Producing High-Strength Aluminum Alloys

Implementing New Materials like AHSS Lightweight Plastic Parts Under-Hem Adhesives Ruhls for Lightweighting

WHEEL-END & SUSPENSIONS: INNOVATIVE LIGHTWEIGHTING OPTIONS

+ & MORE!
Lightweighting is a global trend in the automotive industry driven by the Corporate Average Fuel Economy (CAFE) standards in the U.S. and the Clean Air for Europe program to reduce CO₂ emissions from automotive vehicles. Using a combination of lighter-weight materials (i.e., aluminum and composite) in vehicle design and manufacturing significantly improves fuel consumption. Since regulators around the globe are expected to call for even more stringent emissions standards in the future, the importance of lightweight materials will only increase. Aluminum substrates could make up as high as 35 percent of vehicle content to help meet these demands.

Today, approximately 25 percent of a car’s fuel consumption is attributable to vehicle weight. Cutting-edge materials boost the fuel economy of automobiles because it takes less energy to accelerate a lighter object than a heavier one. Lightweight materials offer great potential for increasing vehicle efficiency and meeting U.S. and global CO₂ requirements.

The Environmental Protection Agency (EPA) standards in the U.S. by model year 2025 are projected to result in an average industry fleetwide level of 163 grams/mile of CO₂, which is equivalent to 54.5 miles per gallon (mpg). Thus, lightweighting provides a path for the auto industry to build automobiles that are lighter with better fuel efficiency. In Europe, vehicle weight reduction continues to be a top priority in efforts to reduce greenhouse gas (GHG) emissions. Standards there are aiming to meet 60 mpg for small cars and 46 for large cars by 2025. Legal standards together with increased fuel prices are strong motivating factors for working hard to move toward low-emission vehicles.

**METHODS OF JOINING**

These developments potentially impact all methods of vehicle construction, including how to attach different parts seamlessly and safely. There is a distinct difference between using conventional joining methods for metal parts, such as rivets and welding—which were the common method of closure—and structural adhesives.

**A New Under-Hem, Two-Component Adhesive Technology**

By Walid Omar Sr., Manager, OEM Sales, and Federico Ciardelli, Global Business Manager, Automotive Assembly, LORD Corporation

**Structural Adhesive Improvements Help Auto Manufacturers Meet Lightweighting Targets**
Structural adhesives are lighter than rivets and welding, contributing to an overall reduction in vehicle weight, along with increased performance over mechanical fastening. (See Figure 1.) Rivets and welding, for example, can create specific stress in the area where they are applied, while adhesives being applied on longer or larger areas can distribute the stress caused by the joining process. Also, mechanical methods of closure can cause other problems. Welding, for example, may produce corrosion around the weld, rivets distortion and aesthetic distortions.

Typically, structural adhesives are considered more cost effective when they simplify or reduce steps in the joining processes. Moreover, conventional joining methods do not work with the lightweight composite substrates found on more and more vehicles today, while structural adhesives are designed to work on these materials. Many OEMs are considering the option of removing rivets and welds and using multi-substance steel and composite substrates to achieve federal requirements. In some situations, a conventional joining solution can work on composite materials, but structural adhesives remain the recommended method for composites.

THE STRUCTURAL ADHESIVE DIFFERENCE

Lightweight materials need to be sustained by specific structural adhesives that fit both the materials and the processes used. The combination of lightweight materials and structural adhesives can be quite significant in achieving the complete bonding criteria, but it bears noting that a structural adhesive is easily adapted to an OEM’s specific production processes to accommodate some aspects, such as adhesive open time and/or cure temperatures requirements.

A strong, smart, structural adhesive should be adaptive to various needs, provide the ability to bond a variety of substrates, guarantee its structural bonding performance and avoid read-through, especially in the case of low-density and thinner gauge composites. A structural adhesive must deliver this multifunction and keep engineered dimensional stability, in particular when it comes to panel-closure bonding. Structural adhesives that can cure at room temperature provide a certain advantage.

Engineered structural adhesives have proven an effective and efficient solution when it comes to meeting the engineering demands of OEMs for lightweighting trends. They allow new materials to be bonded to each other or allow processes to accommodate lightweight materials, which would not be possible otherwise. These specialty formulated structural adhesives provide for the development of a high-strength bond at room temperature within the OEM processing window, along with the ability to bond through various stamping lubricants without advanced cleaning or surface preparation, and with low or no pre-heating.

