WACKER

CREATING TOMORROW'S SOLUTIONS

ELASTOSIL®

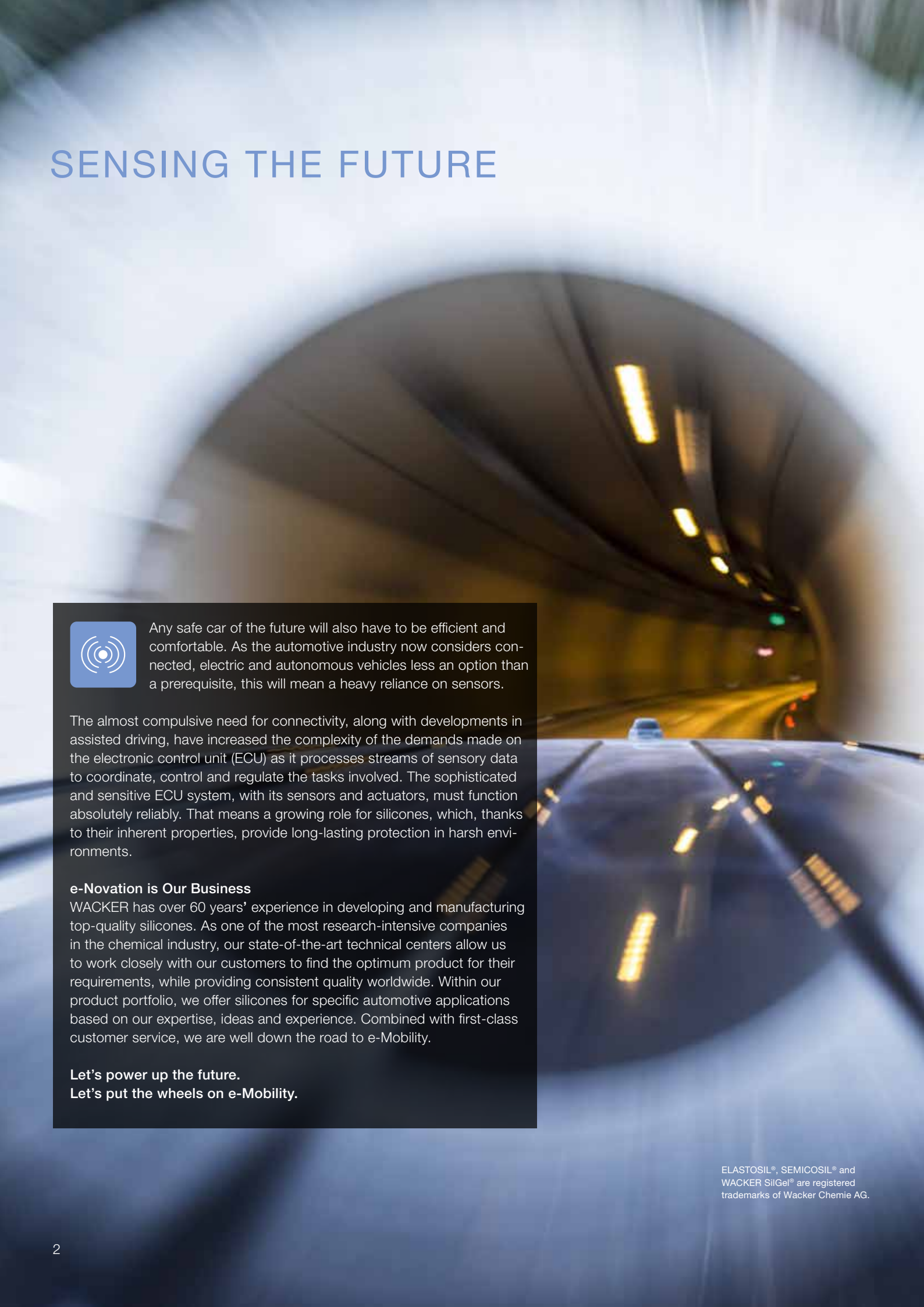
SEMICOSIL®

WACKER SilGel®

MOBILITY

# e-NOVATION FOR SENSORS AND ECUS
# POWERED BY SILICONES

# SENSING THE FUTURE



Any safe car of the future will also have to be efficient and comfortable. As the automotive industry now considers connected, electric and autonomous vehicles less an option than a prerequisite, this will mean a heavy reliance on sensors.

