

Henkel high-performance

# PANEL REINFORCEMENTS

NEXT GENERATION OF LIGHTWEIGHT DESIGNS



Henkel

**Driving Your Future.**

Structural Inserts

Structural Adhesives

Panel Reinforcement

Structural Tapes & Patches

# ENABLING LIGHTWEIGHT DESIGN WITH HIGH-PERFORMANCE PANEL REINFORCEMENTS

## EXECUTIVE SUMMARY

This White Paper explores the challenges presented by automotive OEM panel lightweighting aspirations and the advanced structural panel reinforcement solutions offered by Henkel. These panel solutions, in the form of reinforcement patches and sprayable reinforcements, optimize localized panel stiffness to help prevent “oil canning” and maintain overall panel integrity. Outcomes of applying these solutions are the successful use of reduced vehicle panel thicknesses to meet automotive industry lightweighting goals.

Key product properties and characteristics are outlined, underscored by the proven combination of Henkel engineering expertise and OEM collaboration that has become a vital resource to automotive design professionals at virtually every stage of project development.

## BACKGROUND

**Automobiles are becoming lighter.** The megatrend of lightweighting is driven by electrification, where the added mass of the energy storage subsystem must either be controlled – or ideally, totally offset – in order to provide the equivalent end-user experience.

Reducing mass in an automobile has primary and secondary fuel-saving effects. The primary effect is that a reduced-mass vehicle expends less energy to reach the same level of performance and range. Reducing mass also introduces opportunities to achieve greater performance and range while maintaining the same battery size. Secondly, weight optimization enhances braking system and suspension performance.

One way to achieve lightweighting is to reduce metal panel thickness in closures such as doors and hoods. However, closures are primary end-user touch points. Increased stiffness leads to improved user perception and experience and thus improved customer satisfaction.<sup>1</sup> This leads to the immediate contradicting requirement that stiffness must remain constant or increased while panel thickness is simultaneously reduced.

<sup>1</sup>Rhiu, Ilson & Ryu, Taebeum & Jin, Byungki & Yun, Myung. (2011). Analysis of Customer Satisfaction on the Stiffness of Outside Panels of Passenger Cars. Human-Computer Interaction. Users and Applications Lecture notes in computer science. 6764. 257-265. 10.1007/978-3-642-21619-0\_34.

