WACKER

CREATING TOMORROW'S SOLUTIONS

ELASTOSIL®

POWERFUL SILICONE SOLUTIONS FOR TECHNICAL TEXTILES

A SYSTEMATIC APPROACH TO SILICONE COATINGS

From consulting, formulation and technology services to tests and pilot series for specific applications.

Offering the right solution for virtually every coating job, silicones are suitable for all common coating techniques and any conceivable application – even ones that are not yet feasible.

Silicones are ideal for a wide variety of uses thanks to their special chemistry and, most of all, their extraordinary material properties. Manufacturers can also vary the properties of silicones virtually at will via a combination of different grades and additives.

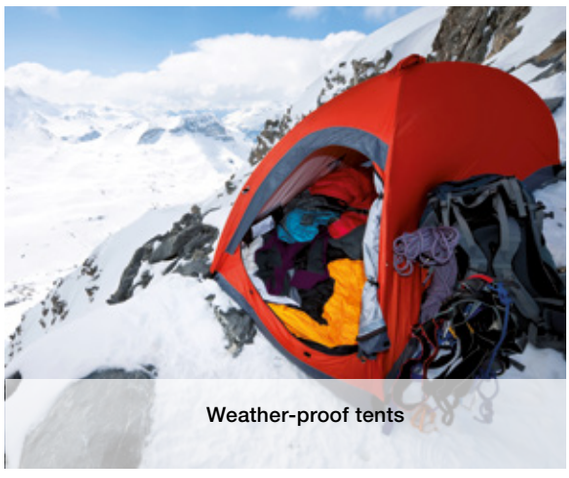
Silicones can be used for coating nearly any type of fabric. The art of formulation requires a great deal of experience and creativity and a wealth of knowledge about relevant chemical and processing relationships. WACKER SILICONES' technical service specializes in precisely that. We help you manage the often difficult balancing act between product, coating system and substrate in order to achieve the perfect end result.

Info

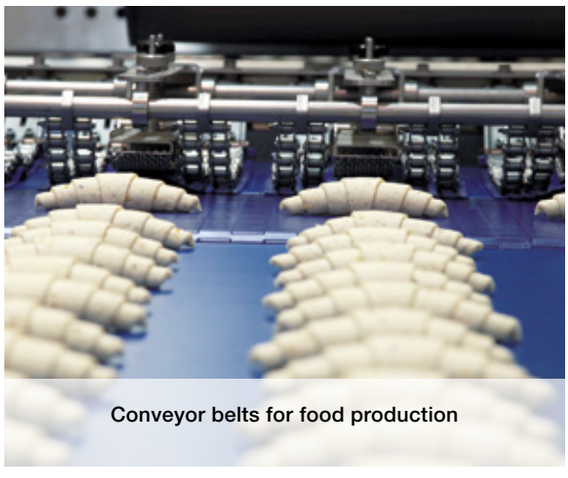
We will advise you on formulations and will conduct application-related testing for you. We will gladly show you the opportunities and advantages of innovative coating technologies that meet your individual needs. Upon request, we can also carry out pilot runs for you (product width up to 90 cm).

