LOCTITE®

TECHNOMELT®

DRIVING SUSTAINABILITY, INNOVATION AND CIRCULARITY IN AUTOMOTIVE INTERIOR DESIGN

EXPLORING THE SHIFT TOWARD ECO-FRIENDLY MATERIALS AND CIRCULAR SOLUTIONS

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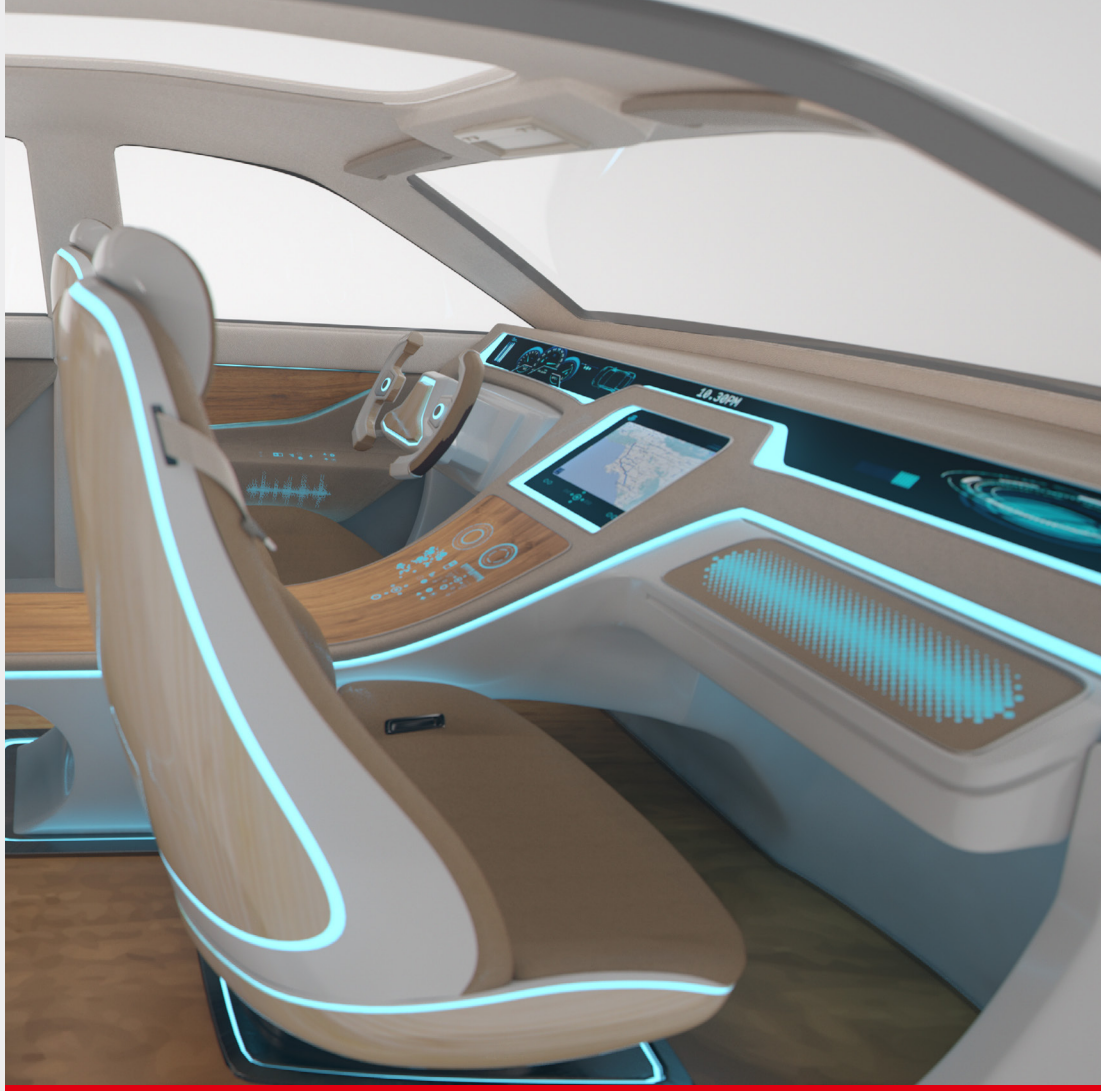
ABSTRACT

