

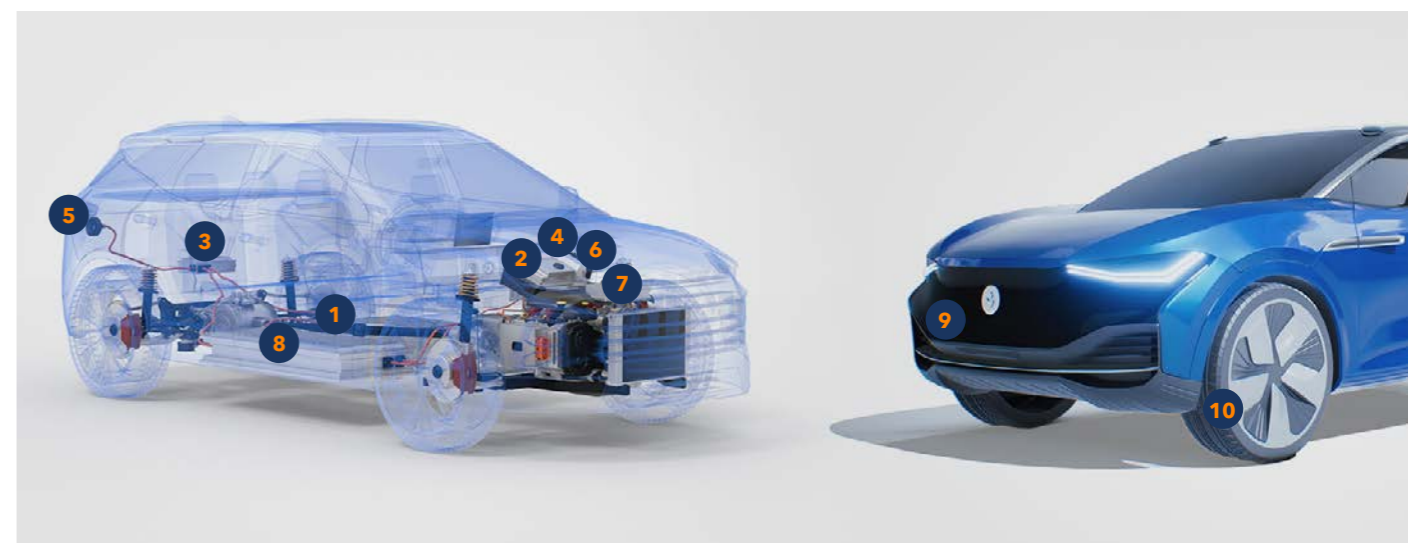


# SILICONES FOR E-MOBILITY



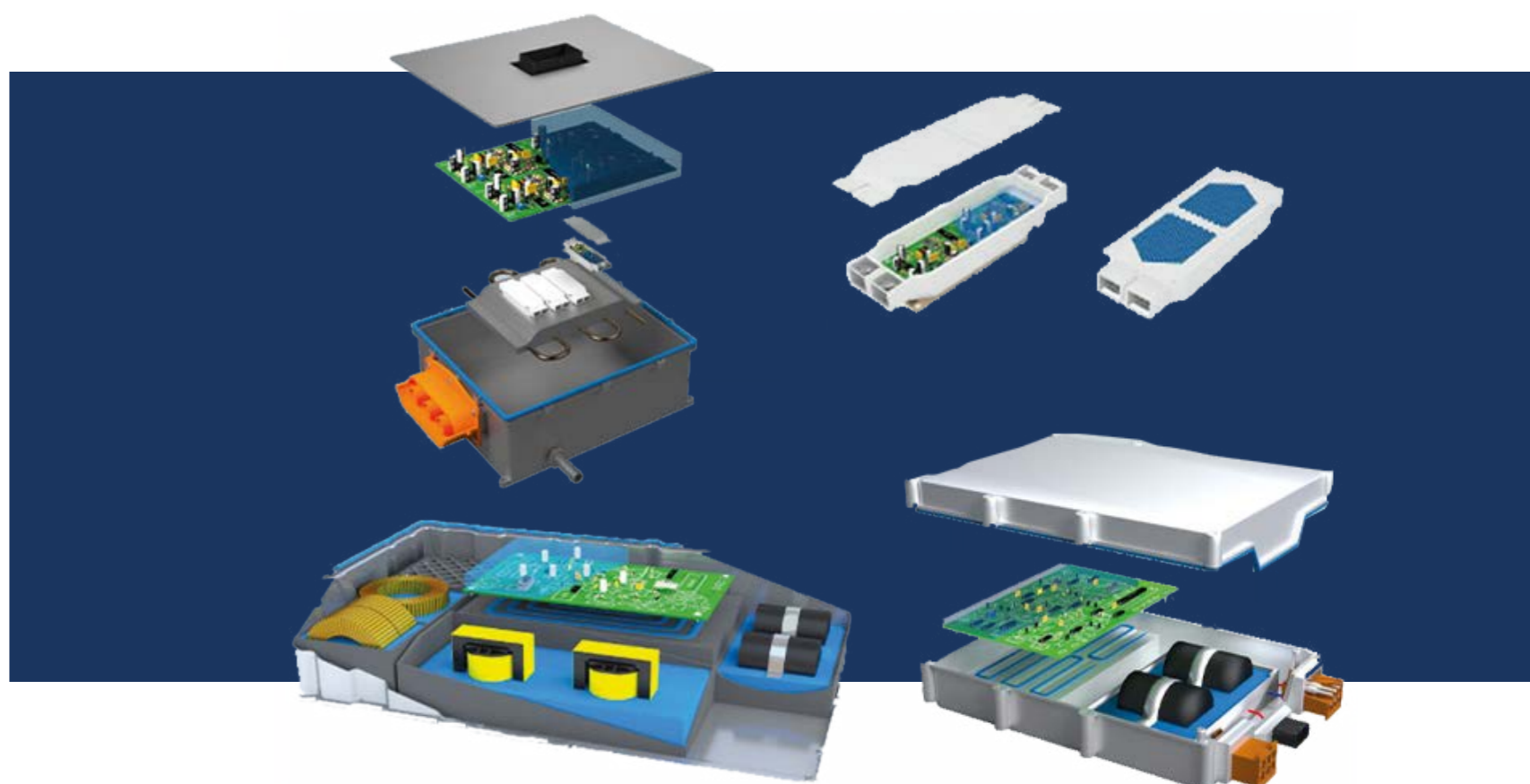
MATERIAL SOLUTIONS FOR  
E-MOBILITY & ELECTRIFICATION

## MATERIAL SOLUTIONS FOR E-MOBILITY & ELECTRIFICATION



As a new era of e-mobility emerges, it's accompanied by new manufacturing challenges that require new material solutions. Companies must innovate in order to meet these challenges. Momentive's advanced material solutions play an essential role in the vehicles of today and tomorrow. From thermal management and battery solutions to cable and connector materials; from sensor coatings to adhesives and seals -- Momentive's innovative silicones help shape the future of e-mobility and drive our new vehicles forward.

1. Power Electronics
2. High Voltage Battery Systems
3. Electrified Powertrain
4. EV Thermal Solutions
5. Seals & Connectors
6. EV Cables
7. Fuel Cell Sealing
8. Two-Component Integrated Sealing Systems
9. Front-End Modules
10. Sustainable Tire Solutions for Range



