Limitless Silanes

Bonding Organic and Inorganic Materials

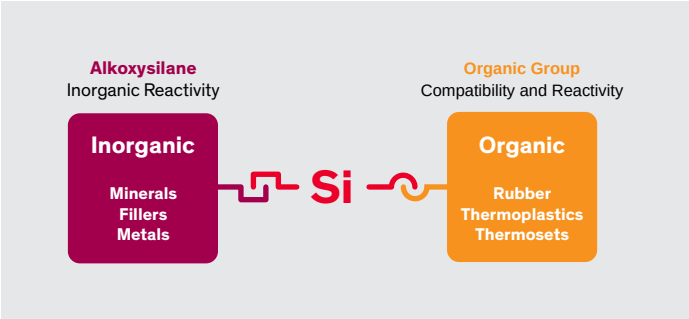
The First
In Silane Development

Dow Corning pioneered the development of silanes – and the synergy of organic and silicon chemistries – more than 60 years ago. Today, they remain instrumental in allowing new materials to be developed in a wide variety of industries with greater reliability and improved performance. And Dow Corning continues to be a leader in developing and supplying silane solutions.

What is a silane?

A silane is a molecule comprised of one central silicon atom with four attachments. These substituent groups can be nearly any combination of nonreactive, inorganically reactive, or organically reactive groups. Silanes are the smallest silicon-based molecules, ensuring good depth of penetration into substrates. A silane that contains at least one carbon-silicon bond structure is known as an organosilane. In many applications, the term "silane" is a generic term typically referring to an organofunctional alkoxysilane. Here, the terms silane, alkoxysilane and organofunctional alkoxysilane are used interchangeably. They react with themselves and any hydroxyl (OH) groups within the substrate, often when moisture is present, forming a silicone resin network. This formation of strong chemical bonds provides durability.

Figure 1: The silane coupling mechanism



Functions and benefits

Silanes enable the development of new materials with greater reliability and improved performance. Silanes can function in many different ways to achieve various benefits, which include:

Coupling agent
Silane coupling agents are silicon-based chemicals that contain two types of reactivity – inorganic and organic in the same molecule. A silane coupling agent will act as an interface between an inorganic substrate (such as glass, metal or mineral) and an organic material (such as an organic polymer, coating or adhesive) to bond the two dissimilar materials.

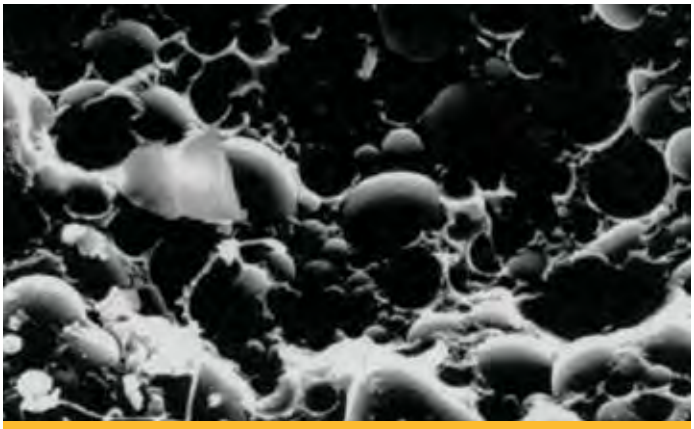
Adhesion promoter
Silanes are effective adhesion promoters when used as additives or primers for paints, inks, coatings, adhesives and sealants. By using the right silane coupling agent, a paint, ink, coating, adhesive or sealant can be converted to a material that often will maintain adhesion even if subjected to severe environmental conditions.

Hydrophobing and dispersing agent
Alkoxysilanes with hydrophobic organic groups attached to silicon will impart that same hydrophobic character to a hydrophilic inorganic surface. They are used as durable hydrophobing agents in construction, bridge and deck applications. They are also used to hydrophobe inorganic powders to make them free-flowing and dispersible in organic polymers and liquids. Generally, alkoxysilanes are not effective at hydrophobing unfilled plastics.

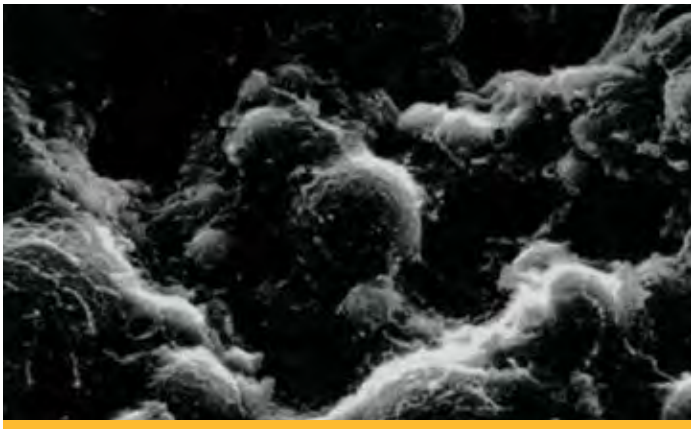
Moisture scavenger
The alkoxy groups of silanes will hydrolyze in the presence of moisture to convert water molecules to alcohol molecules. Organotrialkoxysilanes are often used in sealants and other moisture-sensitive formulations as water scavengers.