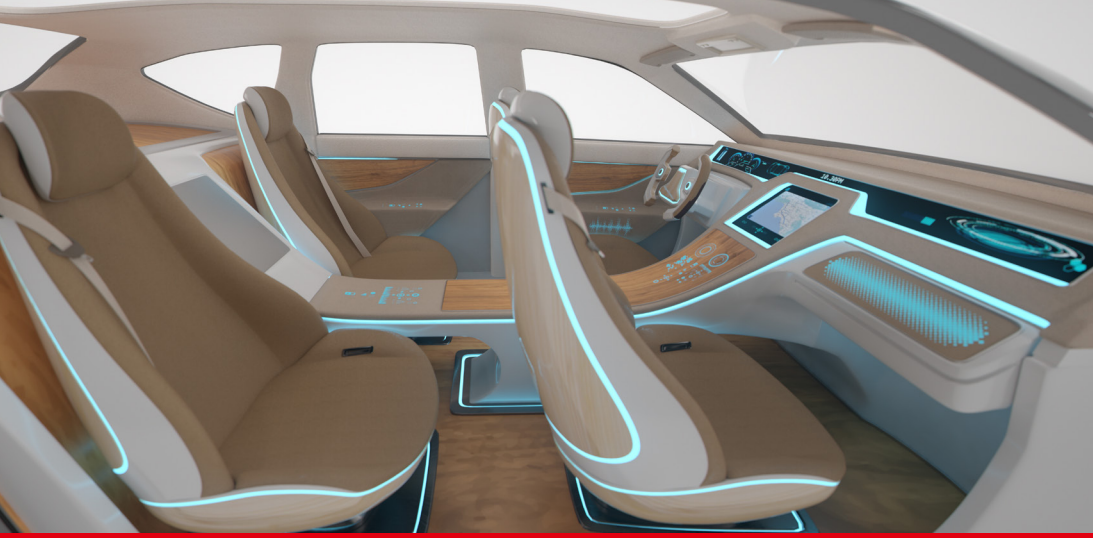
The automotive industry is undergoing a transformative shift toward sustainability driven by concerns over climate change, resource depletion, and increased consumer demand for eco-friendly products. As the passenger's direct environment and operational interface, the automotive interior plays an important role in this transformation. Today's consumers demand more than just a mode of transportation; they seek a holistic and immersive experience while on the road. At the same time, circularity of synthetic plastic materials – which are broadly used in automotive interiors – is increasingly a focus of legislators and consumers. Automakers and suppliers are investing in research and development to enhance not only the sustainability of the interior but also the quality of materials, infotainment systems, and human-machine interfaces. This white paper explores the latest trends in automotive interior components, highlighting innovations, materials, and legislative trends that reduce environmental impact while enhancing the overall driving experience.

Henkel

Henkel Adhesive Technologoies



DISCOVER HOW HENKEL SUPPORTS VEHICLE INTERIOR DESIGNERS IN THEIR PURSUIT OF TECHNICAL INNOVATION, AESTHETIC BEAUTY, SURFACE DURABILITY, AND ENVIRONMENTAL RESPONSIBILITY.



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SUSTAINABLE MATERIAL SELECTION

Automakers are increasingly adopting sustainable materials such as recycled plastics, plant-based materials like natural fibers, and leather alternatives. The use of bio-based and recycled materials not only reduces the actual environmental footprint of vehicles but also appeals to eco-conscious consumers.