UNDER-HEM STRUCTURAL ADHESIVES

When we look closer at under-hem structural adhesives, their most important function is not only to bond inner and outer panels, providing corrosion-resistant sealing, but also to ensure the dimensional stability of automotive closure panels throughout the entire production process.
from Body-in-White (BIW) to e-coating. As an example, aluminum is one of the dominant lightweight materials whose properties are such that it does not “like” to go through heat. Therefore, having a two-component (2C) adhesive solution that cures at room temperature with no or low heat gives OEM engineers the freedom and flexibility to better design and manufacture with these lightweight substrates.

Under-hem structural adhesives are an example of an adhesive that helps OEMs adopt thinner and lighter materials such as high-strength steels and aluminum for their lightweight properties without any deterioration to the class “A” surface of these closures. Under-hem adhesives are used to bond two panels in areas such as hoods, doors, liftgates, trunk lids and fenders.

LORD Versilok® 273/331 adhesive is an example of a multi-substrate, under-hem structural adhesive that is gaining popularity in the automotive industry. (See Figure 2.) This two-component, epoxy-modified acrylic adhesive bonds a variety of automotive sheet metals, including hot-dip galvanized, electro-galvanized, bare aluminum and cold rolled steel. This type of adhesive can be used in a range of temperature curing—either room-temperature cured or heat-cured for faster processing. Versilok 273/331 is designed with glass beads to provide a strong mechanical lock that will prevent shifting of substrate panels during production processes.

It’s important to note that not all structural adhesives have this multi-substrate ability.

Whatever your choice for an optimal under-hem adhesive, it’s important to consider whether it meets these success factors:

- High initial handling strength that aids in production processes to improve quality and drastically reduce waste and scrap parts
- Dimensional stability. Freedom in the production processes and the transportation of finished parts to other assembly plants
- Improved crash resistance
- Improved corrosion resistance. Sustained through the “harsh” traditional OEM environmental cycle

**CONCLUSION**

As advances are made, lightweight body construction has become a key target and consideration in the auto industry. Structural adhesives in these constructions are an enabling technology. The continuous development of bonding systems will ensure that new substrates can be bonded with enhanced safety and durability in the future. Aluminum, being one of the rising substrates that traditionally does not fare well in high temperatures, works best with an adhesive that requires little or no heat to cure, helping to avoid issues such as panel deformation during the production cycle. As with any new material or process, the challenge ahead remains educating OEMs on how to combine parts, materials and production processes.
A global OEM brought a quality challenge to LORD Corporation. The automobile manufacturer needed to improve the initial bond strength at room temperature and also gain long-term corrosion improvement. These parts were being shipped overseas, as well as across country, experiencing large amounts of vibration.

LORD was asked to provide a high, initial room-temperature strength adhesive. The goal was to deliver an improved, under-hem adhesive versus the current generation with a higher level of corrosion resistance on all substrates. This particularly applied to hot-dip galvanizing (HDG), with equal or better humidity lay-over behavior (HLO), meeting the 20-week VDA standard aging cycle and 3,000 hours salt-spray test.

Using LORD Versilok 273/331 decreased corrosion by 20 percent. There was a significant improvement in corrosion resistance on aluminum and electro-galvanized steel. Also, it substantially improved the dimensional stability of closure panels due to improved adhesion and elasticity.

The OEM benefited from an increase in shelf life because of better stability and better chemical activity of the hardener component. Additionally, there was complete corrosion knock-down (CKD) of closure panels because of an improved resistance against humidity lay-over. There was also better packaging behavior and processability, with no requirement to heat the two-component, epoxy-modified acrylic adhesive to obtain the correct mixing ratio. LW

ABOUT THE AUTHORS

Walid Omar, OEM Sales Manager for LORD Corporation, has 25-plus years of automotive experience. He focuses on developing and delivering structural adhesives and NVH-engineered solutions to OEM manufacturers and their tiers. These technological solutions accommodate present and future needs for the vehicle body structure with emphasis on lightweighting assembly components.

Federico Ciardelli, Global Business Manager for Automotive Assembly Solutions, has an MBA from the IESE Business School and has worked for LORD Corporation since November 2013. Prior to joining LORD, Mr. Ciardelli held many sales and marketing executive positions in various automotive Tier 1 companies, such as Pilkington, Faurecia and Hitachi.

ABOUT LORD CORPORATION

LORD Corporation is a diversified technology and manufacturing company developing highly reliable adhesives, coatings, motion-management devices and sensing technologies that significantly reduce risk and improve product performance. For more than 90 years, LORD has worked to provide innovative oil and gas, aerospace, defense, automotive and industrial solutions. With world headquarters in Cary, N.C., LORD has approximately 3,100 employees in 26 countries and operates 19 manufacturing facilities and 10 R&D centers worldwide. For more information, visit http://www.lord.com.