

ELASTOMERS, PLASTICS & COMPOSITES

SILICONES

Compounds and Properties



SILICONES – A WORLD OF UNLIMITED
POSSIBILITIES

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ALL-ROUNDERS CAN BE FOUND EVERYWHERE



Silicones are truly jacks of all trades, capable of standing up to the toughest of requirements. Modern life would be inconceivable without silicones. And, thanks to the freedom for designing the silicone molecule, there are countless future applications still to come.

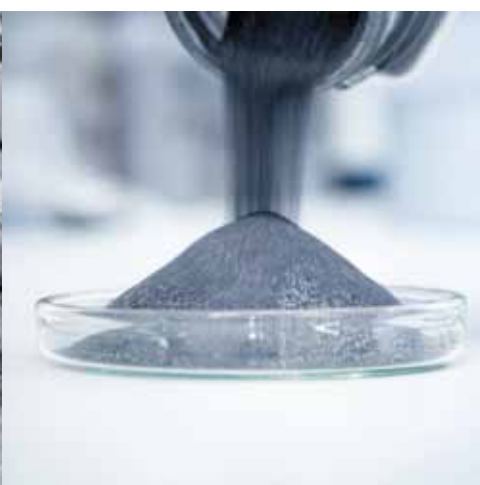
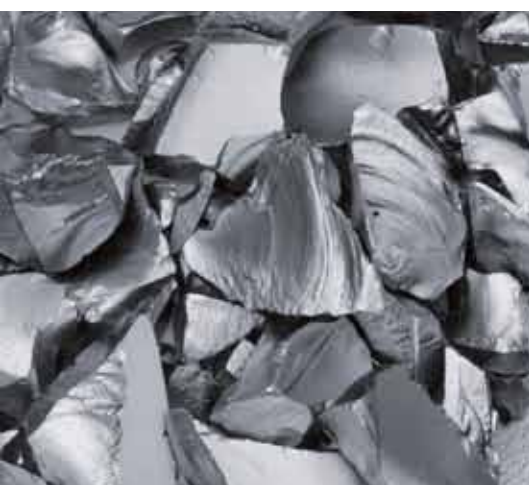
We encounter silicones every day, though we hardly ever notice them. Under the hood, silicone rubber protects the car electronics against moisture and dirt; in car lacquers silicone additives provide gloss; in washing machines, silicone antifoam agents prevent the detergent from foaming over; in shampoo they give hair its sheen; they provide woolen garments with a typical soft hand, and, as silicone resin emulsion paints, they give masonry water repellency, while allowing water vapor and carbon dioxide to diffuse out of its interior.

Silicones also perform superbly in medical applications, where high resistance or a state-of-the-art product is required: as a highly pure material for medical tubes, plasters or orthopedic products, as a reliable sealant and insulating material in electrical equipment or insulators. Pyrogenic silica is also used as a thickening additive in adhesives for the rotor blades of wind generators.

This outstanding versatility is the result of silicone chemistry: silicones are modern synthetic products based on a raw material, quartz sand, which is available in practically unlimited quantities. Their versatile performance is due to the chemical structure and the many different ways it can be modified. As a result, silicones can be provided with tailor-made properties that are fascinating and offer continually new possibilities.

On the following pages, let us guide you through the world of silicones. Discover the unique chemical and physical properties, and gain insights into the versatile applications they open up.

FROM RAW MATERIAL TO THE PRODUCT WORLD



Silicon

The chemistry of silicon and its compounds is extremely dynamic. Hardly any technology in recent decades has shaped technical progress so strikingly as silicon chemistry. This success story begins with the element silicon.

Elementary Facts

In nature, silicon occurs exclusively in oxidized form, as the compounds silicon dioxide and silicates. Silicon is the second commonest element in the Earth's solid crust, accounting for 25.8 percent by weight, and the most important component of inorganic materials. Since silicon is very rarely found as an element in nature, it was not isolated until relatively recently. On the other hand, siliceous construction and engineering materials, such as sand, clay and ceramics, have been available since time immemorial.