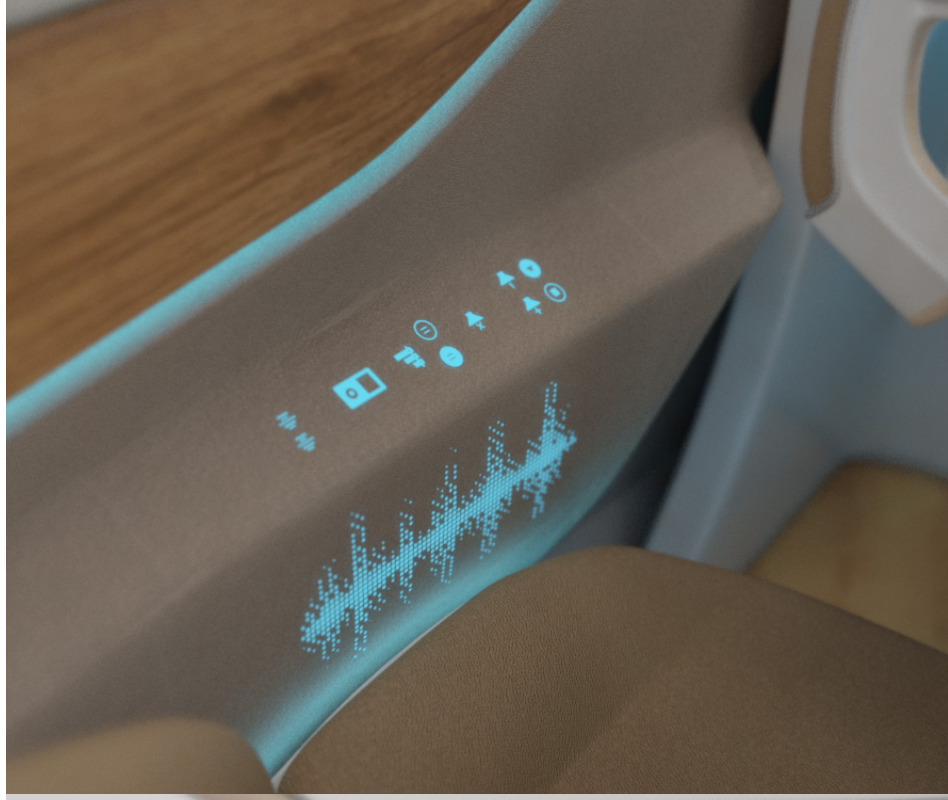
At the same time, luxury interiors are becoming more attainable as automakers expand premium materials, ambient lighting systems, and innovative human-machine interfaces (HMI) from luxury full-size to premium mid-size and even compact vehicles. Leather will continue to be used as premium coverstock for seats, armrests, door panels or instrument panels. More delicate materials like mushroom or cactus leather and plant-based engineered materials – from rattan and eucalyptus, for example – will constitute a growing niche. Other commonly used coverstocks for interior components include back-foamed films made of PVC or TPO.

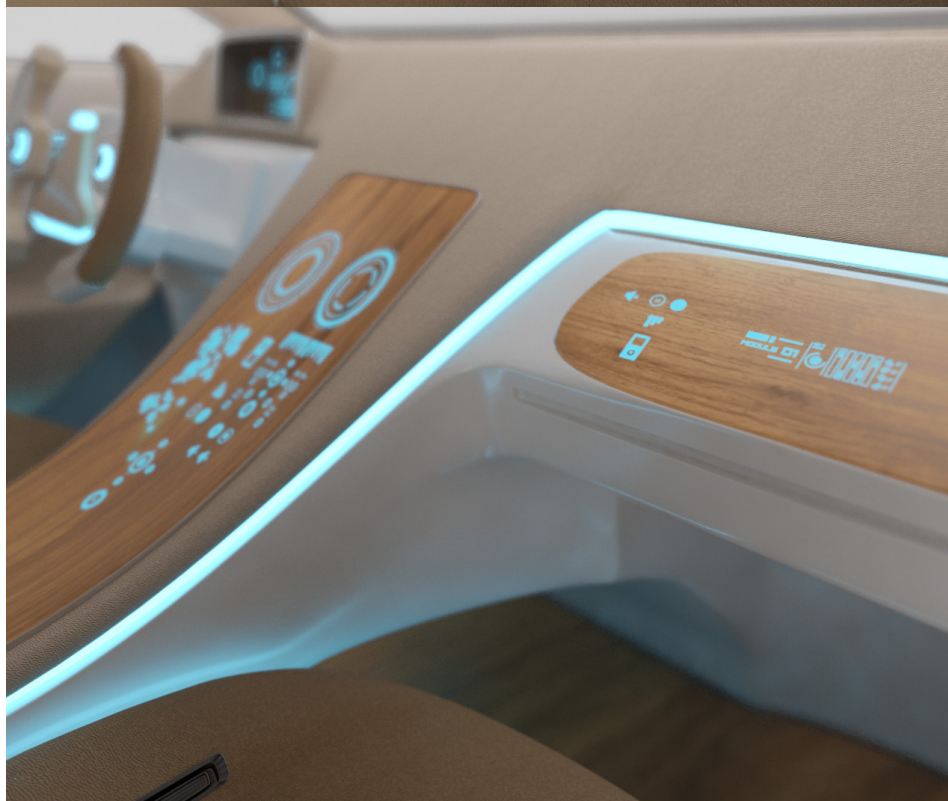
These coverstocks are usually affixed with lamination adhesives onto structural carriers, which are typically made of thermoplastics like PP or PC/ABS. Commonly used adhesives are non-reactive hot melts, reactive polyurethane hot melts (PUR), waterborne polyurethane dispersions (PUD), and solvent based adhesives. While the latter adhesive has been replaced by the more eco-friendly solvent-free and waterborne adhesives for decades, the share of hot melt adhesives continues to increase due to several advantages, foremost being eliminating the time and energy consumption required to dry PUD adhesives.

