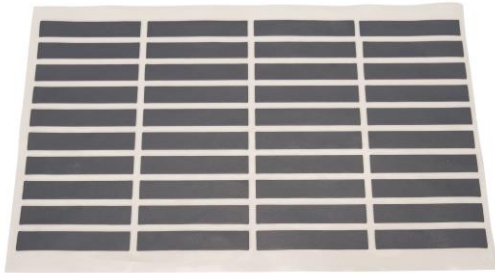


Enabling Lightweight Design

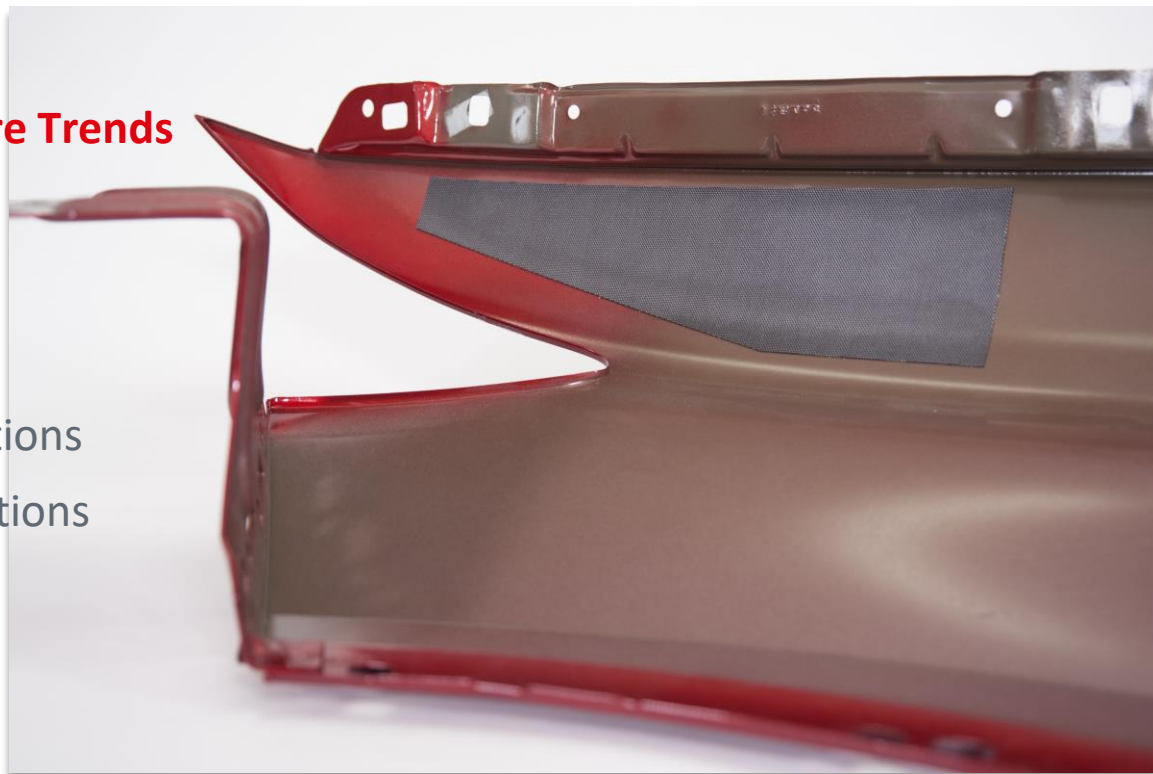
Acoustic, Sealing and Structural Tapes & Patches



| Agenda

1. Automotive Body Structure Trends

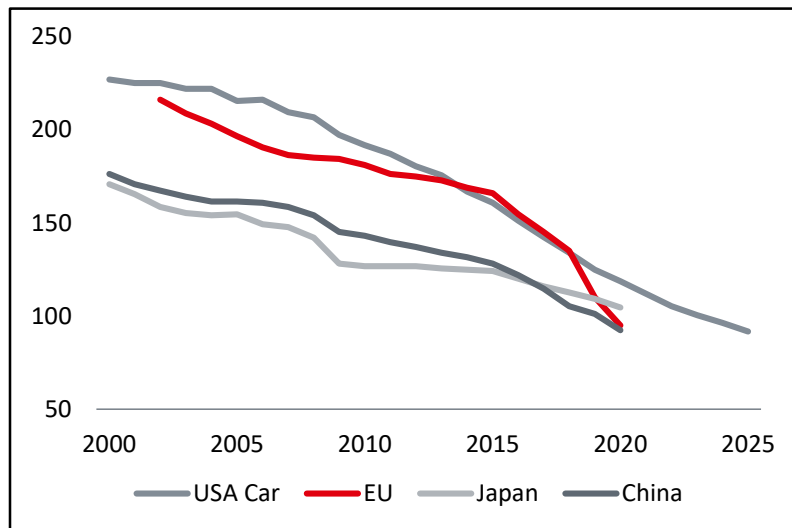
- 2. Acoustic Tape Solutions
- 3. Sealant Tapes
- 4. Damping Patches
- 5. Reinforcement Patch Solutions
- 6. Structural Foam Tape Solutions



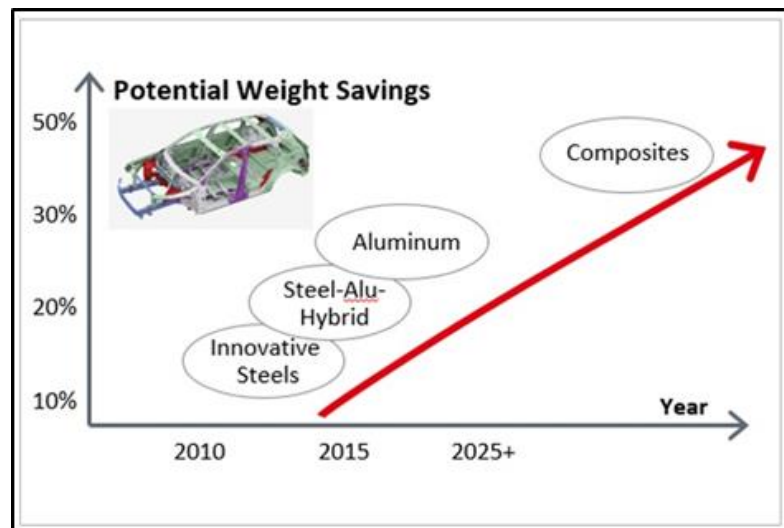
| Automotive Target: CO₂ Emissions Reduction