Silicate stabilizer
Functions as a silicate stabilizer to prevent agglomeration and precipitation of silicates during use. The predominant application is in engine coolant formulations to stabilize the silicate corrosion inhibitors.

Figure 2: SEM image of silica-filled epoxy resin



Without Silane



With Silane

Why silane coupling agents are used

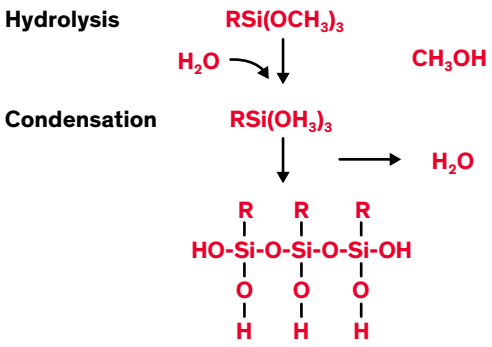
When organic polymers are reinforced with glass fibers or minerals, the interface, or interphase region between the polymer and the inorganic substrate, is involved in a complex interplay of physical and chemical factors. These factors are related to adhesion, physical strength, coefficient of expansion, concentration gradients and retention of product properties.

Silane coupling agents have the unique chemical and physical properties to not only enhance bond strength, but also prevent de-bonding at the interface due to use and aging, especially in humid conditions. The coupling agent provides a stable bond between two otherwise poorly bonding surfaces. Figure 2 shows (via an SEM of the fracture surface) the difference in adhesion between a silica-filled epoxy resin with silane versus without silane. With silane, the epoxy coating on the silica particles is apparent; without silane, clean silica particles can be see in the epoxy matrix.

Silane coupling agents also increase the resistance to humidity and other adverse environmental conditions encountered by composites. Other benefits of silane coupling agents include:

- Better wetting of inorganic substrates
- Lower viscosities during compounding
- Smoother surfaces of composites
- Less catalyst inhibition of thermoset composites
- Clearer reinforced plastics

Figure 3: Hydrolysis of alkoxysilanes



Silane Product Overview

Bonding Organic and Inorganic Materials

Product Name	Functionality	Chemical Description	CAS #
Dow Corning® 11-100 Additive	Alkyl	Alkyl functional siloxane	N/A
XIAMETER® OFS-1579 Silane	Alkyl	Methyl and ethyl triacetoxysilane	4253-34-3 and 17689-77-9
XIAMETER® OFS-6070 Silane	Alkyl	Methyltrimethoxysilane; CH_3-Si$(OCH_3)_3$; MTMS	1185-55-3
XIAMETER® OFS-6341 Silane	Alkyl	n-Octyltriethoxysilane; $C_8H_{17}Si(OC_2H_5)_3$; nOTES	2943-75-1
XIAMETER® OFS-6665 Silane	Alkyl	n-Octyltrimethoxysilane; nOTMS	3069-40-7
XIAMETER® OFS-6403 Silane	Alkyl	Butyl triethoxysilane; iBTES	17980-47-1
XIAMETER® OFS-2306 Silane	Alkyl	Butyl trimethoxysilane; iBTMS	18395-30-7
Dow Corning® Z-6701 Silane	Alkyl	Methyldimethoxysilane $CH_3Si(H)(OCH_3)_2$	16881-779
Dow Corning® Z-6264 Silane	Alkyl	N-propyl trimethoxysilane; nPTMS	1067-25-0
Dow Corning® 1-6184 Water Repellent	Alkyl	Water-soluble siloxane	N/A
Dow Corning® Z-6689 Water Repellent	Alkyl	Silane/siloxane blend	N/A
Dow Corning® Z-6690 Water Repellent	Alkyl	Silane/siloxane blend	N/A
XIAMETER® OFS-0772 Siliconate	Alkyl	Sodium methyl siliconate	16589-43-8
XIAMETER® OFS-0777 Siliconate	Alkyl	Potassium methyl siliconate	31795-24-1
XIAMETER® OFS-6011 Silane	Amino	Aminopropyltriethoxysilane; $H_2NC_3H_6$-Si$(OC_2H_5)_3$	919-30-2
XIAMETER® OFS-6020 Silane	Amino	Aminoethylaminopropyltrimethoxysilane; $H_2NC_2H_4NHC_3H_6$-Si$(OCH_3)_3$; AEAPTMS	1760-24-3
Dow Corning® Z-6137 Silane	Amino	Aminoethylaminopropylsilane; Triol homopolymer; $H_2NC_2H_4NHC_3H_6$-Si$(OH)_3$ in water 22% actives; Low methanol content; Pre-hydrolyzed version of XIAMETER® OFS-6020 Silane	68400-09-9
Dow Corning® Z-6121 Silane	Amino	Aminoethylaminopropyltrimethoxysilane; $H_2NC_2H_4NHC_3H_6$-Si$(OCH_3)_3$; 50% actives in n-butanol/methanol	1760-24-3
XIAMETER® OFS-6300 Silane	Vinyl	Vinyltrimethoxysilane; 99% actives; VTMS	2768-02-7
XIAMETER® OFS-6518 Silane	Vinyl	Vinyltriethoxysilane; H_2C=CH-Si$(OC_2H_5)_3$; VTES	78-08-0
XIAMETER® OFS-6032 Silane	Amino/Vinyl	Vinylbenzylaminoethylaminopropyltrimethoxysilane; $(H_2C$=CHC_6H_4-CH_2-$NHC_2H_4NHC_3H_6$-Si$(OCH_3)_3)$; HCl 40% in methanol	171869-89-9
Dow Corning® Z-6269 Silane	Amino/Vinyl	Cationic vinylbenzyl and amino functional methoxysilane; 40% actives in methanol; Higher actives purity version	171869-89-9
Dow Corning® Z-6132 Silane	Amino/Vinyl	Hydrolyzed version of XIAMETER® OFS-6032 Silane; 37% solids in methanol	171869-90-2
XIAMETER® OFS-6224 Silane	Amino/Vinyl	Vinylbenzylaminoethylaminopropyltrimethoxy silane; $(H_2C$=CHC_6H_4-CH_2-$NHC_2H_4NHC_3H_6$-Si$(OCH_3)_3)$; Partially hydrolyzed at 33% in methanol; Low chloride	171869-90-2
XIAMETER® OFS-6062 Silane	Mercapto	3-Mercaptopropyltrimethoxysilane; $HS(CH_2)_3Si(OCH_3)_3$; MPTMS	4420-74-0
XIAMETER® OFS-6040 Silane	Epoxy	Glycidoxypropyltrimethoxysilane; $CH_2(O)$ $CHCH_2OC_3H_6$-Si$(OCH_3)_3$; GPTMS	2530-83-8
XIAMETER® OFS-6030 Silane	Methacryl	Methacryloxypropyltrimethoxysilane; H_2C=$CH(CH_3)C(O)OC_3H_6$-Si$(OCH_3)_3$; MAPTMS	2530-85-0
Dow Corning® Z-6883 Silane	Phenyl/Amino	Phenylaminopropyl trimethoxysilane; $PhNHC_3H_6Si(OCH_3)_3$	3068-76-6
XIAMETER® OFS-6124 Silane	Phenyl	Phenyltrimethoxysilane; $(C_6H_5$-Si$(OCH_3)_3)$	2996-92-1
XIAMETER® OFS-6697 Silane		Tetra ethoxysilane; TEOS	78-10-4
XIAMETER® Q1-6083 Antifreeze Additive		Phosphonate sodium siliconate; 40% sodium (trihydroxyysilyl)-propylmethophosphonate in water	84962-98-1

