# Perspectives on Thermoset Composites Use in the Global Automotive Market
# FEIPLAR – Saõ Paolo, Brasil

Presented by Cedric Ball
Ashland Performance Materials
November 2008

# Contents

- Automotive Environment
- Current Thermoset Composites Use
- Customer Needs
- Outlook for Composites Growth
- Latest In Developments In Thermoset Composites

# The 2008 Global Financial Crisis

*The automotive industry is facing the most complex challenges in its history. Never has it been more crucial for suppliers, automakers and retailers to adjust, adapt and overcome these challenges.*



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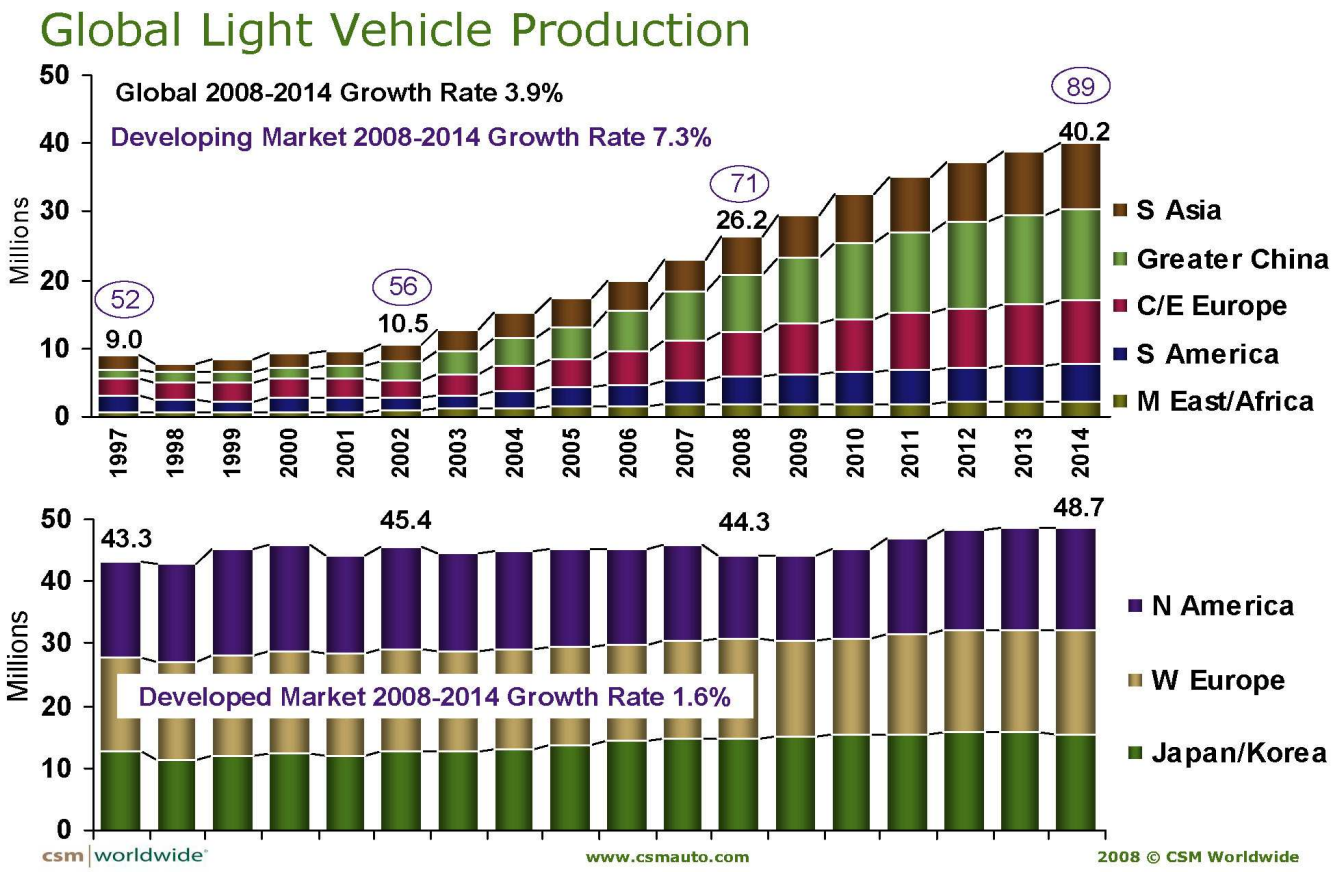
# Market Dynamics


- **U.S. Economy Struggling**
- **Crude Oil And Raw Material Volatility**
- **Manufacturing Migration To Emerging Markets**
- **Increasing Emphasis On The Environment**

# Market Drivers & Trends

| Suppliers | Automotive Manufacturers | Retailers | Consumers |
|---|---|---|---|
| • Increasing Competition<br>• Modularization<br>• Complexity<br>• E-Business Dev'ment<br>• Raw Material Costs | • Increasing Competition<br>• Excess capacity<br>• Development Costs<br>• Consolidation of Supply and Retail base | • Increasing Competition<br>• Decreasing margins<br>• New Info Technologies<br>• Alternative Channels | • Access to Information<br>• Increasing choice<br>• Car as Fashion<br>• Rising Fuel Costs<br>• Environment & Safety |
| • Consolidation<br>• Selective Development<br>• Market Diversification | • Globalization<br>• Consolidation<br>• Modularization<br>• Production Flexibility<br>• Rationalization<br>• Brand Management | • Consolidation<br>• Aftersale Income | • Demand for Best Value<br>• Demand for Best Offer<br>• Customization<br>• Fuel efficiency<br>• Carbon footprint |

# Global Light Vehicle Production



Current Use

# Transportation Market

## Light Vehicle and Heavy Truck Applications


**$70.6 Billion**

Cast Parts: $66,100 MM = (31% of $213 Billion Global Castings Market)
Composite Parts: $2,720 MM
Thermoset Resin-Based Adhesives: $1,800 MM

**$2,676 MM = "TAM"**

Casting Consumables: $1,600 MM
Thermoset Composite Resins (All Chemistries): $960 MM
Thermoset Resin-Based Adhesives: $116 MM

*Sources: E-Composites 2004-2010, p147., Skeist, PGPhillips, American Foundry Society, Ashland Estimates
All figures are OEM sales plus aftersale parts and services. Rail is rolling stock only.



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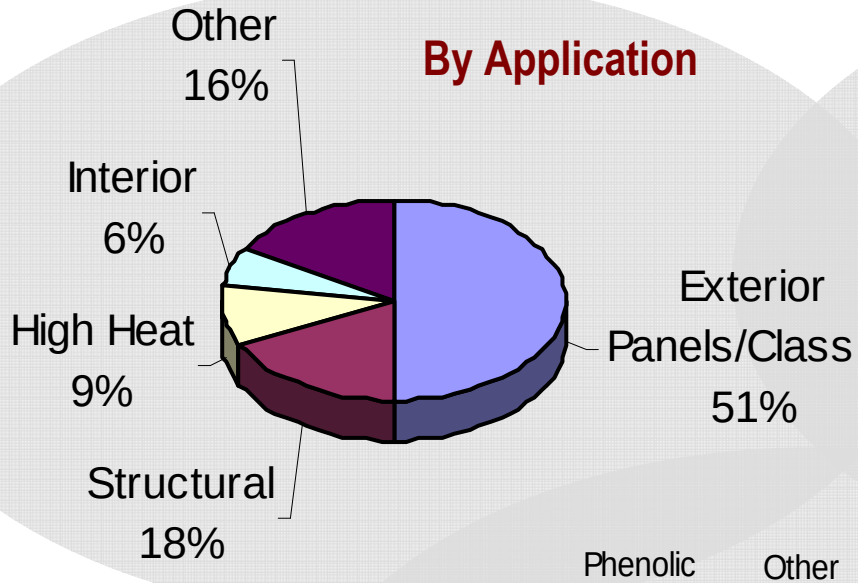
Current Use