EXPLORE A WIDE RANGE OF APPLICATIONS

Heat-resistant clothing

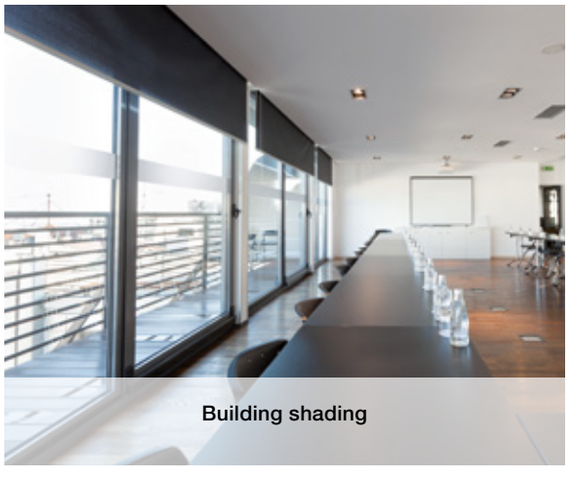


Weather-proof tents

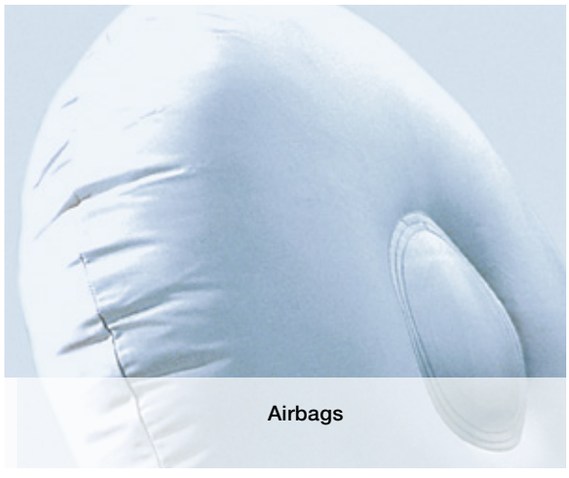


Conveyor belts for food production

Non-slip garters



Building shading



Airbags

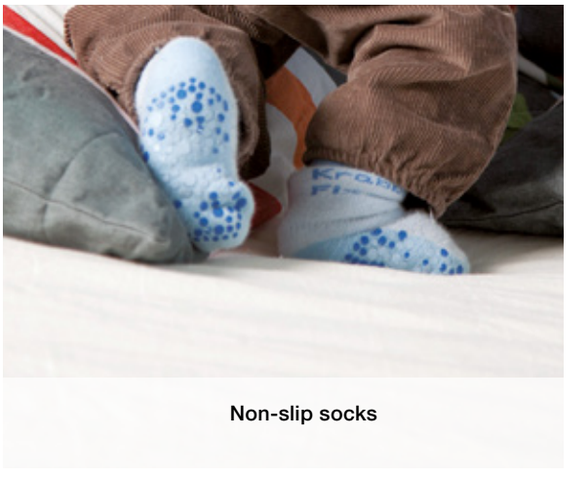
Flame-retardant clothing

Architectural membranes

UV-stable paragliders

Functional clothing for outdoor activities

Bellows

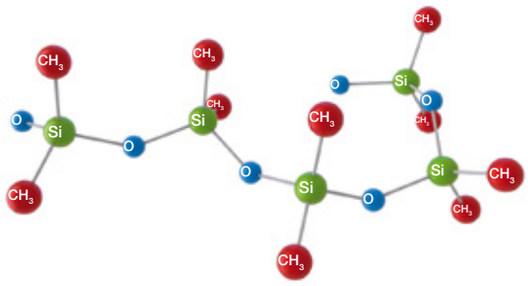


Non-slip socks

SILICONE PROPERTIES

Silicones are polymers with an inorganic backbone, which consists of alternating oxygen and silicon atoms with organic side groups. Silicones thus resemble organically modified quartz. The structure – unique throughout the world of polymers – is what lends silicones their extraordinary properties and makes them so interesting for applications such as textile coatings.

Chemical Structure of a Linear Silicone Polymer



The silicon-oxygen backbone makes silicones highly stable.

Elasticity
Silicone elastomers are extremely elastic materials, with elongation at break over 1,000% for some grades. As such, they can be reliably used as coatings for highly elastic textiles – such as ELASTAN® – without limiting textile functionality.

Hydrophobic, Waterproof Materials
Silicone rubber is a water-repellent material. The contact angle of a drop of water on a smooth silicone surface is approx. 130°, which means that water does not wet textiles coated with silicone. In addition, even very low coating weights produce textiles capable of withstanding water columns of >10 m as described in EN 20811.

Temperature Resistance
Silicones' outstanding material properties include their flexibility and ability to withstand a broad range of temperatures. Typically, silicone elastomers are used continuously at temperatures ranging from -45 °C to +180 °C; specialty grades can be used at temperatures of up to 250 °C and can even tolerate 300 °C for brief periods.

Flame Resistance
Silicones are inherently flame-resistant polymers. The autoignition temperature of silicone elastomers is approx. 430 °C. In the event of a fire, silicone reverts to silicon dioxide (which accumulates as white ash); the gases formed are non-corrosive and non-toxic. Special additives ensure that silicone-coated textiles also meet highly stringent fire-safety requirements.

Chemical Resistance
Silicone elastomers are resistant to many organic chemicals and to aqueous solutions of dilute acids and bases. In solvents such as ketones, esters and hydrocarbons, the rubber swells, but its chemical structure does not break down.

UV and Weathering Resistance
Silicones are extraordinarily resistant to UV radiation. Combined with their hydrophobic properties and considerable chemical resistance, this makes them exceptionally resistant to weathering. The industrial climate test described in DIN 50018 – SFW 2.0 S (2 l sulfur dioxide) has shown that specialty blends withstand 1.5 million cycles with no change in their surface properties. Since silicones absorb short-wave UV light, silicone coatings can also protect textile fibers that would otherwise be more susceptible to UV damage.

Electrical Properties
Silicones are electrically insulating materials with a typical dielectric strength of >23 kV/mm as per IEC 60243 (tested on a 1 mm plate). WACKER also offers specialized electrically conductive and antistatic silicones.

Wash Resistance
Silicones can form chemical bonds with a large array of substrates, making silicone-coated textiles particularly durable – a characteristic demonstrated by their outstanding wash resistance, for example.

Anti-Slip Properties
Soft silicone coatings lend anti-slip properties to textiles, making them exceptionally wash resistant and skin compatible.

Food Contact
When processed properly, many silicones meet Recommendation XV of the German Federal Institute for Risk Assessment (BfR) and requirements of the Food and Drug Administration (FDA) 21 CFR § 175.300 Resinous and Polymeric Coatings. Please note: each individual silicone formulation must be approved for use in food industry applications.

Biocompatibility
Silicones are biologically inert. In other words, biological organisms do not identify silicone as foreign, making silicone elastomers ideal for use in medical applications. USP Class VI and ISO 10993 certification is available for select grades.

Sterilizability
Silicone elastomers are exceptionally resistant to common sterilization methods (steam, ETO and gamma radiation) – another property that makes them the perfect fit for medical applications.