The almost compulsive need for connectivity, along with developments in assisted driving, have increased the complexity of the demands made on the electronic control unit (ECU) as it processes streams of sensory data to coordinate, control and regulate the tasks involved. The sophisticated and sensitive ECU system, with its sensors and actuators, must function absolutely reliably. That means a growing role for silicones, which, thanks to their inherent properties, provide long-lasting protection in harsh environments.

**e-Novation is Our Business**
WACKER has over 60 years' experience in developing and manufacturing top-quality silicones. As one of the most research-intensive companies in the chemical industry, our state-of-the-art technical centers allow us to work closely with our customers to find the optimum product for their requirements, while providing consistent quality worldwide. Within our product portfolio, we offer silicones for specific automotive applications based on our expertise, ideas and experience. Combined with first-class customer service, we are well down the road to e-Mobility.

**Let's power up the future.**
**Let's put the wheels on e-Mobility.**

# SILICONES AS PROBLEM-SOLVERS

**To meet the challenges faced by ECUs, WACKER's wide portfolio of silicones can come up with many of the solutions. Not only do they protect the electronics, they also offer functional safety and thermal management, while still being efficient in processing and production.**

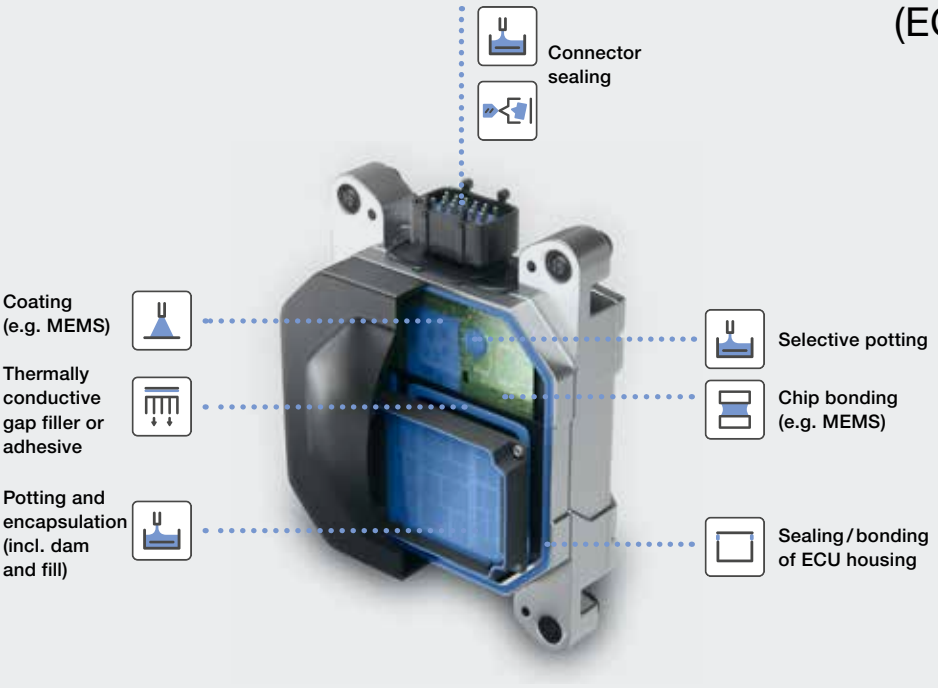
Very delicate components, such as sensors, can be encapsulated with WACKER's ultra-low modulus gels for their protection. With their low modulus over a wide range of temperatures, silicones can help to reduce mechanical and thermal stress and minimize the risk of operational failure. They can perform well at extreme temperatures between -90 °C and over 200 °C (special grades up to 230 °C), while thermally conductive adhesives, encapsulants and gap fillers all assist in the dissipation of heat. WACKER's low-energy curing adhesives shorten processing times, reduce costs and provide flexibility with bonding substrates. Working closely with our clients, we optimize our products for their in-line quality control processes.