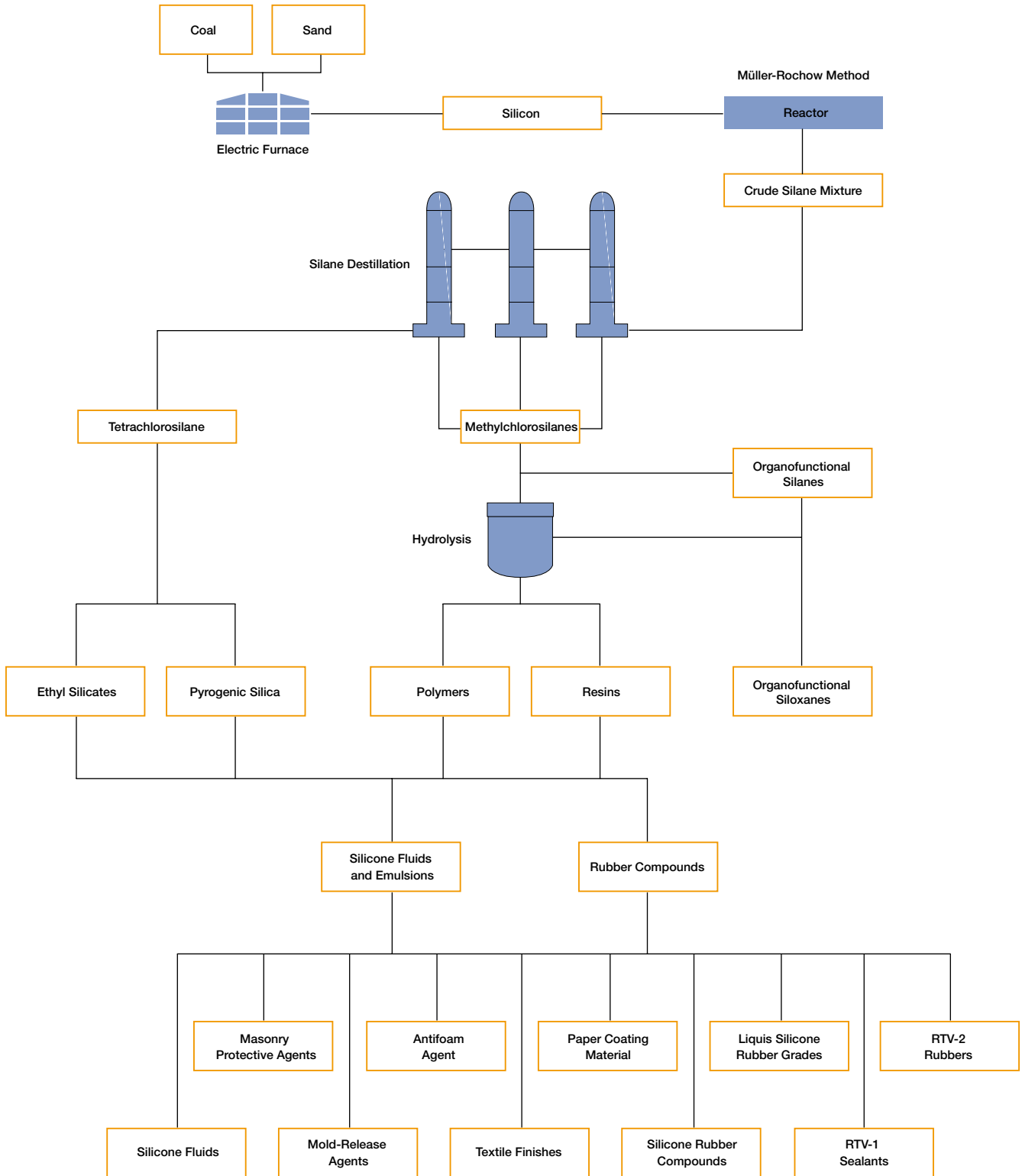
Silicone Chemistry is Very Efficient

In 1940/41, Professors Müller and Rochow independently discovered how to react silicone with methyl chloride gas (CH_3Cl) to form liquid methylchlorosilanes. This step provided the starting materials for the industrial manufacturing of silicones and launched a global boom in silicone production. Based on the pioneering work of Dr. Siegfried Nietzsche,

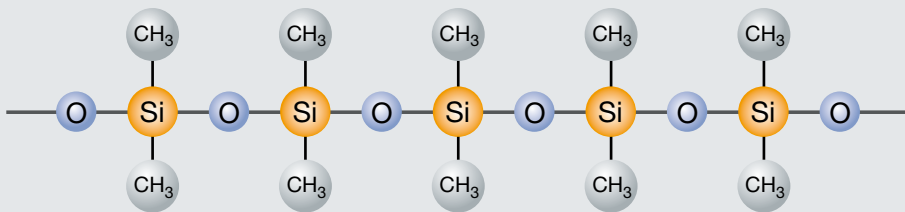
WACKER, in 1947, became the first European company to start researching the field. In the following years, WACKER processes laid the cornerstone for the modern and efficient manufacturing of organochlorosilanes and silicone products.

This was the beginning of the success story. These early scientific accomplishments underlie WACKER's reputation as the European pioneer of silicone chemistry. Now globally active, the Group uses complex chemical processes to manufacture versatile product classes such as silicone fluids, resins or elastomer compounds.

The production scheme for WACKER silicones



HIGHLY FLEXIBLE ELEMENTARY BUILDING BLOCKS



The figure illustrates the typical structure of a linear silicone polymer (polydimethylsiloxane). The nonpolar methyl groups can rotate freely around the silicon-oxygen chain, forming a shield for the polar main chain. The shielding explains the low surface tension and high spreading power that make silicones ideally suited for use as efficient hydrophobizing agents.

Silicones, silanes and the various siloxane units – a few words about terminology, classification and structure.

The Term “Silicone”

The term “silicone” was coined by F. S. Kipping (1863-1949), and refers to the formal analogy between these silicon compounds and the equivalent oxygen compounds of carbon (poly-silicoketones). However, the Si-O-Si group is better described by the term “siloxane.” Strictly speaking, therefore, all silicones should correctly be termed “polysiloxanes.” Nowadays, the term silicone is principally used in conjunction with the technical applications of polysiloxanes.

Silanes are the Starting Point

The starting point and chief building blocks for silicone production are silanes. Silanes are produced by direct synthesis from silicon and methyl chloride (Müller Rochow synthesis). They are colorless, clear, mobile liquids that are soluble in organic solvents – including anhydrous alcohol in certain cases. The low molecular mass of silanes makes them highly volatile.

The Silicone Structure

Silicones, known to chemists as polydiorganosiloxanes, have a structure that resembles quartz modified with organic groups. They consist of an “inorganic” backbone built up of alternating silicon and oxygen atoms. The other two bonds of the silicon atoms are occupied with organic groups (preferably methyls), which are responsible for silicones’ semi-organic nature.

STRUCTURAL VARIETY AS A FORMULA FOR SUCCESS

Silicone chemists distinguish between four different structural units:

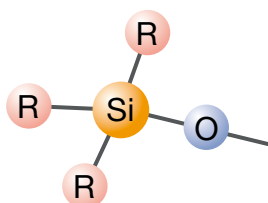
Monofunctional units
permit chain termination.

Difunctional units
form the backbone of macromolecular chains and ring compounds.

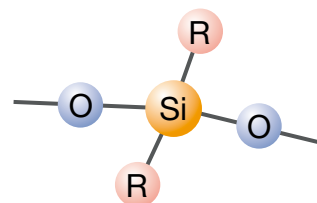
Trifunctional units
produce branched molecules and form the basis of resins.

Tetrafunctional units
lead to crosslinked structures similar to silicates.

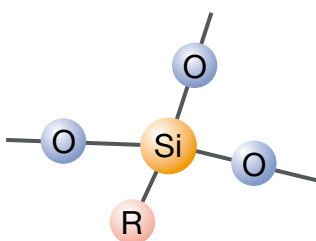
Monofunctional units



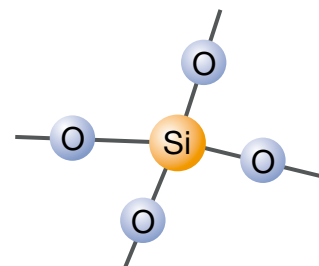
Difunctional units



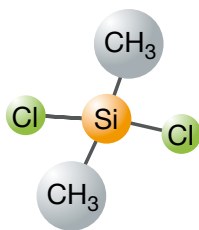
Trifunctional units



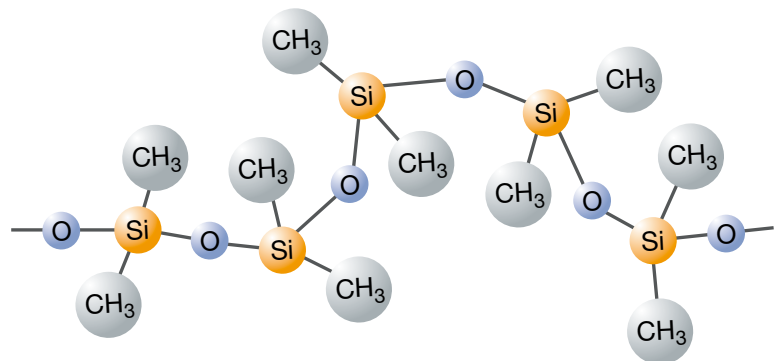
Tetrafunctional units



Chemical structure of a silane
(dimethyldichlorosilane)



Chemical structure of a linear silicone polymer (polydimethylsiloxane)