Lightweight is a strategic Henkel Innovation Target

Forecast into 2025



Move to lighter materials

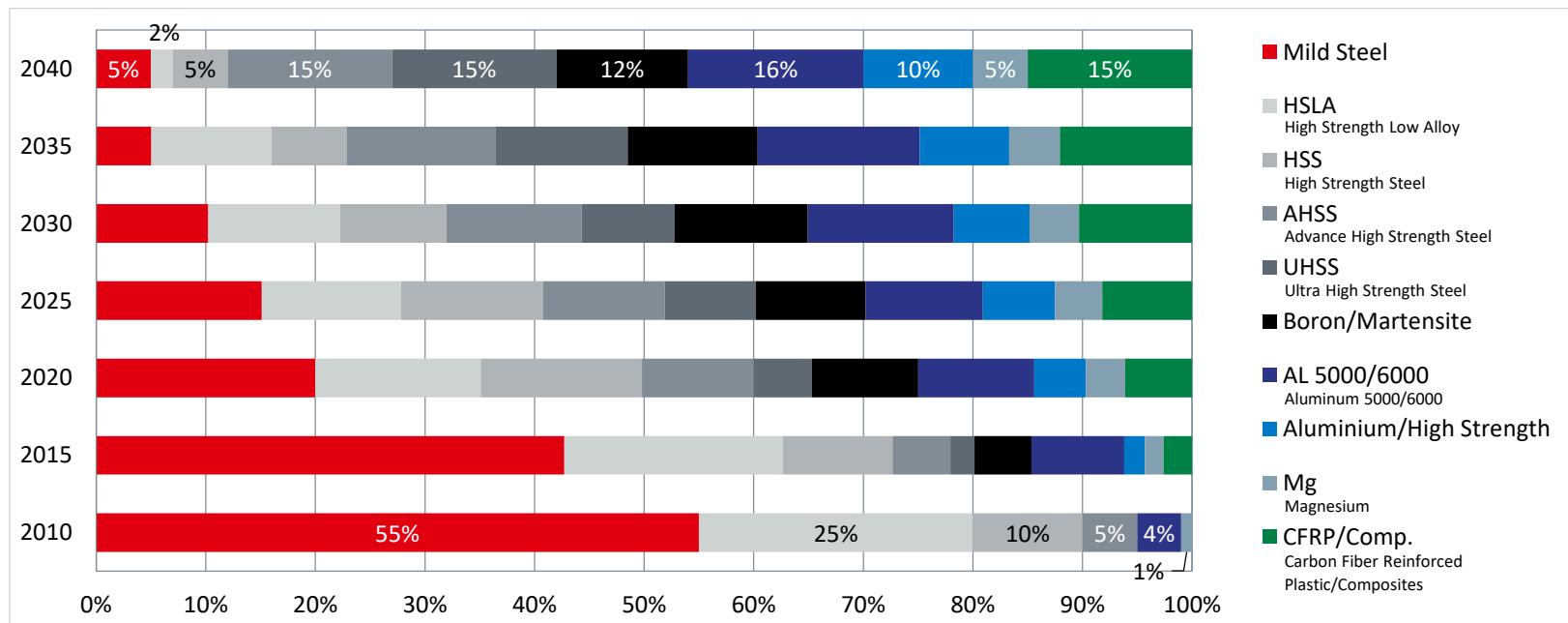


> **We develop technology to drive adoption of lightweight materials & increase safety**

Source: ICCT

| Materials in BIW: Usage Projection 2010 → 2040

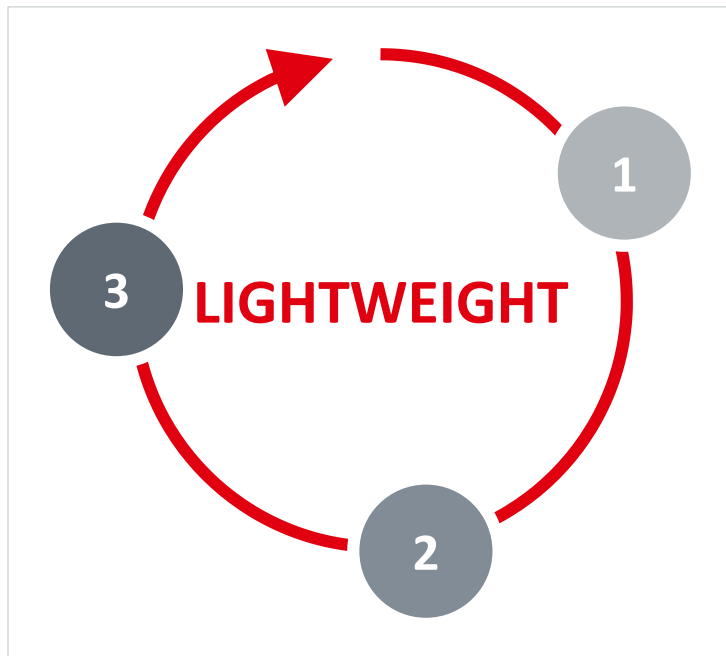
Material Distribution in the U.S. Fleet (Body-in-White Plus Closures), 2010 to 2040



Source: CAR Research

| Challenge Lightweight Design

Material – Process – Engineering



1 > Material

Low density tapes and patches have low density and allow the use of a variety of metal & substrate grades

2 > Process

Application in body shop and Tier 1's
Excellent wash resistance through pretreatment process

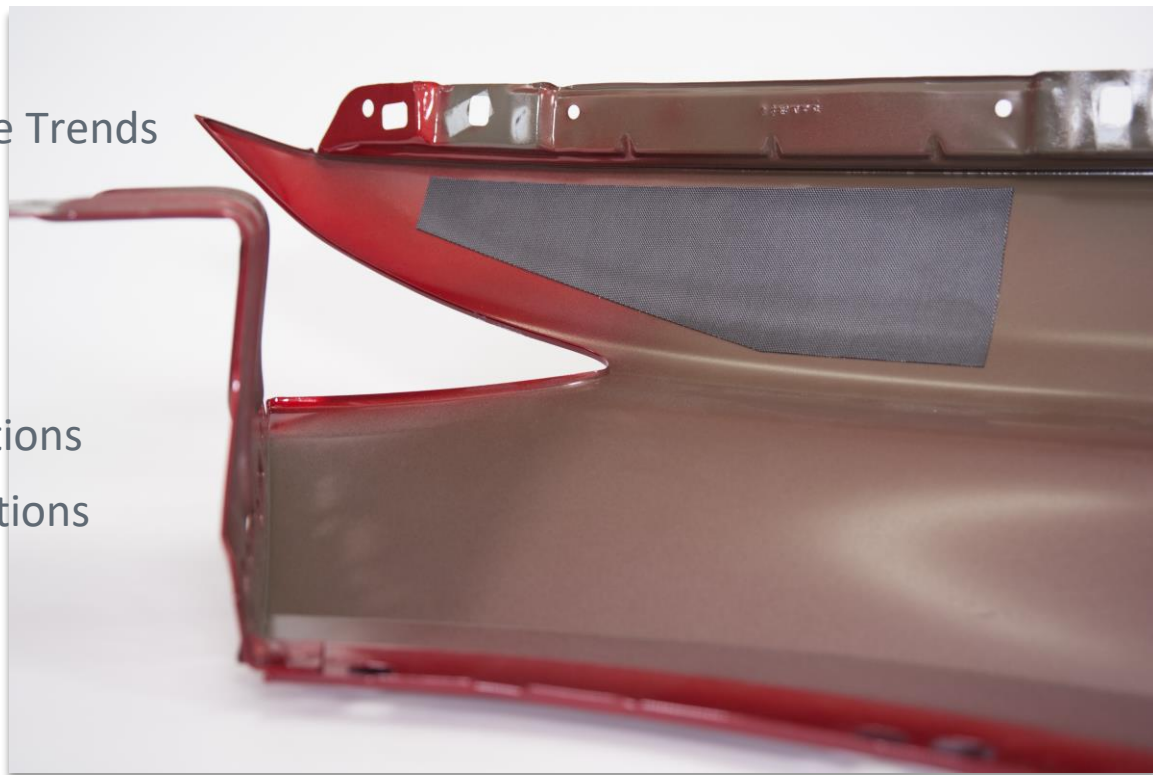
3 > Engineering

Through design and engineering the tape and patch designs can be optimized by reducing the size and shape