**Silicones can be used in electronic control equipment and sensors to:**

- Seal/bond housing components (CIPG, FIPG and preformed gaskets)
- Coat or bond individual elements (e.g. MEMS)
- Protect electronic components by potting or encapsulating
- Assist in the dissipation of heat (thermal management)
- Facilitate lens molding for optical sensors with highly transparent LSR

## Silicone Application Fields

### Sensor




For optical sensors: lens molding with high transparent LSR, vibration damping and decoupling with LSR

### Electronic Control Unit (ECU)

**For more information** on LSR and HCR products and applications, please contact us or consult our brochure "Solid and Liquid Silicone Rubber – Material and Processing Guidelines"

# SILICONE SEALING TECHNIQUES

**Modern adhesive bonding methods are progressively taking the place of traditional mechanical joining technologies. Elastic bonding with silicone sealant adhesives offers obvious advantages not only in handling and functionality, but also in durability and cost efficiency.**

ECUs and sensors have to be sealed effectively to protect sensitive electronics against severe physical challenges. WACKER provides reliable silicone sealing solutions for applications such as ECU casings and connectors, using three different sealing techniques: preformed gaskets, cured-in-place gaskets (CIPG) also known as dry assembly gaskets, and formed-in-place gaskets (FIPG) also known as wet assembly gaskets. The seals are either manufactured in a separate injection-molding process, cured before the parts are assembled or cured-in-place.

## Sealing Technology

| | Preformed Gasket | Cured-In-Place Gasket (CIPG) | Formed-In-Place Gasket (FIPG) |
|---|---|---|---|
| Silicone type | LSR, HTV | RTV-1, RTV-2 | RTV-1, RTV-2 |
| Application method | Insert* | Dispensing | Dispensing |
| Time of assembly | After curing | After curing | Before curing |
| Adhesion to substrates | None | Only to one part | To both parts |
| Disassembly | Possible | Possible | Impossible |
| Mode of sealing | Compression | Compression | Adhesive bonding |
| Description | • O-rings, surface seals and profile gaskets manufactured in separate process<br>• Self-adhesive LSR allows fully automated production of hard-soft composites | • Sealing technology for non-slump RTV silicones | • Compared to CIPG, dimensional accuracy can be lower<br>• Simpler design of parts and lower development costs |

*or 2-part molding (hard-soft composites)

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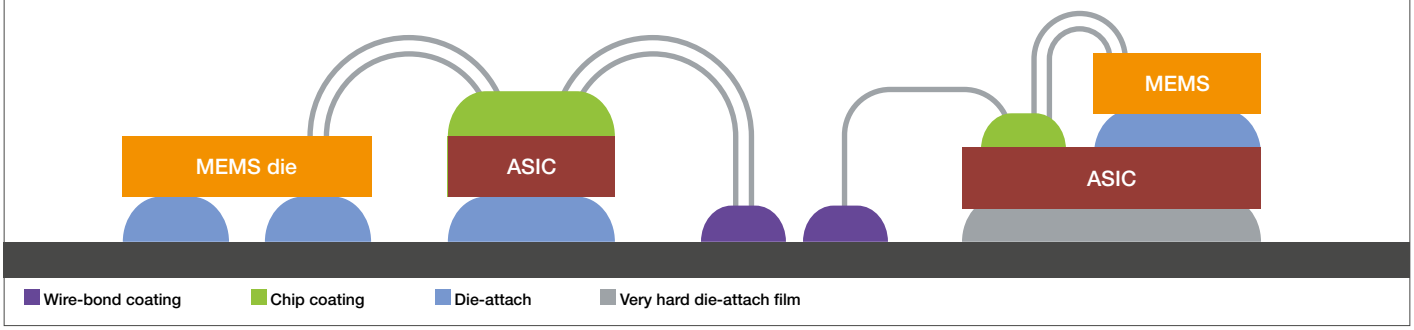
# MEMS AND SILICONES – A STRONG ATTACHMENT

