Silanes for Adhesives & Sealants

Power Chemical Corporation Limited

SiSiB® SILANES

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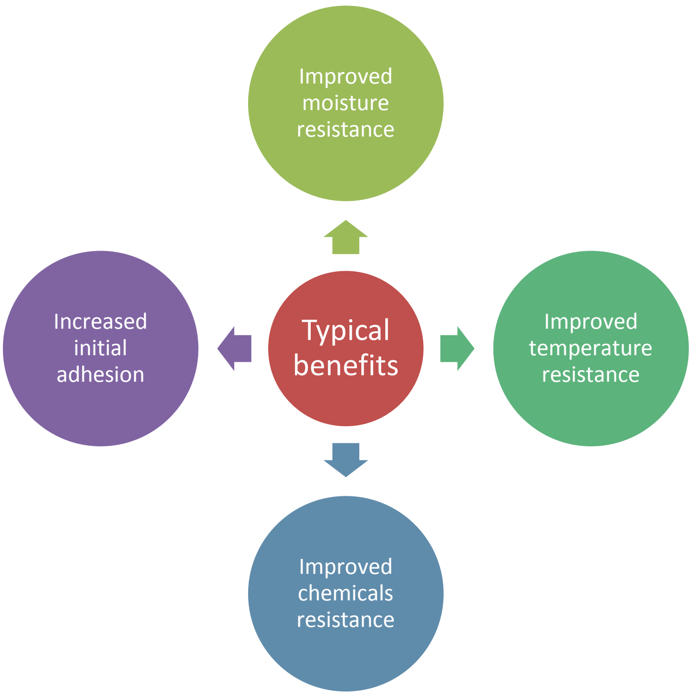
Your reliable partner in the Organosilane field.

SiSiB® silanes are widely used in adhesives and sealants to improve environmental resistance, increase adhesion and other mechanical properties, provide a secondary moisture-activated curing mechanism, filler modification, surface priming, end-capping strategies, water scavenging, formulation stability, adhesion catalysis, etc.

SiSiB® Silane Adhesion Promoters (enhance adhesion)

SiSiB® silane adhesion promoters are bifunctional organosilicone compounds which act as molecular bridges between the polymer matrix of an adhesive or sealant and the substrate, either inorganic or organic. SiSiB® SILANES can improve adhesive or sealant adhesion significantly.

The silane end contains hydrolysable alkoxy groups that are activated by reaction with ambient moisture. The hydrolysable alkoxy groups attached to the silicon end of the silane are typically either methoxy or ethoxy. Once activated (hydrolyzed), the resultant silanol groups will condense with other silanols or with reactive groups on the surface of a substrate such as SiOH, AlOH, or other metal oxides or hydroxides.The silane's ability to bond to a surface will generally be determined by the concentration of such sites on the surface.



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ISO9001 ISO14001 certificated

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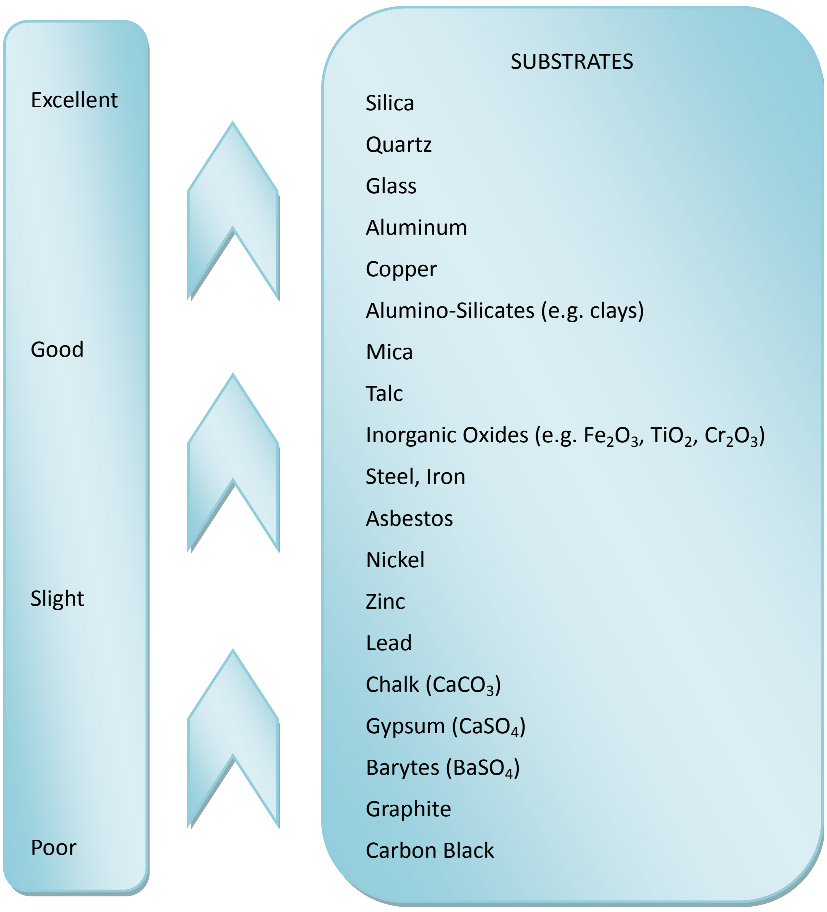
Selecting the optimal silane for an application requires matching the reactivity of the silane's organofunctional group to that of the polymer.