# Composite Resins

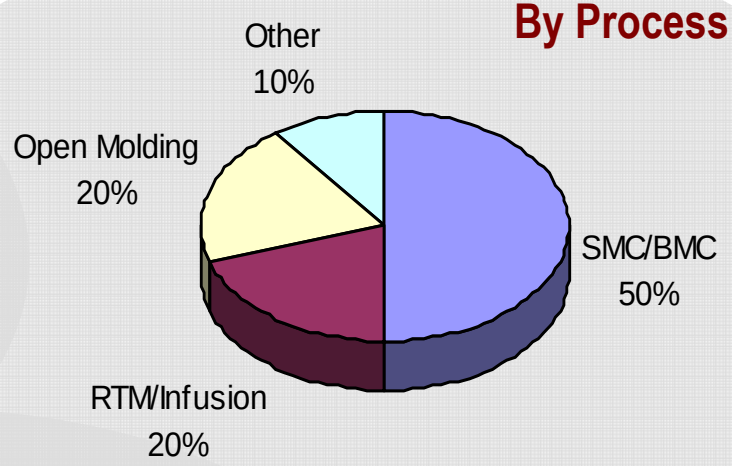
## for Light Vehicle & Heavy Truck End Use Segments



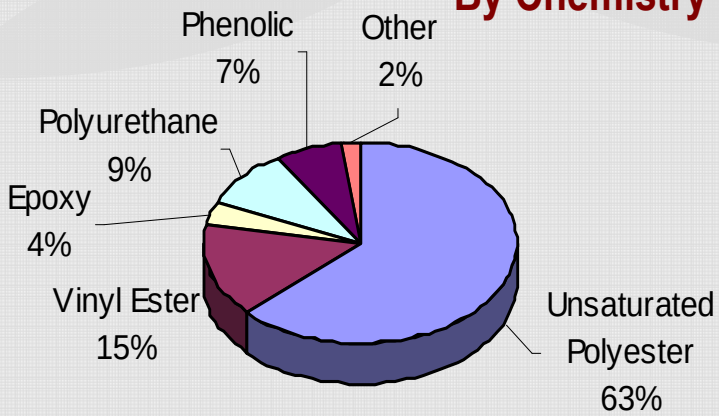
### By Application




### By Process



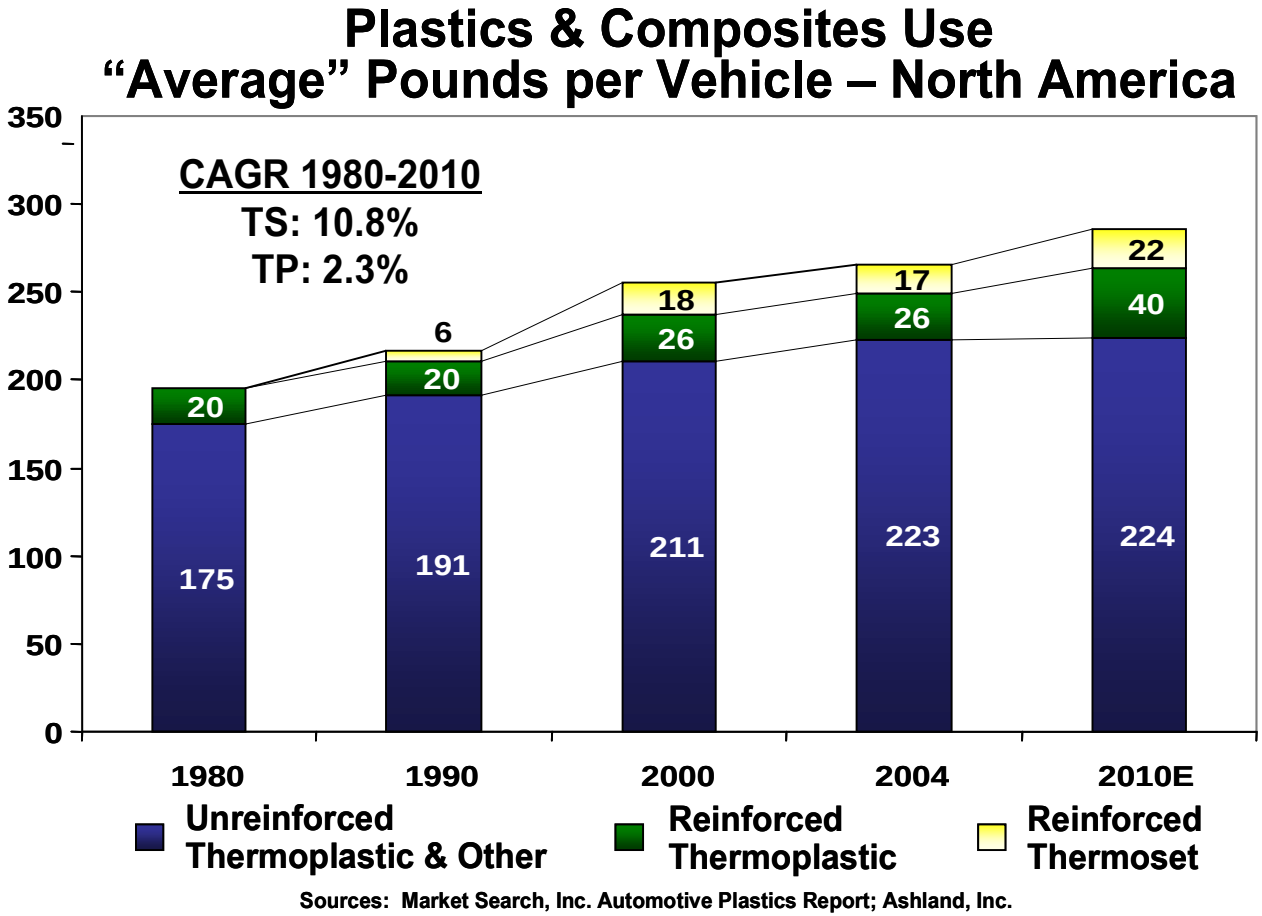

### By Chemistry




*Sources: E-Composites 2004-2010, p33, p167 and Ashland Estimates

Current Use

# Market Acceptance of Composites



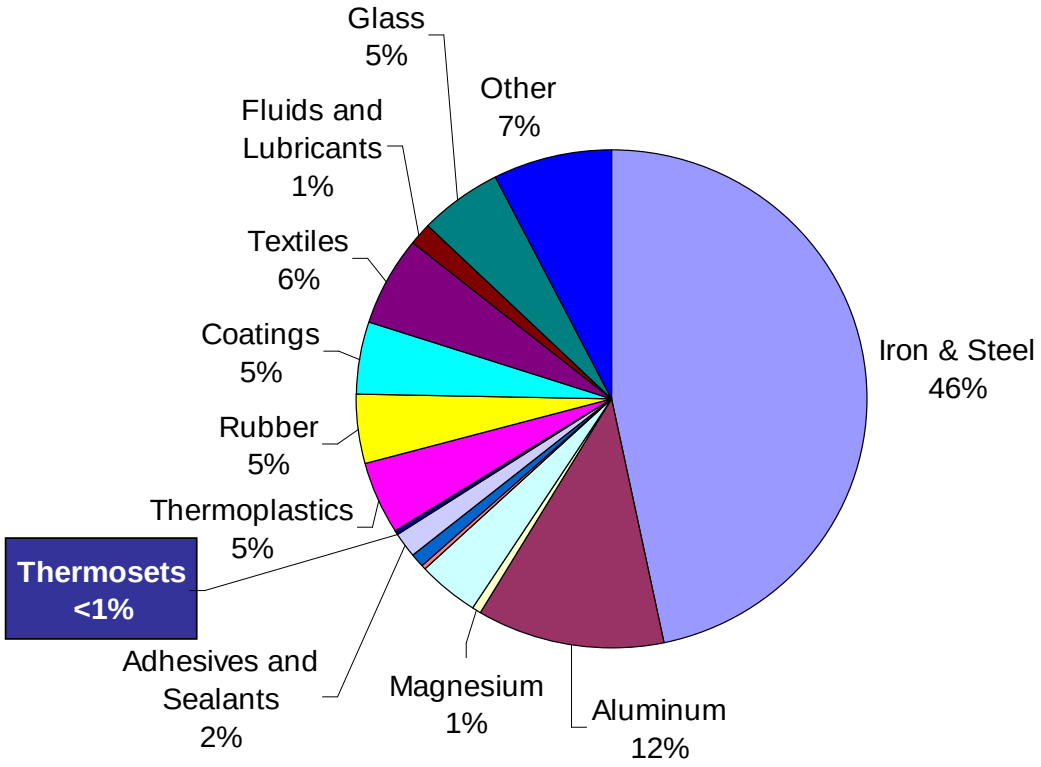

Sources: Market Search, Inc. Automotive Plastics Report; Ashland, Inc.

**The trend for composites is toward greater use.**

Current Use

# Materials Use on a Typical Vehicle

## Percent Materials Value of Typical Light Vehicle

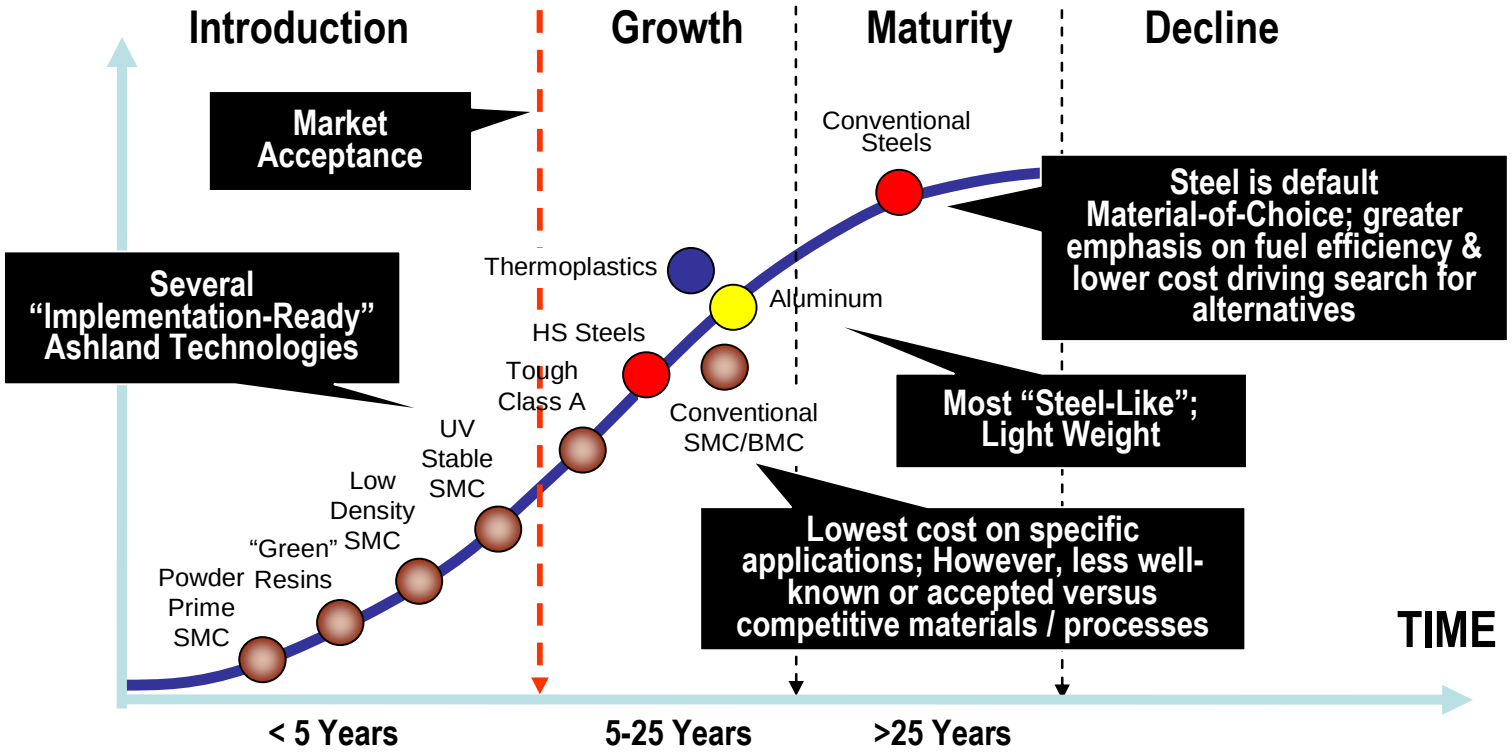



Sources: American Chemistry Council, US Bureau of Economic Analysis, Center for Automotive Research, Ashland Estimates