Potential Uses of SEMICOSIL® Adhesives in MEMS Systems




**Micro electro-mechanical systems (MEMS) are a combination of miniaturized electronic and mechanical elements, sensors and active elements on a sub-layer. With fewer cables and connectors, MEMS' compact size, low weight and excellent reliability make it possible to implement a whole system on a single substrate or chip. MEMS sensors have a unique role to play in today's society. For example, they are the microphone, gyroscope and accelerometers that make your cellphone so versatile. They also enable your automobile to maximize driving comfort and to meet emission targets. To bond MEMS chips and application-specific integrated circuits (ASIC) to other substrates, while providing protection, requires specialized silicone die-attach adhesives. WACKER offers a range of these within its product portfolio.**

WACKER's SEMICOSIL® and ELASTOSIL® products can be seen as covering three main areas in sensor and ECU technology: soft gels for potting and encapsulation, adhesives for sealing the ECU and sensor components and adhesives for chip coating, die-attach and wire-bond reinforcement in MEMS. They are room-temperature or high-temperature vulcanizing, 1- or 2-part silicone rubber grades that can be customized to the specific requirements of the electronic components and their manufacturing processes. They provide very effective protection, as well as being ideal for cost-effective mass production as they can be processed fully automatically in mixing and metering units.

**WACKER's die-attach adhesives can offer the following benefits:**

- Excellent adhesion
- Wire-bond reinforcement
- Vibration damping
- Chemical protection
- Light blocking
- < 0.4 mm dot size
- Optimized rheology for high-speed deposition
- Fully jettable
- Very low bleed