From Semi-Organic Plastics

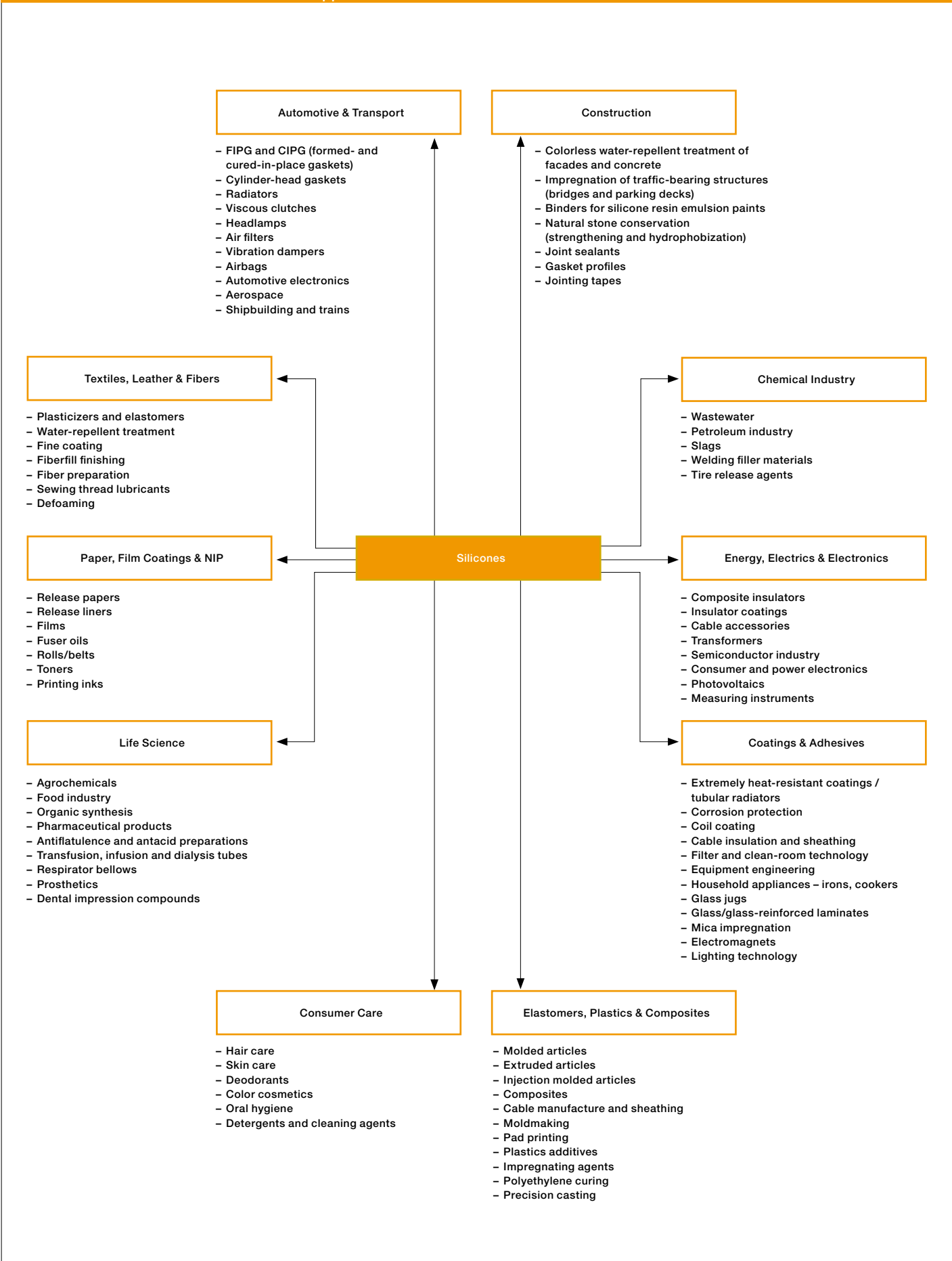
Silicones are a special group of plastics. The term “plastic” is normally used to refer to organic materials that do not occur in nature. Silicones are classed as semi-organic materials since the element silicon has a strong metallic character compared to carbon.

Remarkably Stable

The Si-O bond energy is significantly greater than that of a C-C bond. This has far-reaching effects on the stability and resistance of silicones to a variety of influences. For example, silicones have remarkable thermal and thermooxidative resistance. Silicones are also far less readily attacked by electromagnetic and particle radiation (UV, alpha, beta and gamma rays) than organic plastics.

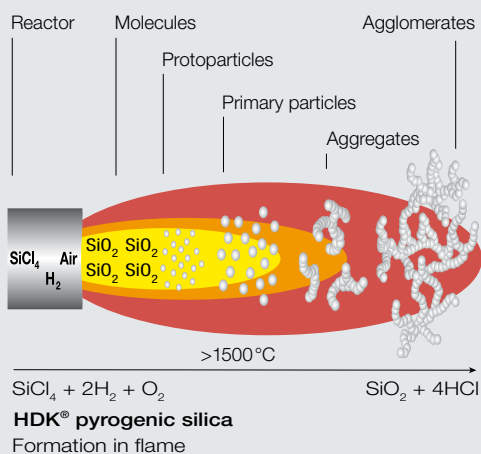
Versatile Formulas

Silicones’ chemical structure allows them to be produced in a number of variations. By using siloxane units with different valences, products can be made with oily, polymeric, resinous or crosslinked properties. At the same time, the organic groups bound to the silicon pave the way for a diverse range of modifications. It is this variability that makes possible the impressive variety of silicone products: greases, release agents, antifoam agents, paint additives, paper coatings, hydrophobizing agents, high or room-temperature vulcanizing silicone rubbers, and many, many more.





PYROGENIC SILICA



Chemical Structure and Properties

Pyrogenic silica consists of $\text{SiO}_{4/2}$ tetrahedra, each of which is linked to adjacent tetrahedra by means of a common oxygen atom. Pyrogenic silica is produced at temperatures over 1,000 °C by introducing volatile chlorosilane into an oxyhydrogen flame. The primary particles have a smooth, non-microporous surface of about 5 to 30 nm. In the flame, the primary particles fuse into larger units, called aggregates, with sizes from about 150 to 500 nm. As the aggregates cool, they form flaky tertiary structures of about 1 to 250 μm in size, called agglomerates. Hydrophilic pyrogenic silica has about 2 silanol (-Si-OH) groups per square nanometer. Hydrophobic pyrogenic silica is produced by the reaction of -Si-OH groups with organosilicon compounds and has about 0.5 to 1 silanol groups per square nanometer.

Effects and Applications

Thickening and Thixotropy

Pyrogenic silica is particularly important for controlling the flow and spread of paints and coatings, adhesives and sealants, unsaturated polyester resins, cosmetics and pharmaceuticals.

Reinforcement

Natural rubbers, synthetic rubbers and silicone elastomers must be reinforced with active fillers to give them the desired mechanical properties such as hardness, tensile strength, elongation at break and tear resistance (notch resistance). The required system properties can be individually tailored by means of the active filler pyrogenic silica.

Free-Flow agents

Pyrogenic silica significantly improves the flow properties of powdery substances. In many areas, such as bulk goods, fire extinguishers, powders for cosmetics, pharmaceuticals, foods,

animal feed, toners for photocopiers and powder paints in industrial and automotive coatings.