## ENRICH LIVES BY ENABLING PIONEERING TECHNOLOGIES

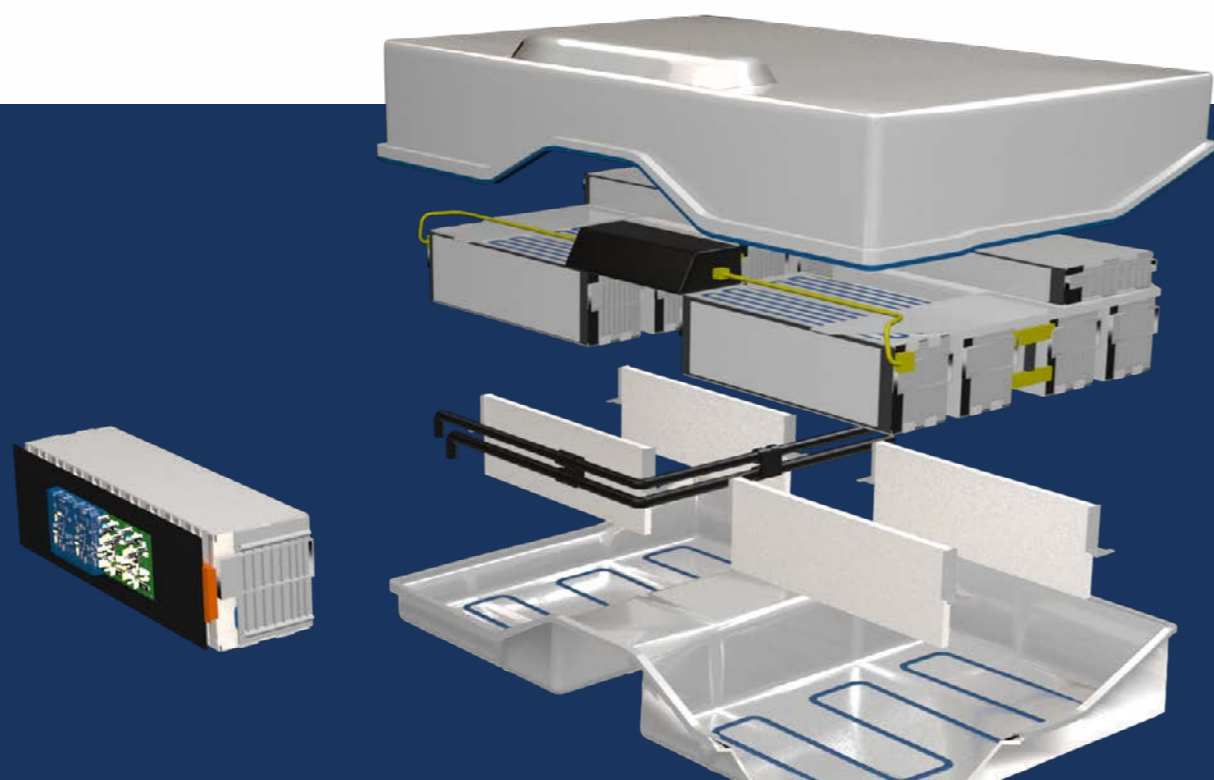
Silicone used to protect our electronic touchscreens enhances the user experience, better enabling a connected world.

Specially formulated materials that enable the manufacture of high-end electronics with improved reliability, longevity and durability. Serving a range of consumer electronics and e-mobility applications, as well as in critical aerospace and aviation applications that require high temperature and stress resistance.



## ONE: POWER ELECTRONICS

Vehicle power electronics process, control and distribute electric power to other vehicle systems, as well as control the speed and torque of the motor. Momentive silicone solutions offer **thermal management, encapsulation/potting, and sealing** for power electronics, including **inverter systems (and IGBT modules), DC/DC converters, and onboard chargers** (pictured left to right, blue areas indicate material applications):



## TWO: HIGH VOLTAGE BATTERY SYSTEM

Momentive's silicone solutions for **battery modules** include thermal management (**thermal gap fillers, adhesives**), **thermal potting and gel encapsulation**, and sealing adhesives.

For battery housing components, Momentive's SFR100 silicone fluid is a non-halogenated flame retardant enables excellent EV fire safety performance without compromising other important properties such as mechanical toughness or non-corrosiveness.