Translucency and Pigmentability
Silicone elastomers are translucent. By blending them with ELASTOSIL® pigment pastes, you can obtain silicone elastomers in virtually any color, maximizing your product design flexibility.

SILICONE PRODUCT GROUPS

WACKER SILICONES offers you a number of silicone systems that differ substantially from each other in terms of processing parameters – regardless of the properties of the cured rubber. The differences lie primarily in the application method, in the curing rate and temperature, and in the number of components. Each product group offers specific processing advantages tailored to particular applications. Contact your technical representative to discuss the selection of system components most suitable for you.

ELASTOSIL® R	
Crosslinking mechanism	Peroxide curing
Components	1- or 2-component systems
Solvent	Solvent-free; can be dispersed with solvents
Viscosity	Stiff pastes
Curing	In a drying tunnel, 150 – 200 °C, 1 – 5 min
Processing	Knife coating, calendering, extrusion
Benefits	High resistance to substances that disrupt the curing process, very good mechanical properties, high heat resistance, rapid curing

ELASTOSIL® R *plus*	
Crosslinking mechanism	Addition curing
Components	1- or 2-component systems
Solvent	Solvent-free; can be dispersed with solvents
Viscosity	Stiff pastes
Curing	In a drying tunnel, 130 – 200 °C, 1 – 3 min
Processing	Knife coating, calendering, extrusion
Benefits	Rapid curing, excellent mechanical properties, dry surface

ELASTOSIL® LR	
Crosslinking mechanism	Addition curing
Components	2-component systems
Solvent	Solvent-free; can be dispersed with solvents
Viscosity	10,000 - 500,000 mPas·s
Curing	In a drying tunnel, 130 – 200 °C, 1 – 3 min
Processing	Knife coating, dip coating
Benefits	Very rapid curing, good processability, considerable formulation flexibilit

ELASTOSIL® RD	
Crosslinking mechanism	Addition curing
Components	2-component systems
Solvent	Xylene or white spirit
Viscosity	5,000 – 700,000 mPas·s
Curing	Evaporate solvent at no more than 100 °C and then cure for 1 – 3 min at 130 – 200 °C in a drying tunnel
Processing	Knife coating, dip coating
Benefits	Excellent mechanical properties, good processability, considerable formulation flexibility, dry surface, low coating weights possible

ELASTOSIL® E	
Crosslinking mechanism	Condensation curing
Components	1-component systems
Solvent	Solvent-free or solvent-based
Viscosity	50,000 – 350,000 mPas·s
Curing	Skin forms at room temperature after approx. 15 min, fully cured after 1 – 3 days (dependent on atmospheric humidity)
Processing	Knife coating, dispensing, screen printing
Benefits	High resistance to substances that disrupt the curing process, easy processing, good adhesion

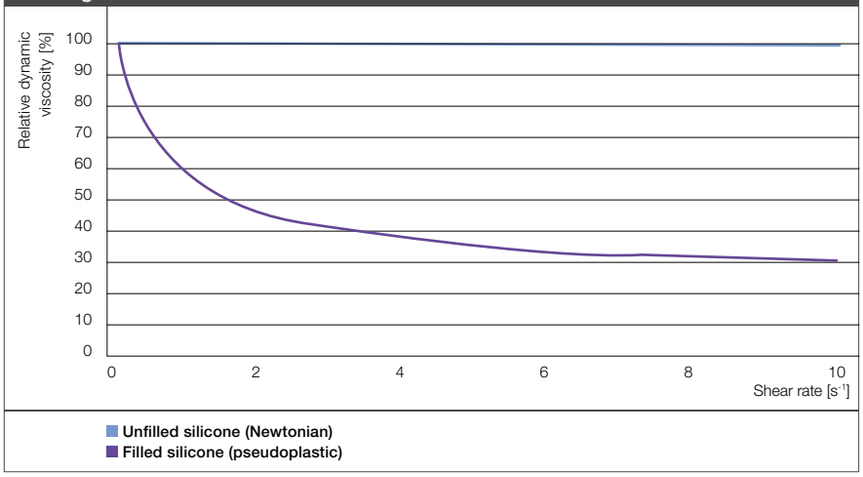
PROCESSING

Silicone Rheology

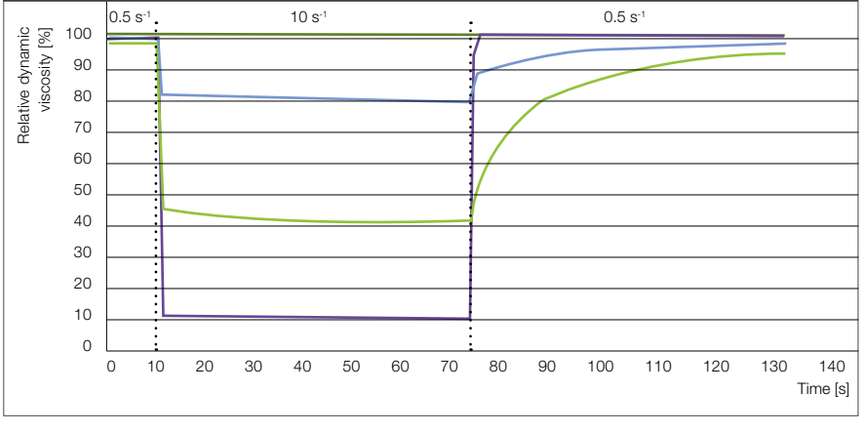
The flow properties of silicone polymers are highly unusual in that silicones behave like Newtonian fluids, even at high molecular weights. In other words, their viscosity is virtually independent of the shear rate applied. If, however, the silicone contains reinforcing fillers such as pyrogenic silica (WACKER HDK®), the rheological properties change to produce pseudoplastic materials. These materials exhibit shear-thinning behavior as a result.