VERSATILE LAMINATION ADHESIVES

Modern TECHNOMELT® hot melt adhesives can be precisely sprayed onto 3D-shaped carriers or preformed coverstocks, or they can alternatively be roller-coated onto flat substrates. The actual lamination can be done via vacuum, press or in-mold grain (IMG) lamination. Typically, the adhesive is reactivated by heat during the lamination process, while pressure sensitive reactive hot melt adhesives (e.g., TECHNOMELT® PS 8668), and PURs with long open time (e.g., TECHNOMELT® PUR 4663) can be laminated without heat reactivation.

While non-reactive hot melts like TECHNOMELT® AS 8383 build their cohesive strength purely by physical processes, i.e., temperature-induced vitrification and crystallization, PURs only require these processes to build their initial green strength – subsequently needing only the humidity of the air to complete the chemical crosslinking process. As a result, PUR hot melts achieve higher temperature resistance and can stand service temperatures above 120° C, while non-reactive hot melts typically have lower maximum service temperatures and are predominantly used below the beltline of the vehicle interior.





INTERIOR LAMINATION DESIGN TRENDS

AMBIENT LIGHTING

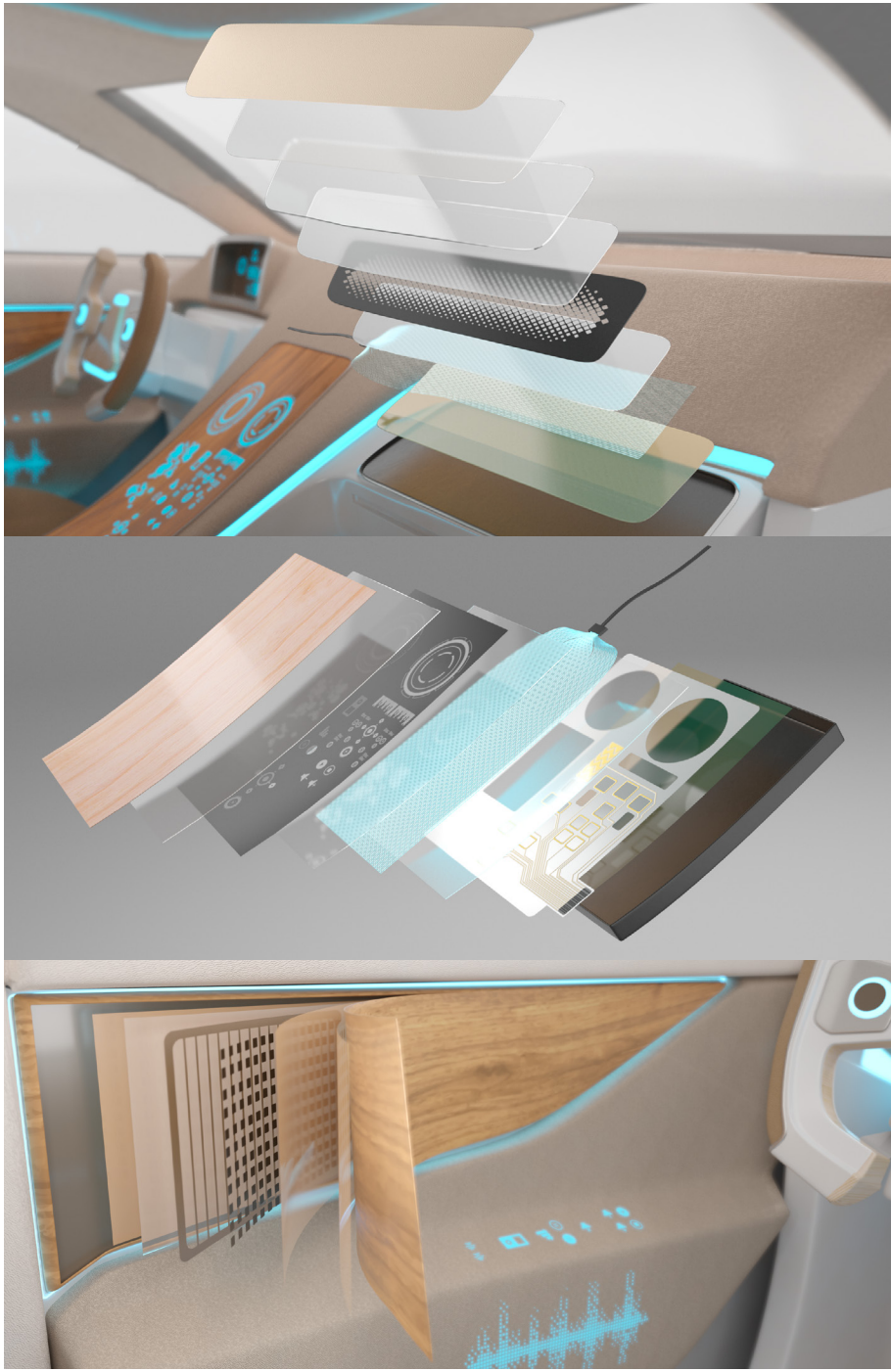
A significant emerging trend in current vehicle interior design is using backlit surfaces for ambient lighting. New translucent surface materials are available that appear non-translucent when unilluminated yet allow ambient lighting and further light effects like illuminated logos when backlit. To laminate backlit coverstocks, translucent and non-yellowing adhesives like TECHNOMELT® PUR 9062 or PUR 9041 need to be used. They stay colorless and translucent even after extended exposure to heat and UV light while also offering the full performance characteristics of PUR lamination adhesives.