# PRODUCT OVERVIEW
# SILICONES FOR SENSORS / ECUS

## Sensor / ECU Assembly **Potting and Encapsulation**

**Gels for potting and encapsulation of sensitive electronic components**

| Product | Features | Curing Type | Curing Initiated by | Product Type | Viscosity D = 0.5 1/s [mPa·s] | Hardness | Tensile Strength [MPa] | Elongation at Break [%] | Density, cured [g/cm³] | Curing |
|---|---|---|---|---|---|---|---|---|---|---|
| ELASTOSIL® RT 601 | General purpose potting, crystal clear, shrink-free curing | Addition | Heat | 2-part, 9:1 | 3,500 | 45 Shore A | 6.0 | 100 | 1.02 | 20 min / 70 °C; 10 min / 100 °C |
| ELASTOSIL® RT 745 “S” | Tough gel, medium hardness, primerless adhesion | Addition | Heat | 2-part, 1:1 | 1,000 | 35 Shore 00 | 0.3 | n.a. | 0.96 | 60 min / 80 °C; 10 min / 120 °C |
| SEMICOSIL® 900 LT | Very soft, translucent, low-temperature flexible, specified ion content | Addition | RT or heat | 2-part, 1:1, long potlife | 15,000, thixotropic | Pen 70 mm / 10 | - | - | 1 | 12 h / 25 °C, 10 min / 120 °C |
| SEMICOSIL® 911 | Very soft, low bleed, specified ion content, low volatile | Addition | Heat | 2-part, 1:1, long potlife | 8,500, thixotropic | Pen 60 mm / 10 | - | - | 0.99 | 6 h / 25 °C, 5 min / 100 °C |
| SEMICOSIL® 912 | Very soft, for fill application, low bleed | Addition | Heat or UV | 2-part, 10:1, BKS* | 1,000 | Pen 70 mm / 10 | - | - | 0.97 | BKS* |
| SEMICOSIL® 914 | Very soft, clear, for dam application, low bleed | Addition | Heat or UV | 2-part, 10:1, BKS* | 55,000, thixotropic | Pen 70 mm / 10 | - | - | 0.99 | BKS* |
| SEMICOSIL® 915 HT | Sh00 hardness, clear yellowish, high temperature resistant up to 210 °C | Addition | Heat or UV | 2-part, 10:1, BKS* | 1,000 | 15 Shore 00 | - | - | 0.97 | BKS* |
| SEMICOSIL® 917 | Soft, UV tracer, low bleed | Addition | Heat or UV | 2-part, 10:1, BKS* | 11,000, thixotropic | Pen 55 mm / 10 | - | - | 0.98 | BKS* |
| SEMICOSIL® 920 LT | Very soft, clear yellowish, low-temperature flexible, specified ion content | Addition | Heat | 2-part, 1:1, long potlife | 450 | Pen 70 mm / 10 | - | - | 0.98 | 30 min / 110 °C, 10 min / 150 °C |
| SEMICOSIL® 928 F | Soft gel, oil and NOX resistant | Addition | Heat | 1-part | 6,000 | Pen 50 mm/10 | - | - | 1.3 | 4 h / 100 °C; 30 min / 150 °C |
| SEMICOSIL® 944 | Extremely fast cure, UV tracer | Addition | Heat or UV | 2-part, 10:1, BKS* | 12,000, slightly thixotropic | 45 Shore 00 | - | - | 0.98 | BKS* |
| SEMICOSIL® 949 UV | Very low viscosity, UV tracer, primerless bonding | Addition | Heat or UV | 2-part, 10:1, BKS* with 949 UV B or 950 UV B | 200 | 35 Shore 00 | - | - | 0.97 | BKS* |
| SEMICOSIL® 9242 | Soft, low bleed, low volatile, UV tracer, specified ion content | Addition | Heat | 1-part | 20,000, thixotropic | Pen 50 mm / 10 | - | - | 0.98 | 40 min / 130 °C, 10 min / 150 °C |
| WACKER SilGel® 612 | Very soft, clear, low bleed, general purpose, UL-94 HB | Addition | RT or heat | 2-part, 1:1, long potlife | 1,000 | Pen 70 mm / 10 | - | - | 0.97 | 8 h / 25 °C, 15 min / 100 °C |
| WACKER SilGel® 612 EH | Soft, fast cure, low bleed, inhibition robust | Addition | RT or heat | 2-part, 1:1, short potlife | 1,000 | Pen 35 mm / 10 | - | - | 0.97 | 90 min / 25 °C, 10 min / 70 °C |
| WACKER SilGel® 613 | Very soft, clear, general purpose, low volatile | Addition | Heat or UV | 2-part, 10:1, BKS* | 200 | Pen 70 mm / 10 | - | - | 0.97 | BKS* |