Current Use

# Market Acceptance of Composites

## *Composites Product Life Cycle vs. Competitive Materials*




Prepared by Cedric Ball

**Composites is a growth stage materials industry gaining acceptance.**

Customer Needs

# Cascade of Needs in Transportation

**OEM**
1. Regulatory and performance compliance
2. Lowest manufactured cost
3. Design freedom
4. Parts integration
5. Weight reduction

**Molder**
1. Defect-free
2. Consistent quality
3. Short cycle time
4. Adhesive-friendly
5. Versatile formulations

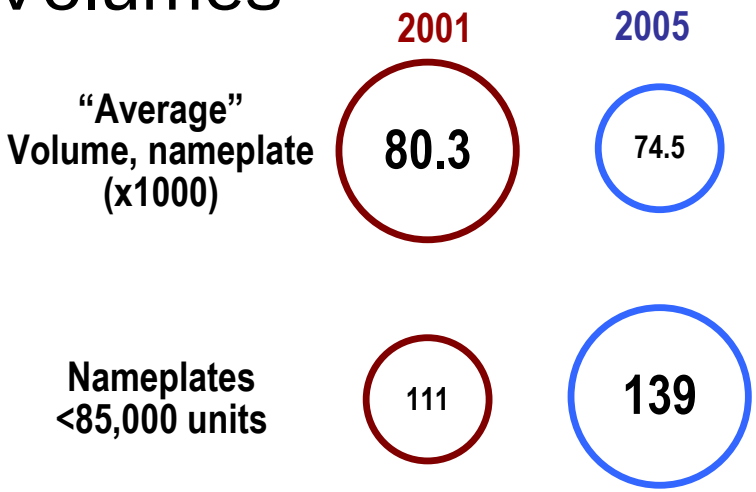
**Compounder**
1. Consistent quality
   - Viscosity
   - Reactivity
   - Thickening
   - Color
2. Versatile formulations
3. Stable shelf-life