The silanes can be blended into an adhesive formulation or used as primers on substrates. The structure and reactivity of the silane will affect the ability of the silane to migrate. The most effective way to promote adhesion is to apply the silane as a primer to the surface, followed by application of the adhesive/sealant. In this way, the silane will be on the surface and therefore at the interface where it can enhance adhesion between the polymer and the substrate. Silane primers are usually dilute solutions of 0.5 to 5 percent silane in alcohol or water/alcohol solvent. They are wiped or sprayed on the substrate, after which the solvent is allowed to evaporate. While the concentration needed for a specific application may vary, one percent (1%) based on resin content is recommended as a good starting point.

SiSiB® SILANES EFFECTIVENESS



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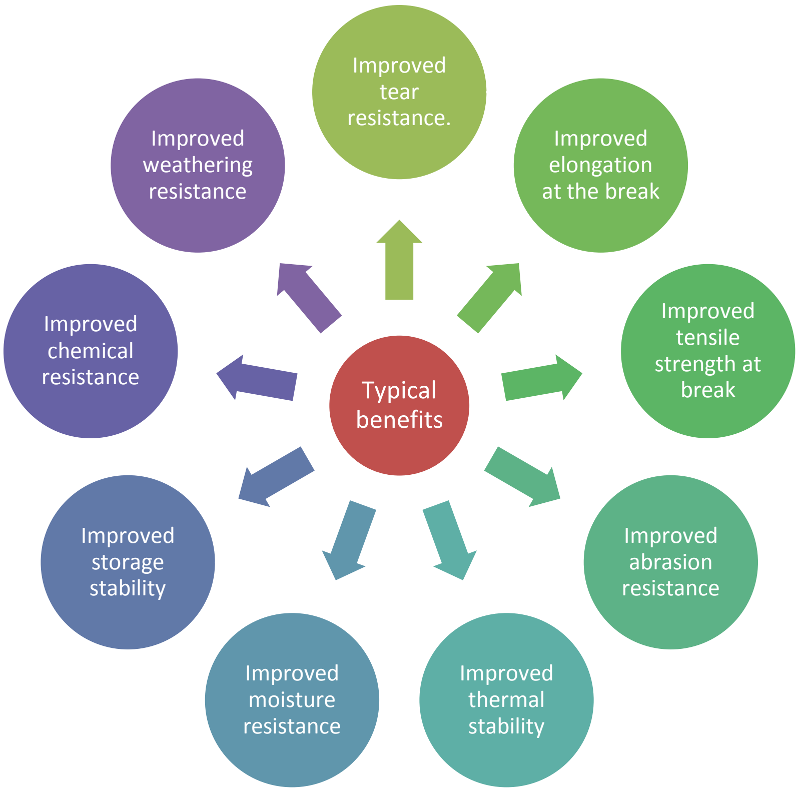
SiSiB® Silane Crosslinkers

(Provide a moisture- activated cure mechanism)

SiSiB® silanes can be used to crosslink polymers such as acrylates, polyethers, polyurethanes, and polyesters.