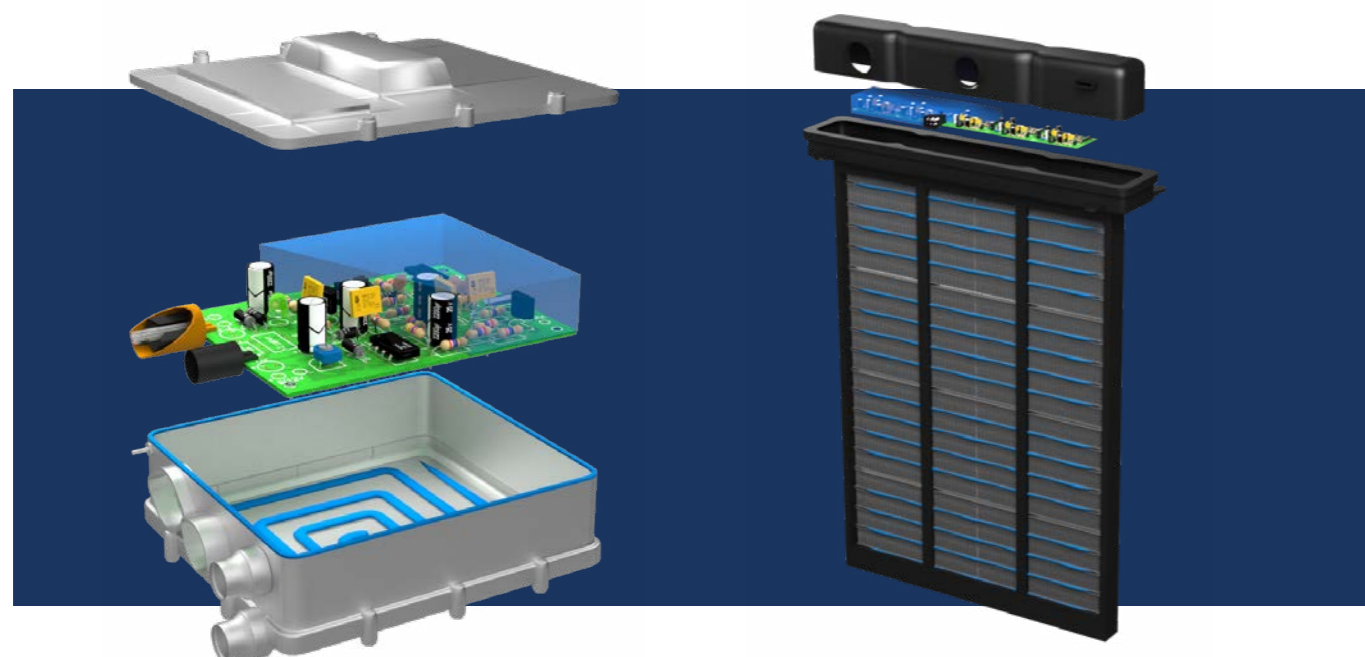


## THREE: ELECTRIFIED POWERTRAIN

- Silicone applications for the **Integrated Drive Motor / Generator** include connector potting, encapsulation material, sealing adhesives, and thermal management material.
- Silicone applications for the **e-axle** include encapsulation, connector potting, thermal potting and other thermal management, as well as sealing adhesives.

## FOUR: EV THERMAL SOLUTIONS

- **Coolant heaters** improve battery performance by delivering consistent temperature distribution inside the battery pack and its cells. Silicone applications here include encapsulation, connector potting, thermal management, and sealing adhesives.
- The **electric coolant pump** regulates and provides coolant to the cooling system. Silicone applications here include encapsulation and connector potting, thermal management, and sealing adhesive.
- **PTC (Positive Temperature Coefficient) Air Heater** heats the vehicle cabin using high-voltage electricity from the battery or hydrogen cell. Silicone applications here include encapsulation, connector potting, thermal management, sealing adhesives, and structural adhesives.



### SilCool™ Thermal Management Series

Momentive's thermal materials offer very low thermal resistance coupled with high reliability. Find out more about: thermal gap fillers, thermal potting and gel encapsulation, thermal management.

### SnapSil™ Adhesive Series

Momentive's SnapSil adhesive range offer adhesion to various substrates coupled with outstanding mechanical properties. Find out more: SnapSil Silicone Adhesives & Sealants.

### Potting & Encapsulation

Our potting and encapsulation materials offer outstanding protection to electronic components from dust, moisture, fluids and harmful environmental contaminants. Find out more: encapsulation/potting, sealing and bonding adhesives.

## SILICONE ELASTOMERS FOR E-MOBILITY



The future of mobility is being redefined with the paradigm shift from traditional internal combustion technology to steadily growing and continually evolving electric vehicle technology.

As advancements in e-mobility are made, the intrinsic need for advanced materials is ever present and growing. Safety, reliability and performance continue to remain driving forces in the specification of polymers in e-mobility applications.

Silicone's unique properties enable Momentive's materials, such as its LSR and HCR based material technologies, to meet and exceed demanding performance requirements of electric vehicles in a wide breadth of e-mobility applications. Our breadth of experience ensures that wherever there is a need, Momentive will have the industry and technical knowledge and expertise to help our customers and industry partners succeed.