> **Lightweight design is a result of cooperating disciplines**

| Agenda

1. Automotive Body Structure Trends
- 2. Acoustic Tape Solutions**
3. Sealant Tapes
4. Damping Patches
5. Reinforcement Patch Solutions
6. Structural Foam Tape Solutions



| Body Shop Acoustic Tapes

Technology Highlight

Description	▪ Tacky expandable materials that seal large gaps (5-20 mm) in between panels to form a sound absorbing barrier to improve the NVH performance of a vehicle
Application Areas	▪ Outer A,B,C,D pillar cavities ▪ Dash panel ▪ Quarter inner/outer panels ▪ Rocker panels ▪ Tail light openings
Characteristics	▪ Outstanding adhesion to oily metal substrates ▪ Excellent sealing and corrosion resistance ▪ Dry film laminate sets the standard for shape retention and ease of application ▪ Expandable mastic portion seals varying metal gaps
Benefits	▪ Reduces the sound and air from entering the vehicle providing a quiet passenger compartment ▪ Multiple expansion rates allow for design flexibility ▪ Low density parts provides weight savings

Acoustic Tape Before Expansion



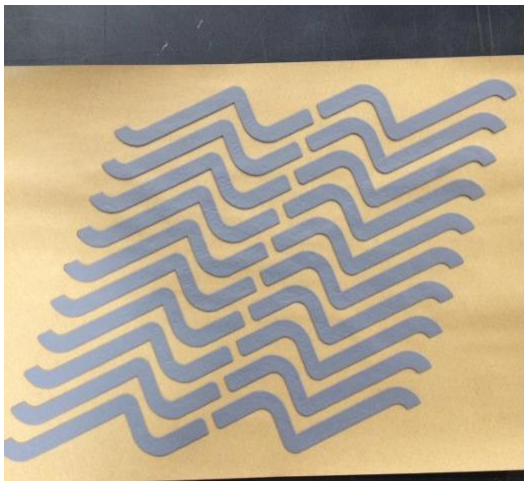
Acoustic Tape After Expansion



| Extruded and Die Cut into Unique Shapes

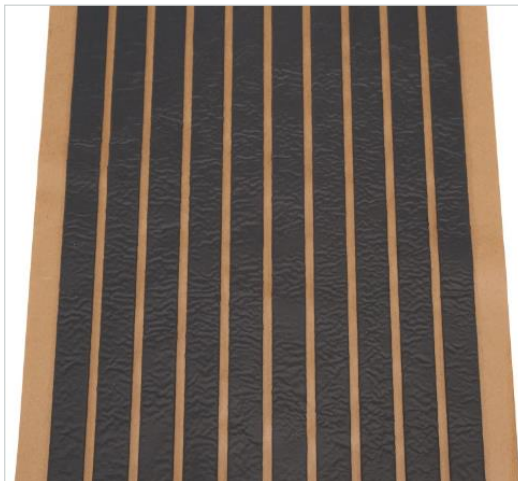
Examples

Rotary die cut



Note: Thin film on top to aid with operator handling

Straight strip



Note: Straight strip parts have an extrusion die to form the width and the length is guillotine cut

Rotary die cut with a hump



Note: Material hump due to gap increased in metal section

| Body Shop Acoustic Tapes

Enable Light Weight Design

Tapes can fill and seal small metal cavities



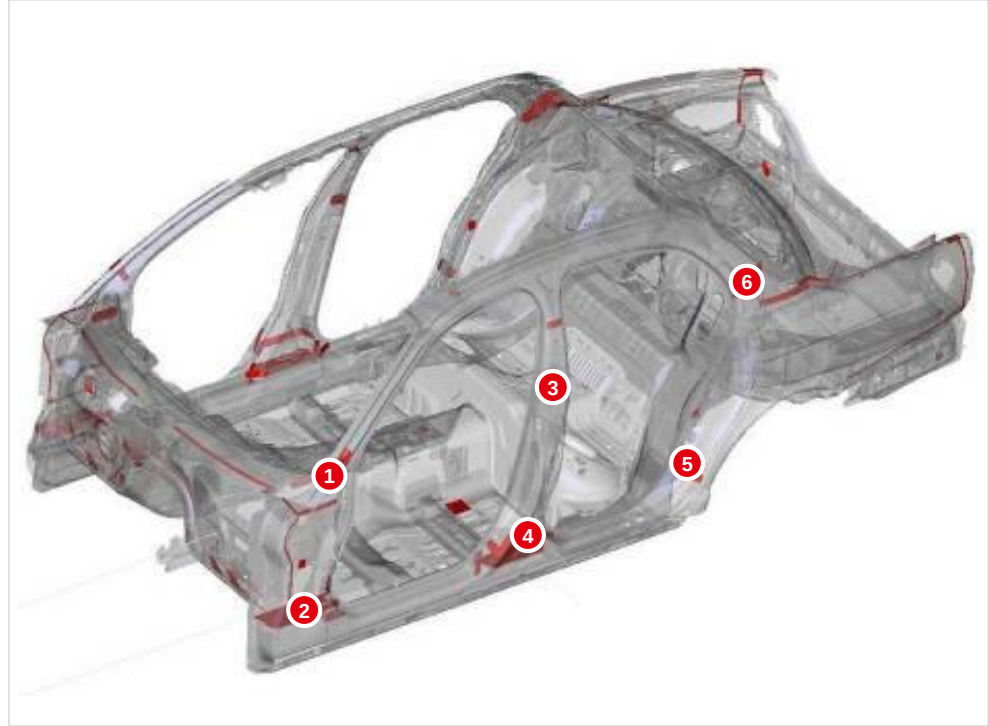
- Compatible on steel and aluminum
- Outstanding adhesion to oily metal substrates
- Low density for weight reduction
- Variety of expandable materials to seal varying metal gaps
- Excellent for sealing small cavity sections

