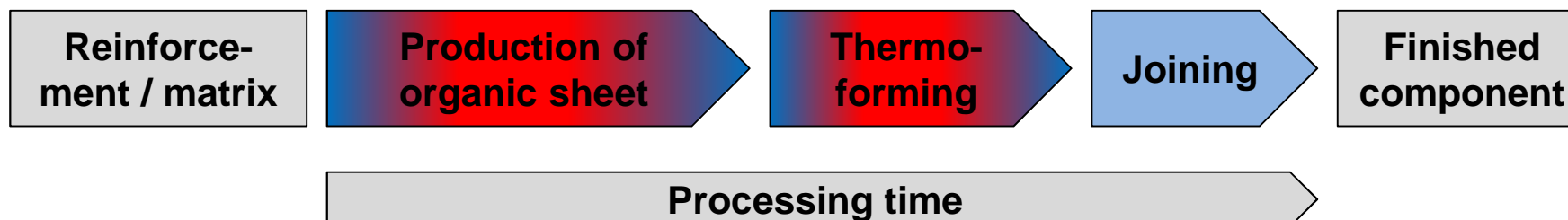


# Process Chain of Thermoset and Thermoplastic Composites

## Thermoset composites



## Thermoplastic composites



**Epoxy & Phenolic composites enable short process cycles and energy efficient molding of net shape components**



# Epikote™ Epoxy resin systems for mass production of light weight composites for structural and exterior parts

# Epoxy Composites take a Unique Position for Structural Composite & Light Weighting

	Thermosets		Thermoplastic
	PU	Epoxy	PA, PPS,..
Strength	+	+++	+
Stiffness	++	++	++
Impact / Toughness	+++	++	+++
Elevated Temperature Props.	+	+++	-
Creep	++	+++	--
Fatigue	++	++	-
H&S (VOC, Toxicity)	-	+++	+++

# Target applications for Epoxy Light Weight Composites

## Structural parts

- Building on **Proven performance** for Structural parts
- The challenge is to **reduce cycle time** and **enable mass production**
  - Liquid molding processes are the best option

## Exterior parts

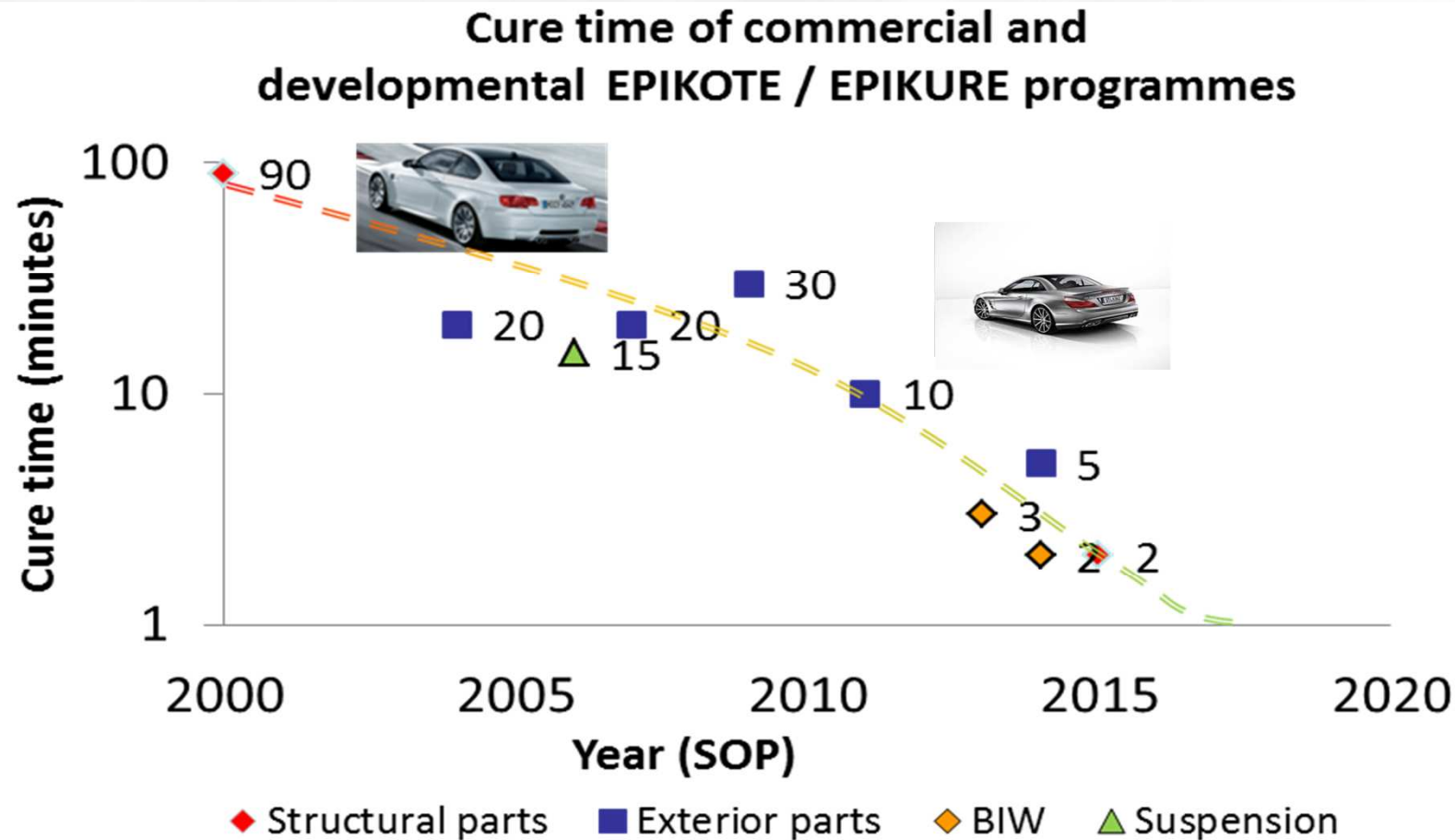
- **Surface finish quality** is critical to make painting process simpler and more robust.
- Visible Carbon and Painted Parts require different approaches
  - Liquid molding processes and Prepreg are both possible