Some of the material characteristics that are key to addressing and solving such complex challenges include:

- High Thermal Stability
- Low compression set without post-cure
- Self-lubricating properties
- Low viscosity
- Fast cure
- Low modulus
- Increased crack resistance
- Outstanding resistance to aging
- Easy to color
- Self-bonding
- Thermal conductivity
- Excellent electrically insulating properties
- Dielectric strength



## FIVE: SEALS AND CONNECTORS

### Silopren™ LSR 3000 Series (Self Lubricating)

The Silopren LSR 3000 Series are two-component liquid silicone rubber for injection molding processes. These materials are an excellent candidates to consider for the manufacture of elastomeric articles requiring self-lubricating properties. The self-lubricating effect is achieved by a fluid which exudes out of the vulcanizate over an extended period of time. It typically starts between a few hours and one day after vulcanization. The Silopren LSR 3000 Series liquid silicone rubber shows a low compression set after vulcanization without post-curing.

Feature Product: Silopren LSR 3366/50



### Silopren LSR 2700 Series (Self-Bonding)

The Silopren LSR 2700 Series are two-component liquid silicone rubber for injection molding, which offer primer-less adhesion to a wide range of substrates including metals and engineering plastics, but without adhesion to the mold. Full bond strength is generally reached after a short post cure (e.g. one hour at 100 degrees Celsius) or by longer storage at room temperature. This makes the Silopren LSR 2000 Series of liquid silicone rubber a good option to consider for cost-efficient manufacturing of high part-quantities in integrated processes, such as multi-component injection molding or insert-molding.

Feature Product: Silopren LSR 2725/40

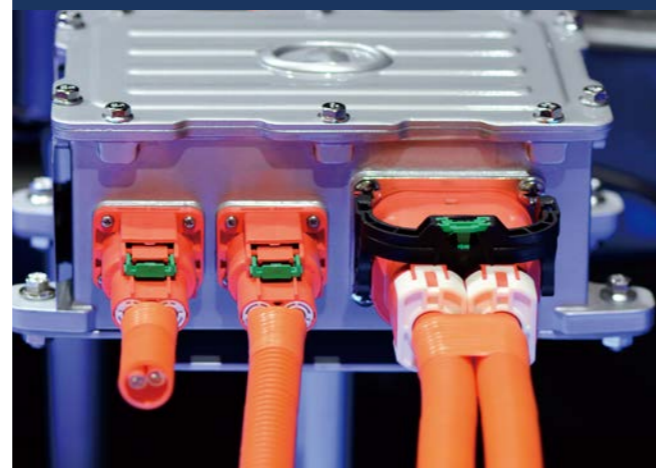
### Silopren LSR 2600 Family

The Silopren LSR 2600 Series offers a wide variety of LSR technologies to cover a broad base of application needs across the e-mobility market. The Silopren LSR 2600 Series are two-component liquid silicone rubbers for injection molding processes. In comparison to the Silopren LSR 2000 Series, the Silopren LSR 2600 Series shows a lower viscosity, improved tear resistance and a higher reactivity. Therefore, it is also possible to reduce the vulcanization temperature while maintaining a standard crosslinking rate. The increased reactivity does not affect the properties of the vulcanizate.

## SIX: EV CABLES

### Addisil™ 70E HPC180 ORANGE

Addisil technology is utilized to meet stringent mechanical, electrical and thermal requirements for e-mobility wire and cable applications. This series is based on an addition cure platinum system that is a particularly attractive solution for high value extrusion applications where compliance, mechanical performance and/or productivity are of critical importance.