# Composites Growth Challenges

- Invested Capital is Based On Steel and Mass Production Economics
- Lack of Awareness and Standardization of Composites
- Lack Of Predictive Engineering Tools/Data
  - Non-linear, Non-isotropic Behavior
  - Difficult Prediction of Fiber Orientation, Placement And Concentration (SMC/BMC)

# Why Be Optimistic? Reason #1

- Volumes Decreasing; No. of Models Increasing
- New Assembly Plants Are More Flexible
- SMC Body Panels Are More Cost Effective Than Steel at Lower Volumes



# Why Be Optimistic? Reason #2

- OEMs Desperately Seeking Lower Cost; Better Performing Alternatives
  - Composites Offer Greater Design Flexibility Than Steel
  - Lower Weight For Same Or Better Performance
  - Lowest Total Cost In Many Situations
- Material Suppliers, Institutes And Universities Are Educating Engineers About Composites
- **Next Step Needed:** Greater Characterization and Standardization of Materials

# Why Be Optimistic? Reason #3

- Predictive engineering tools becoming more available and accurate
  - MoldFlow®
  - CadPress® (Madison Group)
- Material Suppliers, Institutes And Universities Are Characterizing Composite Materials
  - MatWeb®
  - IDAC Non-Linear Materials Library
  - NASA®

# Latest Thermoset Developments

- Tough Low Density SMC
- UV-Stable Mold-In-Color SMC
- SMC/BMC Process Control Technology
- Renewable Resource-Based Resins

Latest Developments

# AROTRAN 720/740 Low Mass SMC


- Customer: Ashland Distribution Company
- OEM: Navistar International
- Production: 2008
- Molder/Compounder: Core Molding Technologies
- Resin: AROTRAN 720 tough low mass Class A system at 1.55 s.g vs. 1.9 s.g.
- Original Part Wt: ~100 lbs.
- Actual Part Weight: 80 lbs.

# UV-Stable SMC Weathering

## (SAE J1960) 35% Fiberglass



**Original** **Low Shrink**

**2000 hrs**

**Original** **Low Shrink**

**4000 hrs**

# Weatherable SMC Field Evaluations



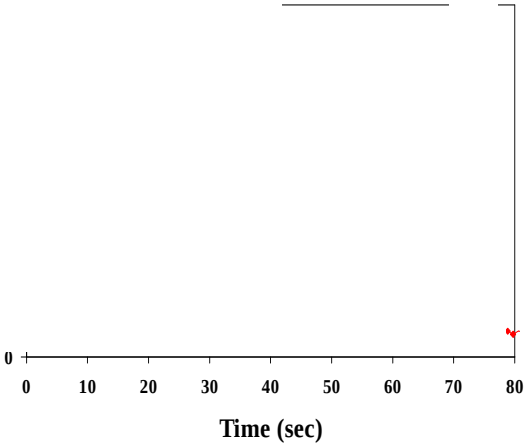
**Weatherable Mold-In-Color SMC Truck Box On Vehicle Since August 2001**

# SmartTrac® Control Technology

**Determines the precise moment of cure in a thermoset resin or compound via impedance monitoring**

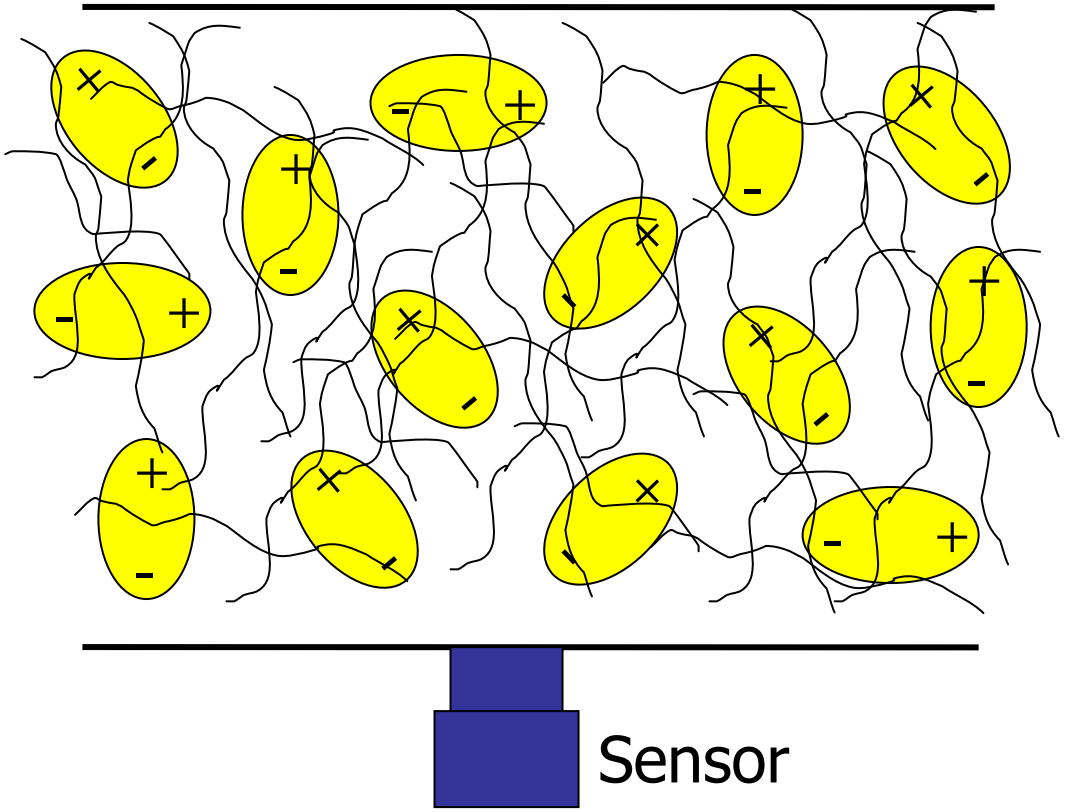
- Benefits to a molder include:
  - Shorter cycle time
  - Less molding scrap
  - Faster troubleshooting
  - Better productivity
  - Lower cost