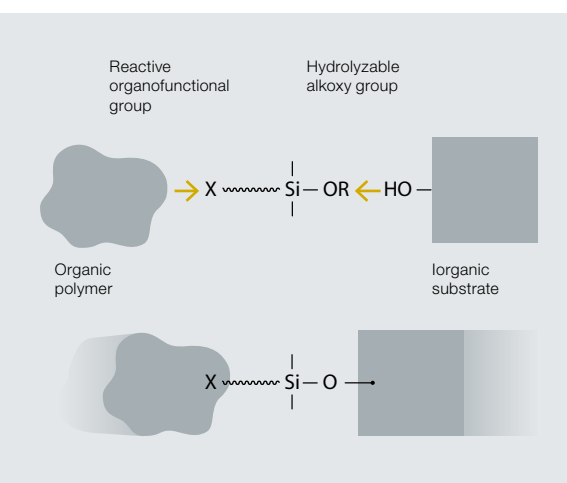
Thermal Insulation

Pyrogenic silica has outstanding thermal insulation properties, up to over 1,000°C at room temperature. Typical applications include vacuum insulation panels (building thermal insulation, insulation of refrigerators), radiant heaters in cooktops, car exhaust systems or fire safety systems for buildings.

Chemical-Mechanical Planarizing

Production of semiconductor devices requires submicroscopic, multilayered structures comprising silicon, silicon dioxide, tungsten, copper and other materials. CMP slurries of pyrogenic silica serve as abrasive particles in the manufacture of such semiconductor devices.

ORGANOFUNCTIONAL SILANES



Chemical Structure and Properties

Organofunctional silanes are hybrid compounds that combine the function of a reactive organic group with the inorganic characteristic of an alkyl silicate, in a single molecule. This allows them to be used as molecular bridges between organic polymers and inorganic materials.

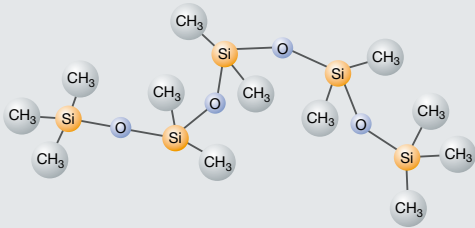
The most widespread organofunctional silanes are trialkoxy silanes with a propylene spacer between the Si atom and the functional group X. The most important functional groups are amino, glycidoxy, sulfur, methacryloxy and vinyl. In recent years, α -silanes have gained increasing importance. Instead of the customary propylene spacers, these α -silanes have a methylene bridge between the Si atom and the functional group, making them much more reactive than conventional γ -silanes. The increased reactivity of the alkoxy has several advantages. Not only does it open up new applications for α -silanes (such as fast-setting adhesives), but it

also makes them interesting building blocks for use in established applications.

Applications

Organofunctional silanes are the main ingredients of almost all adhesives and sealants. As adhesion promoters and curing agents, they improve the physical and mechanical properties and increase chemical resistance. In the plastics industry, vinylsilanes are used for silane curing and producing crosslinkable polyolefin compounds. With their high reactivity, α -silane curing agents can now be used for ecological, user-friendly formulations without tin catalysts and solvents. Organofunctional silanes have become indispensable, particularly in coatings, paints and lacquers. Here, they are used as adhesion promoters or curing agents. But the most important application of organofunctional silanes is as surface modifiers for inorganic materials (such as mineral fillers and glass fibers).

SILICONE FLUIDS



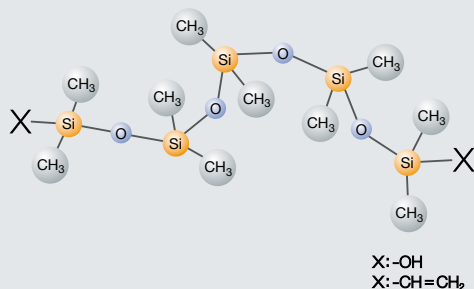
Chemical Structure and Properties

Silicone fluids principally consist of chains of alternating silicon and oxygen atoms with the free valences of the silicon occupied with organic radicals ("R," usually methyl groups, though in special cases they may also be phenyl, vinyl or amino groups). Silicone fluids are transparent, tasteless and odorless liquids with no known harmful effects. Their viscosities lie between 0.65 and 1,000,000 mm²/s depending on the type. They have excellent thermal resistance from -60 to +300°C. Silicone fluids are also characterized by very low volatility, excellent shearing resistance, low surface tension and very good water repellency. Another important feature, of course, is their remarkable electrical properties over a wide temperature range.

Applications

Silicone fluids are ideal for use as hydraulic or transformer oils, damping liquids, diffusion pump fluids, thermally resistant lubricants, dielectrics, defoamers and release agents for photocopiers and laser printers. They can also be used for hydrophobic treatment of glass and mineral wool. Special silicone fluids can be processed into impregnating agents for textiles and leathers. They are also used in very small amounts as paint additives. Other important applications are to be found in cosmetics, pharmaceuticals and medicine.

SILICONE RELEASE AGENTS



Chemical Structure and Properties

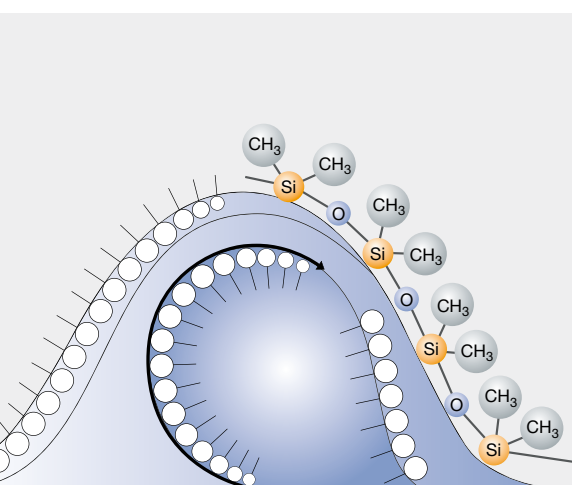
The anti-adhesive properties of silicones make them ideal for highly effective release agents. An outstanding release effect can be obtained just by applying silicone fluids. However, crosslinkable silicone compounds (coating compounds) are used more often. They are based on polydimethylsiloxanes with terminal crosslinkable hydroxyl or vinyl groups. These polydimethylsiloxanes cure by condensation or addition with silicate esters or polysiloxanes with SiH groups to form silicone elastomers.

WACKER offers its customers various solvent-free, solvent-based and emulsion-based systems specially developed for producing silicone release liners.

Applications

The main application of these coating materials is the production of release liners, e.g. for the adhesive label or adhesive tape industries. Since silicone release agents are physiologically harmless and conform to German food legislation, they meet even the strict standards of food packaging or baking paper production. Another important application is in plastics and rubber processing. They also have an excellent track record as internal and external tire release agents.

