Dow Automotive Systems

Adhesive Technology for Automotive Multi-Material Substrate Bonding

Enabling Lightweight
Improving Process Efficiency

September 2013
Authors: Frank V. Billotto; Dr. Benjamin Haag; Dr. Andreas Lutz;
Dr. Stefan Schmatloch
Presenter: Frank V. Billotto

Dowautomotive.com
Dow Automotive Systems

Contents

• Why Weight Savings?
• Why Adhesives?
• Dow’s Composites and Structural Treatment Portfolio
• Adhesive Technologies for Mixed Material Bonding
Dow Automotive Systems

Why Mass Reduction?

- Powertrain improvements alone cannot achieve the fleet fuel efficiency/emissions targets
- Mass reduction is vital for car makers to avoid fuel efficiency or emissions legislated penalties
  - 10% mass reduction = +6-8% fuel efficiency including secondary mass (and cost) reduction of powertrain / chassis
Dow Automotive Systems
Light Weight Material Comparison (Multiple Sources)

Why adhesives?
• Alternative, lighter weight materials of construction will be required
• Adhesives are an enabler for joining dissimilar materials

| Coefficient of Linear Expansion $\alpha$ of Substrates at 20°C, $\mu$m/m/$^\circ$C |
|-------------------------------|------------------|
| Steel                         | 11-13            |
| Aluminum                      | 21-23            |
| Magnesium                     | 26               |
| Continuous CFC                | 0                |
| CFC Molding Compound          | 5-20             |

(CLTE influenced by fiber content, fiber length and orientation)
Dow Automotive Systems
Challenges for Light Weight Vehicles

**Joining**
- Thinner and heat sensitive substrates
- Dissimilar Materials
- Earlier in manufacturing process
- Challenges:
  - Coefficient of linear expansion differences and residual stresses
  - Component distortion due to thermal and mechanical loads
  - Impact of residual stresses on adhesion performance
- Strength, fatigue/durability, and corrosion
- Galvanic corrosion
- Hybrid joining (secondary attachment)

**Performance**
- Safety
- NVH performance
- Ride, handling comfort
- Fuel economy/Environmentally Friendly

*Current and next generation adhesives facilitate solutions*
Dow Automotive Systems – Why Adhesives?
Tradeoffs and Benefits of New Joining Methods Required for Mixed Materials

Cost and Speed of Joining Technology with Consideration to Bonded Materials


Source: Dr. Ing. Bernard Criqui, “Robust Joining Processes for Series Production Today and Tomorrow.”
Dow Automotive Systems – Why Adhesives?
Process Adapted Structural Adhesives

• Break the trend of increasing body weight
• Multi-material use in body shop
• Bonding full aluminium vehicles

BETAMATE™
Bond Line in Yellow

Can be used for OEM, tier or field repair.

Heat Cured and Room Temperature Cured Epoxy Technology
Room Temperature Cured PU Technology

Full Body Bonding
BETAFORCE CFRP Structure

Module Bonding

Multi-Material Use

- Aluminium Sheet
- Cast Aluminum
- Aluminum Profiles
- Warm Stamped Steel
- Cold Stamped Steel

Light Weight Closures

PC Blend
LGF PP

- Body Shop 180° C, 30’
- Paint 80-160° C, 30’
- Trim Shop 25° C
- Repair
Dow Automotive Systems
Adhesive Portfolio for Multi-Material Bonding Applications

Enabling Light Weight
Design Flexibility
Dow Automotive Systems Light Weight Portfolio Synergy

**Fast Cure Resin Matrix Systems**
- Tailored Substrate Surface Chemistry for optimal performance
- Materials Design and Joint Engineering to manage inter-relationship between different substrates
- Down-engineering of composite components by leveraging adhesive joint
- Ability to develop solutions for Body Shop or Trim Shop assembly

**Carbon fiber and Derivatives**
- Optimization of interface between carbon fiber and resin
- Ability to create carbon fiber systems tailored for automotive composite applications

**Structural Cavity Filling Foam**
- Potential to reduce level of carbon fiber in the composite by leveraging reinforcement contribution of structural foam
- Acoustical contribution of foam in composite body sections

**Structural Adhesives**
- Adhesive bonding of cavity sections reinforced with structural foam
- Continuous bond-line contains structural foam within the cavity