# SmartTrac® Control Technology

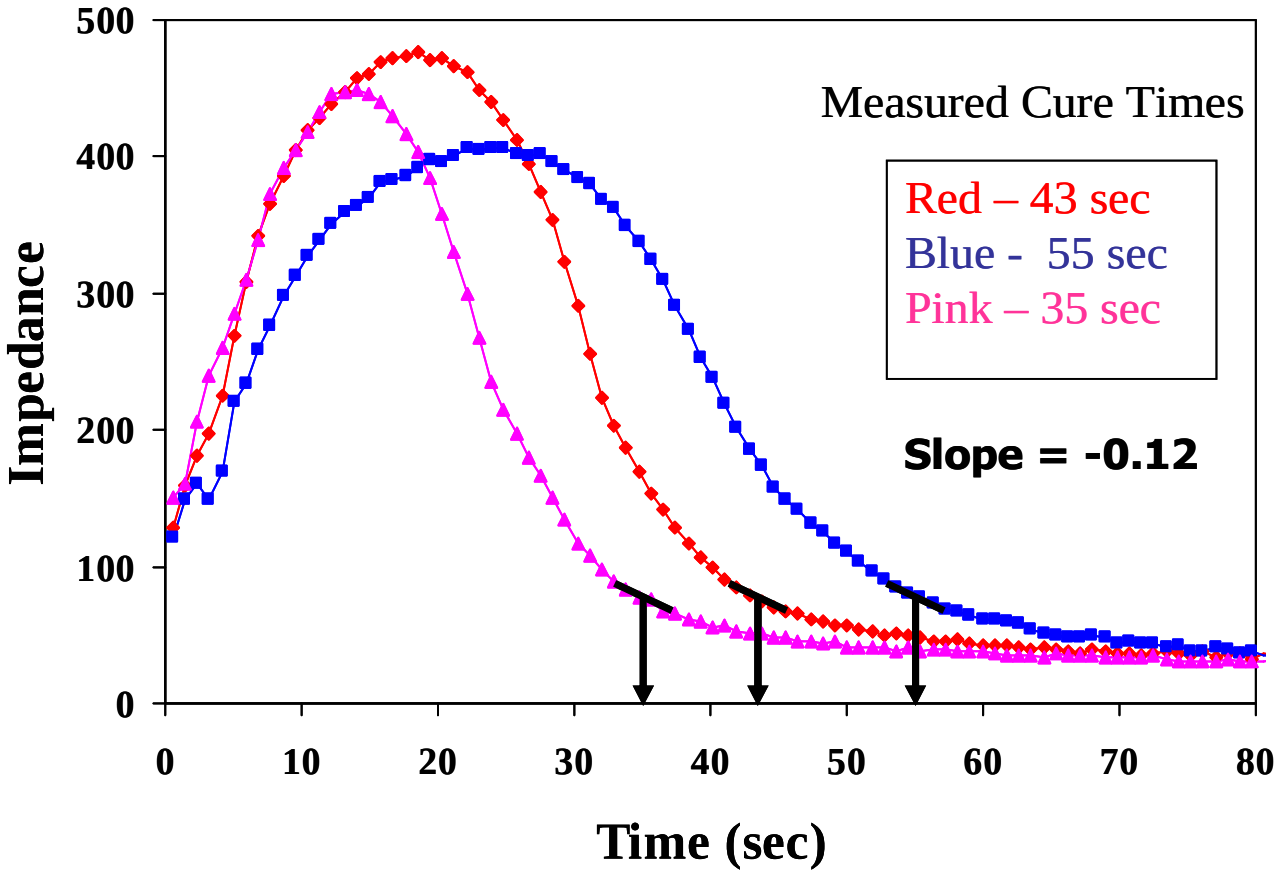



The cross linking starts and this causes the impedance values to decreases due to the respected molecular movement. This is the main goal. This value uses the impedance value to increase.