SILICONE ANTIFOAM AGENTS



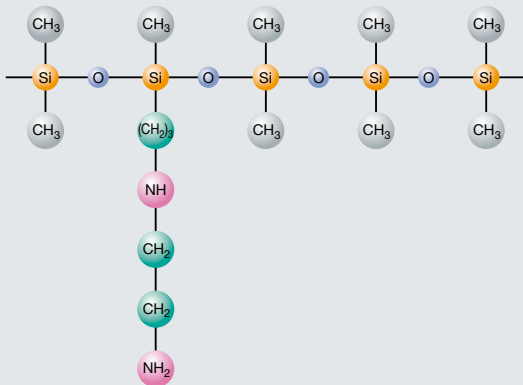
Chemical Structure and Properties

Silicone antifoam agents, too, are based on silicone fluids. The antifoam activity is created by adding various substances in the form of activators, usually fumed silicas. Because of their extremely low surface tension, silicone antifoam agents can spread on foam lamellae and displace the surfactant molecules that stabilize the foam. This causes local weakening of the foam lamellae. The solid hydrophobic components of antifoam agents are transported along with the silicone droplets into the foam lamellae, further destabilizing the lamellae. These effects rupture the foam lamella and cause breakdown of the foam. In contrast to organic defoamers, silicone antifoam agents are highly efficient, chemically resistant and thermally stable.

Applications

Antifoam agents can be used for effective foam control in a wide variety of industries, from the chemical, petrochemical, dye and coatings industries through detergent production, textiles and cellulose, to wastewater treatment. A range of practically tested, economical product systems, such as antifoam agents, antifoam concentrates, antifoam emulsions or antifoam powders, are available to meet all these various requirements. Antifoam agents are either added directly to certain products, or as auxiliaries during the manufacturing process. Because they are physiologically neutral, various special grades can also be used in the sensitive pharmaceutical and food industries.

SILICONE TEXTILE FINISHES



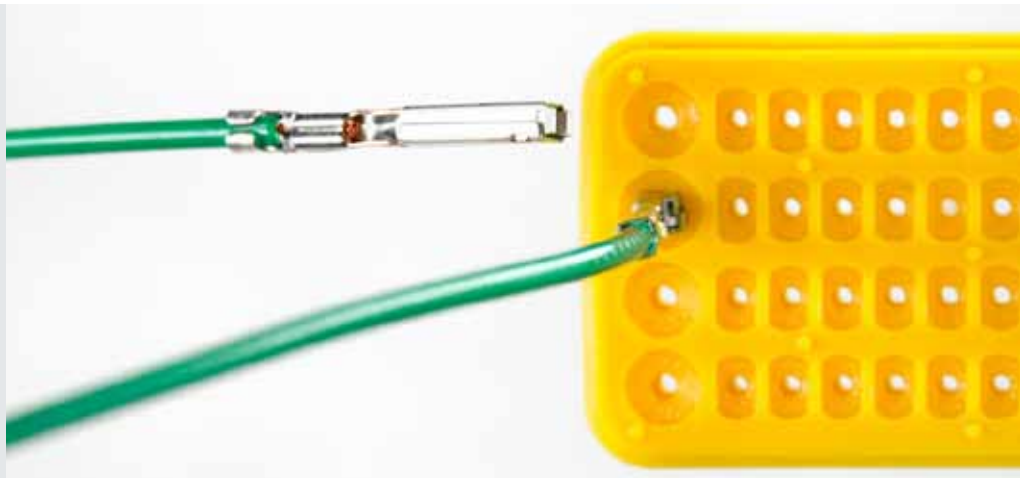
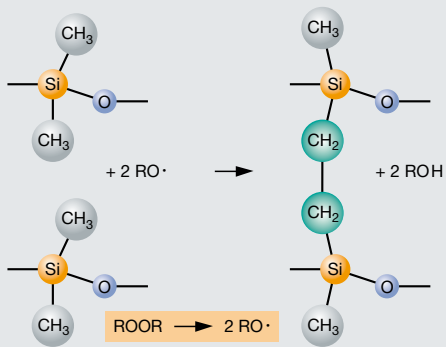
Chemical Structure and Properties

Silicone softeners generally consist of linear aminopolydimethylsiloxanes with a viscosity of 100–100,000 mPa·s. The silicone polymer structure determines the exact range of properties of a textile finish. Their basic units differ, for example, in the chain length, the number of functional side groups and the chain ends (capped or reactive). The amino-functional side groups optimize the distribution of the silicone on the fiber surface and thus ensure maximum softness. Aminosilicones first have to be emulsified before they can be used in water-based textile finishing processes.

Applications

As textile finishes, silicones achieve a variety of effects, such as softness, hydrophilicity, dimensional stability, elasticity, hydrophobicity, color fastness or odor control. Innovative hydrophilic silicone softeners are even capable of combining softness and absorption in textiles. That makes them comfortable to wear and optimizes the moisture balance in applications such as clothing textiles or towels. Silicones are also successfully used in leather finishing, where they optimize soft hand and abrasion resistance at the wet-end, for example. And, as functional additives in finishes, they improve softness, gloss and abrasion resistance. Moreover, special silicone modifiers provide smoothness, gloss, softness, bulk, elasticity and good sewability to various natural and chemical fiber grades.

SILICONE RUBBER COMPOUNDS



Silicone rubber compounds consist of long-chain polysiloxanes and various fillers, such as pyrogenic silica. They can be cured to form silicone elastomers. They are classified according to the curing method, the viscosity of the base polymer, and whether they cure at high or room temperature.

High-Temperature-Vulcanizing Silicone Rubbers

Chemical Structure and Properties of High-Consistency Silicone Rubber (HCR)

Solid silicone rubbers are cured at elevated temperature, either by means of organic peroxides or platinum catalysts. The cured rubber is compounded with reinforcing fillers to give it its mechanical strength. The preferred fillers are pyrogenic silicas with BET surface areas $>100 \text{ m}^2/\text{g}$. It is also possible to add precipitated silicas, inactive fillers (quartz, diatomaceous earths) or special carbon black grades. Thanks to their outstanding properties, HTV silicone rubbers have a whole host of applications. This includes a wide range of service temperatures (-50 to $+200 \text{ }^\circ\text{C}$, or even -90 to $+300^\circ\text{C}$ for special formulations), no known physical or physiological harmful effects, and excellent aging resistance.

Applications

High-temperature-vulcanizing solid silicone rubbers have a successful track record in practically all industries. And new applications are added every day. High-temperature-vulcanizing silicone rubbers are used in the automotive industry, in the electrical transmission and distribution sector, electrical applications, food and personal hygiene, machinery and plant construction and in the construction industry.



Chemical Structure and Properties of Liquid Silicone Rubber (LSR)

High-temperature-vulcanizing rubbers also include liquid silicone rubbers. Their consistency and curing mechanism give them outstanding processing advantages. Liquid silicone rubbers are characterized by a low viscosity compared to solid silicone rubbers and other elastomers. Liquid silicone rubbers are free-flowing, pumpable two-component compounds that are supplied ready to process. They are vulcanized by addition curing. Component A contains a Pt catalyst and component B a SiH-functional curing agent. Compared to peroxide curing, liquid silicone rubbers do not release any curing byproducts.

Applications

Liquid silicone rubbers are used in an impressive array of applications: from the automotive industry, transmission and distribution, electrical, food and personal care, through the machinery, plant engineering and construction sectors to medical applications.