## Dynamically loaded parts

- **Proven performance** on Fatigue and Temperature resistance
- Various approached towards **mass production** under way

# Recent Advances in Epoxy Systems

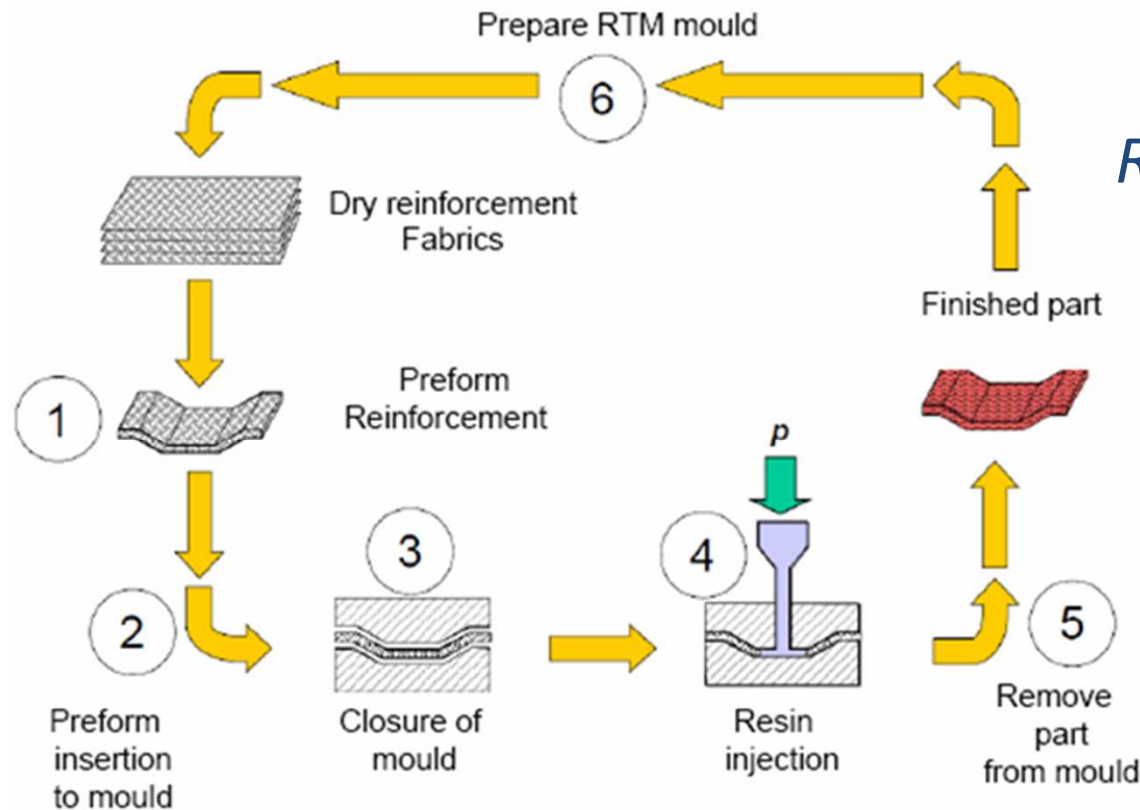
## Cure Time



Substantial progress in epoxy resin technology and processes have been made during the last 3 years