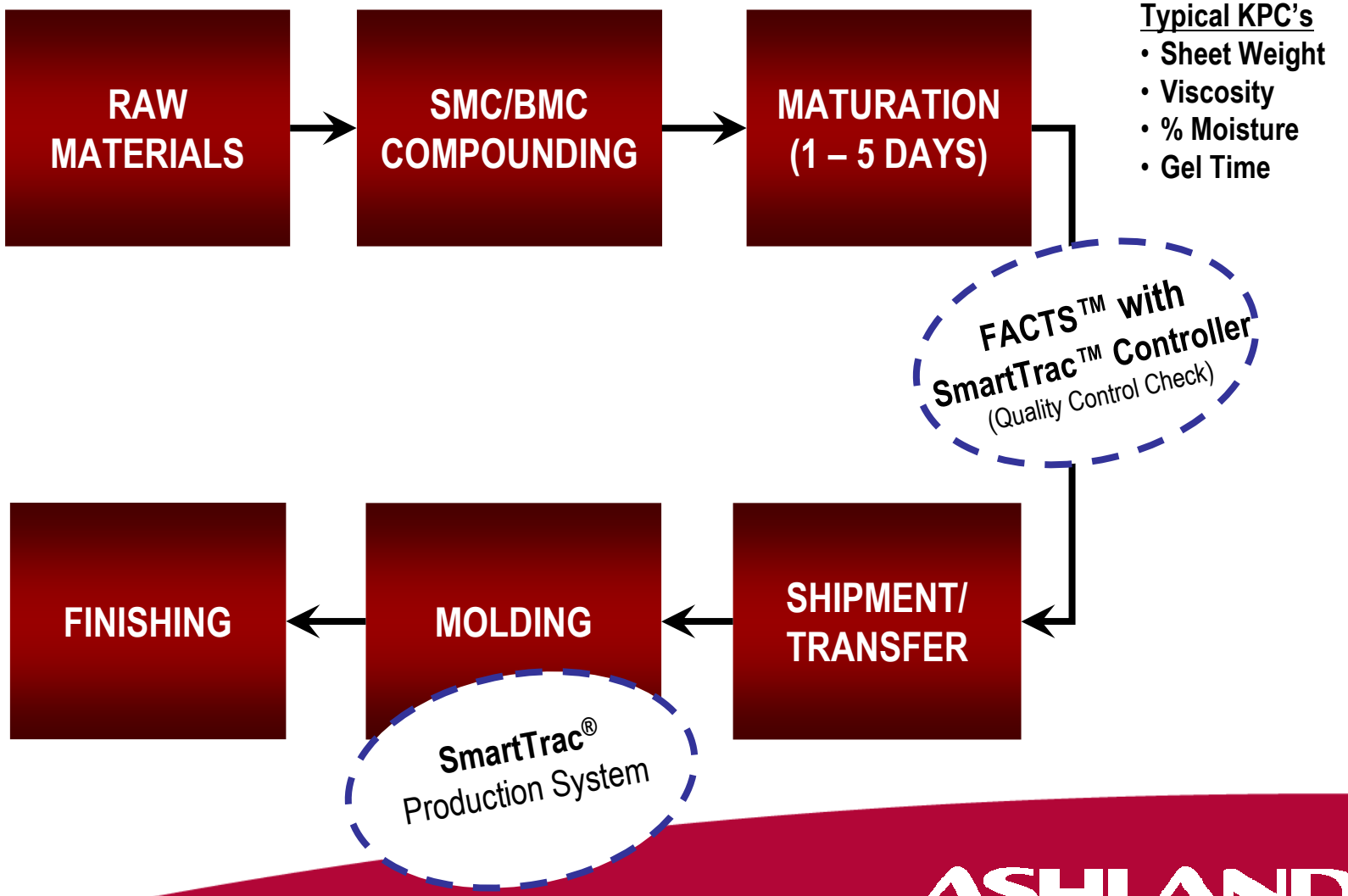
Dipolar and Ionic Behavior



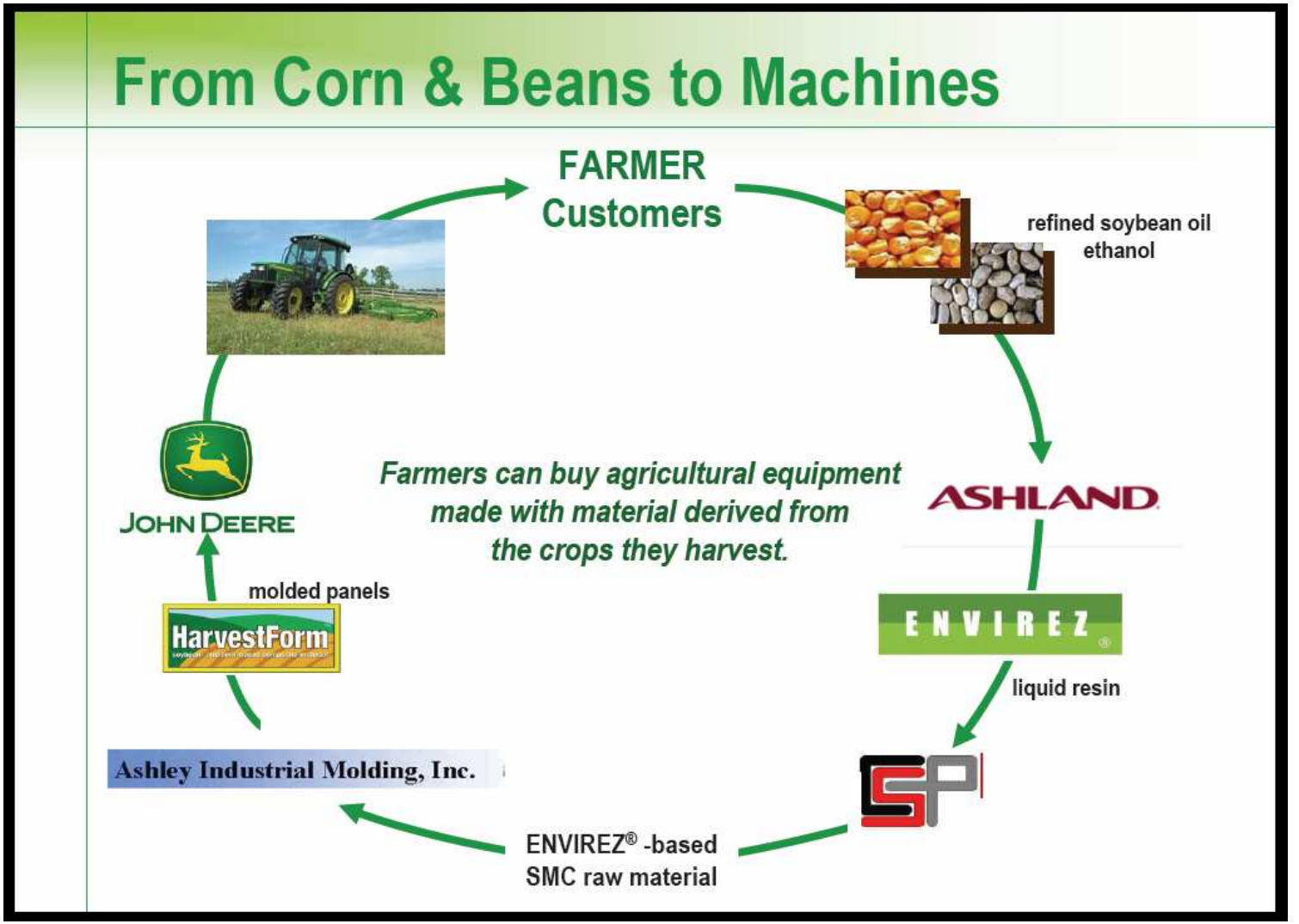
# Batch to Batch Variation



# Where Is The Technology Used?



# ENVIREZ® Soy & Corn-Based Resins



# Application Example


JOHN DEERE

ENVIREZ®

- OEM: John Deere
- Model: 9650 Combine
- Application: Engine Panels
- SOP: Current
- Vehicle Volume: 3,500
- Formulator: CSP
- Molder: Ashley Industrial
- Technology: SMC
- Material:
  - Patented ENVIREZ® renewable resource resin
- Part wt: 36 lbs./ 16 kgs.

ASHLAND

*Thank You!*

# Application Example


Various parts molded by customers Meridian Automotive Systems, Continental Structural Plastics and Molded Fiber Glass companies using **AROTRAN®** resins and **NEULON®** low profile additives from Ashland.

# Application Example


Various parts molded by customers Meridian Automotive Systems using **AROTRAN®** resins and **NEULON®** low profile additives from Ashland.

# Application Example


- OEM: Chrysler LLC
- Model: Dodge Viper
- Application:
  - Fender reinforcement
- SOP: Current
- Vehicle Volume: 1,500
- Technology: CF-SMC
- Material:
  - AROTRAN® 300 carbon-fiber compatible resin system
- Part wt:

DODGE

MERIDIAN AUTOMOTIVE SYSTEMS

AROTRAN®

# Application Example


Various parts molded by customers Meridian Automotive Systems, Continental Structural Plastics and Molded Fiber Glass companies using **AROTRAN®** resins and **NEULON®** low profile additives from Ashland.

# Application Example

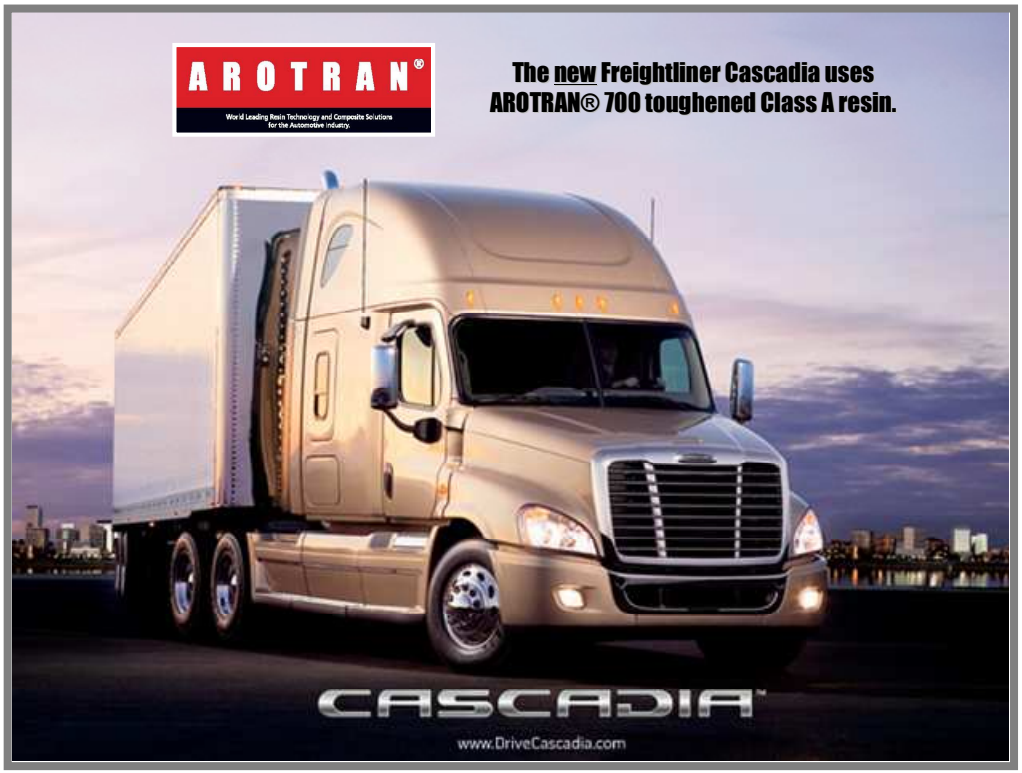
**Hummer H2 hood uses**
**AROTRAN® 611**
**Class A formula**

Various parts molded by customers Meridian Automotive Systems using **AROTRAN®** resins and **NEULON®** low profile additives from Ashland.