| Acoustic Tape Solutions

Typical locations on the vehicle

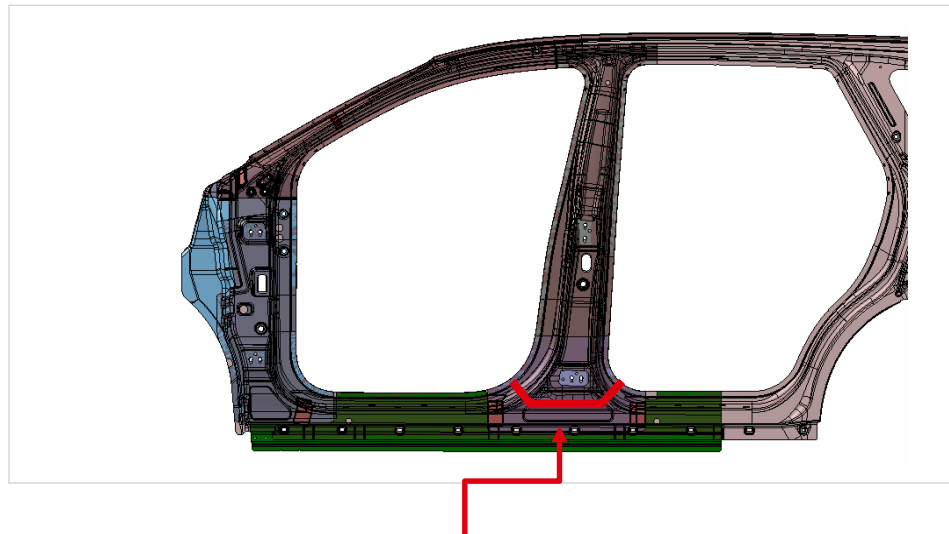
Where to find Tacky Acoustic Tapes

- Tapes applied in body shop or Tier Stampers
- Typical locations are to seal gaps of 5 to 20 mm between structural reinforcement and body outer panels
- The tapes expand as the vehicle goes through the paint ovens and fills the gap in cavity to prevent air and noise from traveling through the cavity



| B-pillar Tacky Tape

Example Application



- Tape applied to B-pillar outer reinforcement
- Seals gap between B-pillar outer reinforcement and B-pillar body side
- Some sections have a gaps as large as 20 mm

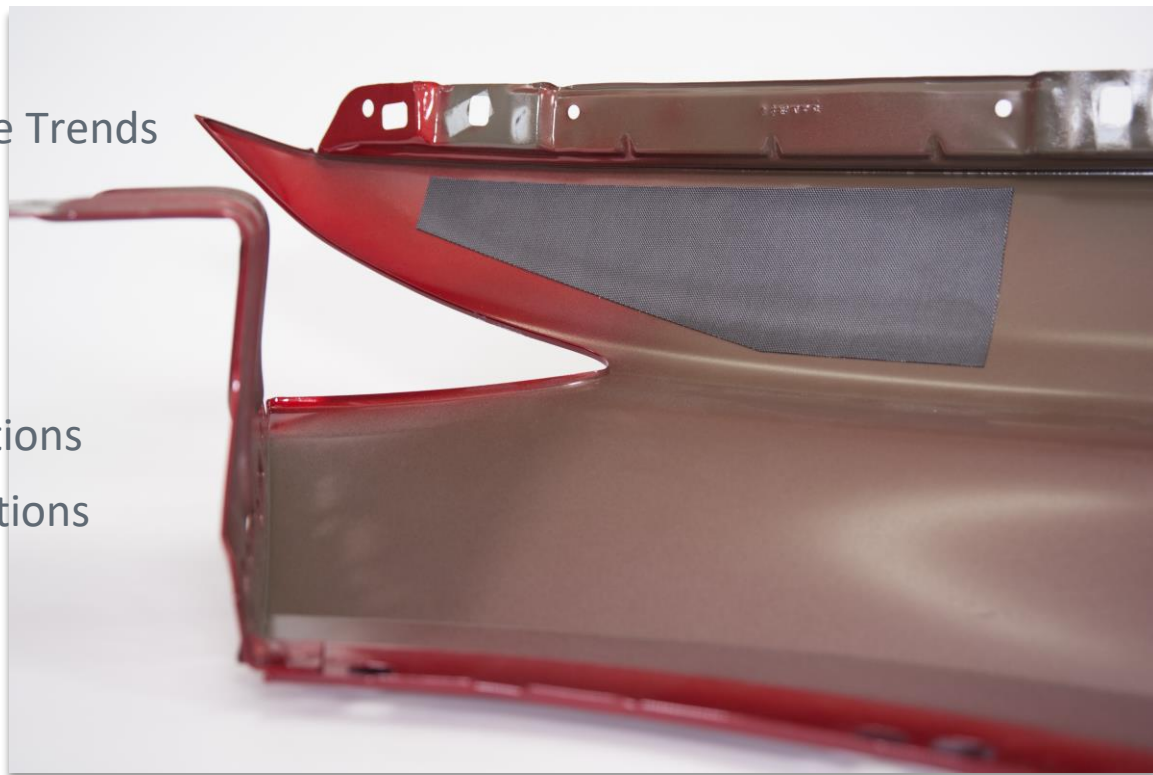
| Overview Body Shop Acoustic Extruded Materials

	Description	Area of Application	Key Characteristics
Teroson RB 22000	Tacky Medium Expansion Acoustic Tape	Outer A,B,C,D pillar cavities, interior panel gaps	Expansion: 300 – 500% Cured Specific Gravity: 0.22 Target Cure Schedule: 10' @ 165 – 171C Min: 30' @ 121C
Teroson RB 22100	Tacky High Expansion Acoustic Tape	Outer A,B,C,D pillar cavities, interior panel gaps	Expansion: 800 – 1000% Cured Specific Gravity: 0.11 Target Cure Schedule: 10' @ 165 – 171C Min: 30' @ 121C
Teroson RB 1021 (New)	Tacky Medium Expansion Acoustic and water seal Tape	Outer A,B,C,D pillar cavities, interior panel gaps, areas to prevent water intrusion	Expansion: 300 – 400% Cured Specific Gravity: 0.24 Target Cure Schedule: 10' @ 165 – 171C Min: 15' @ 140C
Teroson EV 27007	Dry Extrudable Fuel Resistant Tape	Fuel can to bodyside sealing, pillar cavities	Expansion: 200 – 400% Cured Specific Gravity: 0.26 Target Cure Schedule: 10' @ 165 – 171C Min: 30' @ 121C