# How have the short cycle times been achieved?



*Example:  
Resin Transfer Molding  
(RTM)  
Production Process*

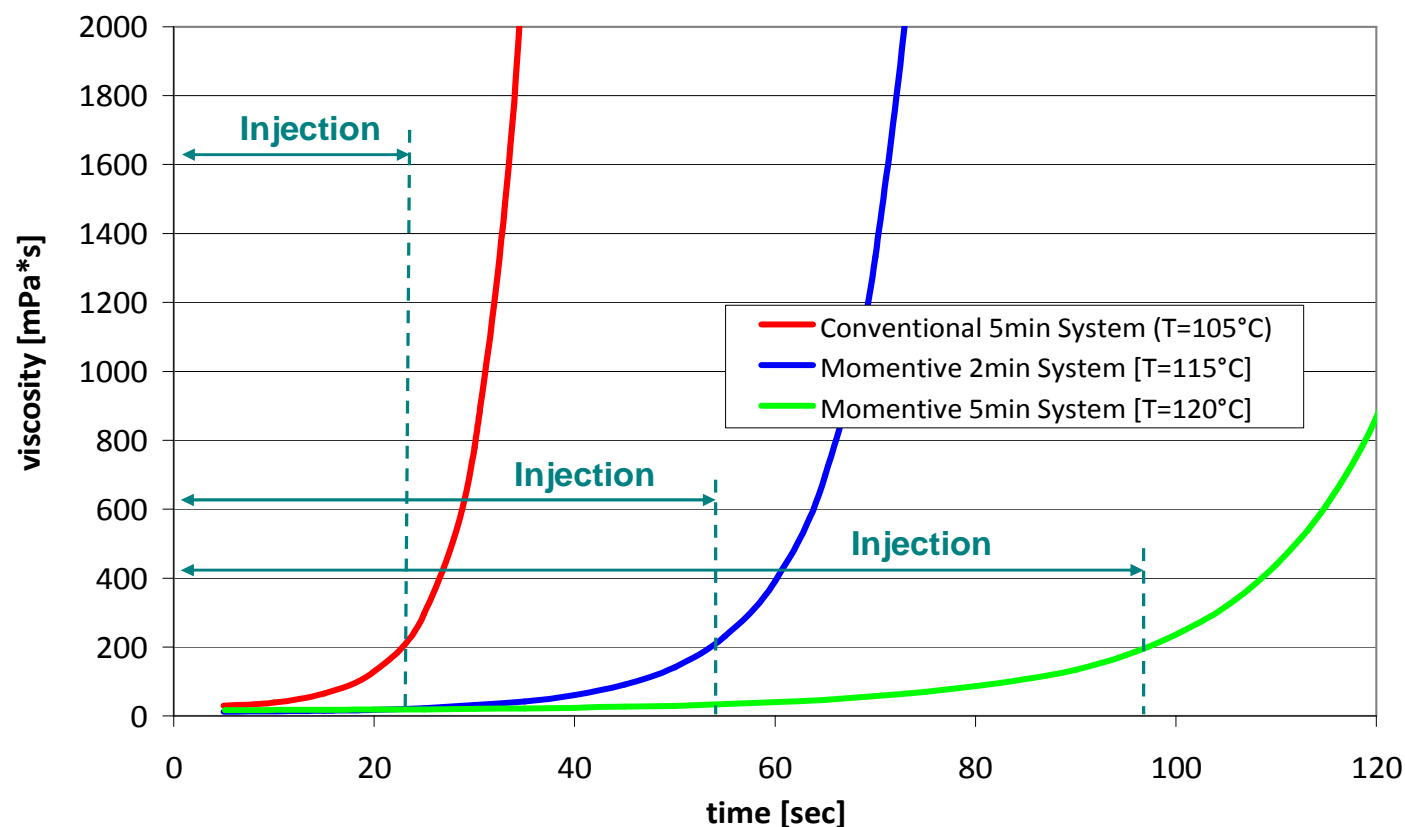
( Diagram courtesy of Dieffenbacher )