SMART SURFACES

Even more sophisticated than ambient lighting, the latest HMI components integrate touch panels into high quality surface materials that can be seamlessly designed into the car interior. Without backlighting, these surfaces appear to be wood, fabric or leather, but when illuminated from the back, touch buttons appear. For the lamination of these interactive surfaces, TECHNOMELT® PUR 9062 or PUR 9041 are ideal solutions. In addition, highly integrated HMIs are using printed electronics where capacitive or force-sensitive sensors are printed with LOCTITE® ECI or EDAG conductive inks on flexible films – enabling extremely slim and flexible designs.

INTERIOR COMFORT

With the transformation of propulsion systems from internal combustion engines (ICE) to battery electric vehicles (BEV), the energy-efficient heating of the passenger compartment becomes eminent. While abundant waste heat from ICEs allows heating of the interior irrespective of energy efficiency, heating the passenger compartment in BEVs requires extra energy and reduces range. To save energy and shorten the time to achieve a comfortable temperature, designers are seeking to generate the heat as close as possible to the passengers by heating the surfaces of interior components. Doing so also creates a more pleasant feeling of warmth than convection heating with warm air, as IR radiation from heated surfaces is transmitted directly to passengers. Printed flexible heating elements that can be laminated directly underneath the coverstock of interior components are an innovative solution attracting significant interest in the industry. These resistive heaters can be designed using silver inks alone or a combination of silver and carbon inks. Positive temperature coefficient inks, commonly abbreviated as PTC inks, are especially suited for use in printed flexible heaters. By dialing in the ink formulation, these innovative inks can self-regulate to a set temperature range anywhere between 30° and 120° C – inherently eliminating any risk of overheating. Henkel offers a full range of LOCTITE® silver based, carbon based and PTC inks.



SHAPING SUSTAINABLE SURFACES

REDUCING CARBON FOOTPRINT

While the product carbon footprint (PCF) of interior components is predominantly driven by the carrier and coverstock, which typically constitute more than 95% of the component's material weight, a carefully chosen lamination adhesive can help reduce the component's PCF even further.

PURs with a low reactivation temperature, like TECHNOMELT® PUR 6225 LE, are not only well-suited to laminate delicate and temperature-sensitive coverstocks like leather, they also significantly reduce the energy consumption and carbon footprint of the lamination process. At the same time, their chemically crosslinked formulation enables high service temperatures despite the adhesive's relatively low melting point. TECHNOMELT® PUR 9800 is formulated with 60% of directly bio-based and recycled plastic-based raw materials, significantly reducing its carbon footprint. These latest generation TECHNOMELT® adhesives have successfully reduced PCFs, and bio-based TECHNOMELT® adhesives can also contribute toward customer claims of using renewably sourced vehicle interior materials.