SILICONE RUBBER COMPOUNDS



Room-temperature vulcanizing Silicone Rubbers

Chemical Structure and Properties of Two-Component Silicone Rubber (RTV-2)

RTV-2 silicone rubbers are two-component pourable, spreadable or kneadable compositions that vulcanize when the curing agent component is added and form highly elastic silicone rubber. They are cured at room temperature (RTV = room-temperature vulcanizing). There are two ways of vulcanizing them: condensation curing is performed with an organotin catalyst, generating alcohol as byproduct. Addition curing, on the other hand, uses a platinum catalyst and does not produce byproducts.

Special silicone rubber grades can be flash vulcanized using UV-light. The vulcanization time can be controlled by adjusting the UV intensity and exposure time. Most cured RTV-2 silicone rubbers retain their full elasticity up to 200 °C. Some products can even be briefly heated to 300 °C. At low temperatures, they retain their flexibility down to -50 °C, or even to -100 °C in the case of special grades. The thermal conductivity of RTV-2 silicone rubber generally allows them to be used for insulating electrical power equipment without causing overheating. The most useful electrical properties are the insulation resistance, breakdown resistance and dissipation factor. The gas permeability of RTV-2 silicone rubbers is around ten times higher than that of natural rubber at room temperature. Another feature that is advantageous in many applications is the excellent release property of the cured rubber surfaces towards organic and inorganic materials.

Applications

The extensive portfolio of RTV-2 silicone rubber products allows cured rubbers to be produced with extremely versatile, highly specialized properties. Therefore, they offer solutions to problems in diverse industrial sectors, including moldmaking, electronics and optoelectronics, household appliances, machinery and industrial plant engineering, medical applications and photovoltaics.



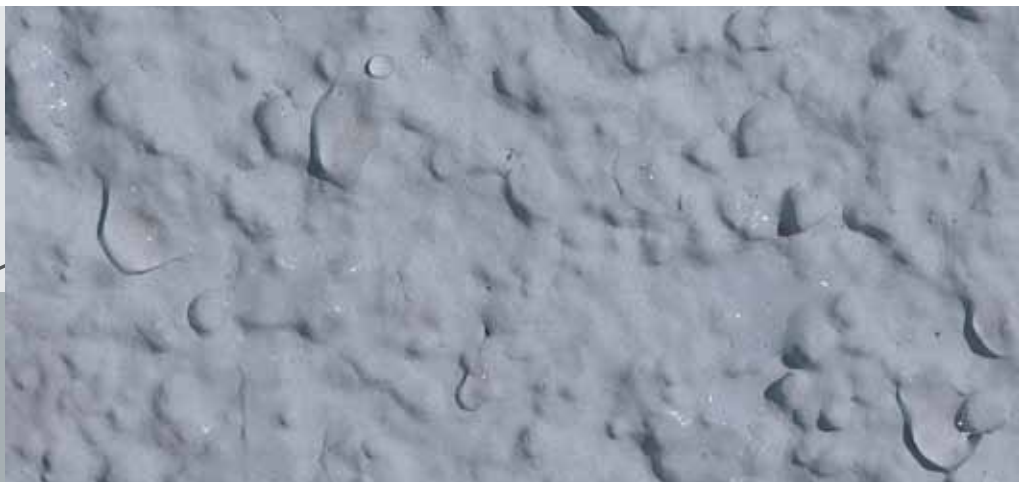
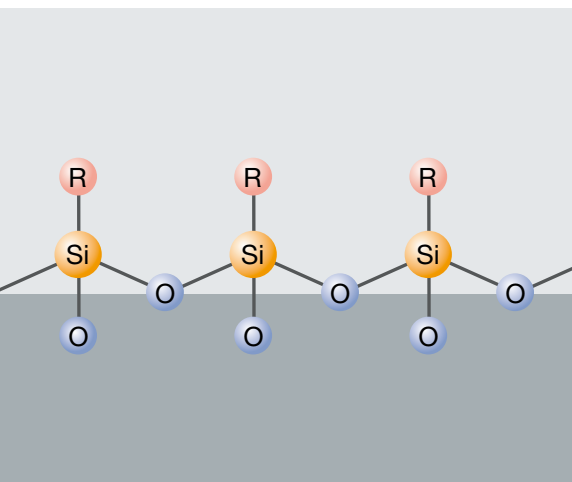
Chemical Structure and Properties of One-Component Silicone Rubber (RTV-1)

RTV-1 silicone rubbers are one-component, ready-to-use RTV systems. They consist of polydimethylsiloxane, curing agent, fillers and additives. After application, they are crosslinked by contact with atmospheric moisture releasing byproducts in the process. Crosslinking starts with the formation of a skin on the surface of the applied silicone rubber and gradually works its way into the compound. Depending on the nature of the crosslinker, a small amount of an amine, an acetic acid or a neutral compound, such as alcohol, is released during vulcanization. RTV-1 silicone rubbers solve numerous problems in sealing bonding and coating. Their outstanding weathering and aging resistance is the result of their special chemical properties.

Applications

RTV-1 can be used in virtually all sealing, bonding and coating applications. It also has an extensive and diverse range of applications in various industries, such as automotive, construction, electrical and electronics, household appliances, medical applications and the textile industry.

SILICONE MASONRY PROTECTION AGENTS



Chemical Structure and Properties

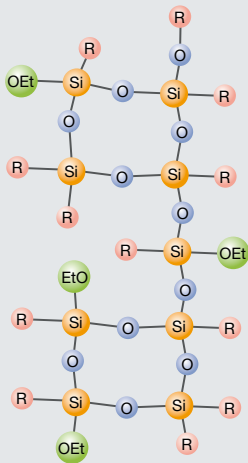
Silicone masonry protection agents are silicone resins that contain crosslinkable groups. Their chemical structure makes them capable of bonding to the substrate while also providing water repellency, without impairing the breathability of the substrate.

Applications

Silicone masonry protection agents are primarily used to protect vertical surfaces (e.g. facades or steeply sloping surfaces, such as roofs) against water absorption. The advantage is that, when it rains, construction materials treated with silicone absorb very little water, and it readily evaporates again during dry weather. The construction material remains dry and moisture damage can be easily avoided. Because of their molecular structure, silicones wet the construction material surface.

Their organic groups (R-) form a sort of hydrophobic molecular “brush.” Consequently, water repellency is achieved not by closing the pores but by canceling out the wettability of the construction material. Since the pores and capillaries remain open, the water vapor permeability of the construction material remains unaffected. WACKER offers silicone masonry protection agents in the form of solvent-based silanes, siloxanes and silicone resins or as solvent-free aqueous products.

SILICONE RESINS



Chemical Structure and Properties

Silicone resins consist of highly branched polymer structures. Considered in detail, they are networks of irregular, mainly tri- or tetrafunctional structural units. Because they can be combined with many organic polymers, it is possible to tailor the numerous properties of silicone resins, e.g. their curing behavior, flexibility, adhesion properties or weathering resistance. The outstanding heat resistance of silicone resins is particularly striking. They can sustain high temperatures of 200 to 250 °C in continuous service, and even up to 600 °C for brief periods. Their dielectric behavior is ideal. Moreover, silicone resins' excellent oxidation resistance and superb mechanical properties make them particularly durable and economic materials.