Once a silicone coating compound has been exposed to an elevated shear force, it takes between a few seconds and a few minutes for the system to return to its original viscosity. Special additives can reduce this relaxation time to fractions of a second, which means that superior structures are possible, too.

Rheological Behavior of Silicones



Sample Relaxation Behavior of Various Silicone Blends Following Application of Shear Force



By adjusting formulations appropriately, manufacturers can alter the flow characteristics of silicones to meet the precise needs of a given application – an important property for coating textiles.

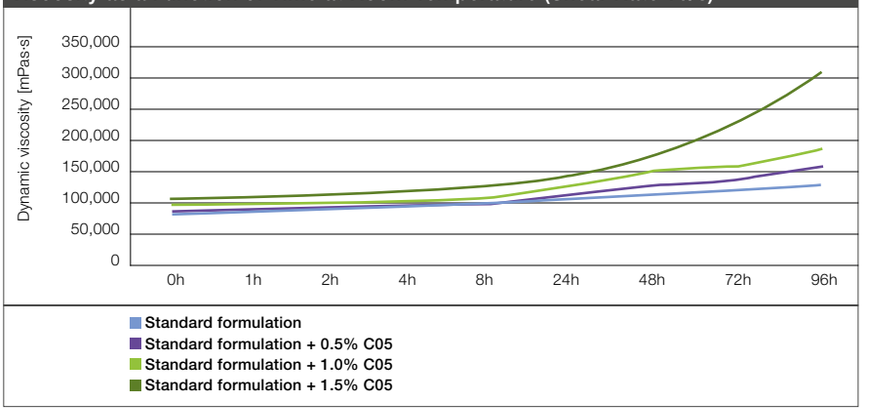
Silicone Reactivity

Silicone elastomers are reactive coating compounds, which means that chemical crosslinking takes place after the material is applied to the textile. This allows the coating to chemically bond to the substrate surface during the curing process and also means that the curing rate can be adapted to the coating process – especially in addition-curing systems. The major influencing factor here is temperature, but, since this is a platinum-catalyzed crosslinking method, the reaction rate can also be adjusted by modifying the amount of catalyst used. Please note that the platinum catalysts used yield highly reactive systems that produce a major effect, even when used in tiny amounts. That, however, makes these systems very susceptible to what is known as platinum poisons. These substances (such as sulfur and phosphorous compounds, certain heavy metals, amines and silane sizings in glass fabric) irreversibly deactivate platinum catalysts and must be avoided, even in small concentrations. If not, the bond formed between the textile and silicone coating will be unstable and/or the systems will no longer be capable of crosslinking.

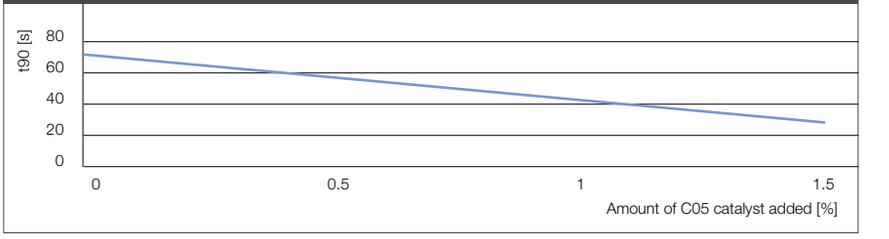
If you require considerable tolerance to foreign materials and impurities, we recommend you use condensation-curing, ready-to-use RTV-1 systems. These systems react in the presence of atmospheric humidity, releasing a byproduct (generally acetic acid). They are highly robust and produce outstanding adhesion to most substrates. The downside is that the curing time is relatively long and cannot be reduced by elevating temperature control.

A third option is to induce silicone crosslinking with peroxides. At elevated temperatures, peroxides decompose and release radicals, which, in turn, prompt the formation of an elastomeric network. While only an option for high consistency rubber, peroxide-curing is highly tolerant of impurities and can be readily adjusted by carefully controlling the temperature. The residence time in the heating tunnel must be long enough to remove any byproducts of the peroxide decomposition, so that odor-free products can be obtained.

Viscosity as a Function of Time at Room Temperature (Shear Rate 10/s)



Crosslinking Rate as a Function of the Amount of Catalyst Used (Isothermal, 130 °C)



Formulation

Additives	
Influencing Factors	**Recommended Additives**
Reactivity	Catalyst C05, Catalyst OL Inhibitor PT 88
Viscosity	Viscosity regulator 64, NT 76
Pseudoplasticity	Adhesion promoter HF 86, Stabilizer 43 NT 76
Adhesion to textiles	Adhesion promoter HF 86, GENIOSIL® GF 80, Catalyst TC 44, Catalyst 77, Crosslinker W, Crosslinker HX
Thermal stability	ELASTOSIL® FL pigment pastes
Flame resistance	ELASTOSIL® AUX BATCH SB 2
Pigmentation	ELASTOSIL® FL pigment pastes
Surface structure, haptics	Various topcoats, see insert

WACKER offers you a broad portfolio of additives for ELASTOSIL® silicones. The Additives table provides an overview of the additives and their influence on silicone coatings. For additional information, please contact your sales or technical representatives.