➤ **Variety of tapes with different expansion rates to seal cavities**

| Agenda

1. Automotive Body Structure Trends
2. Acoustic Tape Solutions
- 3. Sealants**
4. Damping Patches
5. Reinforcement Patch Solutions
6. Structural Foam Tape Solutions



| Sealing Tapes – Body Shop Applications

Technology Highlight

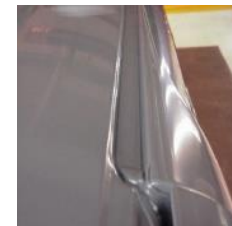
Description	Sealing tape that expands and seals between panels to prevent water, wind and fumes from getting into joint (<5 mm). Typically used in spot welded flanges. Material is heat activated.
Application Areas	- Floor pan - Quarter inner/outer panels - Package trays - Roof headers - Rocker panels - Dash panel and tail light openings
Products and Characteristics	- Teroson RB 10004 - Expansion: 15 - 60% vertical - Teroson RB 10104 - Expansion: 60 - 120% vertical - Teroson RB 10204 - Expansion: 100 - 200% vertical - Curing Conditions: Target: 30' @ 176C; Min: 30' @ 140C
Benefits	- Custom die cuts available to fit a variety of applications and facilitate consistent operator installation Hump cross sections available to fit varying metal gaps - Multiple expansion rates to meet all application areas (60-200%)



| Sealing Tapes – Paint Shop Applications

Technology Highlight

Description	• Pre-formed paintable tape materials to seal against air, dust, water and edge corrosion. Applied in the OEM paint shop.
Application Areas	• Class B locations • Deck lid gutters • Lift gate openings and rear headers • Tail light openings • Roof ditch seams
Products and Characteristics	• Teroson EV 11006 – Tacky medium flow seal • Teroson EV 13007 – Tacky magnetic low flow seal • Teroson EV 28201 – Dry paintable roof ditch ape • Target Cure Schedule: 30' @ 150 – 165C
Benefits	• Extruded strips or custom die cuts available to fit a variety of applications and facilitate consistent operator installation • Tacky materials available to ensure material remains installed through paint shop blower systems • Tacky magnetic variations available for difficult vertical applications



| Paintable Tapes

Die-Cut materials for sealing air, water and dust

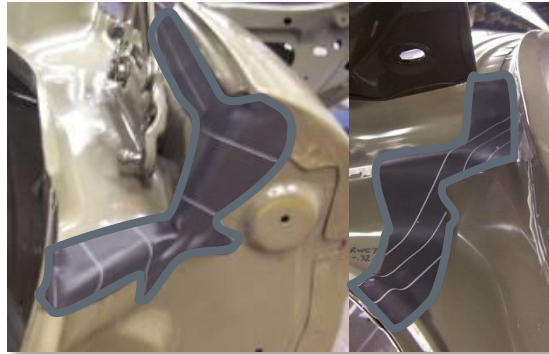
Teroson 11006

is tacky to stick to surfaces and is easy to handle and place



Teroson 13007

for overhang and vertical surfaces. White lines indicate which side up. Opposite side is magnetized



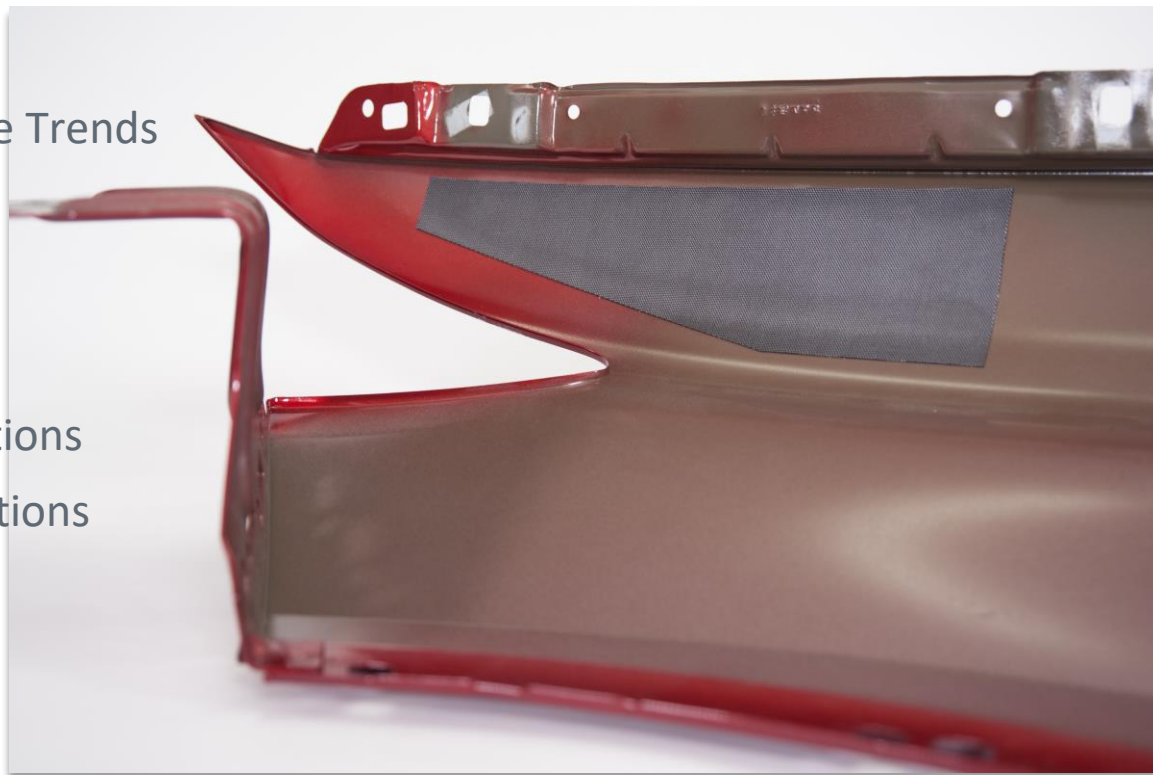
Teroson 28201

for roof ditches are long strips which run from front to back



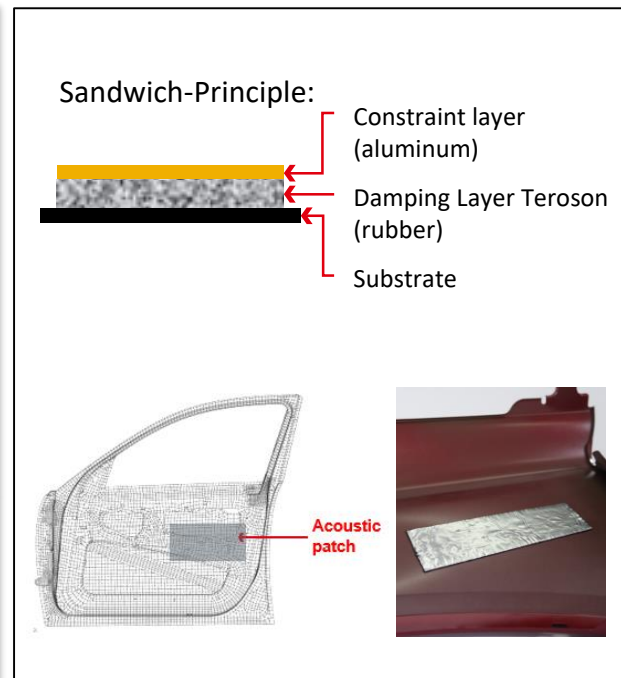
| Agenda

1. Automotive Body Structure Trends
2. Acoustic Tape Solutions
3. Sealant Tapes
- 4. Damping Patches**
5. Reinforcement Patch Solutions
6. Structural Foam Tape Solutions



