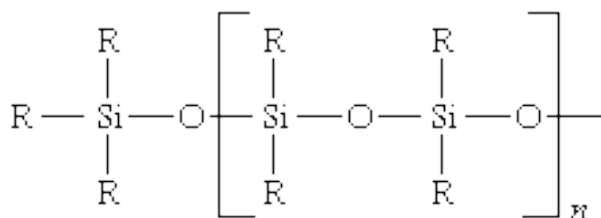
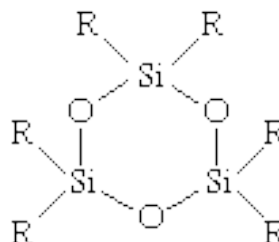


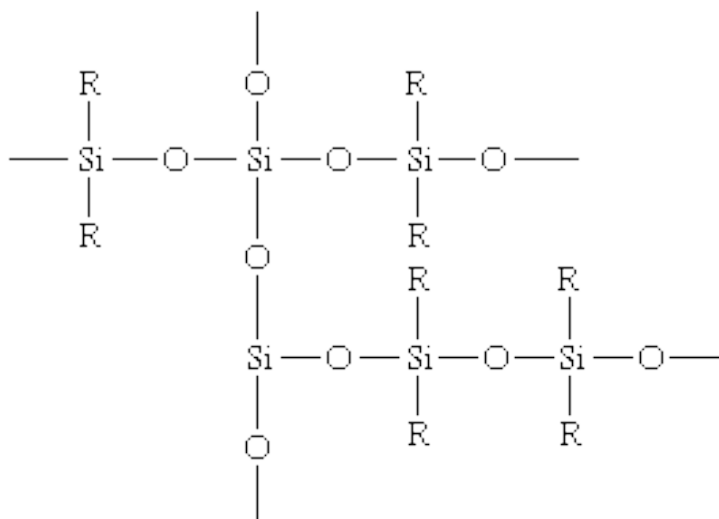
Silicone, also called **polysiloxane**, any of a diverse class of fluids, resins, or elastomers based on polymerized siloxanes, substances whose molecules consist of chains made of alternating silicon and oxygen atoms. Silicones are polymeric organosilicon compounds containing Si—O—Si linkages and Si—C bonds. They are generally very stable, because of the presence of strong silicon-oxygen and silicon-carbon bonds. A general formula for silicones is $(R_2SiO)_x$, where R can be any one of a variety of organic groups. Silicones may be linear, cyclic, or cross-linked polymers, as shown here.



linear silicone

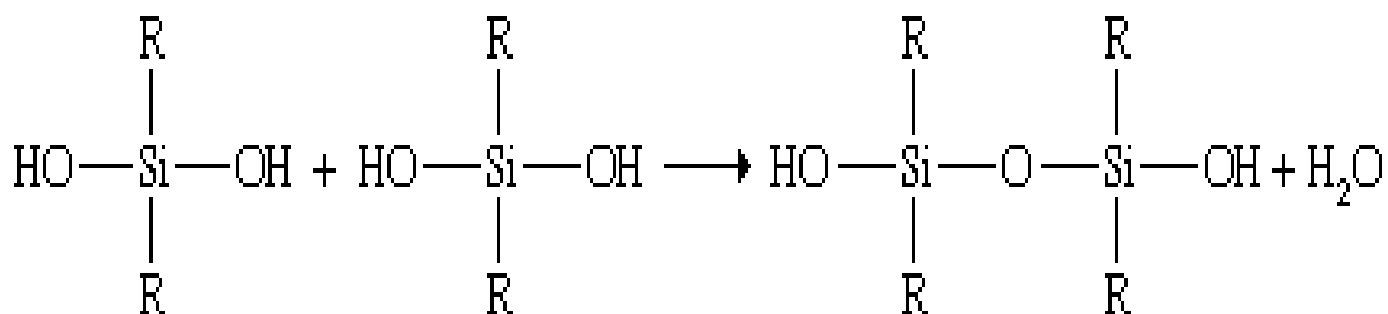


cyclic silicone



cross-linked silicone

Linear and cyclic silicones are produced by the reaction of water with organochlorosilanes of the general formula R_2SiCl_2 , followed by a polymerization reaction that occurs by the elimination of a molecule of water from two hydroxyl groups of adjacent $R_2Si(OH)_2$ molecules.