Crosslinkers

Crosslinkers are functional silicone fluids needed for curing ELASTOSIL® LR and RD grades with the suffix F. The addition of crosslinkers can have a positive effect on properties such as adhesion and rheology in many other formulations as well.

Catalysts

Addition-curing would not even be possible for silicones without catalysts. While raising the concentration of these platinum compounds can increase the curing rate, be aware that it also shortens the pot life. Available catalysts include WACKER Catalyst C05 and Catalyst OL, which is ten times more concentrated.

Inhibitors

Inhibitors are required whenever a longer pot life is needed, which is usually the case when systems are accelerated through the use of additional catalyst. WACKER Inhibitor PT 88 is one such product. The amount of inhibitor to add, which typically varies between 0.5 and 2.0%, depends on the anticipated pot life and the silicone formulation used.

Heat Stabilizers

Silicones exhibit excellent stability at temperatures up to 180 °C. If you require greater heat resistance, we recommend the addition of heat stabilizers, such as ELASTOSIL® AUX Stabilizer H and the following ELASTOSIL® FL pigment pastes: Ivory (RAL 1014), Iron Oxide Red (RAL 3013) and Deep Black (RAL 9005).

Flame-Retardant Batch

While silicones are flame-retardant elastomers, their flame resistance may need to be improved in order to meet the requirements of various fire tests. We offer ELASTOSIL® AUX Batch SB 2 for this specific purpose. It is typically added at a concentration of 2.2%. Please note that a flame-resistant textile and silicone composite is only guaranteed if a very stable adhesive bond exists between the two materials.

Adhesion Promoters

During the crosslinking reaction, silicones already create a strong bond to a large number of substrates. However, many textiles require the addition of adhesion

promoters for the bond to be sufficiently stable. This is typically accomplished through the use of GENIOSIL® GF silanes or adhesion promoter HF 86 added directly into the coating compound at a concentration of approx. 1%.

Substrates that are particularly slow to react can be activated through the use of co-catalysts. We offer the following co-catalysts (added in concentrations of 0.5 – 1%): WACKER® CATALYST TC 44, recommended for polyester, and WACKER® CATALYST 77, recommended for polyamide.

Pigment Pastes

WACKER's ELASTOSIL® FL and PT lines of pigment pastes (for liquid and solid silicone grades, respectively) are specially designed for coloring silicone rubber. Due to these pastes' high pigment content, low concentrations of 1 – 2% are enough to generate highly intense colors – without significantly affecting the properties of the silicone. You can also mix these pastes as required to create practically any conceivable blended color. Most of these pigment pastes are approved for food contact, with USP Class VI and ISO 10993 certification available for select grades. Please see the product overviews for these pastes for more detailed information.

Viscosity Regulators

In most cases, the use of additives in liquid silicones has a visible impact on the rheological properties of the coating compound. This often requires manufacturers to lower the overall viscosity and/or pseudoplasticity. WACKER® VISCOSITY REGULATOR 64 and ELASTOSIL® NT 76 are an excellent option for adapting the flow properties of the silicone to meet your needs. While you may add the viscosity regulator to the coating compound in concentrations of up to 30%, please note that concentrations of 10% or more will have a negative impact on curing unless you add more crosslinker.

Crosslinkers

	Typical Concentration	Impact on Coating Compound
Crosslinker W	1%	Improves adhesion, very little impact on rheology
Crosslinker 525	3%	Excellent mechanical properties, no impact on rheology
Crosslinker HX	5%	Greatly improves adhesion, increases pseudoplasticity

Heat Stabilizers – ELASTOSIL® AUX Stabilizer

Stabilizer	Color	FDA/BfR	Max. Recommended Service Temperature		Concentration
			Peroxide Curing	Addition Curing	
◯ H0	Translucent	-/-	225 °C	225 °C	2%
● H1	Reddish-brown	+/+	250 °C	225 °C	3%
◯ H2	Beige	-/-	250 °C	250 °C	2%
● H3*	Black	+/+	275 °C	275 °C	1.5 – 3%
● H4	Red	+/+	275 °C	225 °C	3%
◯ H6	White	-/-	300 °C	225 °C	3%
◯ H6 F	White	+/+	300 °C	225 °C	3%