# HENKEL SOLUTION

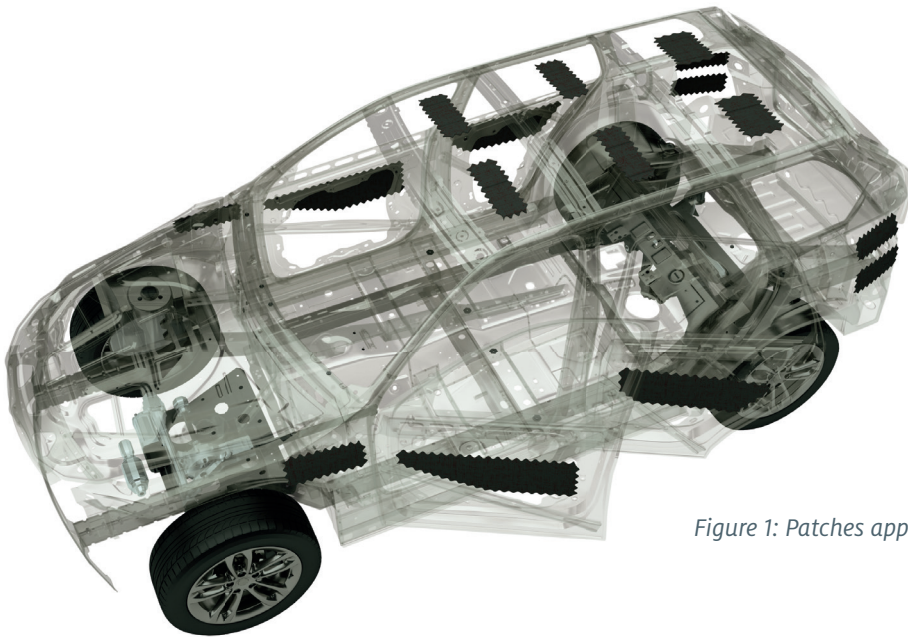
## ENABLING LIGHTWEIGHT DESIGN FOR THIN SHEET METAL PANELS

**Henkel's high-performance panel reinforcement products** provide tailor-made solutions that enable sheet metal thickness reduction without compromising local panel stiffness and dent resistance. Using Henkel's low-density reinforcement products, the customer can progress toward thinner-gauge panels and reinforce them locally to satisfy stiffness requirements at a minimal weight cost. This means that both weight and stiffness targets can be achieved while enabling innovative design.

Henkel reinforcement products can be applied manually or automatically in areas where stiffness is compromised due to panel thickness reduction, in order to meet the requirements for stiffness and dent resistance.

**Two main families of products comprise the portfolio:**

1. Structural reinforcement patches
2. Structural reinforcement sprayable materials



*Figure 1: Patches application areas.*

**Structural reinforcement patches** are bulk materials (epoxy or rubber) with a glass-fiber layer on one side and an adhesive layer on the other, backed by a release paper that must be peeled off prior to application.

Reinforcement patches are extruded at several thicknesses depending the performance requested. Once applied and cured, the part creates a hybrid “sandwich” with the substrate, retaining the localized stiffness required – even on a thinner substrate. Common applications include door panels, front and rear wings (fenders/quarter panels), the hood and, in general, every panel where the need for increased stiffness must be balanced with the need for reduced weight.

**Henkel's broad chemical technology expertise** permits formulating and offering a choice of bulk materials from different technologies and across diverse properties. Epoxy and rubber formulations, along with specialized magnetic bulk materials, are available within the product portfolio. All bulk materials have been designed to provide high adhesion to past, present and future automotive substrates, whether they are electrocoated or primed. This includes cold-rolled steel and aluminum with nominal coating of drawing compounds or lubricants used in the automotive industry.

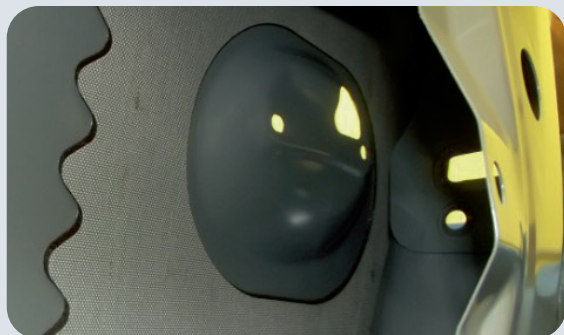


Figure 2: Reinforcement example.

**Structural reinforcement sprayable materials** are bulk reinforcing materials (expandable or not) which can be robotically applied and permit tailored application for targeted stiffness enhancement. Again, both rubber (with higher corrosion resistance) and epoxy technology solutions are available. Materials can either be extruded in place or applied using a swirl or shovel gun spray.

## YOUR SUSTAINABILITY SUPPORT PARTNER



- Vehicle design that utilizes patch or sprayable panel reinforcement solutions helps to reduce raw material consumption by permitting panel downgauging and lightweighting
- When the vehicle is in service, panel lightweighting continues CO<sub>2</sub> reduction by burning less fuel on ICE vehicles and helping to reduce electric energy consumption on EVs
- At the end of vehicle life, lightweighting reduces the amount of material entering landfills, helping to reduce air and water pollution
- Choosing sprayable solutions keeps glass fiber-based waste out of landfills entirely
- During vehicle assembly, sprayable solutions further reduce CO<sub>2</sub> production by eliminating the need for patch-based cardboard packaging and release paper that would otherwise enter the waste stream
- At the vehicle production phase, sprayable solutions such as TEROSON RB 5185 take sustainability even further by eliminating the energy consumption and subsequent CO<sub>2</sub> generation required to extrude patches

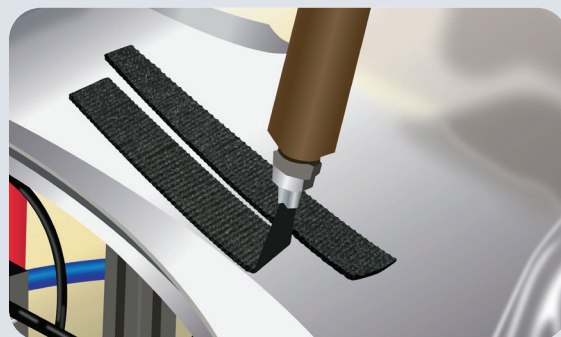


Figure 3: Sprayable reinforcement application example.