Applications				
Water Repellents & Surface Protection	Plastics & Composites	Paints, Inks & Coatings	Adhesives & Sealants	Mineral & Filler Treatment
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				• (Engine coolant)

Bonding to inorganic substrates

Silane coupling agents that contain two or three inorganic reactive groups on silicon will bond well to the hydroxyl groups on most inorganic substrates, especially if the substrate contains silicon, aluminum or a metal in its structure. The alkoxy groups on silicon hydrolyze to silanols, either through the addition of water or from residual water on the inorganic surface. Then the silanols coordinate with metal hydroxyl groups on the inorganic surface to form an oxane bond and eliminate water.

Bonding to polymers

The bond to the organic polymer is complex. The reactivity of a thermoset polymer should be matched to the organo-reactivity of a silane. To optimize the inter-penetrating network bonding mechanism, it is important that the silane and the resin be compatible. Matching the chemical characteristics of the two materials will help improve the chances of forming a good composite with optimum benefits.

Selecting the right silane

The choice of silane should involve matching chemical reactivity, solubility characteristics and, possibly, the thermal stability of the organosilane with the same parameters in the polymer structure.

Figure 4: The inter-penetrating network (IPN) bonding mechanism

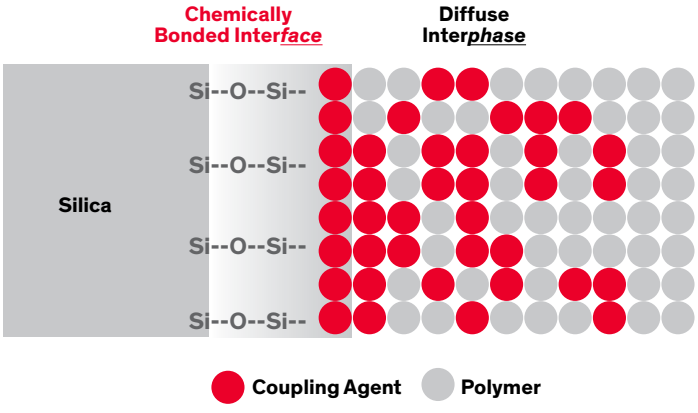
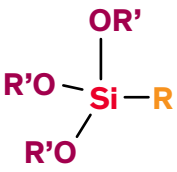
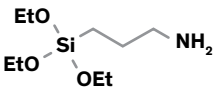