The organofunctional group of the silane can react, and bond to, the polymer backbone. Residual moisture activates the silane's alkoxy groups to the active silanol form which react with each other, liberating moisture, and forming siloxane bonds between the polymers. The resulting Si-O-Si crosslink is extremely durable, offering excellent weather, UV, temperature, chemical and moisture resistance.

SiSiB® Silane Coupling Agents

(Bond pigment or fillers to resins.)

SiSiB® silane coupling agents are used to bind the organic polymers to a mineral or siliceous filler, increase adhesion between fillers and polymers in adhesives and sealant.

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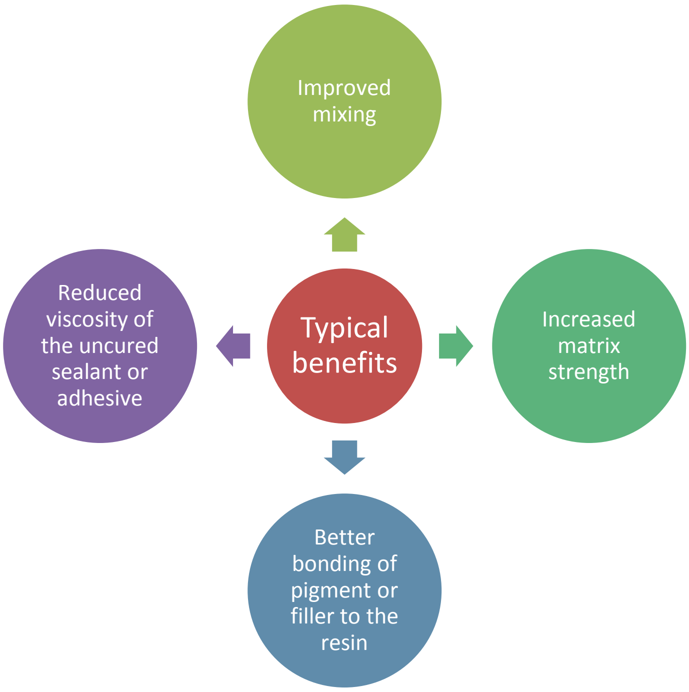
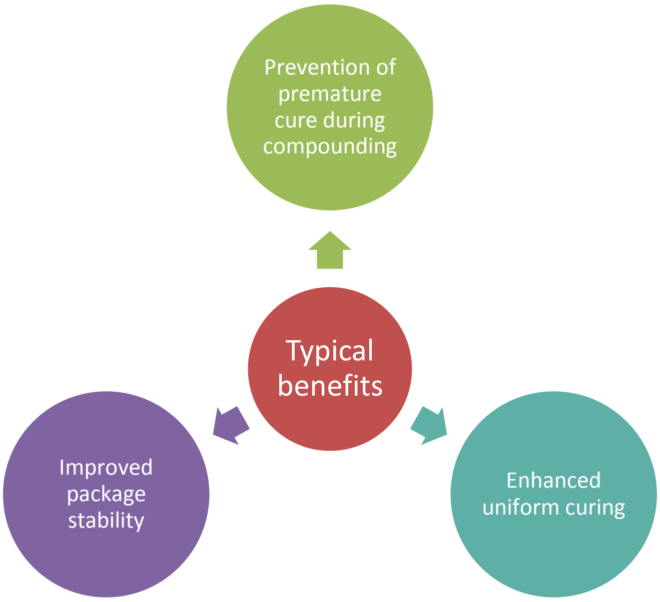


The filler may either be treated with silane before it is added to the sealant formulation (pretreatment method), or it can bind with the filler during compounding (additive method).

SiSiB® Silane Water Scavengers / Drying Agents

Alkoxysilanes react very rapidly with water; they are usually used to capture excess moisture in sealants and adhesives.

Vinyltrimethoxysilane is the most common moisture scavenger, due to the electron interactions of the vinyl group it reacts with moisture faster than other alkoxy silanes, enabling it to function as a moisture scavenger in the presence of



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other silanes incorporated as adhesion promoters, crosslinkers or coupling agents. The amount of silane added will depend on the water content of the formulation constituents.

Methanol is formed as a byproduct, and the vinyl silane crosslinks into an inactive species in the formulation. Other alkoxysilanes, such as methyltrimethoxysilane, are also used as water scavengers.