**Dow Automotive Systems Light Weight Portfolio Synergy**

©™Trademark of The Dow Chemical Company (“Dow”) or an affiliated company of Dow
Dow Automotive Systems
Process Adapted Structural Adhesives

Selection Considerations
- Assembly requirements
- Substrates bonded
- Substrate coatings
- Cure profile
- Functional performance
- Body or Trim shop
- Manufacturing process

Elongation %

Heat Cured and Room Temperature Cured Epoxy Technology

Elastic PU Sealants:

Elastic PU Adhesives & Sealants:

Semi-Structural PU Adhesives:

Structural PU Adhesives:

Epoxy Hybrid Adhesives:

Epoxy Adhesives:

Structural Epoxy Adhesives:

Lap Shear Strength (Mpa)

Body Shop 180°C, 30’ Paint 80-160°C, 30’ Trim Shop 25°C, Repair

Heat Cured and Room Temperature Cured Epoxy Technology

Room Temperature Cured PU Technology
Dow Automotive Systems
Structural Epoxy Adhesives

**Description:** One component 1K epoxy adhesives applied in the body shop and cured in the e-Coat paint process, and two component 2K used for repair or no oven cure capability.

**Benefits:**
- Increased static and dynamic stiffness, improving vehicle quality, safety, and NVH
- Reduction of the number of welds and increased manufacturing efficiencies with reduced cycle time
- Enables lightweight material bonding like aluminum, magnesium and composites
- Bonds substrates such as oily galvanized steel, cold rolled steel and aluminum without a primer
- Compatible with other mechanical and thermal joining techniques
- Down-gauged substrates
- Excellent corrosion resistance

**Closure Bonding Applications:**
- Doors
- Hoods
- Trucks
- Lift gates

**Body Structure Bonding Applications:**
- Underbody
- Pillars
- Roofs
Dow Automotive Systems
History of Practiced Crash Durable Adhesive (CDA) Bonding

Dow first to market.

- **Normal CDA**
  - High viscosity
  - CDA and semi-CDA

- **Low Viscous CDA**
  - High impact
  - Humidity resistant
  - High application speed

- **Streamable CDA**
  - Lowest viscosity
  - High impact
  - Humidity resistant
  - High application speed
  - Jet spray

- **Wash-Off Resistant CDA (1st Gen)**
  - High viscous yield, low viscosity
  - CDA and semi-CDA
  - Humidity resistant

- **Optimized Adhesion (1st & 3rd GEN)**
  - Cohesive failure mode on CRS and GA
  - High impact
  - Humidity resistant
  - Optimized corrosion

- **Storage Stable CDA (1st & 2nd GEN)**
  - High viscosity yield, lower viscosity
  - CDA and semi-CDA
  - Shelf life, 9-12 months

Focus on adhesive development for multi-material and dissimilar substrate joining to enable light weight vehicle decisions.

- Steel, AHSS
- Aluminum
- Magnesium
- Composites

Next GEN MMM Bonding

12 | 8-2013/FB-krk

™Trademark of The Dow Chemical Company ("Dow") or an affiliated company of Dow
# Dow Automotive Systems
## Structural Epoxy Adhesives Property Overview

<table>
<thead>
<tr>
<th>Overview</th>
<th>1-Part Epoxy Adhesives</th>
<th>2-Part Epoxy Adhesives</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>E-Modulus</strong></td>
<td>Hi &amp; Lo 100-6000 MPa</td>
<td>Hi &amp; Lo 500-4000 MPa</td>
</tr>
<tr>
<td><strong>Tensile Strength</strong></td>
<td>Med &amp; Hi 10-60 MPa</td>
<td>Med &amp; Hi 10-40 MPa</td>
</tr>
<tr>
<td><strong>Tg</strong></td>
<td>90-150 °C</td>
<td>70-110 °C</td>
</tr>
<tr>
<td><strong>Impact Peel Strength</strong></td>
<td>Hi 10-60 N/mm</td>
<td>Hi 8-30 N/mm</td>
</tr>
<tr>
<td><strong>Thermal Stability</strong></td>
<td>Hi (up to 220°C)</td>
<td>Hi (up to 220°C)</td>
</tr>
<tr>
<td><strong>Typ. Curing</strong></td>
<td>180°C, 30’</td>
<td>2-7d, r.t.; 60°C, 2h</td>
</tr>
<tr>
<td><strong>Pre-curing</strong></td>
<td>Induction, IR, oven</td>
<td>RT, Induction, IR, oven</td>
</tr>
<tr>
<td><strong>Handling strength</strong></td>
<td>Pre-cure 40 min - 8 h, r.t.</td>
<td></td>
</tr>
<tr>
<td><strong>Mixed Mat. Bond.</strong></td>
<td>Good</td>
<td>Good-Excellent</td>
</tr>
<tr>
<td><strong>Oil absorption</strong></td>
<td>Yes</td>
<td>Some</td>
</tr>
<tr>
<td><strong>Relative Costs</strong></td>
<td>Med-Hi</td>
<td>Hi</td>
</tr>
<tr>
<td><strong>Process Complexity</strong></td>
<td>Low</td>
<td>Med</td>
</tr>
</tbody>
</table>
Dow Automotive Systems – Next Generation Technology
Structural Bonding Innovations – Composite Bonding