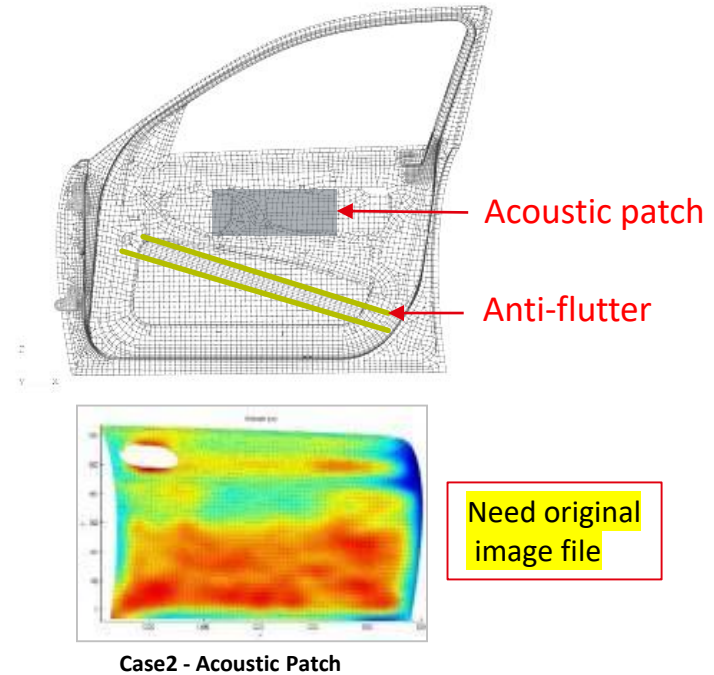
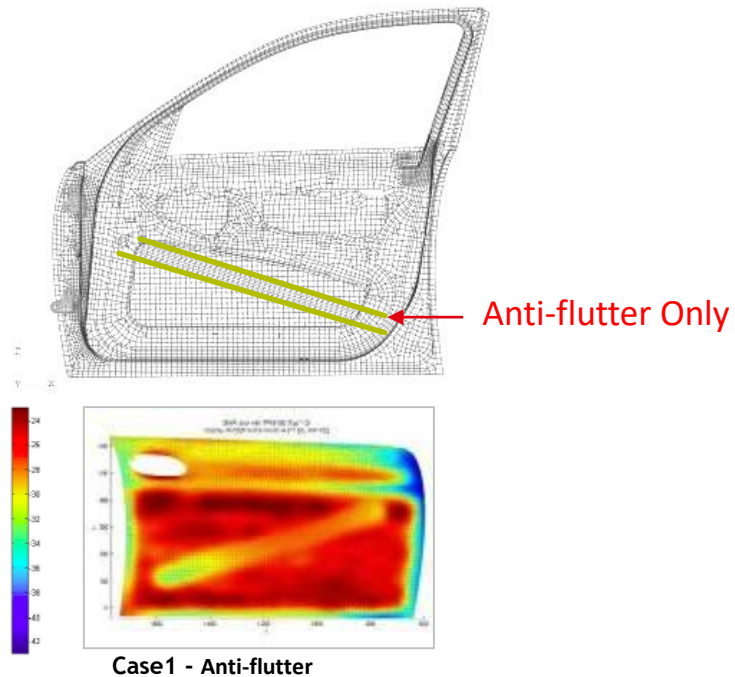
| Constrained Layer Damping and Butyl Sealing Patches

Description	Self adhering, non-reactive sound deadening patch based on butyl rubber with aluminum foil or plastic on the visible surface
Application Areas	- Door panels - Hoods - Fender panels - Body and roof panels for sound deadening
Products and Characteristics	- Teroson RB 23100 – self adhering non-reactive sound deadening patch based on butyl rubber with aluminum foil or plastic on the visible surface - Teroson RB 2451 – permanent plastic butyl sealer based on non-reactive rubbers - Application Temperature 10°C – 70°C
Benefits	- Custom die cut shapes for a variety of applications - Constrained Layer Damping (CLD) concept improves NVH-behavior. - Effective against structure-borne noise vibrations and the noise resulting from metal and plastic components



| Constrained Layer Damping Patch

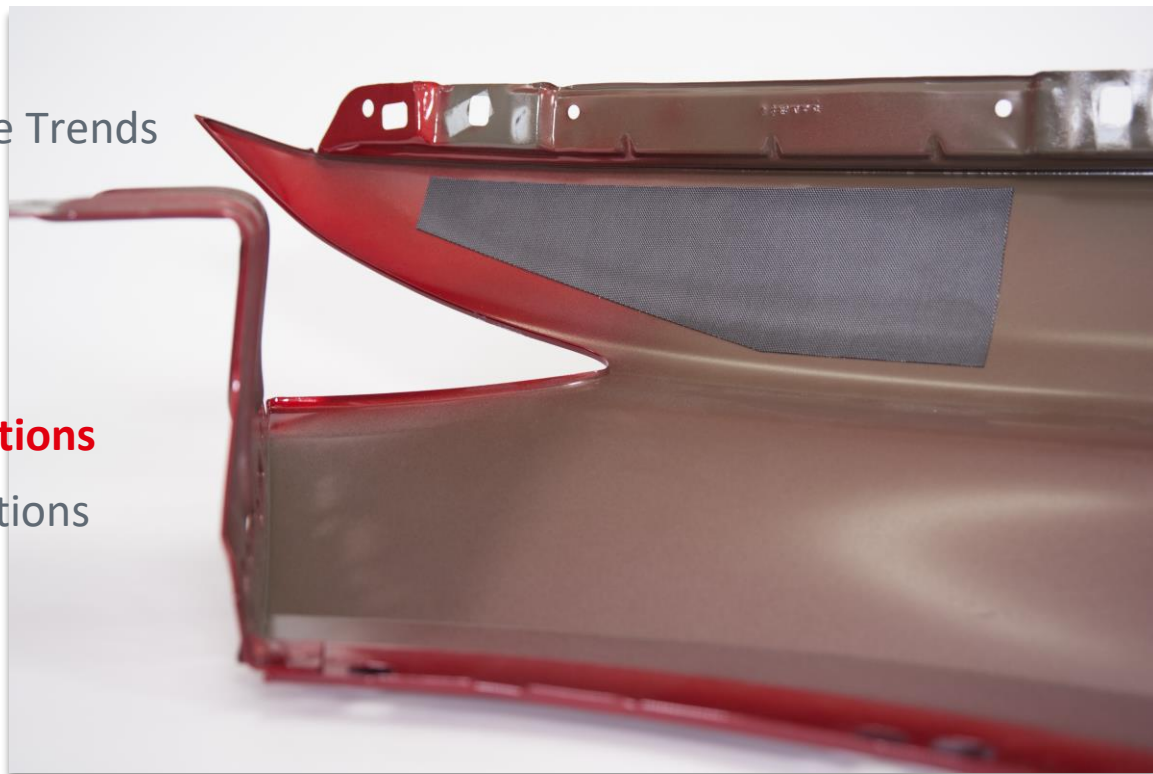
Laser Vibrometry Test



Red = Largest vibration Blue = Smallest vibration

| Agenda

1. Automotive Body Structure Trends
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- 5. Reinforcement Patch Solutions**
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| Reinforcement Patches