**Step ① - Preforming**

**Step ④ - Injection & Cure Cycle**

**Main Limiting Factors**

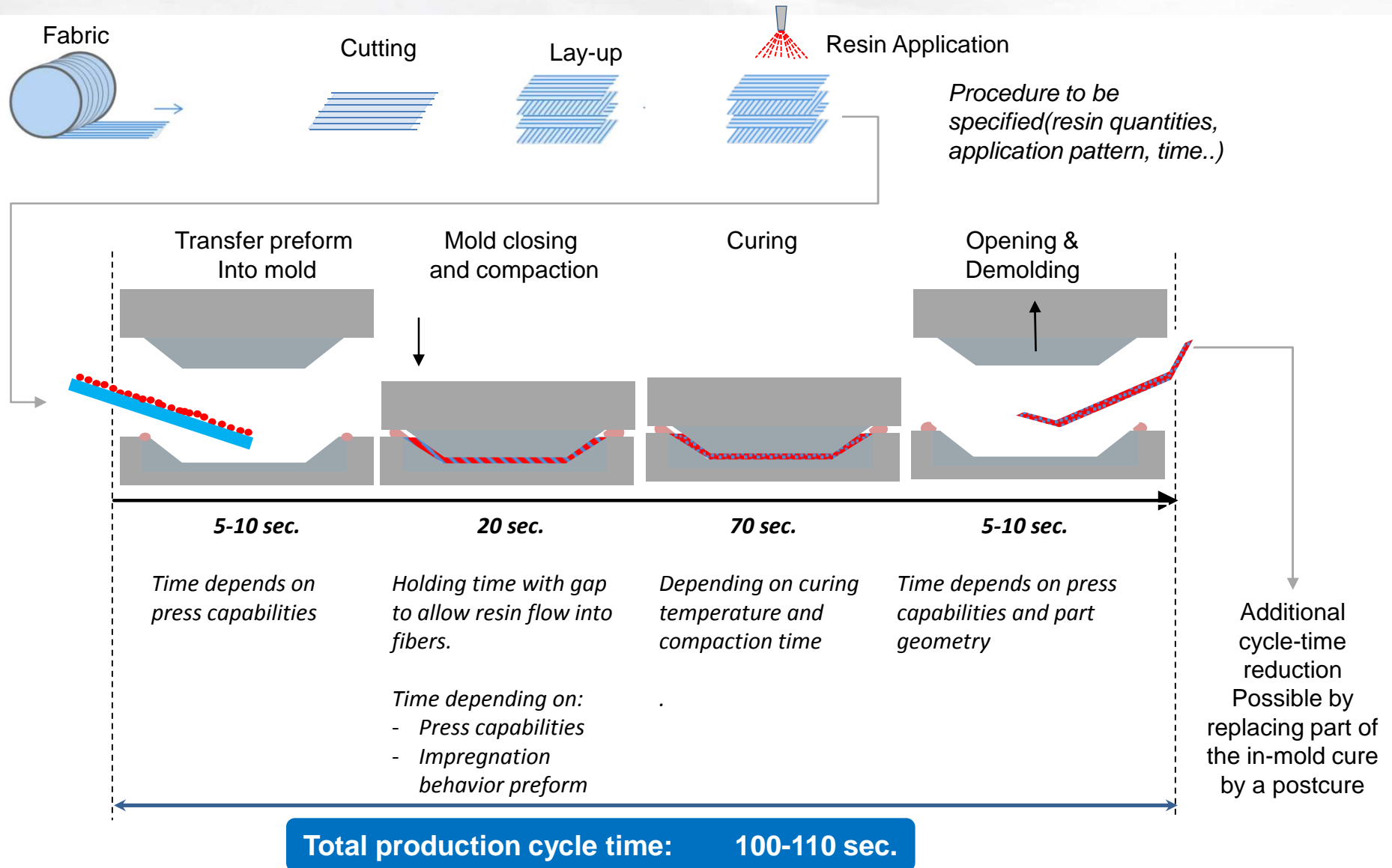
# Enabling Technology: Thermo-latent Short Cycle Time Epoxy Resin Systems