# HENKEL SOLUTION

## PANEL REINFORCEMENT SOLUTIONS ENGINEERING

### Stiffness Solutions

To fulfill the provided parts functionality, the reinforcement solution must be designed to minimize added panel weight while satisfying stiffness requirements. To achieve that, material data input is first created using coupon testing of both product constituents (in the case of patches) and the product itself.

Based on validated material input, the panel requiring reinforcement can be assessed for stiffness before and after the intervention. Finally, the patch geometry or the application size can be optimized using topology optimization software that identifies the necessary product application geometry. Additional design features for ensuring good readthrough resistance (resistance to observable imperfections on the Class-A surface) are also integrated.

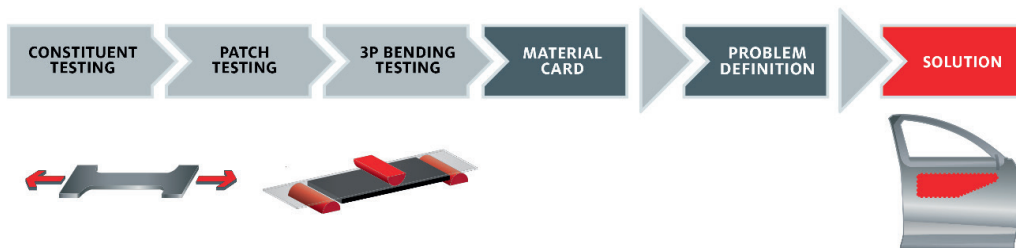


Figure 4:  
Engineering process:  
From tests to a  
full solution.

### Application Process – Imperfection Avoidance

Beyond stiffness solutions, Henkel also offers predictive engineering expertise for product application and curing. Our innovative computer-aided simulation methodologies identify panel surface imperfections before they even occur. In addition, we can reliably simulate curing, shrinkage, thermal expansion and thermomechanical behavior during the product curing process, minimizing the risk of readthrough.

By also combining simulation of chemical kinetics, thermal expansion, shrinkage and mechanical properties, Henkel can predict and test, at a specimen level, yielding valuable defect avoidance recommendations. An example of curing simulation accuracy can be seen in Figures 5 and 6, which illustrate the simulation results of a simple specimen designed to quantitatively assess readthrough that conforms to requirements set during product development. By engaging Henkel during the advanced design stages, vehicle designers and engineers have been able to realize greater design flexibility, enhanced structural performance, improved lightweighting and a reduced environmental footprint.

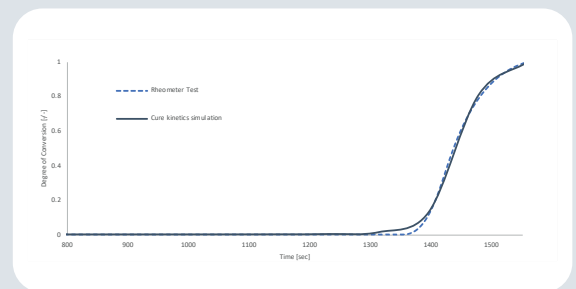


Figure 5: Curing simulation of sprayable reinforcement RB 5185 vs. test results.