# AROTRAN 700/755 In Production

**Parts on the 2008 Freightliner Cascadia**
**Using Ashland AROTRAN® 700-series Tough Resin**

| Description |
|---|
| Roof bow front, XT |
| Roof bow center XT, 72" |
| Roof bow center XT, 60" |
| Roof bow center XT, 48" |
| Roof skin, rear, XT, 72" |
| Roof skin, rear, XT, 60" |
| Roof skin, rear, XT, 48" |
| Roof rein, ctr, upper, 72" RR P3 |
| Roof rein, back, 72" RR P3 |
| Rocker panel assy, slpr, front, LH/RH |
| Rocker panel assy, day cab LH/RH |
| Rocker panel assy. Day cab LH 60" |
| Rocker panel assy. Day cab RH 60" |
| Rocker panel assy. Day cab LH 48" |
| Rocker panel assy. Day cab RH 48" |
| Rocker panel assy, slpr, 72" RR, LH/RH |
| Rocker panel assy, slpr, 60" RR, LH |
| Rocker panel assy, slpr, 60" RR, RH |
| Rocker panel assy, slpr, 48" RR, LH |
| Rocker panel assy, slpr, 48" RR, RH |
| Cowl assy, 125 bbc, LH/RH |
| Roof bow side, XT, LH/RH |
| Roof bow rear, XT, LH/RH |
| Roof reinf, front lower P3 |
| Roof reinf, side lower 72"; LH/RH |
| Roof rein. CBMR, Mid, RR, P3 |
| Roof window reinf, 72" RR P3, LH/RH |
| Roof window reinf, 60" RR P3, LH/RH |
| Hood reinforcement (via Meridian) |




FREIGHTLINER®
Run Smart™

Home
Molded Fiber Glass Companies
A Distinguished International Composites Company

# Application Example

# Application Example

- OEM: Hyundai Motors
- Model: Various
- Application: Luggage Doors
- SOP: Current
- Vehicle Volume: 10,000
- Molder: Hanguk Mold Co.
- Compounder: Hanwha
- Technology: SMC
- Material: AROTRAN® 611
- Approx. Part Wt:  16 lbs / 8 kg

# Application Example


- OEM: A.R.E.
- Model: Various
- Application: Truck Caps/Covers
- SOP: Aftermarket
- Vehicle Volume: ~150,000/year total of various models
- Technology: Open Molding
- Material: AROPOL® Resins and ENGUARD® sanding gel coats

# Application Example

**MRAP: Mine Resistant Ambush Protected Military Vehicle**

# Application Example

- OEM: Navistar International
- Model: MRAP Military Vehicle
- Application: Hood Assembly (non-ballistic)
- SOP: Current
- Vehicle Volume:
- Molder/Compounder: Core Molding Technologies
- Technology: SMC
- Material: AROTRAN® 625
- Part Wt: 100 lbs.

# Application Example


Jeep®

AROTRAN®

Molded by Meridian Automotive Systems using **AROTRAN®** resins and **NEULON®** low profile additives from Ashland.

# Application Example

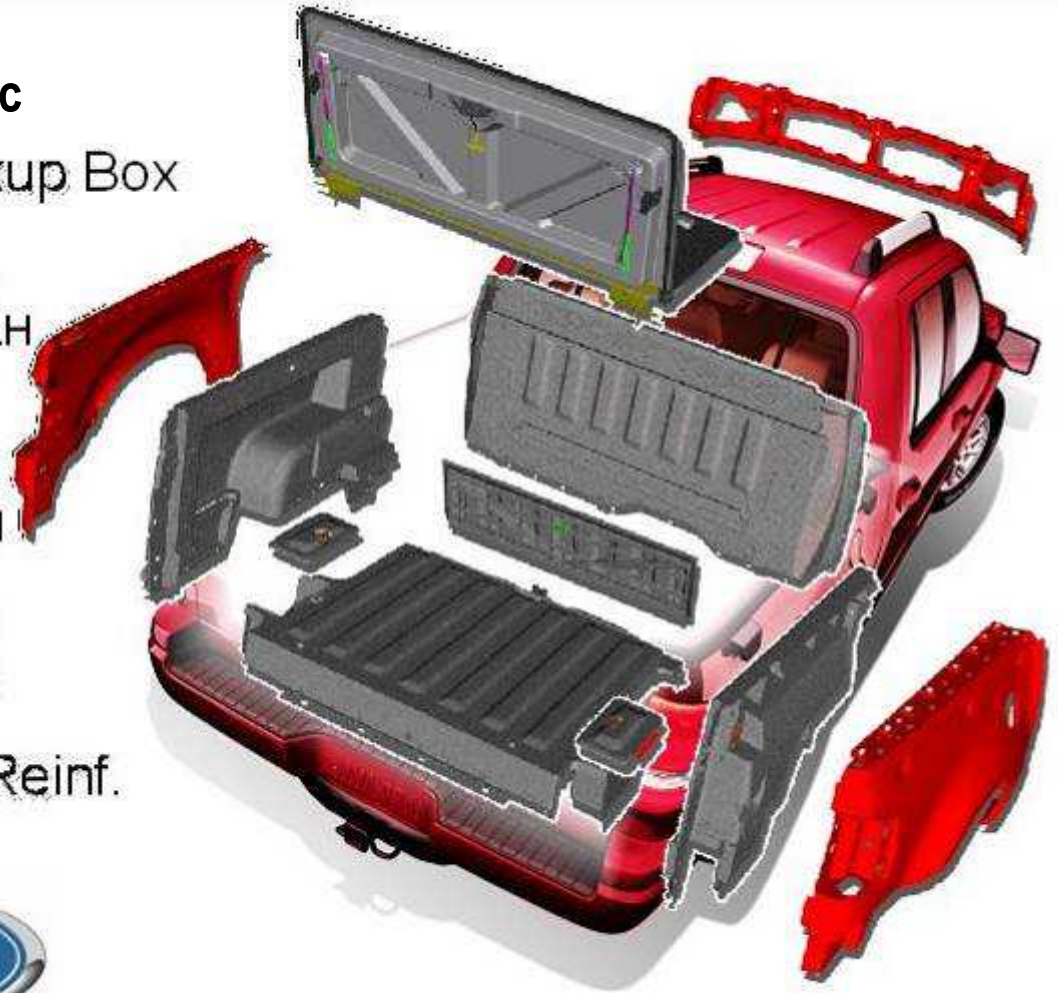
**Pontiac Solstice / Saturn Sky**
**Composite Rear Compartment**
**and Floorpan**
**uses AROPOL® Q 6266**

Molded by Molded Fiber Glass Companies using **AROTRAN®** resins and **NEULON®** low profile additives from Ashland.

# Application Example

**Ford SportTrac**

- Multi-Piece Pickup Box
  consists of:
  Floor Panel & Bins
  Box Inners, RH & LH
  Head Board
- Body Sides
  right hand & left hand
- Tonneau Cover
  two piece, articulated
- Grille Opening Reinf.



Molded by Continental Structural Plastics using **DERAKANE®** epoxy vinyl ester resin only available from Ashland.

# Application Example


Molded by Continental Structural Plastics using **DERAKANE®** epoxy vinyl ester resin only available from Ashland.