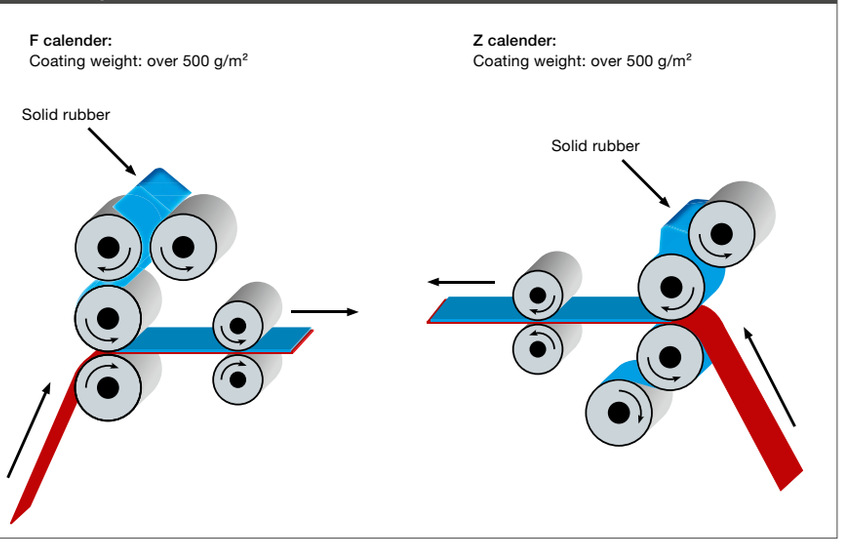
*H3 is not compatible with ELASTOSIL® AUX Crosslinker E; concentration: 1.5% for peroxide-curing silicone rubber, 3% for addition-curing silicone rubber.

Application Methods

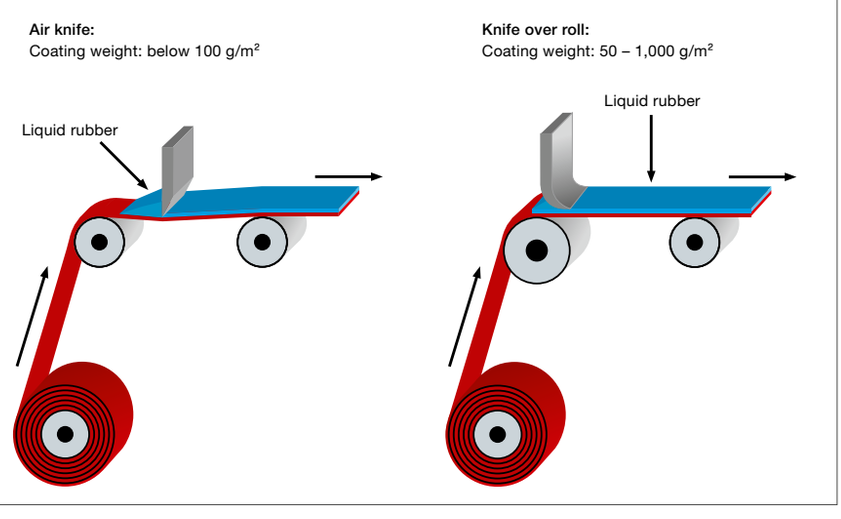
Silicones can be applied by all common application methods for coating textiles. The most common methods are knife coating for liquid silicones and calendering for solid silicones. After careful cleaning, coating equipment used for silicones can even serve for processing other coating compounds, such as PVC or acrylates. We recommend aliphatic solvents such as white spirits or isoparaffins as cleaning agents. After cleaning, the heating tunnel should be held at a temperature of at least 150 °C for about an hour before switching over to other materials.

During the calendering process, solid rubber is rolled to the desired film thickness, applied to the textile under pressure and then subjected to thermal cross-linking. Film thicknesses are typically 1 – 2 mm.
Knife coating, by contrast, is ideal for applying thinner films. In this method, liquid silicone pastes are applied, either manually or automatically, in front of a doctor blade.
The shear force applied under the blade distributes the silicone rubber evenly and allows it to permeate the fabric, resulting in a good adhesive bond. The distance between the blade and the textile defines the resulting coating thickness. If the coating weight is very low, the blade (air knife) is pressed directly onto the textile, allowing for coatings as thin as approx. 10 µm. Expertise and fine-tuning of the silicone paste's rheology are key factors in obtaining excellent coating results by knife coating.