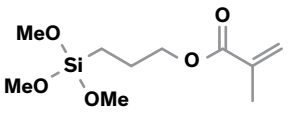
Figure 5: Basic stucture
R= alkyl, aryl, or organofunctional group
OR'= methoxy, ethoxy, or acetoxy



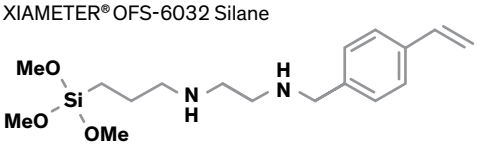
XIAMETER® OFS-6011 Silane



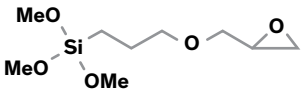
XIAMETER® OFS-6030 Silane



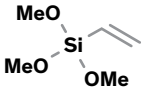
XIAMETER® OFS-6032 Silane



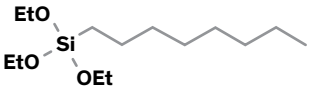
XIAMETER® OFS-6040 Silane



XIAMETER® OFS-6300 Silane



XIAMETER® OFS-6341 Silane



Silane Product Overview
Bonding Organic and Inorganic Materials
(Fold Out)

Water Repellents & Surface Protection

Nature can be a tough adversary – water intrusion, sunlight, wind and abrasion, infiltration of organisms, or even accidental stain damage. Silanes can give water- and stain-repellent properties to surfaces. Alkoxysilyl groups attached to these silanes allow them to penetrate, cure in and bond to many inorganic substrates. These unique properties allow for versatile and durable solutions to protect against harmful water- and oil-borne elements.

Silane-based water repellents create an envelope of protection that extends the life of substrates for years in challenging environments. Benefits may include:

- Excellent water repellency
- Long-term durability
- UV stability
- Depth of penetration
- Water vapor permeability
- High dilution capability and stability
- Clear, uniform, neutral appearance
- Reduced efflorescence
- Reduced freeze/thaw damage
- Chloride ion resistance to deter corrosion of reinforcing steel concrete structures
- Preservation of aesthetics
- Strengthening fragile masonry
- Dimensional stability of wood

Product Name	General Description	Application/Features
XIAMETER® OFS-6341 Silane	Alkyl ethoxy silane	Effective hydrophobing agent and high-temperature additive for other coupling agents
XIAMETER® OFS-6665 Silane	Alkyl methoxy silane	Effective hydrophobing agent that inhibits water absorption and can be used in formulation of water repellant products
XIAMETER® OFS-6403 Silane	Butyl triethoxysilane	Protection against chloride ion intrusion in concrete
XIAMETER® OFS-2306 Silane	Butyl trimethoxysilane	Ideal for treating a variety of substrates to impart water repellency and compatibility with organics
XIAMETER® OFS-6697 Silane	Tetra ethoxysilane; TEOS	Diluent for zinc-rich primers • Additive for other coupling agents
Dow Corning® Z-6689 Water Repellent	Solventless silane/siloxane blend	Active component for formulating penetrating water repellent treatments • Multi-surface water repellent • For neutral and alkaline mineral substrates that require water repellency • Excellent beading in <5 minutes • Dilutable in organic solvent to formulate water repellent products
Dow Corning® Z-6690 Water Repellent	Silane/siloxane blend	Multi-surface water repellent • Low viscosity blend • Easy to apply • Designed for water-free formulations • Quick absorption on wood surface • Impregnation of wood surface provides low impact on appearance and surface tack • Not film forming
XIAMETER® OFS-6264 Silane	Alkyl methoxy silane	Hydrophobing and dispersing agent
Dow Corning® 1-6184 Water Repellent	Water-soluble silane	Low-VOC • Multifunctional • Self-crosslinking
XIAMETER® OFS-0772 Siliconate	Sodium methyl siliconate	Water dilutable • Effective on a variety of substrates
XIAMETER® OFS-0777 Siliconate	Potassium methyl siliconate	Water dilutable • Effective on a variety of substrates

Whether you're looking for a fully formulated water or stain repellent, or a key ingredient in your surface protection formula, Dow Corning offers a wide range of silanes that can meet your needs. Our water and stain repellent materials can be used in solvent- or water-based systems to provide the formulating flexibility needed to meet VOC and ease-of-use requirements, and are available for use in formulations that penetrate a broad range of substrates, including:

- Poured-in-place or pre-cast concrete
- Concrete block
- Sandstone/granite
- Brick/tile/grout
- Wood
- Gypsum/perlite
- Limestone/marble

Surface protection

Dow Corning also manufactures a range of silicates and siliconates for use in formulating pore-blocking sealers and consolidators.

Sealers include pore blockers, which form a resin barrier on concrete surfaces, partially or fully filling the surface pores; and hydrophobing agents, which deeply penetrate the material yet allow concrete to breathe and won't interfere with concrete cure.

Consolidators can extend the life of stone and concrete because they penetrate and cure in and through these materials to help bind them together. They are used in a variety of restoration and flooring applications.