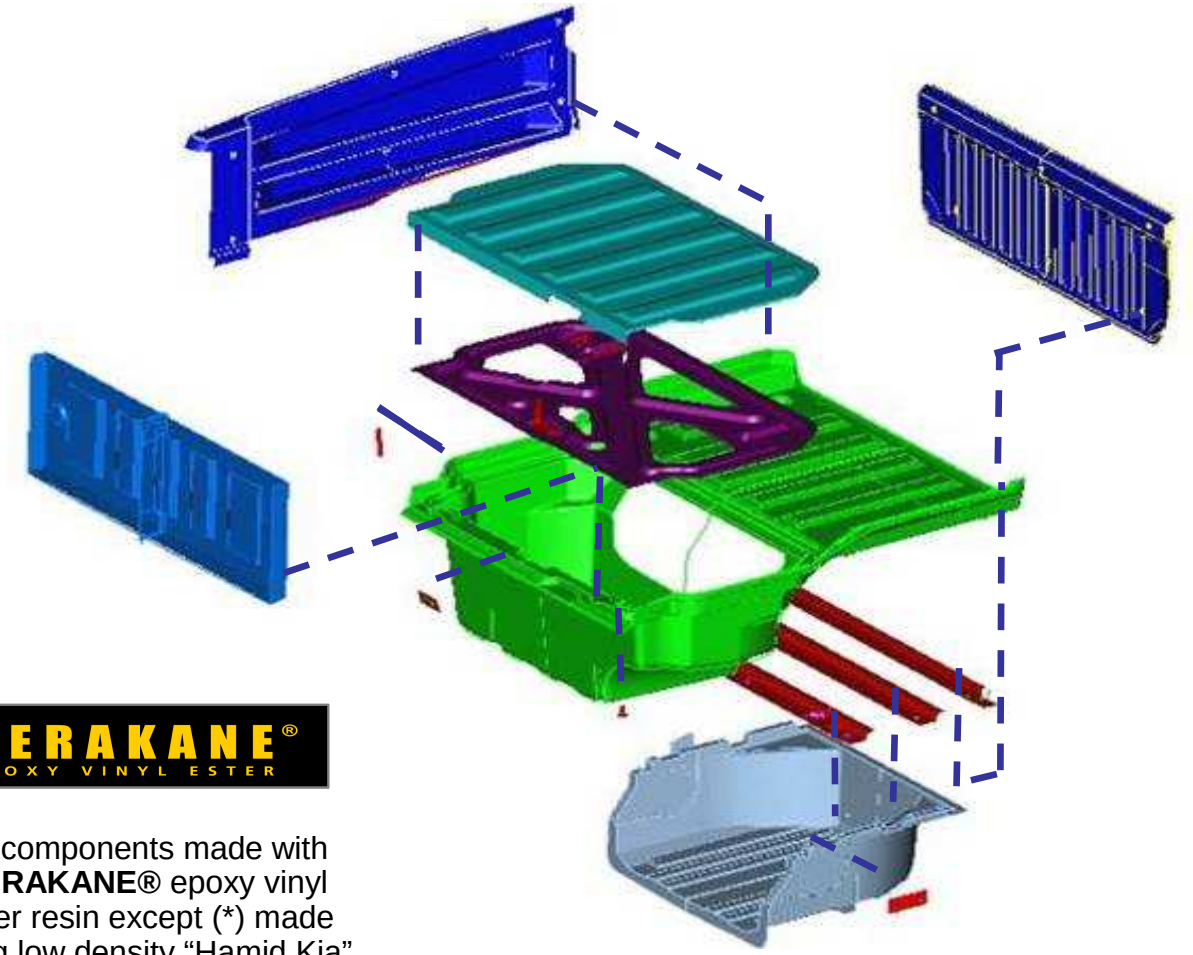
# Toyota Tacoma® Composite Bed


All components made with **DERAKANE®** epoxy vinyl ester resins only available from Ashland, Inc.

# Ridgeline® Rear Compartment


Molded by Meridian Automotive Systems using **DERAKANE®** epoxy vinyl ester resin only available from Ashland.

# Ridgeline® Rear Compartment



DERAKANE®
EPOXY VINYL ESTER

All components made with **DERAKANE®** epoxy vinyl ester resin except (*) made using low density “Hamid Kia” polyester SMC formulation

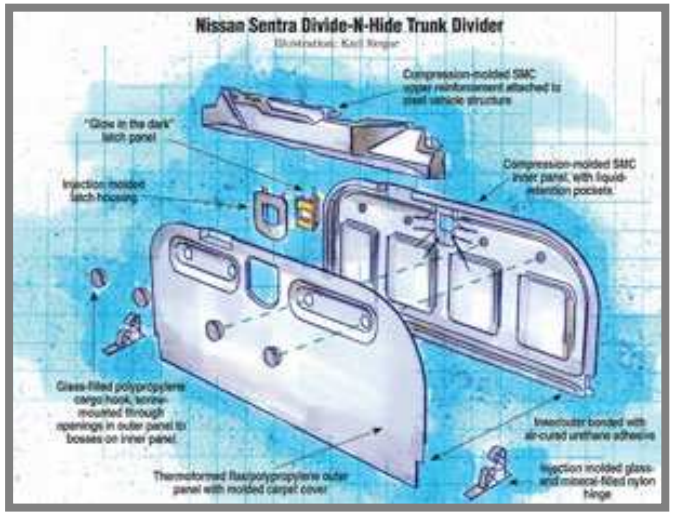
Molded by
Meridian Automotive Systems

# Application Example




**Nissan Sentra Divide-N-Hide™ trunk system**
**Molded by Meridian Automotive Systems (USA)**

# Application Example




***Divide-N-Hide™ trunk system***

- OEM: Nissan
- Model: Sentra
- Application: Trunk Divider
- SOP: Current (Option)
- Vehicle Volume: 75,000
- Molder/Compounder: Meridian Automotive Systems
- Technology: SMC
- Material: AROTRAN® 618
- Part Wt: 10 lbs. / 4.5 kgs.

MERIDIAN AUTOMOTIVE SYSTEMS

AROTRAN®

# Application Example


- OEM: Volvo
- Model: VN 730
- Application: Reinforcement - Hood Inner
- SOP: Current
- Vehicle Volume:
- Compounder / Molder: Meridian Automotive Systems
- Technology: SMC
- Material: AROTRAN® 618
- Part wt: 40 lbs. (inner only)

# Application Example


DERAKANE®
EPOXY VINYL ESTER


Valve cover material compounded by Bulk Molding Compounds, Inc. using **DERAKANE®** epoxy vinyl ester resin only available from Ashland.

# Application Example


DERAKANE®
EPOXY VINYL ESTER

- OEM: Ford Europe
- Model: DuraTorq™ TDCi
- Application: Valve Cover
- SOP: Current
- Molder: Dana Victor-Reinz
- Compounder: Polynt
- Technology: BMC
- Material: DERAKANE® 780

# Application Example

Mack MD-11 composite valve cover molded by Meridian Automotive Systems.

# Application Example

Mack TRUCKS

DERAKANE®
EPOXY VINYL ESTER

# Application Example

McNeilus
An Oshkosh Corporation Company

# Application Example


McNeilus
An Oshkosh Corporation Company

HETRON®

- OEM: McNeilus
- Model: Revolution
- Application: Mixing Drum
- SOP: Current
- Vehicle Volume: 1,000
- Fabricator: McNeilus
- Technology: Filament Winding
- Material:
  - Includes HETRON® corrosion resistant vinyl ester resin
- Part wt: 2,450 lbs.