Applications

WACKER supplies silicone resins as pure products, solvent-based and solvent-free systems, emulsions, but also powders. With their excellent thermal resistance, silicone resins are first class binders for all heat-resistant coatings. Silicone resins with reactive groups are principally used for modifying alkyd, epoxy and acrylic coatings. Such modified coatings offer excellent weathering resistance and elasticity (e.g. for coil coating). In the plastics industry, silicone resins are also used as heat-resistant molding compounds and release coatings. Silicone resins' excellent heat resistance and outstanding range of

properties are also very much in demand for electrical applications, such as binders for fiberglass laminates and cements for incandescent lamp bases, or impregnants for electrical windings. In addition, they are useful as water repellents in masonry protection or as binders in silicone resin facade paints.

PIONEER ACHIEVEMENTS WITH GREAT PROMISE

WACKER had already begun its research on silicon (instead of carbon) based plastics just after the Second World War. This new start and the early successes in generating hyper-pure silicon for the semiconductor industry are the reason for the excellent reputation we now enjoy as a pioneer of silicon chemistry.

F.S. Kipping first succeeded in synthesizing organosilicon compounds as early as 1898. But since these resinous products could be neither distilled nor crystallized, Kipping stopped there. He couldn't have known that, only 50 years later, the new class of silicones would revolutionize the plastics world with their unique properties.

The starting point for this development was the direct synthesis of methylchloro-

rosilanes from silicon powder and chloromethane. R. Müller and E. Rochow developed the process independently of one another in the early 1940s. It was a critical breakthrough, since silanes are still made by this process to this very day, before being processed into the desired silicones.

The first silicone product, a paste from Dow Corning for protecting aircraft electrical ignition systems against moisture and dielectric barrier discharges, was produced in 1944. Soon afterwards in 1947, S. Nitzsche started research into silanes and silicones at WACKER. He had already begun investigating organosilicon compounds during his postdoctoral studies at the University of Jena. We owe it to his persistence that production of the first silanes started as early as 1949 despite the difficult

postwar environment. In the following years, WACKER very rapidly developed new applications. In 1952, the product range covered silicone fluids, fluid emulsions, antifoam agents, impregnants, pastes and release agents. These first successes were revealed to the expert world at the Hanover trade show, and other events.

Work also began in 1952 on silicone elastomers, and 1,100 kg high-temperature vulcanizing HCR silicone rubbers was sold in 1953. As of 1954, room-temperature vulcanizing (RTV) grades were added, first as two-component then as one-component compounds. Silicone-resin-based masonry protection agents were an increasingly important market segment in this early phase. From 1970, WACKER finally produced two-component silicone rubbers that



1947–1950

- Initial silicone research in Burghausen
- First silicones pilot plant in "Salettl"
- Development of silicone fluids and resins



1951–1955

- Expansion of the silicone product range: antifoam agents, masonry protection agents, textile impregnants,
- emulsions and HTV and RTV silicone rubbers
- WACKER silicone products are a hit at the Hanover trade show



1957–1969

- Further expansion of silicone production to over 200 product grades
- Development of ELASTOSIL® sealants
- Changeover to the fluidized bed method for silane direct synthesis
- 33% share in SWS Silicones Corp. in Adrian/Michigan, USA

could be cured with platinum catalysts. This meant they could be vulcanized rapidly without emission of byproducts. The outstanding properties of silicones compared to other plastics includes their stability to both extremely low and high temperatures. In recent decades, WACKER has succeeded in successfully developing this branch. It has expanded and modernized existing production lines, and opened up new silicone-production sites across the world. The pioneers were the forerunner of the present Wacker Chemicals Corporation in Adrian, Michigan, USA, in 1969 and Wacker Chemicals East Asia in Tokyo, Japan, in 1983. And WACKER continued to expand in Germany, as well: The Nünchritz plant, which WACKER acquired from Hüls AG in 1988, has been successfully expanded to become WACKER's biggest silicone site after Burghausen.

WACKER's priority is to continue to optimize existing systems while developing completely new products. For example, in 2006 the newly inaugurated WACKER innovation prize for independent work went to A. Fehn. His research allowed WACKER to expand its portfolio with platinum-vulcanizing addition-curing systems for silicones – an incalculable advantage in the processing of silicone rubber.

WACKER systematically promotes innovations in silanes and silicones not only internally, but also externally: With this philosophy, the WACKER silicone award for outstanding academic work in organosilicon chemistry was inaugurated in 1987 – together with the Kipping Award, it is the most important silicone award in the world.

Moreover, WACKER founded the Institute of Silicon Chemistry at the Technical University of Munich in 2006.

WACKER SILICONES division currently manufactures over 3,000 products. They are used in all important modern industries, such as construction, automotive, transport, plastics, electrical and electronics, paints and coatings, paper or textile. And there is no end to this success story in sight.



1970–1978

- Development of rapid addition-curing RTV-2 silicone rubbers
- Production of HDK® pyrogenic silica, used for example as a filler in silicone rubbers
- The BAYPLAN Bavarian masonry protection agency is formed for silicone masonry protection
- Expansion of production capacities in Burghausen

1981–1987

- Founding of Wacker Chemicals East Asia Ltd., Tokyo, Japan
- Production start for thermal insulating materials
- Founding of Wacker Silicones Corporation, Adrian/Michigan, USA
- Presentation of the first WACKER Silicone Award to Professors Jutzi and Auner

1988–2008

- Set up and expansion of silicone production sites in the USA and Asia
- Acquisition of the Nünchritz plant and ongoing expansion as a silicone site
- Record production of the three-millionth metric ton of methylchlorosilanes in Burghausen
- Foundation of the Institute of Silicon Chemistry at the Technical University of Munich

NEW IDEAS SHAPE THE FUTURE

Innovations are the engine of silicone chemistry. They create products with new, unique property profiles and fields of application. And they ensure more efficient and more environmentally friendly production. In this way, innovations make life easier today and pave the way to the future.

Hybrids Create New Possibilities

The combination of inorganic silicones with organic polymers is increasing in importance. That is demonstrated by a host of existing applications, but even more so by the wide scope of conceivable future applications. When silicones are used as key components of organic systems, their important properties, such as thermal stability, surface properties and resistance, result in innovative materials with completely new combinations of properties. For example, silicone copolymers in hairspray achieve the completely unique combination of hold and softness. Or – thanks to silicones – a silicone-based thermoplastic combines hitherto contradictory properties in one material: thermoplastic processability, paintability, high transparency, water repellency and much more. Thus, combining silicones with other substances opens up still more possibilities.

Looking to the Future

Silicone chemistry responds promptly to social and economic change, sets trends itself and always tries to satisfy the customer's needs. This is impressively demonstrated by certain pioneering applications: silicone sealants give architects all the innovative and environmentally friendly potential of modern construction with large-area structural glazing facades. Finely divided silicas in organic adhesives firmly bond rotor blades of wind turbines, even in inclement weather and with extreme temperature fluctuations. Special silicone non-stick coatings reduce fuel consumption by preventing the fouling of ships' hulls. Novel finely divided silicas allow tires to be manufactured with reduced rolling resistance and optimized grip on wet roads. This reduces fuel consumption and increases road safety. All these innovative applications make one thing perfectly clear: silicone chemistry still has a great future before it. And WACKER's various technology platforms form a unique basis for shaping this future.