Technology Highlight

Description	▪ The material is supplied in die cut form on release paper and used to reinforce and stiffen body panels, thin metal sections or high stress areas
Application Areas	▪ Door panels ▪ Hoods ▪ Fender, body and roof panels
Characteristics	▪ Formulated to work in Body Shop prior to Ecoat bake ▪ Heat curing epoxy sealant laminated to a fiberglass reinforcing layer ▪ Provides adhesion to electrocoated, primed metal, galvanized, cold rolled steel, and aluminum
Benefits	▪ Low density provides weight savings opportunities ▪ Custom die cuts improves operator installation ▪ Magnetic and non-magnetic versions available to allow for metal substrate flexibility



| Reinforcement Patches

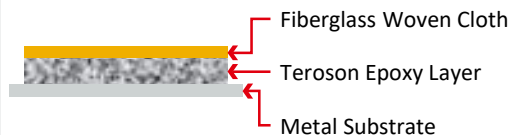
Enable Light Weight Design

Stiffening patches decrease panel deformation



Sandwich Design for Increased Performance

Sandwich-Principle:



- Compatible on steel and aluminum
- Outstanding adhesion to oily metal substrates
- Low density for weight reduction

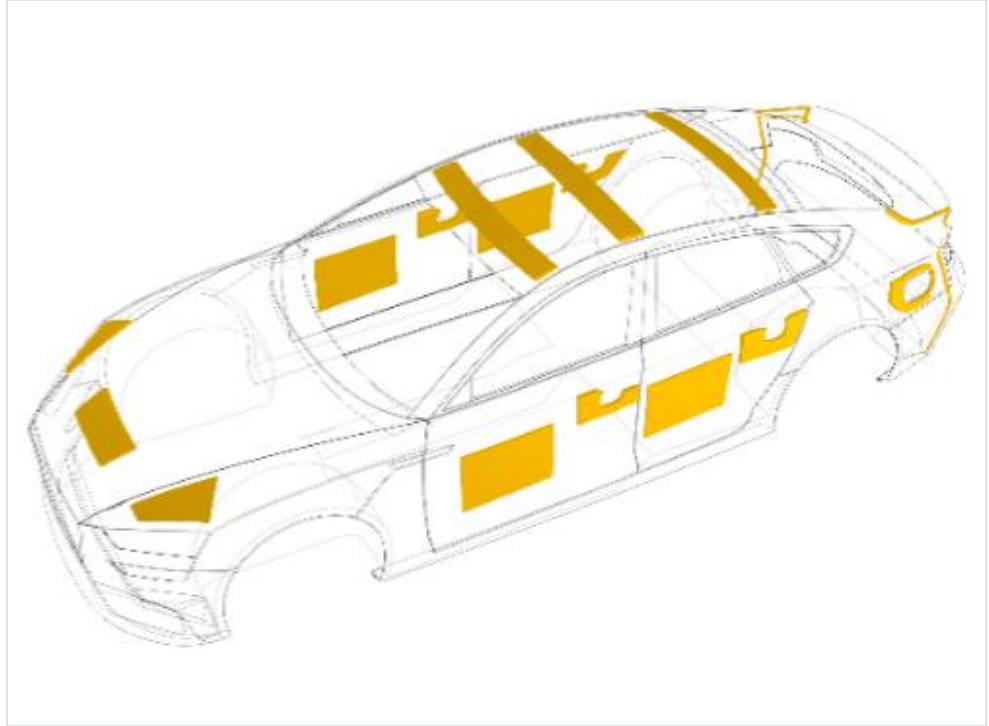
- Tacky magnetic material exhibits superior wash off resistance
- Excellent for local stiffness

Reinforcement Patches

Typical locations on the vehicle

Where to find Stiffening Patches

- Applied in body shop and occasionally in paint shop
- The patch cures and bonds to the metal as the vehicle goes through the paint ovens
- Typical locations are door panels, hoods, fenders, body side outer, and roof panels
- Prevents oil canning and panel deformation

