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Silicones Simplified
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A Guide to Silane Solutions

Adhesives and Sealants

Adhesives and Sealants

Silanes are widely used to improve the adhesion of a broad range of sealants and adhesives to inorganic substrates, such as metals, glass and stone. Sealants are based on filled, curable elastomers and have the dual purpose of preventing passage of water, air and chemicals through the zone where applied; in some cases they also serve as an adhesive. Their usefulness in the aircraft, automotive and construction industries depends upon their ability to form durable bonds to metal, glass, ceramic and other surfaces – bonds that will withstand exposure to heat, ultraviolet radiation, humidity and water.

Adhesion Promoters

A silane coupling agent will function at the interface between the sealant or adhesive and the substrate to act as an adhesion promoter. An organofunctional silane uses a mechanism similar to that described earlier for bonding an inorganic substrate and a sealant or adhesive polymer. The silane coupling agent is chosen by matching its organic functionality to the polymer to optimize bonding. Table 1 suggests silanes to evaluate for various polymer systems.

Often, mixtures of silanes are used as adhesion promoters to provide enhanced hydrophobicity, thermal stability or crosslinking at the bonding site.

The silanes can be blended into an adhesive formulation or used as primers on substrates. When added to the adhesive formulation, the silane must be free enough to migrate to the interphase region between the adhesive/sealant and the surface of attachment. The structure and reactivity of the silane will affect the ability of the silane to migrate. Usually more than one silane is evaluated for an application to empirically choose the best performing silane.

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.

When added to sealants or adhesives or used as primers on substrates, an improvement in adhesion is often realized with the bond showing greater resistance to moisture attack at the interface. This can result in:

- Increased initial adhesion
- An adhesive bond with longer life
- Greater temperature resistance
- Greater chemical resistance

Crosslinkers

Silanes can be used to crosslink polymers such as acrylates, polyethers, polyurethanes and polyesters. The organofunctional portion of the silane can react, and bond to, the polymer backbone in a sealant or adhesive. The alkoxysilyl group on the silane should not crosslink prematurely in order to be available to provide crosslinking once the sealant or adhesive is applied in its intended application.

Table 1. Silane Coupling Agent Recommendations for Various Polymers – Matching Organoreactivity to Polymer Type

Organic Reactivity	Application (suitable polymers)
Amino	Acrylic, Nylon, Epoxy, Phenolics, PVC, Urethanes, Melamines, Nitrile Rubber
Benzylamino	Epoxies for PCBs, Polyolefins, All Polymer Types
Chloropropyl	Urethanes, Epoxy, Nylon, Phenolics, Polyolefins
Disulfido	Organic Rubber
Epoxy	Epoxy, PBT, Urethanes, Acrylics, Polysulfides
Epoxy/Melamine	Epoxy, Urethane, Phenolic, PEEK, Polyester
Mercapto	Organic Rubber
Methacrylate	Unsaturated Polyesters, Acrylics, EVA, Polyolefin
Tetrasulfido	Organic Rubber
Ureido	Asphaltic Binders, Nylon, Phenolics; Urethane
Vinyl	Graft to Polyethylene for Moisture Crosslinking, EPDM Rubber, SBR, Polyolefin
Vinyl-benzyl-amino	Epoxies for PCBs, Polyolefins, All Polymer Types

A silane-crosslinked sealant or adhesive can show enhanced properties, such as:

- Tear resistance
- Elongation at break
- Abrasion resistance
- Thermal stability
- Moisture resistance

Water Scavengers

The ability of alkoxy silanes to react very rapidly with water makes them useful in sealant and adhesive formulations to capture excess moisture. A very common moisture scavenger is vinyltrimethoxysilane. The presence of the vinyl group attached to silicon increases the rate of reaction of the methoxysilane with water to give efficient elimination of water. Methanol is formed as a byproduct, and the vinyl silane crosslinks into an inactive species in the formulation. Other silanes, such as methyltrimethoxysilane, are also used as water scavengers.

Silane water scavengers in a formulation can:

- Prevent premature cure during compounding
- Enhance uniform curing
- Improve in-package stability



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Coupling Agents

Silane coupling agents are used to increase adhesion between fillers and the polymer matrix in sealants and adhesives.

The silane coupling agent treatment on the filler can provide:

- Better bonding of the pigment or filler to the resin
- Improved mixing
- Increased matrix strength
- Reduced viscosity of the uncured sealant or adhesive

Product Information

A complete list of XIAMETER® brand silanes for use in formulating sealants and adhesives is available at xiameter.com.

In addition, Dow Corning Corporation also offers a wide variety of *Dow Corning*® brand specialty silicone material and service options as well as other silicon-based materials available to help you keep your innovative edge in the marketplace. Visit dowcorning.com to learn more about the many additional silicone and silicon-based options available to you from Dow Corning.

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