**2min System = EPIKOTE™ 05475 / EPIKURE™ 05500 / HELOXY™ 112**

**2 X longer injection window => ~ 60s @ 2min cure**

# Liquid Compression Molding (LCM) Process Cycle



# Lightweight Epoxy Composites

## Process and Application Options

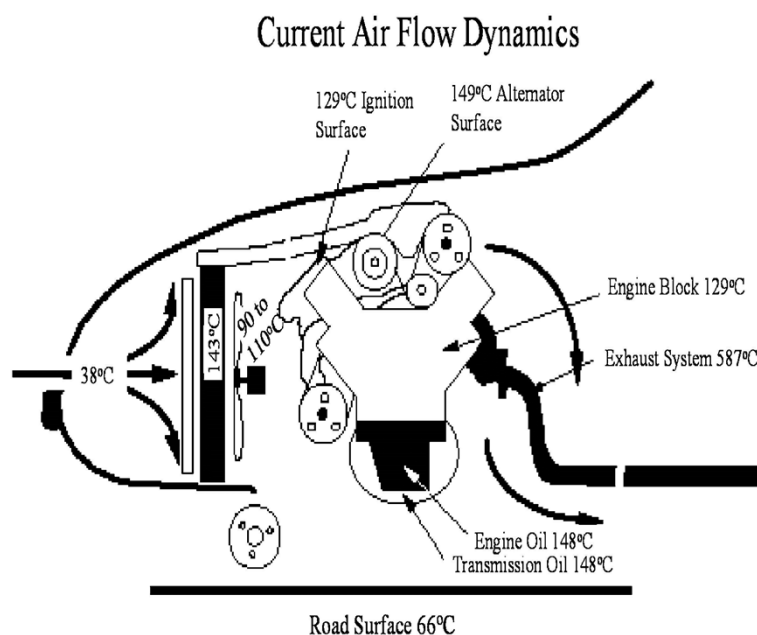
	Liquid Compression molding LCM	HP-RTM	LP-RTM	Prepreg Compression molding	FiWi
<b>Structural Parts</b>					
Simple 3D shape	<2 min	2-3 min	3-8 min	3-5 min	
3D shapes		2-3 min	3-8 min		
Tubular parts		2-3 min	3-8 min		
<b>Exterior Parts</b>		20 min for visible carbon	20 min for visible carbon	5 min for painted parts	
<b>Dynamically loaded Parts</b>					
Coil springs					Y
Leaf springs		5 min		20 min	Y
<b>CNG , H2 tanks</b>					
Type III and IV					Y



# **Bakelite™ Engineering Thermoset compounds for Mass Production of Light-Weight Under-the-Hood Parts**

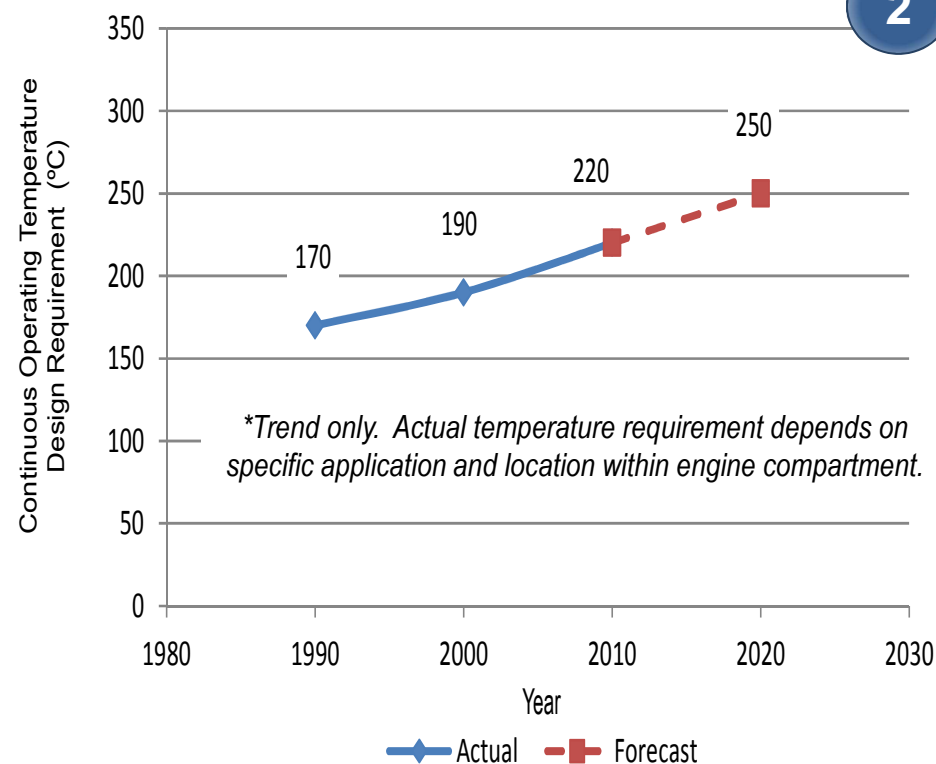
# Engine Compartment Operating Temperature Design Requirements Increasing