Figure 6: Silicone-based products penetrate deeply, forming a repellent layer within the substrate

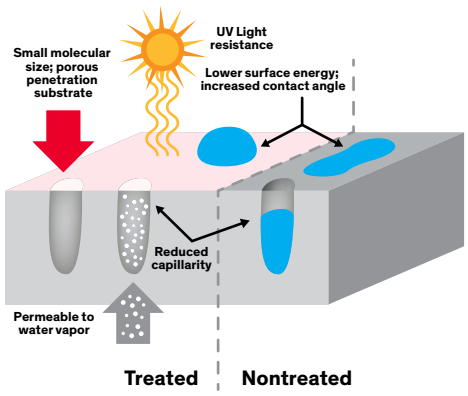
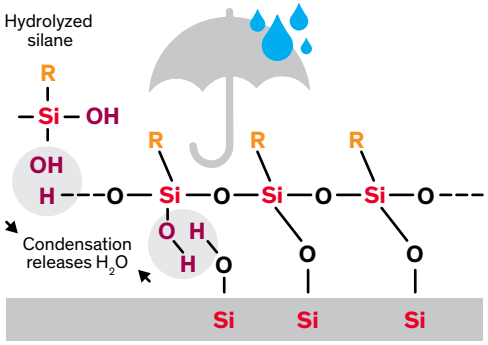


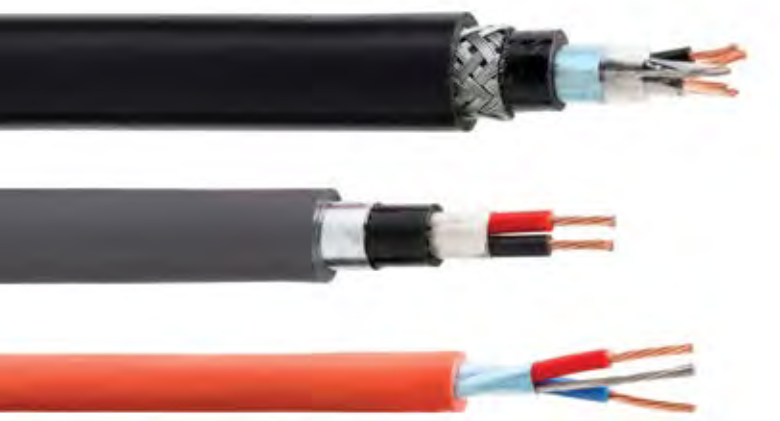
Figure 7: SiOH groups chemically bond to the substrate and condense to form a polymer film on the surface



Dilution System	Typical Actives Usage Level %	Specific Gravity	Flash Point	Substrate						
				Concrete	Mortar & Brick	Stone	Ceramics	Wood	Anti-stain	Damp Proofing
Solvent	5 to 100	0.88	65	•	•	•			•	
Solvent	5 to 100	0.91	66	•	•	•			•	
Solvent	5 to 100	0.88	62	•	•	•				
Solvent	5 to 100	0.92	32	•	•	•				
Solvent	5 to 100	0.93	54	•	•	•				
Solvent	5 to 15	0.96	10							•
Solvent	5 to 15	0.94	37					•		
Solvent	5 to 100	0.93	26.6	•	•	•				
Water	3.5 to 7.5	1.05	27					•		•
Water	0.5 to 3	1.25	>100		•		•			
Water	0.5 to 3	1.29	>100		•		•	•		

Plastics & Composites (Including fiberglass)

Whether you need performance enhancements or process improvements, the unique properties of silanes can provide the solution. Silanes are critical to the strength and durability of composites and can provide more effective coupling and dispersion treatments as well as greater protection against environmental conditions.



Silanes from Dow Corning:

- Enhance the mechanical and electrical properties of fiberglass-reinforced polymers
- Improve resistance to moisture attack at the interface
- Increase the strength and durability of composites under wet and dry conditions
- Provide wet-out and lubrication to the glass fiber
- Boost fiber strand integrity, production and handling
- Achieve reliable performance in cycling tests from hot to cold extremes

Rubber compounding

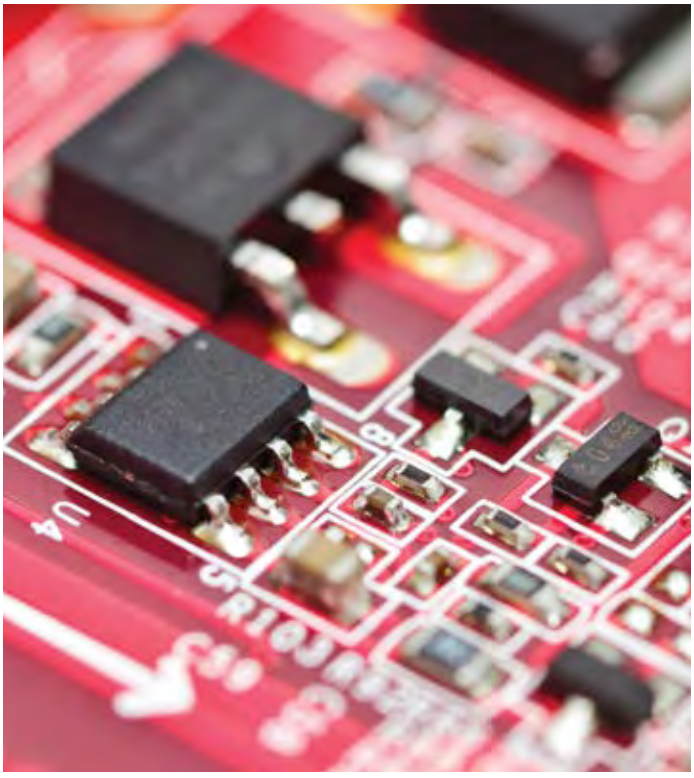
As demand increases for elastomeric products in colors other than black, and with the mechanical attributes similar to those provided by carbon black, silanes are the key to providing a method of effectively bonding various inorganics to the polymer phase.