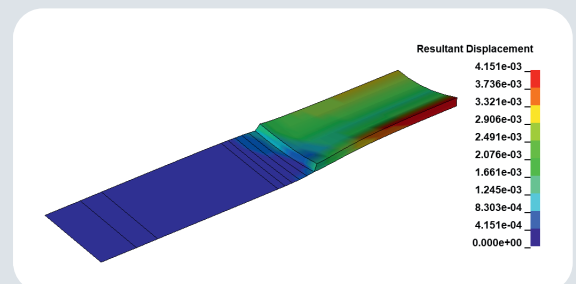


Figure 6: 1D specimen simulation for curing effects testing.

# HENKEL SOLUTION

## GENERAL PANEL REINFORCEMENT PROPERTIES CONSIDERATIONS

In general, solution properties can be divided into two main categories:

1. Cured properties
2. Uncured properties

## CURED PROPERTIES

### Stiffness

The main function of the cured products is the enhancement of panel stiffness. As such, this is a key cured-product evaluation factor in room temperature conditions as well as in conditions specified by customers in relation to product aging, presence of oil on the substrate, etc. Flexural stiffness is assessed according to either OEM specifications or Henkel's own custom test methods (Figures 7a and 7b). This involves comparing the amount of force required to reach a certain level of deflection for the untreated substrate and the substrate with the applied reinforcement. To ensure compliance with the customer's requirements, some specimens are aged and compared to their unaged counterparts to validate that there is no significant drop in performance.

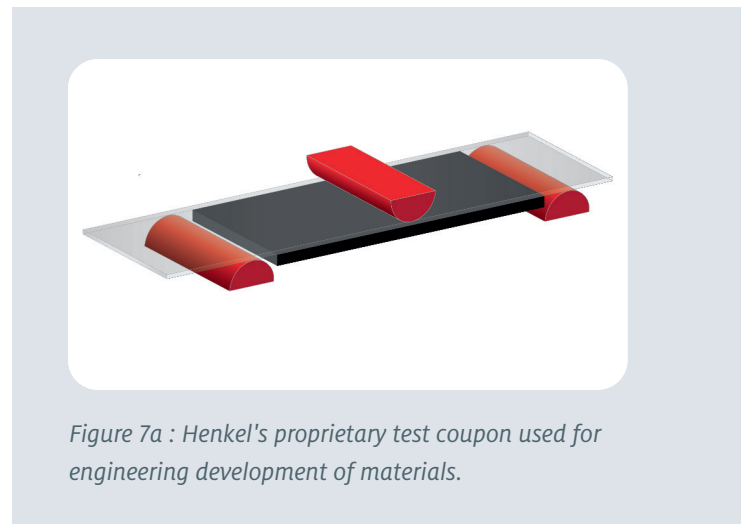


Figure 7a : Henkel's proprietary test coupon used for engineering development of materials.

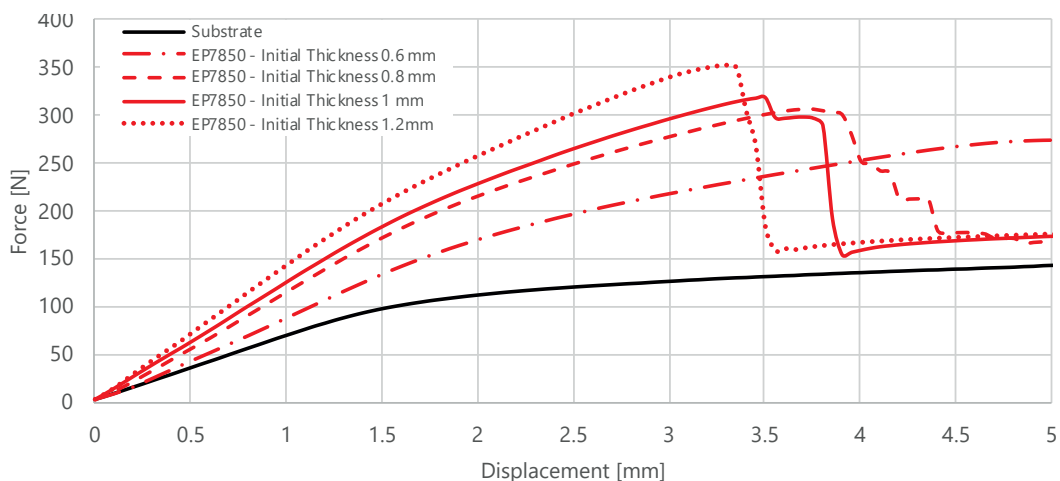


Figure 7b: Force vs. Displacement of three-point bending.