Low-Modulus Crash Durable Adhesive (CDA)
• High impact peel resistance and crash durability
• Low-Modulus at high Tg
• Designed for CFRP and high-strength steel
• Good strength and adhesion on steel and aluminum substrates, in particular also on CFRP and PA
• Good failure mode and corrosion resistance

<table>
<thead>
<tr>
<th>Properties</th>
<th>Crash Durable Adhesive</th>
</tr>
</thead>
<tbody>
<tr>
<td>E-Modulus</td>
<td>640 MPa</td>
</tr>
<tr>
<td>Glass Transition</td>
<td>113°C (DSC)</td>
</tr>
<tr>
<td>Temperature Tg</td>
<td>111°C (DMA)</td>
</tr>
<tr>
<td>LSS* CFK-CFK</td>
<td>16-25 MPa</td>
</tr>
<tr>
<td>LSS* H420-H420</td>
<td>21 MPa</td>
</tr>
<tr>
<td>LSS* CFK-H420</td>
<td>20 MPa</td>
</tr>
<tr>
<td>Impact Peel Energy*</td>
<td>18 J (23 °C); 5 J (-40°C)</td>
</tr>
</tbody>
</table>

*Oil: PL 3802-39S, Curing : 180 °C, 30 min

Structural Adhesive
• High Tg, E-Modulus
• Adhesion
• Corrosion Resistance
• Cost-Efficient
• High Elongation

CFK EP Matrix
• High Tg >200 °C
• Demold Time <3 min
• Durability
• Cost/Efficient
• Class A Finish
Dow Automotive Systems – Next Generation Technology
Structural Bonding Innovations

Heat Cured Epoxy Technology, 1-Part

• Next Gen Structural Epoxy Product
  – Successful customer trials
  – High thermal stability with optimum cure kinetics
  – Modern toughening technologies for improved dynamic strength
  – Capabilities to withstand induced thermal strains during ELPO cycle

BETAMATE™ Epoxy Technology Body Shop Application

**Trademark of The Dow Chemical Company (“Dow”) or an affiliated company of Dow**
Dow Automotive Systems
Case Study: All Aluminum Sedan

Vehicle: "Aluminum-intensive sedan. Weight-saving benefits make aluminum a natural choice. Extrusions, stampings, and castings are expertly joined for rigidity and strength."

Products:
- Structural 1K epoxy crash durable adhesive
- Structural 1K epoxy hem adhesive
- Elastic glass bonding polyurethane adhesive

Vehicle Applications:
- Body structure
- Closure
- Glass bonding

Enabling Technology:
- One-part, high performance, heat-curing, epoxy adhesive
- Enables use of alternative materials in vehicles to reduce weight
- Enables joining of low weight materials (Al) in general body shop

Substrates Bonded:
- Pre-treated aluminum (cast, sheet and extruded)

Cure Cycle:
- Standard e-Coat cure process

Key Product Features:
- Excellent adhesion to aluminum
- Superior stress durability
- Resistant to degradation and substrate corrosion with environmental aging
- High sag resistance and wash-off resistance
- Excellent low temperature peel strength
Dow Automotive Systems
Case Study: Light Weight Closures

Product:
• Low Modulus, 1K epoxy structural adhesive

Vehicle Application:
• Engine hood hem flange

Enabling Technology:
• Provides a reliable hemming solution enabling OEMs to use advanced ultra-light weight materials like Aluminum to reduce weight and improve fuel economy
  • One component, easy application
  • Low modulus minimizing part deformation or read through after cure heat
  • High strength ensures durability