Upcoming Regulation Change in the European Union

In July 2023, the European Commission published their *Proposal for a Regulation on circularity requirements for vehicle design and on management of end-of-life vehicles.* This proposed regulation will affect how vehicles are designed to include recycled materials and accommodate recyclability when scrapped. A consultation period is under way, during which the European Parliament and the Council of Europe are examining the proposal to articulate a final position, after which the final text will be agreed in trilateral negotiations.

Most relevant for the design of interior components will be two mandatory requirements:

1) At least 25% of the plastic used in new cars must be post-consumer recyclate, of which 25% must be closed-loop recyclates (coming from end-of-life vehicles).
2) At least 30% of the plastic in end-of-life vehicles must be recycled.

Elastomers are not anticipated to be in the scope of these requirements.

The new end-of-life vehicle regulation (ELVR) will be linked to the Type Approval Framework Regulation (EU) 2018/858, so compliance with the ELVR will be relevant for the type approval of any new vehicle being sold in the EU.

Another important aspect of the regulation is its Extended Producer Responsibility, which mandates OEMs to bear the costs of collection, waste treatment and recycling of end-of-life vehicles.

The new ELVR is expected to take effect in 2031 or 2032.

A modern light vehicle contains roughly 200 kg of synthetic plastic materials, of which about half are polyolefins. Engineers designing new vehicles or new components for future vehicles will have to consider compliance with the new circularity requirements. In the design phase of new interior components, both the use of recycled plastic, as well as economically efficient recycling of the plastic at end-of-life, will have to be accounted for. Extended Producer Responsibility will likely entail adding a price tag for potential recycling expenses to each relevant component during the initial type approval of a new vehicle model. This will create a financial incentive for suppliers to design components that can be recycled efficiently.

Adhesives Facilitating Circularity

There are multiple ways Henkel is already helping facilitate compliance with the new regulation. Substrates containing recycled plastic can be challenging to bond, as impurities within the plastic can migrate to the surface, interfering with adhesion between the substrate and adhesive. Selecting and validating the right adhesive will be more challenging with recycled plastic, as its surface properties can show significant variations from batch to batch.

To enable recycling for components with plastic substrates, Henkel supports two different approaches. TECHNOMELT® adhesives can often be recycled with the plastic. If adhesively bonded substrates are compatible, it is possible to select an adhesive that will mitigate the need to separate sub-components and materials.

Henkel already has extensive experience with recycling-compatible plastic adhesives for fast-moving consumer goods packaging. With its range of adhesives designed for recycling, Henkel enables packaging to go beyond current functionalities – to create flexible packaging that has recyclability "built in." Products in this range must fulfill stringent external testing requirements for sustainability. Now, Henkel is transferring this concept to automotive interior components, enabling full-component recyclability for plastic substrates that are predominantly based on the same polymer chemistry.

Sometimes, a combination of different materials is still required for functional reasons. In these cases, debonding is necessary at end-of-life to enable closed-loop-recycling of any plastics. Henkel has developed cost efficient processes and technologies for debonding and partners with recyclers and customers to select a debonding solution that facilitates recycling at end-of-life. Now more than ever, automotive components need to be intentionally designed for recycling, which includes selecting the right adhesive, designing the adhesive joint, and defining the debonding process, if necessary.

CONCLUSION

With Henkel Adhesive Technologies, automotive component designers can reap the benefits of decades of experience designing, joining, and recycling plastic components. By partnering together early in the component design phase, designers can better overcome challenges, reduce complexity, and ultimately save time and money. When pursuing emerging trends like integrated ambient lighting, smart surfaces or printed electronics, engineers can capitalize on Henkel's extensive testing capability, global collaboration and manufacturing capability, and proven product performance. No matter the challenge, Henkel's knowledgeable application engineering and product development teams bring a fresh perspective, helping customers continue to innovate and prepare for the future.

WE MAKE INTERIOR INNOVATION HAPPEN

Henkel holds a leading market position as an innovation and development partner to automotive OEMs as well as manufacturers for EV batteries, electrical and electronics modules, and vehicle interior, exterior, powertrain, and chassis components. With a broad and diversified portfolio of advanced adhesives, sealants, battery safety materials, thermal management materials, conductive electrode coatings and dielectric coatings, supported by an extended network of partners and world-class capabilities in modeling, simulation and application technologies, Henkel stands out as a comprehensive solution partner, enabling next-generation vehicle component design and production.

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