Plastics compounding

Silanes have been used to improve filler dispersion and glass fiber incorporation into thermoplastic compounds for some time. New products like *Dow Corning*® 11-100 Additive not only help with filler dispersion, but can also help improve fire retardant properties of magnesium hydroxide filled halogen-free polyolefin compounds. In addition, treated fillers will absorb less moisture resulting in more durable products with better dielectric properties. Silane dispersing agents can also help reduce the effort and energy needed in the compounding operation.

Fiberglass-reinforced polymers

Silane coupling agents are a critical component of fiberglass-reinforced polymers. They provide a stable bond between incompatible, non-bonding organic and inorganic substrates, to effectively treat fiberglass cloth to bind inorganic glass fibers to organic resin. Silane coupling agents are used on fiberglass for general-purpose reinforced plastic applications, such as automotive, marine, sporting goods and building construction, as well as for high-performance applications in printed circuit boards and aerospace composites.



Plastics & Composites (Including Fiberglass)

Product Name	Functionality	Chemical Description	Application/Features
Dow Corning® 11-100 Additive	Alkyl	Alkyl functional siloxane	Filler dispersion aid with extended shelf life • Impart hydrophobicity to inorganic filler surface • Improve inorganic filler de-agglomeration
XIAMETER® OFS-6011 Silane	Amino/ Ethoxysilane	Aminopropyltriethoxysilane; $H_2NC_3H_6$-$Si(OC_2H_5)_3$	Coupling agent for thermoset resins with glass or mineral fillers
XIAMETER® OFS-6020 Silane	Amino/ Methoxysilane	Aminoethylaminopropyltrimethoxysilane; $H_2NC_2H_4NHC_3H_6$-$Si(OCH_3)_3$	Coupling agent for many thermoset and thermoplastic resins with glass or mineral fillers
XIAMETER® OFS-6030 Silane	Methacryl/ Methoxysilane	Methacryloxypropyltrimethoxysilane; $H_2C{=}CH(CH_3)C(O)OC_3H_6$-$Si(OCH_3)_3$	Coupling agent for many thermoset and thermoplastic resins with glass or mineral fillers
XIAMETER® OFS-6518 Silane	Vinyl/ Ethoxysilane	Vinyltriethoxysilane; $H_2C{=}CH$-$Si(OC_2H_5)_3$	Crosslinker for polyethyene polymers and copolymers
XIAMETER® OFS-6032 Silane	Amino/Vinyl/ Methoxysilane	Vinylbenzylaminoethylaminopropyltrimethoxysilane; $(H_2C{=}CHC_6H_4$-CH_2-$NHC_2H_4NHC_3H_6$-$Si(OCH_3)_3)$; HCl 40% in methanol	Coupling agent for many resin systems • Useful for fiberglass-reinforced printed circuit boards • Improved adhesion of organic polymer to inorganic substrate or filler • Improved wet and dry physical properties of composite • Improved mixing and compatibility of filled systems • Compatible with epoxies, polyolefins polymer types
Dow Corning® Z-6269 Silane	Amino/Vinyl/ Methoxysilane	Cationic vinylbenzyl and amino functional methoxy-silane; 40% actives in methanol; Higher actives purity version	Coupling agent for many resins systems • Useful for fiberglass-reinforced printed circuit boards • Improved adhesion of organic polymer to inorganic substrate or filler • Improved wet and dry physical properties of composite • Improved mixing and compatibility of filled systems • Compatible with epoxies for printed circuit boards (PCBs), polyolefins, most polymer types
Dow Corning® Z-6132 Silane	Amino/Vinyl/ Methoxysilane	Hydrolyzed version of XIAMETER® OFS-6032 Silane; 37% solids in methanol; Similar to XIAMETER® OFS-6032 Silane	Prehydrolyzed — may improve customer productivity • Compatible with epoxies for PCBs
XIAMETER® OFS-6224 Silane	Amino/Vinyl/ Methoxysilane	Vinylbenzylaminoethylaminopropyltrimethoxy silane; $(H_2C{=}CHC_6H_4$-CH_2-$NHC_2H_4NHC_3H_6$-$Si(OCH_3)_3)$; Partially hydrolyzed at 33% in methanol; Low chloride; Similar to XIAMETER® OFS-6032 Silane	Prehydrolyzed with reduced Cl content
XIAMETER® OFS-6062 Silane	Mercapto/ Methoxysilane	3-Mercaptopropyltrimethoxysilane; $HS(CH_2)_3Si(OCH_3)_3$	Coupling agent to improve the adhesion of sulfur-cured elastomers to inorganic fillers, fiberglass and surfaces; treated fillers compatible with epoxy, polysulfide, EPDM, natural rubber, SBR, nitrile rubber
XIAMETER® OFS-6040 Silane	Epoxy/ Methoxysilane	Glycidoxypropyltrimethoxysilane; $CH_2(O)\,CHCH_2OC_3H_6$-$Si(OCH_3)_3$	Used for silica treatment for EMC application
Dow Corning® Z-6883 Silane	Phenyl/Amino/ Methoxysilane	Phenylaminopropyl trimethoxysilane; $PhNHC_3H_6Si(OCH_3)_3$	Adhesion promoter for EMC • Improved adhesion between metal and resin and inorganic fillers and resin
Dow Corning® Z-6137 Silane	Amino/Silanol	Aminoethylaminopropylsilane triol homopolymer; $H_2NC_2H_4NHC_3H_6$-$Si(OH)_3$; In water 22% actives; Low methanol content	Adhesion promoter • Coupling agent • Resin additive • Improves chemical bonding of resins to inorganic material
Dow Corning® Z-6121 Silane	Amino/ Alkoxysilane	Aminoethylaminopropyltrimethoxysilane; $H_2NC_2H_4NHC_3H_6$-$Si(OCH_3)_3$; 50% actives in n-butanol/methanol	Improves chemical bonding of resins to inorganic material
Dow Corning® Z-6701 Silane	Methyl/ Hydrogen/ Methoxysilane	Methyldimethoxysilane; $CH_3Si(H)(OCH_3)_2$	Reactive in hydrosilation to form methoxysilyl functional materials • Polymer modification for adhesives and sealants