**Find out more at:
www.wacker.com**



OUTSTANDING SCIENCE

WACKER Chair

WACKER endowed the Institute of Silicon Chemistry at the Technical University of Munich (TUM) in late 2006. The facility is under the direction of the Chair of Macromolecular Chemistry:

The WACKER Chair and the Silicon Institute are headed by Professor Bernard Rieger, an expert in macromolecular chemistry. This Institute is housed in the TUM chemistry building in Garching. Research is concentrated on the field of organofunctional silicon compounds and silicones, with their as yet incompletely explained structure-effect relationships.

Other work focuses on chemical interactions in the coating of surfaces, hybrid and composite systems, silicon-based nanotechnology, materials with completely novel property profiles and pioneering catalytic processes for industrial silicone chemistry. Preferential funding is given to interdisciplinary research at the crossroads between physics, biotechnology, pharmaceuticals, environmental chemistry and material sciences.

WACKER Silicone Award

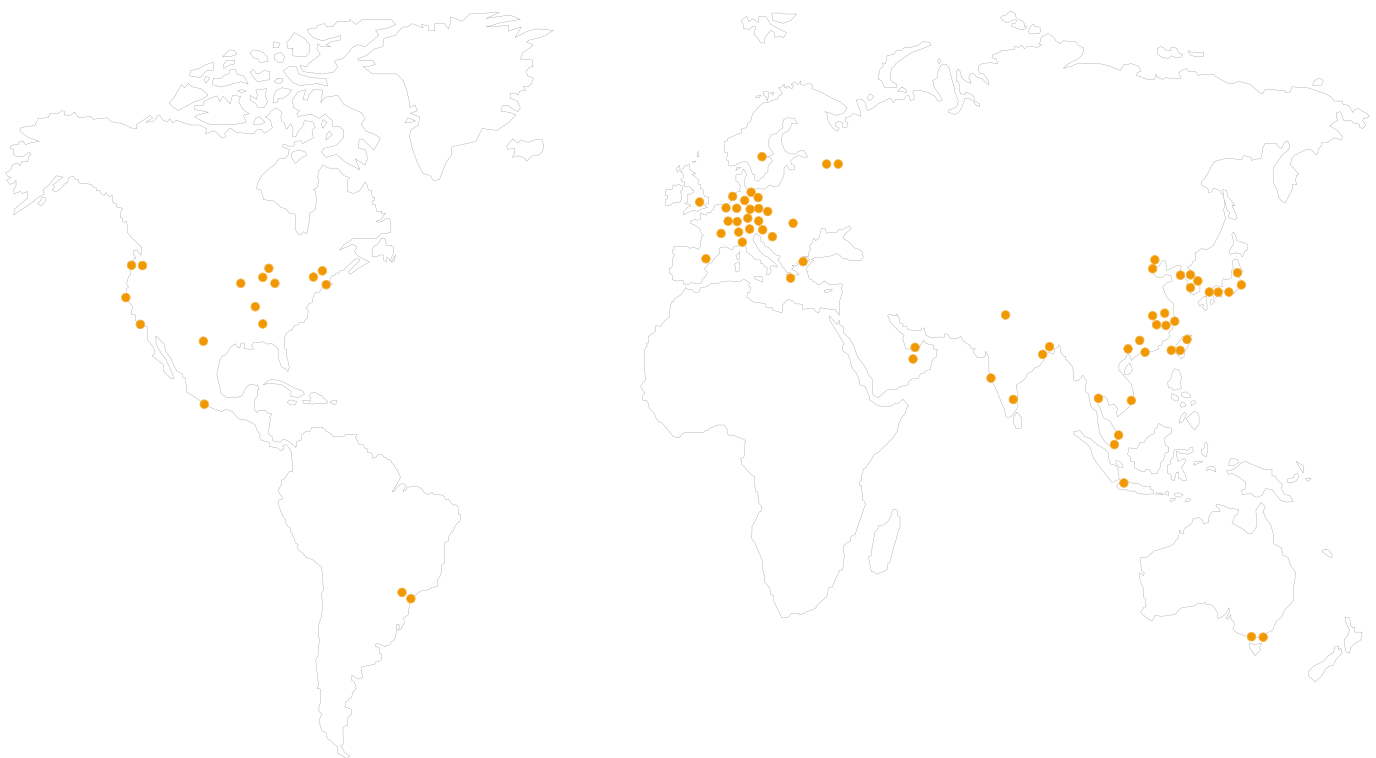
The WACKER Silicone Award, with a cash value of EUR 10,000, ranks alongside the American Chemical Society's Kipping Award as the most important international accolade in silicone chemistry. WACKER's award honors outstanding scientific achievements in silicone chemistry and encourages close cooperation with universities and other research institutes.

Prizewinners

- 2011 Dr. Matthias Drieß, Professor of Organometallic and Inorganic Chemistry, Technical University of Berlin, Germany
- 2009 Prof. Dr. Ulrich Schubert, Institute of Inorganic Chemistry at the Technical University of Vienna, Austria
- 2007 Prof. Yitzhak Apeloig, Israel Institute of Technology, Haifa, Israel
- 2005 Prof. Mitsuo Kira, Tohoku University, Japan
- 2003 Prof. Don Tilley, University of California at Berkeley, USA
- 2001 Prof. Manfred Weidenbruch, University of Oldenburg, Germany
- 1998 Prof. Robert Corriu, University of Montpellier, France
- 1996 Prof. Hubert Schmidtbaur, Technical University of Munich, Germany
- 1994 Prof. Edwin Hengge (†)
- 1992 Prof. Richard Müller (†) and Prof. Eugen Rochow (†)
- 1991 Prof. Hideki Sakurai, Science University of Tokyo, Japan
- 1989 Prof. Robert West, University of Wisconsin, USA
- 1988 Prof. Nils Wilsberg (†), University of Munich, Prof. Reinhold Tacke, University of Würzburg, Germany
- 1987 Prof. Peter Jutzi, University of Bielefeld, Prof. Norbert Auner, University of Frankfurt, Germany



EXPERTISE AND SERVICE NETWORK ON FIVE CONTINENTS



• Sales and production sites, plus 20 technical centers, ensure you a local presence worldwide.

WACKER is one of the world's leading and most research-intensive chemical companies, with total sales of €4.91 billion. Products range from silicones, binders and polymer additives for diverse industrial sectors to bio-engineered 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 five business divisions, operating 25 production sites, WACKER is currently active in over 100 countries. The Group maintains subsidiaries and sales offices in 29 countries across Europe, the Americas and Asia – including a solidly established presence in China. With a workforce of 17,200, WACKER sees itself as a reliable innovation partner that develops trailblazing solutions for, and in collaboration with, its customers. WACKER also helps them boost their own success. Our technical 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.

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