## SEVEN: FUEL CELL SEALING

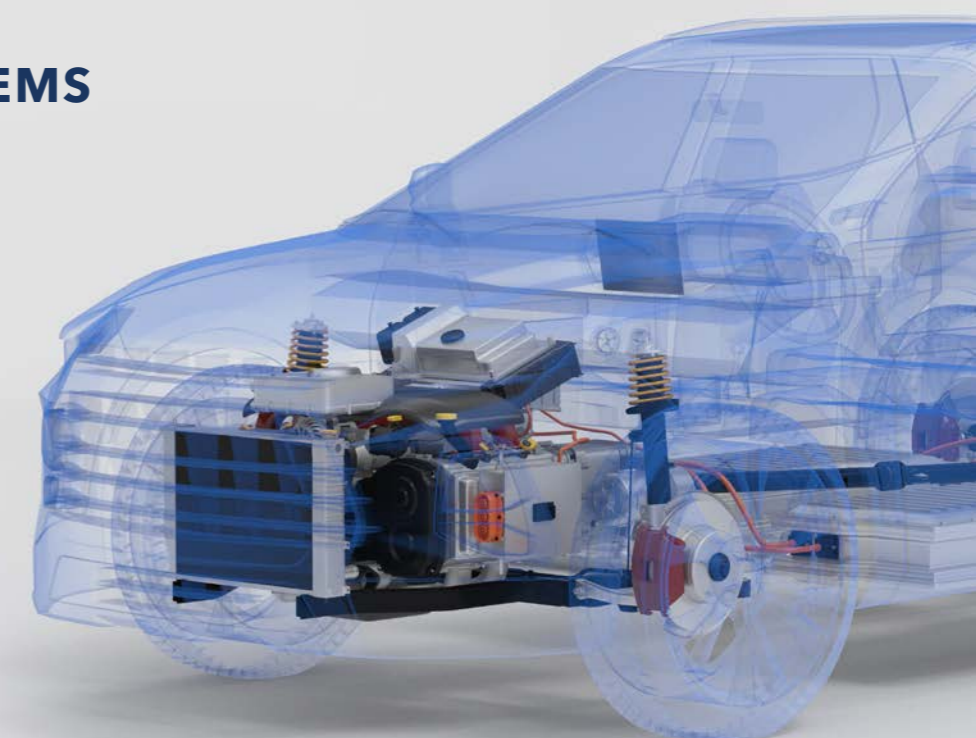
### NL6140DFC

This LSR technology possesses low viscosity to allow decreased injection pressure and, therefore, protection of the bipolar plate substrates during manufacturing/molding.