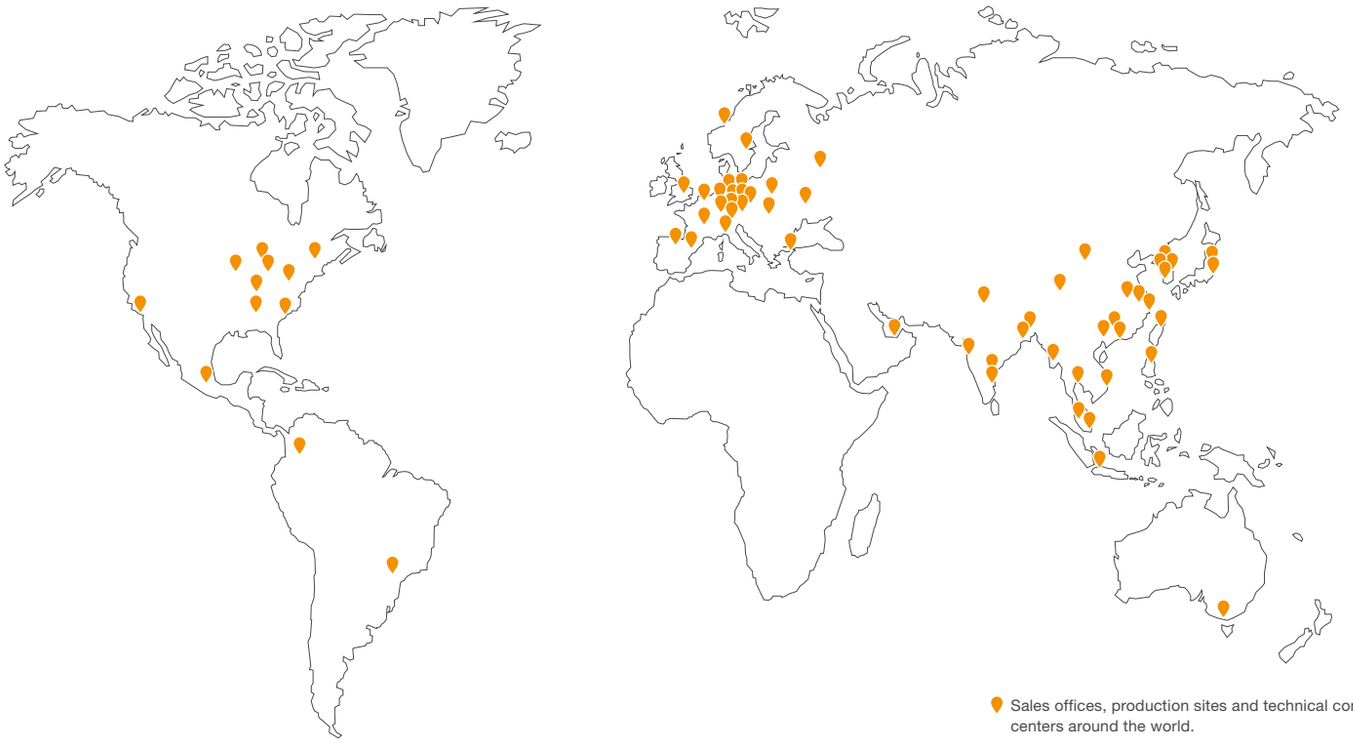
Calendering



Knife Coating



EXPERTISE AND SERVICE NETWORK ON FIVE CONTINENTS



Sales offices, production sites and technical competence centers around the world.

WACKER is one of the world's leading and most research-intensive chemical companies, with total sales of €4.98 billion. Products range from silicones, binders and polymer additives for diverse industrial sectors to bioengineered pharmaceutical actives and hyperpure silicon for semiconductor and solar applications. As a technology leader focusing on sustainability, WACKER promotes products and ideas that offer a high value-added potential to ensure that current and future generations enjoy a better quality of life, based on energy efficiency and protection of the climate and environment.

Spanning the globe with 4 business divisions, we offer our customers highly-specialized products and comprehensive service via 24 production sites, 22 technical competence centers, 13 WACKER ACADEMY training centers and 50 sales offices in Europe, North and South America, and Asia – including a presence in China. With a workforce of some 14,500, we see ourselves as a reliable innovation partner that develops trailblazing solutions for, and in collaboration with, our customers. We also help them boost their own success. Our technical competence centers employ local specialists, who assist customers worldwide in the development of products tailored to regional demands, supporting them during every stage of their complex production processes, if required.

WACKER e-solutions are online services provided via our customer portal and as integrated process solutions. Our customers and business partners thus benefit from comprehensive information and reliable service to enable projects and orders to be handled fast, reliably and highly efficiently.

Visit us anywhere, anytime around the world at: **www.wacker.com**

All figures are based on fiscal 2018.

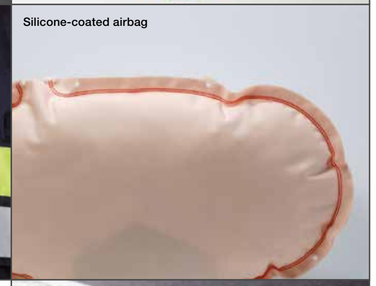
Impregnated outdoor jacket

Architectural textile

Silicone-coated nonvoven fabric

Silicone-printed fabric

Fire-protective clothing



Silicone-coated airbag

Silicone-coated hose for thermal insulation

Silicone-coated non-slip garter

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6934e/08.19 replaces 6934e/09.18

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CREATING TOMORROW'S SOLUTIONS

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ELASTOSIL®

PRODUCT OVERVIEW

SILICONE RUBBER FOR TEXTILE COATING

Rubber Dispersions · High Temperature Curing Silicone Rubber · Room Temperature Curing Silicone Rubber · Top Coats