Applications										
Thermoplastic				Thermosets			Fiberglass	Polymer Modification	Surface Treatment	
Filler Dispersion	Reinforcement Coupling	Adhesion Promotion	Crosslinking	Reinforce Glass Composites	Reinforce Coupling	Adhesion Promotion	Surface Modification		Adhesion Promotion Primer	
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Paints, Inks & Coatings

The unique capabilities of silanes make them ideal for high-performance paints and coatings, as do their ability to withstand physical, chemical, environmental and thermal degradation. They can be used in waterborne or solventborne formulations, are compatible with most binder systems, are suitable for low-VOC, sustainably formulated products and are versatile and easy to use.

The use of silanes in coatings can provide improvements in adhesion; resistance to moisture, chemicals, ultraviolet (UV) rays and abrasion; and improved dispersion of fillers. Silanes are also used as intermediates to produce silicates and siliconates via reaction with metal hydroxide. These materials are used in protective finishes, such as zinc-rich primers, masonry treatments for water repellency, or compounded directly into concrete coatings for improved physical properties and water repellency.

Primers

Silanes provide crucial functionality in the primer segment because they allow formulas to be tailored to specific application performance requirements, enhance adhesion and also offer controlled water resistance, UV and thermal stability, surface activity, chemical resistance and corrosion protection.

Automotive clearcoats

Color-plus-clear coating systems have become the standard for automotive finishes. These coatings deliver outstanding gloss and image distinctiveness, however they are often subjected to damage from environmental elements like stone chipping and abrasive scratching. The inclusion of a surface-reactive silane coupling agent has been shown to improve scratch resistance.

Product Name	Functionality	Chemical Description	Application/Features
XIAMETER® OFS-6011 Silane	Amino/Ethoxy-silyl	Aminopropyltriethoxysilane; APTES; 99% actives	Coupling agent for many thermoset and thermoplastic resins and/or adhesion promoter
XIAMETER® OFS-6020 Silane	Amino/Methoxy-silyl	Aminoethylaminopropyltrimethoxysilane; 99% actives	Coupling agent for many thermoset and thermoplastic resins and/or adhesion promoter
XIAMETER® OFS-6030 Silane*	Methacrylate/ Methoxy-silyl	3-Methacryloxypropyltrimethoxysilane; 98% actives	Coupling agent for unsaturated resin systems
XIAMETER® OFS-6032 Silane	Amino/Vinylbenzyl/ Methoxy-silyl	Cationic vinylbenzyl and amino-functional methoxy-silane; 40% actives	Coupling agent to improve adhesion of organic resins to inorganic surfaces (e.g. epoxy based print circuit board)
XIAMETER® OFS-6040 Silane*	Epoxy/Methoxy-silyl	Glycidoxypropyltrimethoxysilane; 99% actives	Coupling agent for various thermoset resins with glass or mineral
Dow Corning® Z-6121 Silane	Amino/Alkoxy-silyl	Aminoethylaminopropyltrialkoxysilane; 50% actives	Adhesion promoter recommended for use with epoxy coatings, silicone-resin based coatings and alkyd finishes • Can be incorporated into epoxy coatings • Room-temperature curing agent for silicone resin-based coatings • Can be used with alkyd coatings • Effective over a wide range of concentrations • Curing agent for silicone resin-based coatings • Eliminates oven cure
Dow Corning® Z-6137 Silane	Amino/Silanol	Aqueous solution of amino-functional silicone polymers; 22.5% actives	An additive or primer in water-based systems to improve bonding between organic binder and inorganic substrate • Works well with phenols and epoxies — may also work with polyurethanes and acrylics • Low methanol content (<1%)

*When used as a primer, apply by dipping or brushing.