2



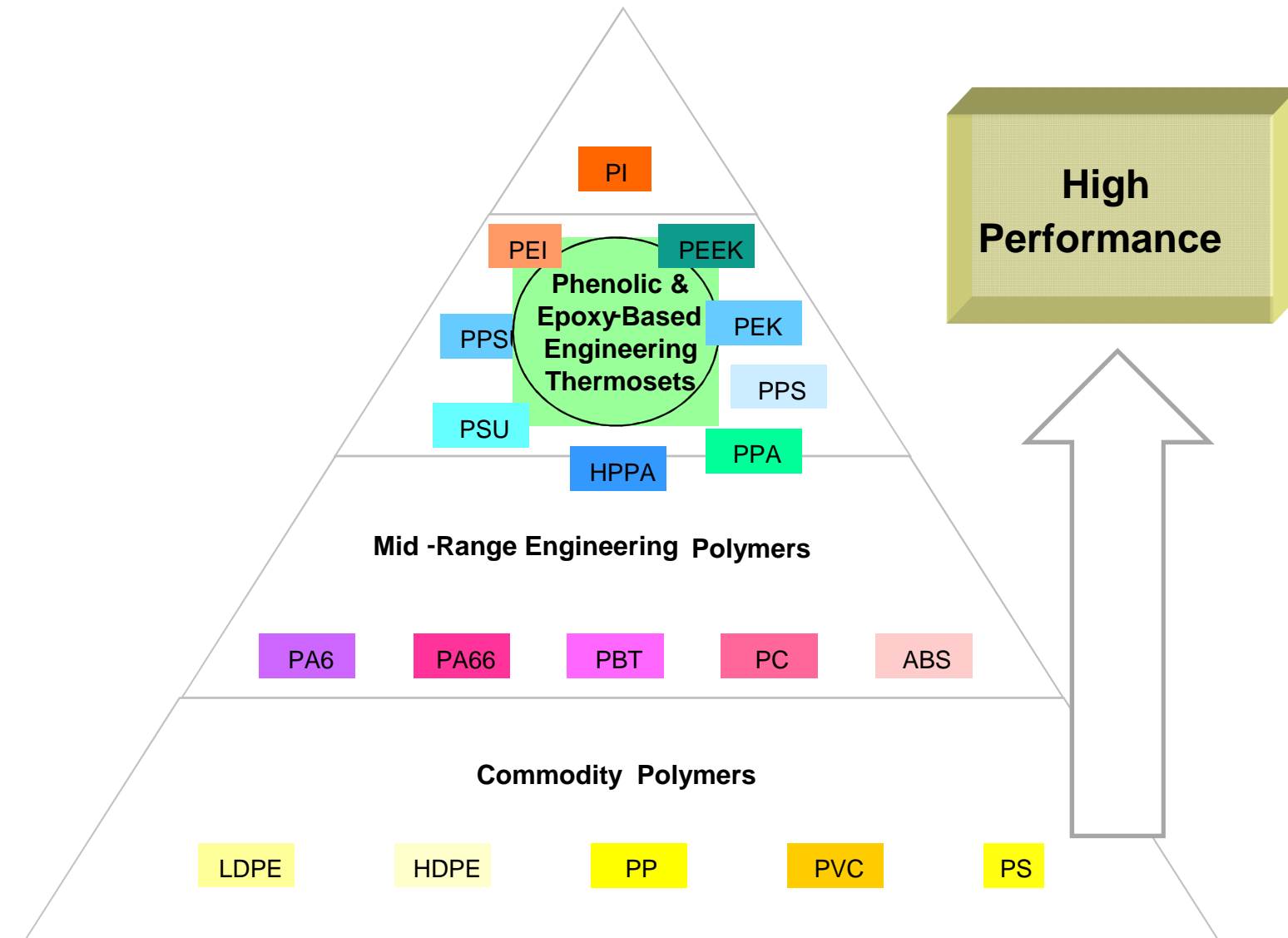
Air flow assisted operating temperatures for components range from ~130°C - 150°C.