## Sensor / ECU Assembly **Adhesives**

**Sealing of electronic control unit and sensor components, housings and lids**

| Product | Features | Curing Type | Curing Initiated by | Product Type | Viscosity D = 0.5 1/s [mPa·s] | Hardness | Tensile Strength [MPa] | Elongation at Break [%] | Density, cured [g/cm³] | Curing** |
|---|---|---|---|---|---|---|---|---|---|---|
| ELASTOSIL® E4 | CIPG / FIPG | Acetoxy | RT | 1-part, RTV-1 | Non-slump | 15 Shore A | 1.7 | 900 | 1.02 | 120 h / 23 °C |
| ELASTOSIL® RT 720 | Low-energy cure adhesive, CIPG, FIPG, excellent mech. properties, flowable adhesive | Addition | Heat | 2-part, 1:1 | 35,000 | 40 Shore A | 6 | 300 | 1.1 | 45 min / 90 °C, 15 min / 125 °C |
| ELASTOSIL® RT 722 | Low-energy cure adhesive, low volatile, excellent mech. properties | Addition | Heat | 2-part, 1:1 | Non-slump, thixotropic | 45 Shore A | 6 | 300 | 1.1 | 45 min / 90 °C, 15 min / 125 °C |
| ELASTOSIL® RT 725 LV | Low-energy cure adhesive, low volatile, UV tracer | Addition | Heat | 2-part, 1:1 | Non-slump | 50 Shore A | 7 | 250 | 1.1 | 10 min / 100 °C, 30 min / 60 °C |
| ELASTOSIL® N 9111 black / white | RTV-1, excellent adhesion | Alkoxy | RT | 1-part, RTV-1 | Non-slump | 35 Shore A | 2.5 | 500 | 1.25 | 12 h / mm, 23 °C / 50% RH |
| SEMICOSIL® 811 | Low-energy cure adhesive, low-temperature cure, oven free, fast adhesion build-up at moderate temperature, FIPG | Addition | RT, heat or UV | 2-part, 10:1, BKS* | 260,000, thixotropic | 30 Shore A | 3.3 | 330 | 1.08 | BKS* |
| SEMICOSIL® 986/1k | Sealing adhesive, FIPG, thixotropic, specified ion content, UV tracer | Addition | Heat | 1-part | Non-slump | 50 Shore A | 5 | 200 | 1.1 | 30 min / 130 °C, 10 min / 150 °C |
| SEMICOSIL® 987 GR | Sealing adhesive, CIPG, FIPG, specified ion content | Addition | Heat | 1-part | Non-slump, thixotropic | 55 Shore A | 5 | 200 | 1.1 | 60 min / 130 °C, 10 min / 150 °C |
| SEMICOSIL® 988 / 1k gray / tran | Sealing adhesive, CIPG, FIPG, specified ion content | Addition | Heat | 1-part | Non-slump, thixotropic | 35 Shore A | 4.5 | 350 | 1.1 | 60 min / 130 °C, 10 min / 150 °C |
| SEMICOSIL® 989/1k | Very good adhesion, CIPG, FIPG, ion content specified | Addition | Heat | 1-part | Non-slump | 55 Shore A | 6 | 200 | 1.1 | 1 h / 130 °C; 10 min / 150 °C |
| SEMICOSIL® 9882 | Fast curing, designed for large part CIPG and for ovenless IR curing process | Addition | Heat or IR light | 2-part, 1:1 | Non-slump | 30 Shore A | 7 | 500 | 1.1 | CIPG IR / heat cure 60 – 130 °C: > 30 min / 60 °C; > 10 min / 100 °C |

* BKS = Batch-Kit System: base component to be combined with ELASTOSIL® CAT PT ELASTOSIL® CAT PT-F or ELASTOSIL® CAT UV to allow curing at room temperature, under heat or by UV light (for details, please refer to the respective technical datasheet)

** Speed of adhesion build-up dependent on substrate

# PRODUCT OVERVIEW
# SILICONES FOR SENSORS / ECUS

## Sensor / ECU Assembly **Chip Bonding**

**Silicone adhesives for die-attach and chip / wire-bond coating**

| Product | Features | Curing Type | Curing Initiated by | Product Type | Viscosity D = 0.5 1/s [mPa·s] | Hardness | Tensile Strength [MPa] | Elongation at Break [%] | Density [g/cm³] | Curing |
|---|---|---|---|---|---|---|---|---|---|---|
| SEMICOSIL® 267 | Jettable chip coating and adhesive, black | Addition | Heat | 1-part | 30,000 | 50 Shore A | 2 | 80 | 1.1 | 1 h / 130 °C; 10 min / 150 °C |
| SEMICOSIL® 268 | Jettable chip/wire-bond coating and adhesive, black | Addition | Heat | 1-part | 100,000 | 50 Shore A | 2.6 | 80 | 1.1 | 1 h / 130 °C; 10 min / 150 °C |
| SEMICOSIL® 269 | High-hardness sealing adhesive, black | Addition | Heat | 1-part | 200,000 | 60 Shore A | 2.3 | 40 | 1.1 | 1 h / 130 °C; 10 min / 150 °C |
| SEMICOSIL® 984/1k | Ultra-low stress MEMS die-attach adhesive, jettable chip/wire-bond coating adhesive, black | Addition | Heat | 1-part | 85,000 | 15 Shore A | 0.7 | 200 | 1.1 | 1 h / 130 °C; 10 min / 150 °C |
| SEMICOSIL® 986/1k | MEMS and ASIC die-attach adhesive | Addition | Heat | 1-part | Non-slump | 50 Shore A | 5 | 200 | 1.1 | 30 min / 130 °C; 10 min / 150 °C |
| SEMICOSIL® 988/1k | MEMS die-attach adhesive, low stress | Addition | Heat | 1-part | Non-slump | 35 Shore A | 4.5 | 350 | 1.1 | 1 h / 130 °C; 10 min / 150 °C |
| SEMICOSIL® 989/1k | MEMS and ASIC die-attach adhesive | Addition | Heat | 1-part | Non-slump | 55 Shore A | 6 | 200 | 1.1 | 1 h / 130 °C; 10 min / 150 °C |