Product	Curing mechanism	Characteristics	Color	Viscosity at 1/sec [mPas] DIN EN ISO 3219 / 25 °C	Viscosity at 10/sec [mPas] DIN EN ISO 3219 / 25 °C	Hardness Shore A ISO 7619-1	Tensile strength [N/mm²] ISO 37 Typ 1	Elongation at break [%] ISO 37 Typ 1	Tear resistance [N/mm] ASTM D 624 B	Processing	BfR XV. Silicones*	FDA 175.300 coatings*
Rubber Dispersions												
ELASTOSIL® RD 6600 F	Addition	Good mechanical properties, dry surface, solid content: 40 % in xylene	Transparent	115,000	45,000	60	5.5	350	12.0	Addition of 3 % ELASTOSIL® CROSSLINKER 525 or 1 % WACKER® CROSSLINKER W required	-	-
ELASTOSIL® RD 6680 F	Addition	Electrically conductive, solid content: 50 % in white spirits	Black	18,000	4,000	35	3.5	420	10.0	Addition of 3 % ELASTOSIL® CROSSLINKER 525 or 1 % WACKER® CROSSLINKER W required	-	-
WACKER® FINISH CT 51 L	Condensation	Silky and flexible coatings, solid content: 25 % in toluol	Transparent	31,000	19,000	-	-	-	-	Addition of WACKER® INHIBITOR PT 88 and 1 % WACKER® CATALYST C05 required	+	+
High Temperature Curing Silicone Rubber												
ELASTOSIL® LR 3001/55 FR A/B	Addition	Flame retardant (UL 94: V-0)	Grey	250,000	150,000	51	5.5	340	17.0	A/B-System, mixing ratio A:B = 1:1	-	-
ELASTOSIL® LR 6200 A/B	Addition	Low viscosity, dry surface	White	15,000	9,000	40	2.8	210	4.6	A/B-System, mixing ratio A:B = 1:1	-	-
ELASTOSIL® LR 3003/20 TR	Addition	General purpose, excellent mechanical properties	Transparent	360,000	210,000	22	8.3	870	24.0	A/B-System, mixing ratio A:B = 1:1	+	+
ELASTOSIL® LR 3003/30	Addition	General purpose, excellent mechanical properties	Transparent	210,000	100,000	30	7.0	610	21.0	A/B-System, mixing ratio A:B = 1:1	+	+
ELASTOSIL® LR 6240 A/B	Addition	Good flexibility, high modulus	Transparent	30,000	20,000	30	1.7	290	4.9	A/B-System, mixing ratio A:B = 1:1	+	+
ELASTOSIL® LR 6250 F	Addition	General purpose	Transparent	53,000	32,000	36	5.0	350	10.4	Addition of 3 % ELASTOSIL® CROSSLINKER 525 or 1 % WACKER® CROSSLINKER W	-	+
ELASTOSIL® LR 6260 A/B	Addition	High dielectric strength	Ivory	57,000	31,000	39	5.1	380	8.9	A/B-System, mixing ratio A:B = 1:1	-	+
ELASTOSIL® LR 6320 F	Addition	General purpose	Transparent	28,000	23,000	20	2.4	450	4.3	Addition of 10 % ELASTOSIL® CROSSLINKER SX or 3 % ELASTOSIL® CROSSLINKER 525 or 1 % WACKER® CROSSLINKER W required	+	+
ELASTOSIL® LR 6360 F	Addition	General purpose	Transparent	38,000	28,000	60	5.0	150	6.1	Addition of 5 % WACKER® CROSSLINKER W required	+	+
ELASTOSIL® NT 76	Addition	Newtonian rheology	Transparent	40,000	40,000	20	0.7	160	2.3	Addition of 3 % ELASTOSIL® CROSSLINKER 525 required	+	+
ELASTOSIL® R 401/40	Peroxide	General purpose	Transparent	n. a.	n. a.	40	10.0	580	28.0	Addition of 1.5 % ELASTOSIL® AUX CURING AGENT E or 0.7 % ELASTOSIL® AUX CURING AGENT C1 required	+**	+**
ELASTOSIL® R *plus* 4001/40	Addition	General purpose	Transparent	n. a.	n. a.	40	11.0	940	38.0	Ready to use system	+	+
Room Temperature Curing Silicone Rubber												
ELASTOSIL® E43 N	Condensation	General purpose, excellent adhesion, tin-free	Transparent	300,000	260,000	35	4.5	350	12.0	Ready to use system	+	+
ELASTOSIL® E50 N	Condensation	General purpose, self leveling, tin-free	Transparent	63,000	53,000	35	1.5	150	5.0	Ready to use system	+	+
ELASTOSIL® E91	Condensation	Anti-slip surface, fast curing with steam, tin-free	Transparent	100,000	60,000	20	1.2	350	-	Ready to use system	-	-
ELASTOSIL® E92 N	Condensation	Anti-slip surface, fast skin formation at room temperature, tin-free	Transparent	160,000	90,000	20	1.5	350	-	Ready to use system	-	-
Top Coats												
ELASTOSIL® 47007	Addition	Low coefficient of friction, solvent-free	Ivory	16,000	7,000	-	-	-	-	Addition of 3 % ELASTOSIL® CROSSLINKER W or 5 % WACKER® CROSSLINKER HX required	-	-
ELASTOSIL® RD 3151 F	Addition	Glossy varnish, easy to clean, solid content: 50 % in white spirits	Transparent	20,000	3,500	-	-	-	-	Addition of 3 % WACKER® CROSSLINKER W required	-	-
ELASTOSIL® RD 6620 F	Addition	Matt varnish, solid content: 50 % in xylene	Colorless, opaque	330,000	75,000	-	-	-	-	Addition of 1 % WACKER® CROSSLINKER W required	-	-

* Valid for the silicone base. Additives have to be evaluated separately!
** Valid after post-curing (4h/200 °C)

WACKER

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