SiSiB® Silanol Terminated Silicone Fluids for RTV

The silanol (-OH) terminated silicone polymer is the basis for the formulation of one-component, moisture curing RTV silicones and two-component, condensation curing RTV silicone compounds. The synthesis of silicone polymer is a multistep process beginning with elemental silicon.

SiSiB® Crosslinking Agents for Curing Silicone Sealants

The cross-linking agent used in RTV silicone systems consists of a species that can be represented as R-Si-X3 (typically used in one-component systems) or Si-X4 (typically used in two-component systems). The R is an organic group such as a methyl, ethyl, or vinyl, phenyl, and the X is a moisture hydrolysable group. A simplified cure mechanism for a one-component silicone RTV sealant is show below:

Figure A: Reaction of crosslinker with polymer ends:

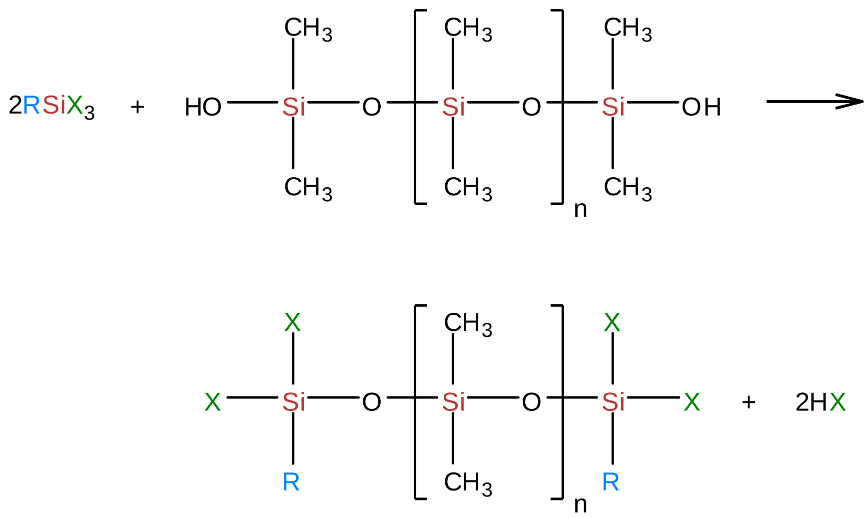

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Figure B: Reaction of crosslinker-capped polymer end with moisture:

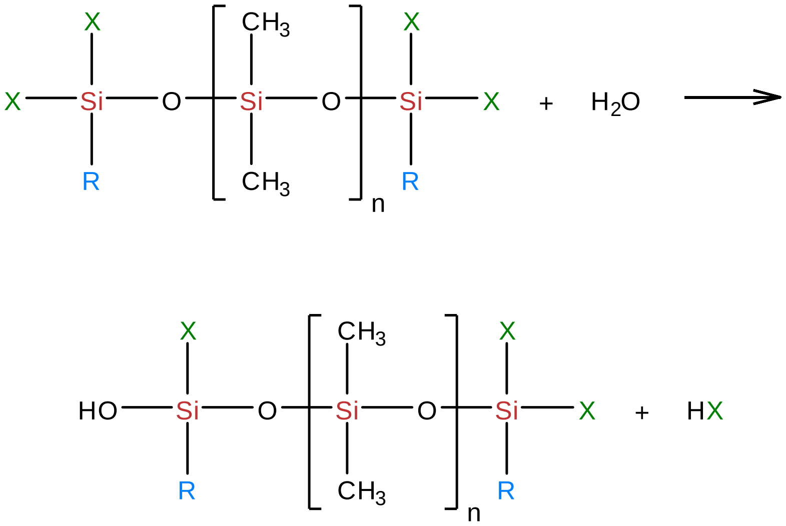
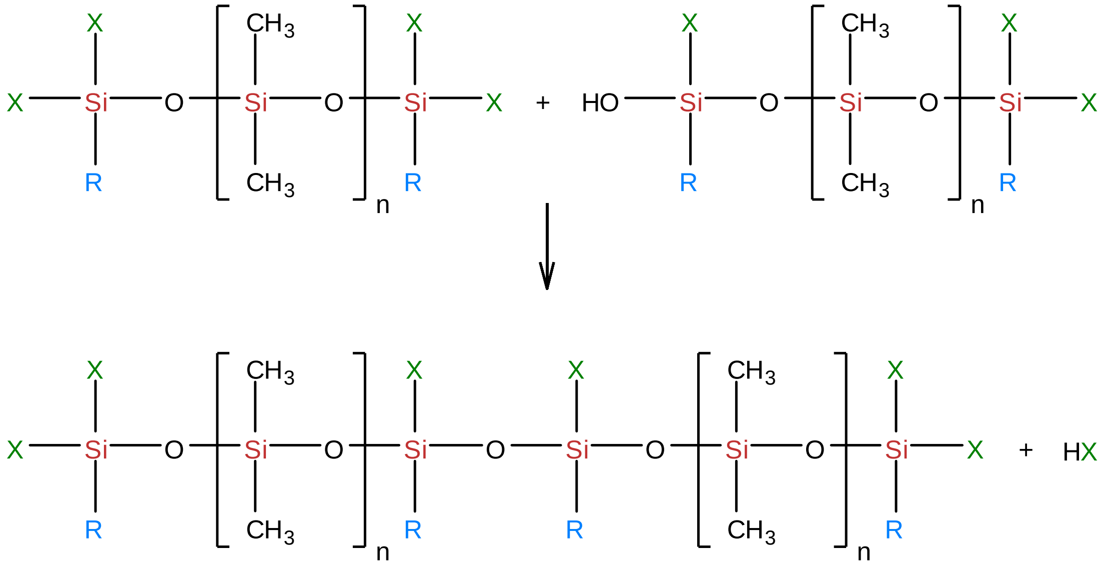