Excursions and design temperatures can be higher =>



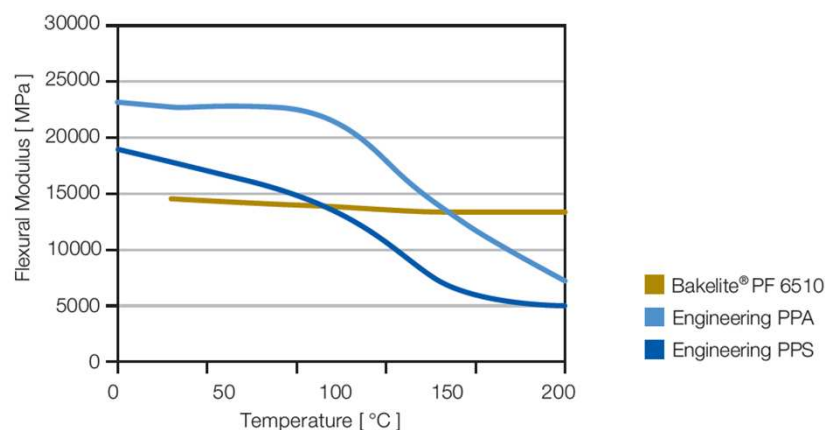
Sources: Data from [High-Temp Thermoplastics: Higher Expectations](#), CompositesWorld, 2012, The Changing Automotive Environment: High-Temperature Electronics, R. Johnson et al., 2004.