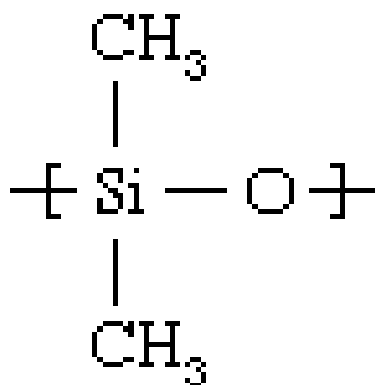
Silicone polymers incorporate some of the properties of both carbon-hydrogen compounds and silicon-oxygen compounds. They are stable to many chemical reagents and to heat. Depending on their degree of polymerization and the complexity of the attached organic groups, silicones can occur in the form of oils, greases, rubberlike substances, or resins. They are used as lubricants, hydraulic fluids, and electrical insulators. They are especially useful as lubricants in applications where there are extreme variations in temperature, because their viscosity changes very little as the temperature changes. Silicones are also water-repellent.

Their chemical inertness, resistance to water and oxidation, and stability at both high and low temperatures have led to a wide range of commercial applications, from lubricating greases to electrical-wire insulation and biomedical implant.

Composition, Structure, and Properties

The silicones differ from most industrial polymers in that the chains of linked atoms that make up the backbones of their molecules do not contain carbon, the characteristic element of organic compounds. This lack of carbon in the polymer backbones makes polysiloxanes into unusual “inorganic” polymers—though in most members of the class two organic groups, usually vinyl (CH_2), methyl (CH_3), or phenyl (C_6H_5), are attached to each silicon atom. A general formula for silicones is $(\text{R}_2\text{SiO})_x$, where R can be any one of a variety of organic groups.

The most common silicone compound, poly-dimethylsiloxane, can illustrate the central characteristics of the class. The starting material is metallic silicon, which is obtained from silica sand. Silicon is reacted with methyl chloride (CH_3Cl) over a copper catalyst, forming dimethyldichlorosilane ($[\text{CH}_3]_2\text{Si}[\text{Cl}]_2$). By reacting this compound with water, the chlorine atoms are replaced by hydroxyl (OH) groups. The resultant unstable compound, silanol ($[\text{CH}_3]_2\text{Si}[\text{OH}]_2$), polymerizes in a condensation reaction, the single-unit molecules linking together to form poly-dimethylsiloxane with concomitant loss of water. The dimethylsiloxane repeating unit of the polymer has the following structure:



Siloxane molecules rotate freely around the Si-O bond, so, even with vinyl, methyl, or phenyl groups attached to the silicon atoms, the molecule is highly flexible. In addition, the Si-O bond is highly heat-resistant and is not readily attacked by oxygen or ozone. As a result, silicones are remarkably stable, and they have the lowest glass-transition temperature (the temperature below which the molecules are locked in a rigid, glassy state) and the highest permeability to gases of any polymer. On the other hand, the Si-O bond is susceptible to hydrolysis and attack by acids and bases, so silicone plastics and rubbers are relatively weak and readily swollen by hydrocarbon oils.

Applications

Polysiloxanes are manufactured as fluids, resins, or elastomers, depending on the molecular weight of the polymers and the degree to which the polymer chains are interlinked. Nonvulcanized, low-molecular-weight polysiloxane fluids are exceptionally stable to decomposition by heat, water, or oxidizing agents and are good electrical insulators. They make excellent lubricants and hydraulic fluids, as well as emulsions for imparting water repellency to textiles, paper, and other materials. Silicone resins are used in protective coatings and electrically insulating varnishes and for laminating glass cloth.

Vulcanized silicone rubber is prepared in two principal forms: (1) as room-temperature-vulcanizing (RTV) elastomers, which are low-molecular-weight liquids that are cast or molded into desired shapes and then interlinked at room temperature, and (2) high-temperature-vulcanizing (HTV) elastomers, which are higher-molecular-weight gums that are mixed and processed like other elastomers. Silicone rubbers are usually strengthened by fillers such as silica; other fillers are mixed in to add bulk and colour. Valued for their electrical-insulating properties, chemical stability, and the wide temperature range over which they retain resiliency,

silicone rubbers are used mainly in O-rings, heat-resistant seals, caulks, gaskets, electrical insulators, flexible molds, and (owing to their chemical inertness) surgical implants.

History

Siloxanes were first characterized as polymers by the English chemist Frederic Stanley Kipping in 1927. Because Kipping thought that the structure of the repeating unit was essentially that of a ketone (the polymer chains formed by silicon atoms, with oxygen atoms attached by double bonds), he incorrectly called them silicones, a name that has persisted. In 1940 American chemist Eugene George Rochow at the General Electric Company laboratories in Schenectady, N.Y., U.S., prepared methyl siloxanes by the process that remains the basis of modern polymerization methods. Meanwhile, researchers at Corning Glass were exploring the production of silicones, and in 1943 Corning and the Dow Chemical Company formed the Dow Corning Corporation to produce silicone products.