Substrates Bonded: Aluminum sheet

Cure Cycle:
• Normal e-Coat baking workable

Heat Cured Epoxy Technology, 1-Part
Dow Automotive Systems
Process Adapted Structural Adhesives

Selection Considerations
- Assembly requirements
- Substrates bonded
- Substrate coatings
- Cure profile
- Functional performance
- Body or Trim shop
- Manufacturing process

Elongation %

Lap Shear Strength (Mpa)

Epoxy Hybrid Adhesives:
Epoxy Adhesives:
Structural Epoxy Adhesives:

Elastic PU Sealants:
Elastic PU Adhesives & Sealants:
Semi-Structural PU Adhesives:
Structural PU Adhesives:

Heat Cured and RT Cured Epoxy Technology
Room Temperature Cured PU Technology, 2-Part

Body Shop 180° C, 30’ Paint 80-160° C, 30’ Trim Shop 25° C, Repair

Heat Cured and RT Cured Epoxy Technology
Room Temperature Cured PU Technology, 2-Part

Dow Automotive Systems
Process Adapted Structural Adhesives

Selection Considerations
- Assembly requirements
- Substrates bonded
- Substrate coatings
- Cure profile
- Functional performance
- Body or Trim shop
- Manufacturing process

Elongation %

Lap Shear Strength (Mpa)

Epoxy Hybrid Adhesives:
Epoxy Adhesives:
Structural Epoxy Adhesives:

Elastic PU Sealants:
Elastic PU Adhesives & Sealants:
Semi-Structural PU Adhesives:
Structural PU Adhesives:

Heat Cured and RT Cured Epoxy Technology
Room Temperature Cured PU Technology, 2-Part

Body Shop 180° C, 30’ Paint 80-160° C, 30’ Trim Shop 25° C, Repair

Dow Automotive Systems
Process Adapted Structural Adhesives

Selection Considerations
- Assembly requirements
- Substrates bonded
- Substrate coatings
- Cure profile
- Functional performance
- Body or Trim shop
- Manufacturing process

Elongation %

Lap Shear Strength (Mpa)

Epoxy Hybrid Adhesives:
Epoxy Adhesives:
Structural Epoxy Adhesives:

Elastic PU Sealants:
Elastic PU Adhesives & Sealants:
Semi-Structural PU Adhesives:
Structural PU Adhesives:

Heat Cured and RT Cured Epoxy Technology
Room Temperature Cured PU Technology, 2-Part

Dow Automotive Systems
Process Adapted Structural Adhesives

Selection Considerations
- Assembly requirements
- Substrates bonded
- Substrate coatings
- Cure profile
- Functional performance
- Body or Trim shop
- Manufacturing process

Elongation %

Lap Shear Strength (Mpa)

Epoxy Hybrid Adhesives:
Epoxy Adhesives:
Structural Epoxy Adhesives:

Elastic PU Sealants:
Elastic PU Adhesives & Sealants:
Semi-Structural PU Adhesives:
Structural PU Adhesives:

Heat Cured and RT Cured Epoxy Technology
Room Temperature Cured PU Technology, 2-Part

Dow Automotive Systems
Process Adapted Structural Adhesives

Selection Considerations
- Assembly requirements
- Substrates bonded
- Substrate coatings
- Cure profile
- Functional performance
- Body or Trim shop
- Manufacturing process

Elongation %

Lap Shear Strength (Mpa)

Epoxy Hybrid Adhesives:
Epoxy Adhesives:
Structural Epoxy Adhesives:

Elastic PU Sealants:
Elastic PU Adhesives & Sealants:
Semi-Structural PU Adhesives:
Structural PU Adhesives:

Heat Cured and RT Cured Epoxy Technology
Room Temperature Cured PU Technology, 2-Part

Dow Automotive Systems
Process Adapted Structural Adhesives

Selection Considerations
- Assembly requirements
- Substrates bonded
- Substrate coatings
- Cure profile
- Functional performance
- Body or Trim shop
- Manufacturing process

Elongation %

Lap Shear Strength (Mpa)

Epoxy Hybrid Adhesives:
Epoxy Adhesives:
Structural Epoxy Adhesives:

Elastic PU Sealants:
Elastic PU Adhesives & Sealants:
Semi-Structural PU Adhesives:
Structural PU Adhesives:

Heat Cured and RT Cured Epoxy Technology
Room Temperature Cured PU Technology, 2-Part