## EIGHT: TWO-COMPONENT INTEGRATED SEALING SYSTEMS

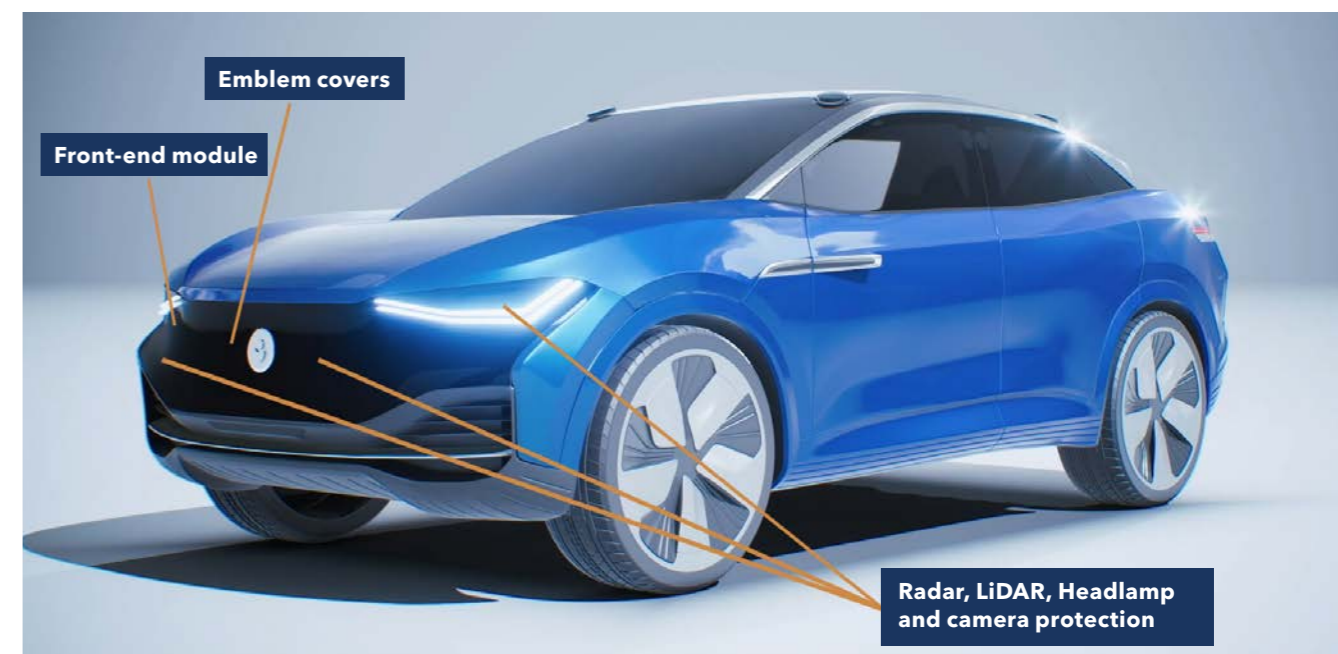
### Silopren LSR 2740

E-Mobility design engineers now have the ability to leverage two-component hard-soft design systems, and allow the sealing features to be integrated into the engineering thermoplastic part design. This further allows for ease of assemble, and helps ensure critical seal placement and performance.



## HARDCOATS FOR E-MOBILITY

Our SilFORT™ line of hardcoats enables customers to replace glass and metal with lightweight plastics in a number of demanding applications. Our hardcoats offer excellent performance and protection, while allowing for a high degree of design freedom. SilFORT hardcoats help extend the long-term exterior durability and performance of plastics, such as polycarbonate and polymethylmethacrylate (PMMA), as well as maintain their color, gloss, light transmission and physical properties.



## NINE: FRONT-END MODULES

In contrast to vehicles of the past, where air flow to the engine was required, with electric vehicles the traditional front grill can be replaced by front-end modules made from light-weight plastics, such as polycarbonate. **SilFORT hardcoats for automotive** offer protection to exterior plastic parts by providing excellent chemical, abrasion and weathering resistance, while maintaining a durable, glossy and easy-to-clean surface. These new design concepts also provide the option of ADAS sensor functionality, headlamp integration, and colorful LED lighting effects, while at the same time protecting decorative design elements on the exterior of electric vehicles.

### Other front-end solutions

- Momentive's SFR320 silicone fluid (technical datasheet) improves EV fire safety in non-transparent EV polycarbonate applications such as the front end module, and clear polycarbonate parts such exterior headlamp covers or rear lamp covers, offering an alternative to more corrosive or potentially EHS-compromising choices.
- TSR product family: Our light-diffusing spherical polymethylsilsesquioxane particles can help make undesirable LED 'hot spots' disappear, whereby LED light becomes less irritating to the human eye, while also helping to enable widespread use of energy saving LED lights in EVs.

## ADVANCED TIRE & RUBBER SILANES

From the 1998 legacy introduction of the first advanced tire silanes, to the recent launch of our advanced, treadwear life enhancing NXT Z™ 45 silane, Momentive has continued relentlessly to refine and expand its silanes portfolio to help manufacturers push the boundaries of industry excellence.

Today, Momentive's advanced tire and rubber silanes are allowing manufacturers to reach new heights of efficiency across a range of production processes, and to drive sustainability by enabling greater levels of CO2-limiting fuel efficiency, manufacturing waste reduction, improving rolling resistance, reducing volatile emissions and much more.



## TEN: SUSTAINABLE TIRE SOLUTIONS FOR EV RANGE, EV TIRE GRIP AND WEAR RESISTANCE

Momentive's advanced tire silanes for silica compounds can drive EV innovation further, potentially yielding several improvements in tire performance:

**Range:** Reduced tire rolling resistance yielding higher vehicle range

**Greater Grip:** Safety, acceleration, handling

**Sustainability:** Longer tire life, more miles per charge

**NXT™ silane** can be considered for use in tread compounds, for improved tire rolling resistance without loss of wet traction. NXT silane enables higher silica loadings, a more stable compound viscosity, improved processability and reduced waste and rework, even in functionalized polymer and high surface area silica compounds. With a partly renewable structure, it can also reduce ethanol emissions during tire production.

**NXT™ Z 45 silane** is the ultimate performance silane for EV tires, adding improved wear resistance and enabling an ethanol emission-free tire production.

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