## Adhesion

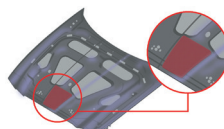
For the reinforcement products to function as intended, the material attached to the substrate is tested using both cleaned and oiled specimens under what is known in adhesive parlance as “lap shear testing,” to verify that:

- The presence of process oil does not deteriorate the adhesion performance of the material
- Proper adhesion is achieved, permitting load transfer from the substrate to the reinforcing product

## Expansion

Most of the reinforcing solutions offered in the Henkel portfolio are expandable products that utilize lower-density bulk material after being cured while also enhancing stiffness via the total increase of thickness of the structural reinforcement patch sandwich. Vertical expansion rates range from 0% to 300%.

Figure 8:  
Example of  
hood application.



## Readthrough

Because structural reinforcement products are primarily used in thin panels that are viewable by the vehicle end-user, special care is taken to ensure that no readthrough on the Class-A surface can be seen. Readthrough is managed through the intelligent cure kinetics design of the bulk material, along with enhanced low-thickness/high-performance patches and either design features (Figure 8) or spray patterns that alleviate the risk.

## UNCURED PROPERTIES

In addition to considering cured product properties, it is also important to consider such uncured properties as:

### Wash-off Resistance

**Wash-off resistance** ensures that the patch or sprayable product does not wash off due to coating fluid flow induced by hydraulic forces in the electrocoat bath process.

### Rheology

For sprayable products, **rheology** of the uncured product governs the speed and mode of application. Henkel tightly monitors and optimizes rheological performance during the development phase through its established testing and formulation expertise.

### Drapability

For reinforcement patches, **drapability** ensures that the patch can easily conform to challenging geometries while also retaining its stiffness enhancement properties. This is achieved by balancing enhanced material properties of the bulk material with thin, pliable fiberglass layers, permitting attachment to difficult geometries while simultaneously ensuring high cured stiffness. The ability to die cut complex shapes further enhances ease of installation.

## PORTFOLIO OF PANEL REINFORCEMENT SOLUTIONS

TYPE OF REINFORCEMENT PRODUCT	PRODUCT NAME	CHEMISTRY BASIS	EXPANSION RATE	CURE SCHEDULE	DENSITY [g/cm <sup>3</sup> ]	SPECIAL CHARACTERISTICS
Patch	EP 7850	Epoxy	260%	160°C ~ 190°C 15-60 min.	0.37	Very high stiffening power, lower thickness patches
Patch	EP 2800	Epoxy-rubber blend	290%	160°C ~ 190°C 15-60 min.	0.36	High stiffening power patches
Patch	RB 5200	Rubber	200%	165°C 10 min.	0.54	Very low readthrough, damping properties
Patch	EP 16005	Epoxy	0%	160°C ~ 170°C 20 min.	1.94	Magnetic
Sprayable	RB 5185	Rubber	35%-100%	150°C ~ 190°C 10-30 min.	0.77-0.93	Jet stream, flat stream, swirl
Sprayable	EP 5041	Epoxy	35%-40%	140°C @ 30 min.+ 160°C @ 30 min.	1.03	Jet stream, flat stream, swirl, shovel spray