Figure C: Reaction of resultant polymer end with another polymer:



Repeated hydrolysis and reaction of resultant polymer end groups lead to full cure with elimination of HX as a by-product of the condensation reaction.

The acetoxy cure system is the most common RTV system, and it has been used for the longest period of time. However, the by-product is acetic acid, and this could be corrosive to metal substrates or undesirable because of the odor. The alkoxy cure systems produce a by-product that is noncorrosive and has an unobjectionable odor. The acetoxy, alkoxy, and oxime chemistries are all prevalent today. The

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characteristic of these cure systems are summarized in table below:

Characteristics of Various RVT silicone Cure Systems

RTV cure system	Characteristics
Acetoxy	Relatively fast cure time and short tack-free time. Good adhesion.
Alkoxy	Longer talk-free time and slower cure than acetoxy. By-product produced is noncrossive and without objectionable odor. Adhesion is not as good as acetoxy.
Oximie	Low corrosion behavior but somewhat longer tack-free and cure times than acetoxy or alkoxy.

In one component systems, the crosslinker is added to filled polymer and immediately reacts with the polymer as indicated in figure A. The reaction results in the formation of two moisture-hydrolysable reactive sites at each end of every polymer chain. Once reacted in such a manner, the product is ready for packaging. It must be kept away from moisture or moisture vapor to avoid the subsequent curing steps and to provide long shelf life.
Once applied and exposed to ambient moisture, two adjacent polymer chains will react through the hydrolysable reactive sites as show in figure B. The cross-linking will continue until all cross-link sites have been completely consumed. The resulting molecule is a highly cross-linked network with good elasticity.

The cure of a RTV two-component silicone sealant occurs in a similar manner. Most often an alkoxy cross-linking agent and a catalyst are packaged together leaving the siloxane as the second part. A reactive metal catalyst such as dibutyl tin diaurate is generally used to begin the curing reaction. The components must, of course, be kept dry to provide adequeate shelf life. Once the two components are mixed, the hydrolysis reaction begins. After this occurs, the cross-linking reaction may be accelerated by exposure to slightly elevated temperatures.

Cross-linking of either one-component or two component RTV silicone systems at room temperature may be accelerated by the use of catalysts at low levels. The catalyst is usually a tin octoate or dibutyl tin dilaurate. The rate of crosslinking is a function of catalyst concentration and its chemical nature. Catalyzed systems are especially useful in forming a quick dry skin that is often desirable in outdoor application where the weather and elements cannot be controlled.

Please note, that Power Chemical Corporation is the manufacturer for raw materials for adhesives and sealants only. We do not sell final formulations.

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