# Performance Classification of Polymers

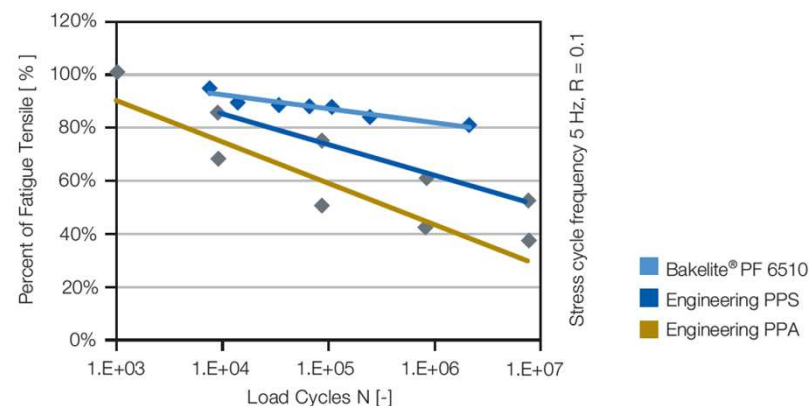


# Value Proposition: Lightweight Materials with Outstanding Overall Performance

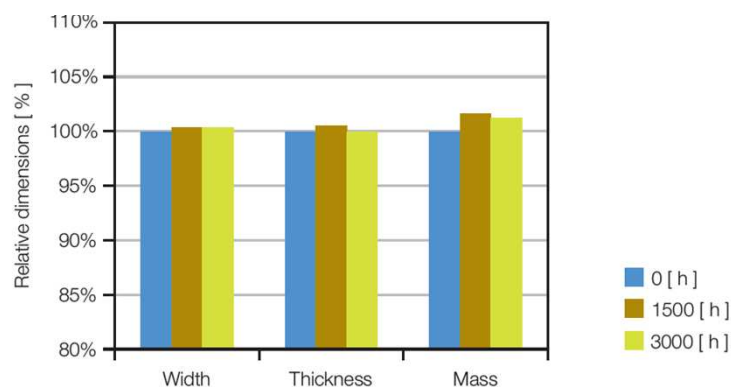
## Thermo Mechanical



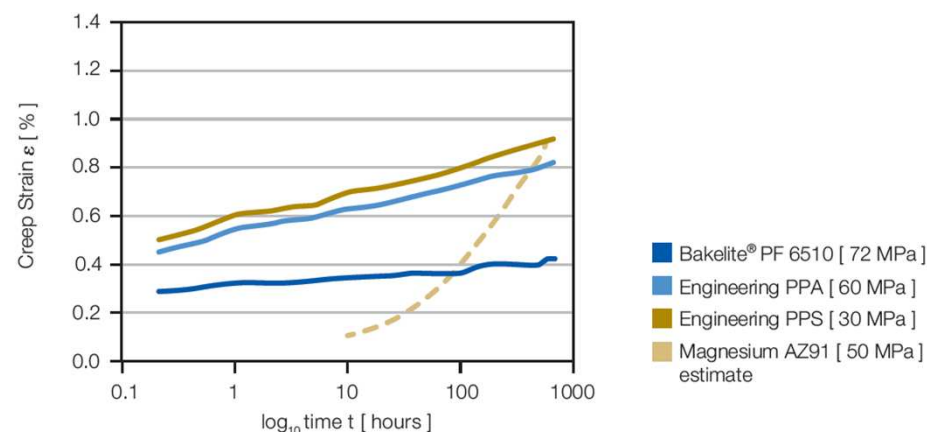
## Fatigue



## Chemical



## Creep





# Processing Engineering Thermosets



Automated  
Injection Molding  
Machine

Automated  
Compression  
Molding Machine



# Engineering Thermoset (ETS) Applications



*Pulley*



*Vacuum Pump*



*Waterpump*



*Turbopump Rotor*



*Break Parts*



*Interior*

# THANK YOU!

**for your  
ATTENTION**

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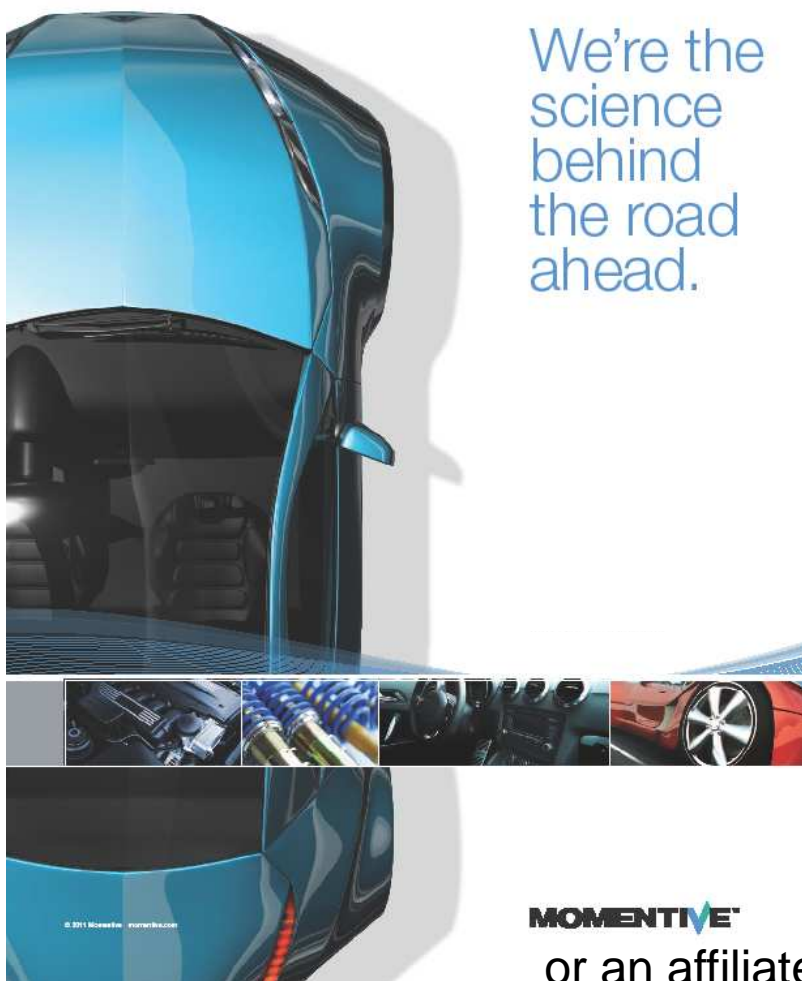
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science  
behind  
the road  
ahead.

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EPIKURE™ Curing Agents  
Heloxy™ Additives  
Bakelite® Thermosets  
Cellobond® Phenolic Resins  
Durite® Phenolic Resins  
Rutaphen® Phenolic Resins  
Versatic™ Acid  
VeoVa™ Vinyl ester monomer  
Cardura™ Glycidyl Ester Monomer  
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