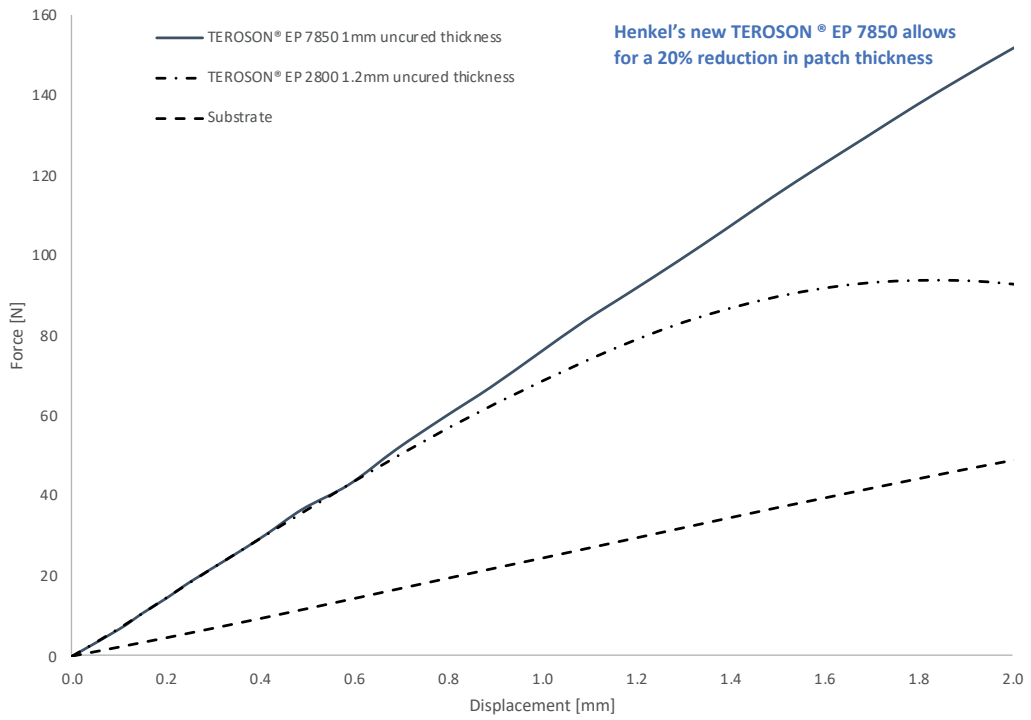


Figure 9: Force displacement behavior of neat and patched steel substrate with TEROSON EP 7850 and TEROSON EP 2800, demonstrating the stiffness increase with the use of the reinforcement.

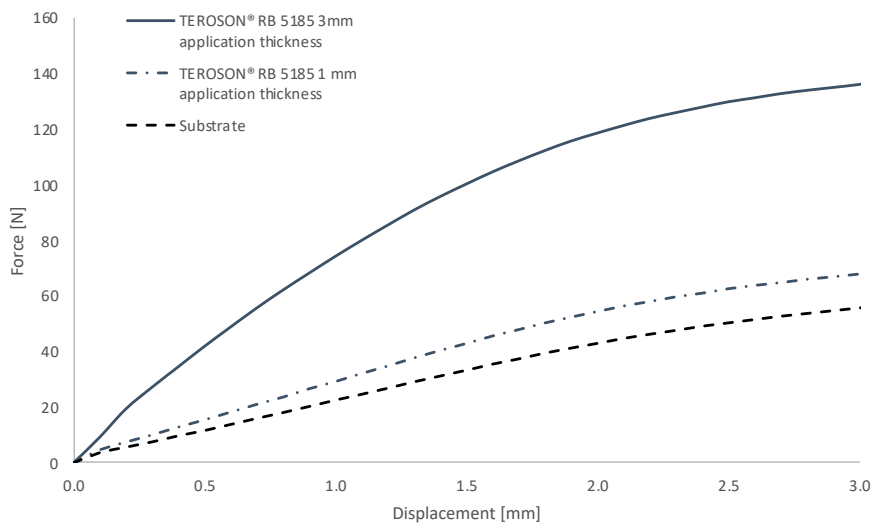


Figure 10: Force displacement behavior of aluminum substrate either neat or after the application of RB 5185 demonstrating the stiffness increase with the use of the reinforcement.





## **GET IN TOUCH WITH US**

For more information on our Panel Reinforcement and rigidity solutions, as well as our other services along the automotive value chain, visit:

**[www.henkel-adhesives.com](http://www.henkel-adhesives.com)**

Or contact us directly at:

**[aaoglobalmarketing@henkel.com](mailto:aaoglobalmarketing@henkel.com)**