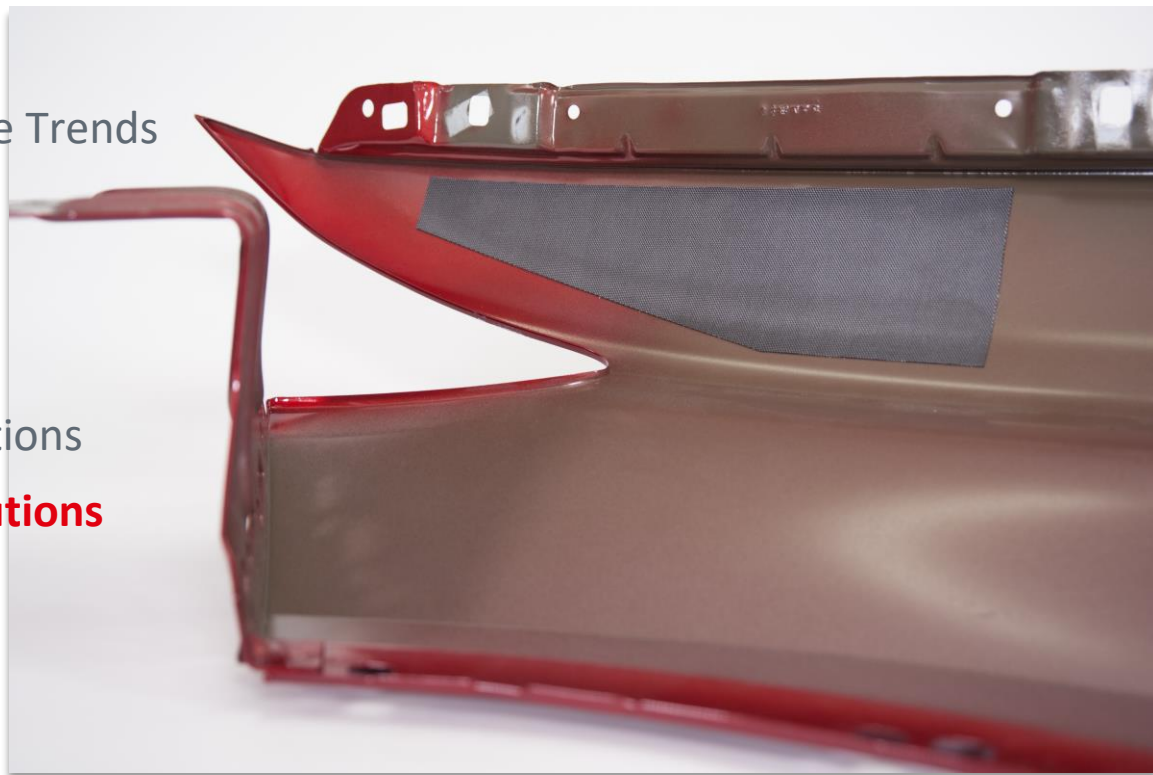


| Overview Reinforcement Patches

	Description	Area of Application	Key Characteristics
Teroson EP 16005	Tacky Magnetic Stiffening Patch	Applied to sheet metal for reinforcement, stiffening and vibration abatement. Generally used on steel substrates	Expansion: 0 – 15% Load at 2mm deflection: 71 N Cured Specific Gravity: 1.9 Target Cure Schedule: 20' @ 165 – 176C Min: 30' @ 121C
Teroson EP 16301	Tacky Expanding Stiffening Patch	Applied to sheet metal for reinforcement, stiffening and vibration abatement. Used on steel and aluminum substrates.	Expansion: 80 – 100% Load at 2mm deflection: 71 N Cured Specific Gravity: 0.6 Target Cure Schedule: 20' @ 165 – 176C Min: 30' @ 121C
Teroson EP 7850 (New)	Tacky Stiffening Patch	Applied to sheet metal for reinforcement, stiffening and vibration abatement. Used on steel and aluminum substrates.	Expansion: 200% Cured Specific Gravity: 0.4 Target Cure Schedule: 20' @ 165 – 176C
TEROSON EP 2800	Expandable panel stiffener	Applied to vehicle body panels.	Expansion: 140 – 200% 3 bending point >20N at 1mm displacement Cured Specific Gravity: 0,6 Target Cure Schedule: 20' @ 165 – 176C Min: 30' @ 121C
TEROSON RB 5200	Rubber-based tacky panel stiffener	Applied to vehicle body panel for reinforcement and vibration damping. Used on steel and aluminum.	Expansion: >150% Stiffening 5mm deflection ; 100% Target cure min. 20' @ 165 C

| Agenda

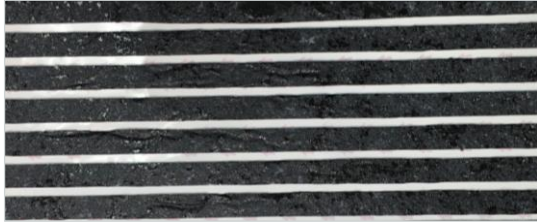
1. Automotive Body Structure Trends
2. Acoustic Tape Solutions
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- 6. Structural Foam Tape Solutions**



| Structural Foam Tapes

Enable Light Weight Design

Structural foam tapes provide a light weight option to locally strengthen metal cavities



- Compatible on steel and aluminum
- Adheres to oily metal substrates
- Low density for weight reduction



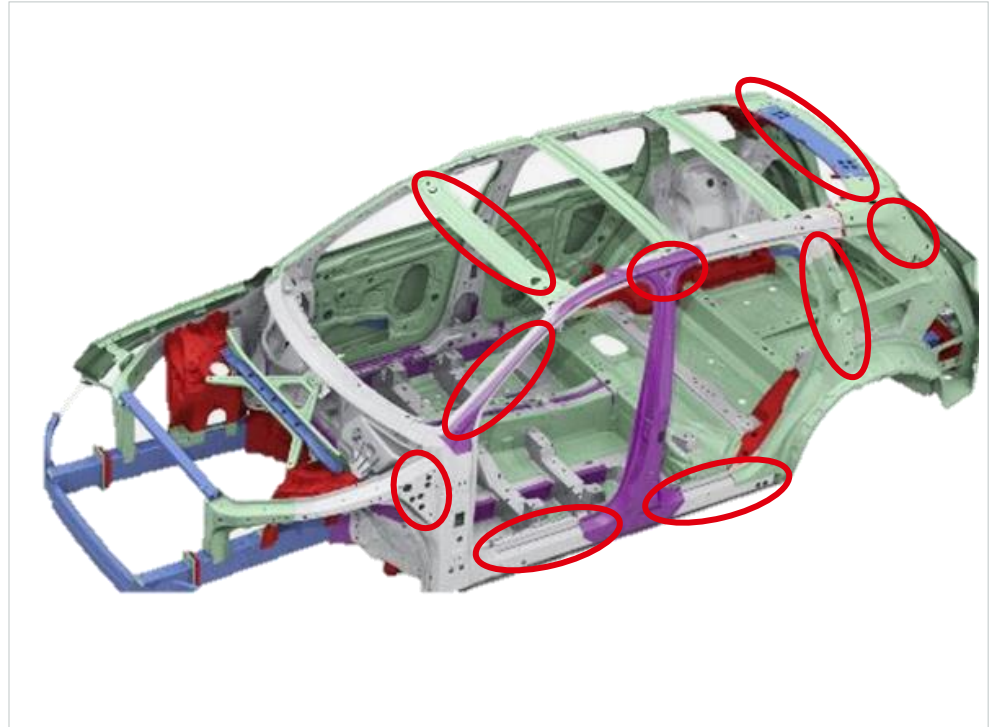
- High expanding version fills larger cavity sections
- Excellent for local stiffness

Structural Foam Tapes

Typical locations on the vehicle

Where to find Structural Foam Tapes

- Applied in body shop and Tier Stampers
- The tapes cure and bonds in between two pieces of metal as the vehicle goes through the paint ovens
- Typical locations are window frames, pillar to roof, pillar to rocker, rocker, and rail sections
- Provides local strength to prevent section from collapsing or bending



| Overview Structural Foam Tapes

	Description	Area of Application	Key Characteristics
Teroson EP 1030HX	Structural Foam Tape, Medium Expansion	Typically Body shop or Tier1 sub assembly prior to E-coat.	Expansion: 90 – 130% Compressive Strength: > 12 MPa Compressive Modulus: > 650 MPa Lap Shear Adhesion > 1.8 Mpa Cured Specific Gravity: 0.4 Target Cure Schedule: 30' @ 170 – 177C Min: 10' @ 170C
Teroson EP 1001	Structural Foam Reinforcement Tape, High Expansion	Window frames, Pillar to roof, Pillar to rocker, Rocker Rail sections	Expansion: 250 – 350% Compressive Strength: > 8 MPa Compressive Modulus: > 425 MPa Lap Shear Adhesion: > 1.8 Mpa Cured Specific Gravity: 0.3 Target Cure Schedule: 30' @ 170 – 177C Min: 10' @ 170C
TEROSON EP 1414	Structural Foam Reinforcement Tape, High Strength	Typically body shop or Tier 1 sub-assembly prior to E-coat, pillars A and B and other spare parts to increase stiffness, fatigue limits and strength	Expansion: 50% Lap Shear Strength > 1MPa Cured Specific Gravity: 0.45 Target Cure Schedule: 30' @ 170 – 177C Min: 10' @ 170C
TEROSON EP 20003	Structural Adhesive in Tape Form	Spot weldable tape for flange / panel bonding across body joinery / structure	Expansion : <15% Initial peel strength : >1500N/mm Lap Shear Strength : >7MPa

| Summary

- Lightweight design is a result of cooperating disciplines of materials, process and engineering
- Body shop acoustic tapes are low density which provides weight savings
- Stiffening patches provide local stiffness to metal panels which offers a weight savings opportunity
- The use of expanding structural foam tapes can bond cavity sections together which will improve strength and reduce weight
- Henkel provides a variety of technologies to help improve the acoustic, sealing, and structural performance of the vehicle



| Thank you!