Dow Automotive Systems
Process Adapted Structural Adhesives

Selection Considerations
- Assembly requirements
- Substrates bonded
- Substrate coatings
- Cure profile
- Functional performance
- Body or Trim shop
- Manufacturing process

Elongation %

Lap Shear Strength (Mpa)

Epoxy Hybrid Adhesives:
Epoxy Adhesives:
Structural Epoxy Adhesives:

Elastic PU Sealants:
Elastic PU Adhesives & Sealants:
Semi-Structural PU Adhesives:
Structural PU Adhesives:

Heat Cured and RT Cured Epoxy Technology
Room Temperature Cured PU Technology, 2-Part

Dow Automotive Systems
Process Adapted Structural Adhesives

Selection Considerations
- Assembly requirements
- Substrates bonded
- Substrate coatings
- Cure profile
- Functional performance
- Body or Trim shop
- Manufacturing process

Elongation %

Lap Shear Strength (Mpa)

Epoxy Hybrid Adhesives:
Epoxy Adhesives:
Structural Epoxy Adhesives:

Elastic PU Sealants:
Elastic PU Adhesives & Sealants:
Semi-Structural PU Adhesives:
Structural PU Adhesives:

Heat Cured and RT Cured Epoxy Technology
Room Temperature Cured PU Technology, 2-Part

Dow Automotive Systems
Process Adapted Structural Adhesives

Selection Considerations
- Assembly requirements
- Substrates bonded
- Substrate coatings
- Cure profile
- Functional performance
- Body or Trim shop
- Manufacturing process

Elongation %

Lap Shear Strength (Mpa)

Epoxy Hybrid Adhesives:
Epoxy Adhesives:
Structural Epoxy Adhesives:

Elastic PU Sealants:
Elastic PU Adhesives & Sealants:
Semi-Structural PU Adhesives:
Structural PU Adhesives:

Heat Cured and RT Cured Epoxy Technology
Room Temperature Cured PU Technology, 2-Part

Dow Automotive Systems
Process Adapted Structural Adhesives

Selection Considerations
- Assembly requirements
- Substrates bonded
- Substrate coatings
- Cure profile
- Functional performance
- Body or Trim shop
- Manufacturing process

Elongation %

Lap Shear Strength (Mpa)

Epoxy Hybrid Adhesives:
Epoxy Adhesives:
Structural Epoxy Adhesives:

Elastic PU Sealants:
Elastic PU Adhesives & Sealants:
Semi-Structural PU Adhesives:
Structural PU Adhesives:

Heat Cured and RT Cured Epoxy Technology
Room Temperature Cured PU Technology, 2-Part

Dow Automotive Systems
Process Adapted Structural Adhesives

Selection Considerations
- Assembly requirements
- Substrates bonded
- Substrate coatings
- Cure profile
- Functional performance
- Body or Trim shop
- Manufacturing process

Elongation %

Lap Shear Strength (Mpa)

Epoxy Hybrid Adhesives:
Epoxy Adhesives:
Structural Epoxy Adhesives:

Elastic PU Sealants:
Elastic PU Adhesives & Sealants:
Semi-Structural PU Adhesives:
Structural PU Adhesives:

Heat Cured and RT Cured Epoxy Technology
Room Temperature Cured PU Technology, 2-Part
Dow Automotive Systems
BETAFORCE™ – Structural 2-Part Polyurethane Bonding Innovations

Description:
• Two component, room temperature curing polyurethane structural adhesives for dissimilar material bonding
• New technology optimized to retain strength and rigidity at elevated temperature

Benefits:
• Manage thermal expansion differences with dissimilar materials
• Retention of material properties over wide temperature range
• Combines optimized modulus, high strength as well as high elongation
• Robust substrate bonding (SMC, CFRP, etc.) for hybrid joining
• Provides corrosion barrier between dissimilar materials
• Good sealing properties
• Room temperature curing, accelerated curing options (oven, IR and induction heating)

Room Temperature Cured PU Technology, 2-Part

Used for post body shop bonding applications
– Structural roof assembly
– Tail gate
– Trunk lids
– Spoiler
– Door modules
– Hybrid composite molders

Room Temperature Cured PU Technology, 2-Part

19 | 8-2013/FB-krk

™Trademark of The Dow Chemical Company (“Dow”) or an affiliated company of Dow
# Dow Automotive Systems

