Material Solutions to Seal Out the Elements in Automotive Lighting Applications

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The engineering design of any automobile is extensive. From the engine to the power train and axles and wheels. Fuel systems. Steering. Restraints and safety systems. Infotainment.

And of course, most visibly for the driver and passengers, interior design, which is scrutinized for both functionality and aesthetics.

Unfortunately, a common complaint is water ingress into interior headliners, typically via sealing gaps surrounding center high-mounted stop lights (CHMSLs).

Any new car buyer will be supremely disappointed to discover their new expensive purchase leaks, and their vehicle's headliner is stained, wrinkled and a home for mildew.

Perhaps the biggest reason for this phenomenon is the gap between OEM material specifications and the performance requirements in the application. Design engineers may select sealing foams which appear to work on paper, based on lab sample validation testing. However, these materials can show issues later on during part validation, or after production, due to real-life environmental conditions and actual part geometry

Generally speaking, the predominant consideration is cost. The materials typically specified for lamp sealing, such as EPDM foam, offer up-front expense savings. On the surface, of course, this is advantageous. A deeper look, however, reveals a more complicated picture.

End users are often reporting leakage within just a few months of new vehicle purchase; for them, the issue is more than just an annoyance. They get saddled with repairs adding to the total cost of ownership, which impacts brand perception. This, in turn, diminishes customer loyalty and reverberates backward in the supply chain to impact dealerships and manufacturers. The latter can respond by publishing repair instructions, but this opens the door to warranty claims and the possibility of recalls. OEMs can also elect to make running changes on their assembly lines to improve parts production, but this is likely to be cumbersome and costly.

An alternative is to treat the challenge as a design engineering opportunity from the beginning of the process. By specifying premium gasket-sealing materials, such as silicone foam tapes, engineers can ensure the long-term viability of rear lamp assemblies. As a result, brand perception is maintained, the potential for warranty claims is diminished and the possibility of recouping initial costs is presented as a function of product reliability and longevity.

Material Considerations

Rear-mounted lamps present several unique considerations relevant to determining an appropriate type of sealing material. Because the housings incorporate plastics — typically ABS

Figure 1. Moisture seeping in vehicle headliners via the center, high-mounted brake light is a common — but entirely preventable — complaint.

Source: Shutterstock

or polycarbonate-ABS (PC-ABS) — substrate compatibility is a factor. PVC sealing foams cannot be used here due to the risk of environmental stress cracking of the housing. CHMSLs, which have transitioned from being located inside rear windows to the current placement trend outside roofs or inside spoilers are particularly unforgiving; they are sealed directly to the vehicle, so the sealing material must perform at 100% effectiveness over the entirety of the vehicle life.

The typical solution, EPDM foam, offers the advantage of being a low-cost material. But it also presents several drawbacks.

One is its largely open-cell structure, which translates to seals requiring high compression — in the range of 50% or more — to effectively block water ingress, especially for larger lamps and more complicated gaskets requiring sealing along ribs. This is further complicated by the fact that EPDM is generally characterized by a high compression set, meaning that compression over time tends to cause permanent deformation. As a result, any movement in the part can compromise the seal. Moreover, this phenomenon limits serviceability: If parts need to be removed for repair, the seal will be less effective when they are put back into place.

Another concern is the possibility of corrosion when in contact with LEDs or electronics. This is relevant to sulfur-cured EPDM, making it inappropriate for lamp sealing. While EPDM cured with peroxide is an acceptable alternative, it is generally more expensive, stiffer and more difficult to assemble in order to get the proper compression level required.

A modest improvement over EPDM can be found in polyurethane (PUR) foam, which offers a lower compression set imparting greater resiliency. PUR foams are primarily micro-cellular, which means high compression level is still necessary to create an effective seal. If the seal becomes exposed to the elements, it can also be compromised by poor UV stability.

At the other end of the spectrum are silicone foams — a superior solution that places a premium on both conformability and durability. Its flexibility can be seen in its low force-to-compress (FTC) to compression-force-deflection (CFD) ratio, which enables better sealing along a rib. At the same time, closed-cell configurations allow for an effective water seal at just 30% compression. Able to withstand a wide temperature range, UV- and ozone-resistant, sulfur-free and non-corrosive, silicone foam is ideal for a variety of automotive applications for which long-term product life is required.

This last point is a key concept. Design engineers specifying silicone solutions must contend with budgetary constraints that may be based on short-reaching analyses. When the wider outlook gets factored in, however, the value of using top-shelf materials such as silicone becomes more easily discernible.

Norseal Silicone Foam

Our solution to the challenge of rear-mounted lamp sealing can be found in our line of **Norseal** Silicone Foams. The medium density, closed-cell F-20 silicone foam rubber serves as the substrate for its 520HGF tape.