## Sensor / ECU Thermal Management **Thermally Conductive Silicone Encapsulants**

**Tough encapsulation materials with good resistance to mechanical and environmental stress**

| Product | Features | Thermal Conductivity [W/mK] | Curing Type | Curing Initiated by | Product Type | Viscosity D = 0.5 1/s [mPa·s] | Hardness | Tensile Strength [MPa] | Elongation at Break [%] | Density [g/cm³] | Lap Shear Strength [N/mm²] | Curing |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ELASTOSIL® RT 607 | General purpose potting | 0.5 | Addition | Heat | 2-part, 9:1 | 10,000 | 55 Shore A | 3.5 | 100 | 1.4 | - | 20 min / 70 °C |
| ELASTOSIL® RT 743 LV-K | General purpose potting, low viscosity | 0.5 | Addition | Heat | 2-part, 1:1 | 1,100 | 20 Shore A | 3 | 150 | 1.5 | - | 60 min / 120 °C |
| ELASTOSIL® RT 736 TC* | Self-leveling, good adhesion properties, UL 94 V-0 | 0.6 | Addition | Heat | 2-part, 1:1 | 3,000 | 63 Shore A | 4.6 | 150 | 1.5 | 1.2 | 60 min / 120 °C |
| ELASTOSIL® RT 744 TC | General purpose potting, low viscosity, medium TC | 1.0 | Addition | 50 °C or higher | 2-part, 10:1** | 9,500 (D = 1 1/s) | 70 Shore A | 3.1 | 70 | 2.2 | - | 15 min / 80 °C |
| ELASTOSIL® RT 738 TC* | Self-leveling, good flow and adhesion properties | 1.1 | Addition | Heat | 2-part, 1:1 | 5,500 (D = 1 1/s) | 20 Shore A | 0.5 | 90 | 1.9 | 0.4 | 60 min / 120 °C |
| ELASTOSIL® RT 747 TC | Self-leveling, good flow and adhesion properties | 1.4 | Addition | Heat | 1-part | 45,000 | 70 Shore A | 4 | 90 | 2.3 | 0.8 | 30 min / 130 °C |
| ELASTOSIL® RT 739 TC* | Self-leveling, good flow and adhesion properties | 2.2 | Addition | Heat | 2-part, 1:1 | 17,000 (D = 1 1/s) | 50 Shore A | 1.3 | 60 | 2.8 | 0.6 | 60 min / 120 °C |

* Under development

** Base component to be combined with ELASTOSIL® CAT PT or ELASTOSIL® CAT PT-F to allow curing at room temperature or under heat (for details, please see product's technical datasheet)