## Structural 2-Part Polyurethane Adhesives Property Overview

<table>
<thead>
<tr>
<th>Overview</th>
<th>2-Part Polyurethane Structural Adhesives</th>
</tr>
</thead>
<tbody>
<tr>
<td>E-Modulus</td>
<td>Lo 10-300 MPa</td>
</tr>
<tr>
<td>Tensile Strength</td>
<td>Med 10-15 MPa</td>
</tr>
<tr>
<td>Mix Ratio by Volume</td>
<td>1:1</td>
</tr>
<tr>
<td>Impact Strength</td>
<td>-</td>
</tr>
<tr>
<td>Thermal Stability</td>
<td>Lo (up to 150C)</td>
</tr>
<tr>
<td>Typ. Curing</td>
<td>Room Temperature</td>
</tr>
<tr>
<td>Pre-curing</td>
<td>IR, Induction, oven</td>
</tr>
<tr>
<td>Handling strength</td>
<td>20 - 45 min, r.t.</td>
</tr>
<tr>
<td>Mixed Mat. Bond.</td>
<td>Good-Excellent</td>
</tr>
<tr>
<td>Oil absorption</td>
<td>No</td>
</tr>
<tr>
<td>Relative Costs</td>
<td>Lo</td>
</tr>
<tr>
<td>Process Complexity</td>
<td>Med</td>
</tr>
</tbody>
</table>
Dow Automotive Systems
Case Study: Dissimilar Material Substrate Joining

Light Weight Closures

Product: Structural Polyurethane Adhesive

Vehicle Application: Deck Lid

Enabling Technology: Provides a reliable joining solution for multi-material designs enabling OEMs to use advanced ultra-light weight materials to reduce weight
- Fast, low cost joining solution for composites and dissimilar materials (CF-SMC) in general assembly
- Little to no pretreatment on composites and coated metals
- 40% weight savings compared to steel

Substrates Bonded: Primerless bonding of carbon fiber composite and SMC

Cure Cycle:
- Fast cure in select locations through induction heating eliminating the need for secondary fasteners
- Remaining bond areas cure at room temperature

Key Product Features:
- Provides uniquely consistent mechanical properties over an extremely wide temperature range
- Primerless bonding of carbon fiber and other composites
- Structural adhesive with optimized elongation
- Extremely rapid green strength development with induction heating
- Low VOC and odor

Structural PU Adhesive Technology, 2-Part
Dow Automotive Systems
Adhesive Application Examples

**Dow Automotive Systems**

**Adhesive Application Examples**

**Body Shop** 180°C, 30’

**Paint** 80-160°C, 30’

**Trim Shop** 25°C

**Repair**

**Structural PU Adhesive Technology, 2-Part**

**BETALINK™ K1, K2**
Cladding, Spoiler Attachment, Wheel Arch Extensions

**BETASEAL™ X2500**
Bonded Carbon Fiber or PC Roof to Magnesium Roof Frame, Bonded PC Hood Engine, Window

**BETAFORCE™ 2850 Series**
Composite Bonding, Coated-Metal-CFRP, CFRP-CFRP

**BETAFORCE™ 9050 Series**
Composite Bonding, Coated-Metal-Composite (SMC, CFRP,)

**BETAFORCE™ 2850 Series**
Roof Bonding, Coated Al-Coated Steel

**Body Shop**

**Paint**

**Trim Shop**

**Repair**

**80-160°C, 30’**

**180°C, 30’**

**25°C**
Dow Automotive Systems
Multi-Material Bonding Adhesives Summary

• **Structural Adhesives** enable vehicle light weight strategies by
  – Bonding **dissimilar materials** including **carbon fiber reinforced composite materials** to many light weight substrates
  – Managing **thermal expansion differences** with dissimilar materials
  – Facilitating **down-gauging** and/or **down-grading** of steel for **cost and weight reduction**

• The continuous bond line provides **improved load transfer** between sheet metal parts, resulting in **improved stress distributions**

• Adhesives **enable dissimilar material joining** when traditional joining methods cannot be used and **addresses galvanic corrosion** concerns

• **Benefits include**
  – Bond many substrates, including metals and composites without priming
  – Increase body stiffness (NVH), improves crash performance
  – Increase vehicle body durability
  – Compatible with other mechanical and thermal joining techniques
Global automotive centers, sales offices and manufacturing facilities throughout Europe, North America, South America, Asia/Pacific, South Africa, India and the Middle East.

Located Where Our Customers Are