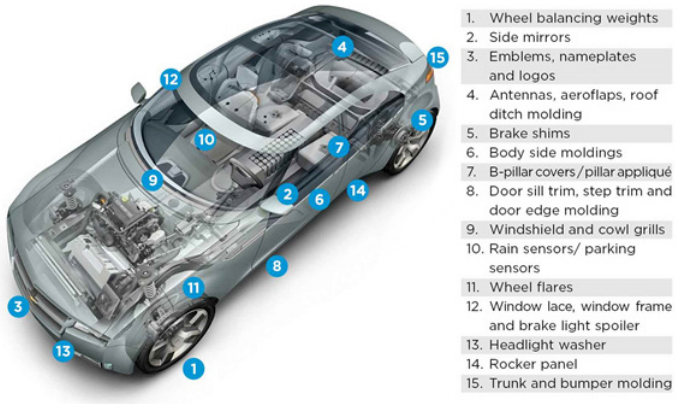

Figure 2: Over 60 years serving the sealing and bonding needs of the automotive world.

Source: **Saint-Gobain** Tape Solutions

Norseal F-20 is known throughout many industries, including multiple transportation sectors, for its resistance to environmental conditions — air, dust, light, moisture and more. **Norseal** 520HGF, shown in Figure 3, employs a film-supported acrylic pressure-sensitive adhesive (PSA) to deliver the benefits of F-20 silicone foam in an easy-to-apply form. 520HGF has a sulfur-free formulation that eliminates corrosivity around electronics, while its low absorption quality imparts durable water sealing; it is also flame-retardant and resistant to chemicals and cleaners. Moreover, it has been shown to outperform other elastomer tapes in numerous arenas — including longevity, weatherability and electrical resistivity — and in extreme temperature applications. 520HGF tapes are available in a variety of thicknesses and form factors including strips, die-cuts, O-rings and other custom shapes and sizes.

Figure 3. **Norseal** 520HGF SNS Tape offers flame-retardant, closed cell F-20 Silicone Foam as the base material, along with a film-supported acrylic pressure-sensitive adhesive

Source: **Saint-Gobain** Tape Solutions

Perhaps most importantly for rear-mounted lamps, the low compression set of both F-20 and 520HGF products translates to more reliable seals with greater serviceability. Here is a look at some of the most salient data:

Norseal F-20 Data

- **Description:** Medium-density, closed-cell silicone foam rubber product
- **Density:** 20 lb/ft^3 / 320 kg/m^3 (ASTM D3574)
- **Compression deflection:** 10 psi / 70 kPa (ASTM D1056)
- **Compression set:** <5% (ASTM D1056 "D"; compressed 50% for 22 hours at 212°F/100°C)
- **Ozone effect rating:** No cracking (ATSM D1171-99 [2007], Method A)
- **UV resistance:** No degradation (SAE J1960)
- **Water absorption:** <1% (ASTM D471/D1056)
- **Temperature range:** -60° to 100°F/-51° to 204°C

Norseal 520HGF Data

- **Description:** Pressure-sensitive adhesive silicone SNS foam tape
- **Adhesion to steel:** 30 oz/in / 335 gm/cm (test method: ASTM D1000)

NOTE: These are typical values and should not be used for specification purposes.

Design engineers also may want to consider that the **Norseal** Foam Product Range is used in a variety of other automotive applications. These include HVAC and cowl grill gasketing for climate control; door lock and quarterlight window vent sealing; and vibration damping solutions for dashboards and interior trims. In addition, **Norseal** Silicone Products support the continuing evolution of electric vehicles (EVs), with sealants to protect from external atmosphere intrusion; compression pads to accommodate expansion and contraction in battery cell stacks; and thermal interface materials to isolate cells in the event of thermal runaway events.

Opportunity Calling

Because of their cost, silicone foams are typically reserved for applications requiring very low compression sets or resistance to extreme temperatures. Specifying their use to address rear-lamp moisture leakage may seem like overkill. As outlined above, however, there is a wider picture to consider. It represents an opportunity for manufacturers to get ahead of a common customer complaint that is perhaps more insidious than they realize.

Saint-Gobain Tape Solutions is well-positioned as a partner to help design engineers realize the potential for success. With over 60 years of experience serving the sealing and bonding needs of the automotive world, we are able to offer a thorough and well-calibrated approach to problems facing the industry today. In addition, our customers are not limited to working with existing inventory, as is the case when dealing with tape suppliers; instead, you could have access to our team of engineers who design the adhesives, and can help you arrive at custom solutions for any application.

Contact us to today to discuss how our silicone options can serve your application needs.

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