# PRODUCT OVERVIEW

# SILICONES FOR SENSORS / ECUS

## Sensor / ECU Thermal Management

### Thermally Conductive Dispensable Silicone Gap Fillers and Pastes

**Soft, flexible gap filling between uneven surfaces across broad temperature range, non-curing, low stress paste solutions**

| Product | Features | Thermal Conductivity [W/mK] | Curing Type | Curing Initiated by | Product Type | Viscosity D = 0.5 1/s [mPa·s] | Hardness | Tensile Strength [MPa] | Elongation at Break [%] | Density [g/cm³] | Lap Shear Strength [N/mm²] | Curing |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| WACKER Silicone Paste P12 | Standard thermal heat sink paste | 0.8 | - | - | 1-part, ready-to-use | Non-slump | Paste-like | n.d. | n.d. | 2.3 | - | - |
| ELASTOSIL® Paste 30 TC* | Thermal heat sink paste | 3.0 | - | - | 1-part, ready-to-use | Non-slump | Paste-like | n.d. | n.d. | 3.2 | - | - |
| SEMICOSIL® Paste 40 TC | High performance paste, screen printable | 4.0 | - | - | 1-part, ready-to-use | Non-slump | Paste-like | n.d. | n.d. | 3.3 | - | - |
| SEMICOSIL® 961 TC | High dosing rate, UL 94 V-0, low volatile | 2.3 | Addition | RT or fast cure at elevated temp | 2-part, 1:1 | Non-slump | 25 Shore A | n.d. | n.d. | 2.9 | - | 4 – 6 h / 23 °C |
| SEMICOSIL® 962 TC | High dosing rate, soft tacky gel, UL 94 V-0, low volatile | 3.0 | Addition | RT or fast cure at elevated temp | 2-part, 1:1 | Non-slump | 25 Shore A | n.d. | n.d. | 3.1 | - | 4 – 6 h / 23 °C |
| SEMICOSIL® 963 TC | High dosing rate, UL 94 V-0, low volatile | 3.0 | Addition | RT or fast cure at elevated temp | 2-part, 1:1 | Non-slump | Pen 20 mm / 10 | n.d. | n.d. | 3.1 | - | 4 – 6 h / 23 °C |

* Under development

## Sensor / ECU Thermal Management Thermally Conductive Silicone Adhesives

**Silicone adhesives to couple components to heat sinks / to active cooling**

| Product | Features | Thermal Conductivity [W/mK] | Curing Type | Curing Initiated by | Product Type | Viscosity D = 0.5 1/s [mPa·s] | Hardness | Tensile Strength [MPa] | Elongation at Break [%] | Density [g/cm³] | Lap Shear Strength [N/mm²] | Curing |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ELASTOSIL® RT 709 CN | Flowable, excellent thermal stability | 0.4 | Addition | Heat | 1-part | 180,000 | 49 Shore A | 4 | 200 | 1.2 | > 2.2 | 10 min / 140 °C, 2 min / 200 °C |
| SEMICOSIL® 970 TC | Universal self-adhesive thermally conductive silicone | 0.8 | Addition | Heat | 2-part, 1:1 | 95,000 | 65 Shore A | 4 | 90 | 2.3 | > 3 | 30 min / 130 °C |
| ELASTOSIL® TC 9800 | General purpose potting, self-bonding | 0.85 | Condensation | RT | 1-part, RTV-1 | 120,000 | 73 Shore A | 3 | 85 | 1.6 | > 1 | Skin forming: 5 min / 23 °C |
| SEMICOSIL® 971 TC | Stir cartridges | 2.0 | Addition | Heat | 1-part | Non-slump | 75 Shore A | 5 | 70 | 2.7 | > 2.5 | 30 min / 125 °C |
| SEMICOSIL® 9712 TC | General purpose adhesive, high heat resistance | 2.5 | Addition | Heat | 2-part | Non-slump | 85 Shore A | 5 | 60 | 2.9 | > 3 | 15 min / 85 °C |
| SEMICOSIL® 973 TC | Primerless adhesion to many substrates, stir cartridges | 3.0 | Addition | Heat | 1-part | Non-slump | 90 Shore A | 3 | 45 | 3.0 | > 2.5 | 30 min / 125 °C |
| SEMICOSIL® 975 TC | High thermally conductive 1-part adhesive | 4.3 | Addition | Heat | 1-part | Non-slump | 98 Shore A | 3 | 45 | 3.3 | > 2.5 | 30 min / 130 °C |

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