Architectural coatings

Including alkoxysilanes in coating formulations can create a more tightly crosslinked, water resistant film that is much less susceptible to moisture attack. The inclusion of silanes can also improve adhesion, abrasion resistance, thermal stability and durability, pigment and filler dispersion, UV resistance and water and chemical resistance.

Industrial coatings

Combining the cure profiles and barrier properties of organic resins with the thermal and UV stability of silanes, formulators have created high-performance coatings with excellent resistance to corrosion and chemical attack as well as thermal and UV degradation. Some of the benefits achieved with silanes include high heat resistance, excellent mechanical strength and improved water and moisture resistance.

	Applications							
	Primer	Additive	Pigment Treatment		Adhesion Promoter			FDA Compliant
			Solvent	Waterborne	Solvent	Waterborne	Radiation-cured	
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Adhesives & 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. The reputation of silane-enhanced sealants and adhesives in the aircraft, automotive and construction industries is built upon their ability to form durable bonds to metal, glass, ceramic and other surfaces – bonds that 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. Mixtures of silanes are used as adhesion promoters to provide enhanced water resistance, thermal stability, or crosslinking at the bonding site. The silanes can be blended into an adhesive formulation or used as primers on substrates, resulting in an adhesive bond with greater resistance to moisture attack, longer life and greater temperature and chemical resistance.

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 and reduced viscosity of the uncured sealant or adhesive.

Product Name	Functionality	Chemical Description	Application/Features	Primer	Additive
XIAMETER® OFS-1579 Silane	Alkyl	Methyl and ethyl triacetoxysilanes	Crosslinker for silicone RTVs		•
XIAMETER® OFS-6070 Silane	Alkyl	Methyltrimethoxysilane; CH_3-Si(OCH_3)$_3$; MTMS	Crosslinker for silicone RTVs • Moisture scavenger		•
XIAMETER® OFS-6011 Silane	Amino/Ethoxy-silyl	Aminopropyltriethoxysilane; APTES; 99% actives	Coupling agent for many thermoset and thermoplastic resins and/or adhesion promoter	•	•
XIAMETER® OFS-6020 Silane	Amino/Methoxy-silyl	Aminoethylaminopropyl-trimethoxysilane; 99% actives	Coupling agent for many thermoset and thermoplastic resins and/or adhesion promoter	•	•
XIAMETER® OFS-6030 Silane*	Methacrylate/ Methoxy-silyl	3-methacryloxypropyl-trimethoxysilane; 98% actives	Coupling agent for unsaturated resin systems	•	•
XIAMETER® OFS-6040 Silane*	Epoxy/Methoxy-silyl	Glycidoxypropyltrimethoxysilane; 99% actives	Coupling agent for various thermoset resins with glass or mineral	•	•
XIAMETER® OFS-6300 Silane	Vinyl/Methoxy-silyl	Vinyltrimethoxysilane; 99% actives	Coupling agent in filled rubbers and plastics and for crosslinking polyethylene		•

*When used as a primer, apply by dipping or brushing.

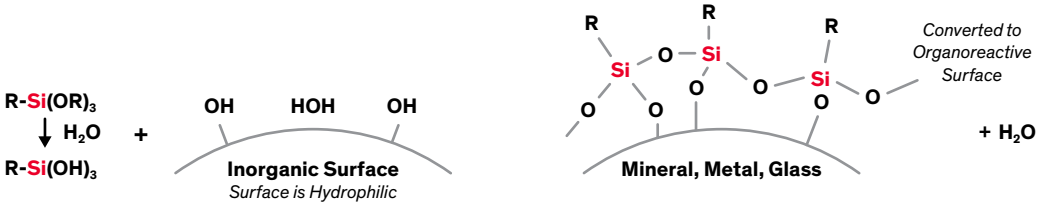
Mineral & Filler Treatments

The metal hydroxyl groups on the surface of minerals are usually hydrophilic and incompatible with organic polymers. Alkoxysilanes are a natural fit to treat the surface of the mineral to make it more compatible and dispersible in the polymer, or even to make the filler a reinforcing additive. Minerals with silicon and aluminum hydroxyl groups on their surfaces are generally very receptive to bonding with alkoxysilanes.

Silane treatment can improve processing, performance and durability of mineral-modified products by reducing the viscosity of the filler/polymer mix, as well as improving:

- Adhesion between the mineral and polymer
- Wet-out of the mineral by the polymer
- Dispersion of the mineral in the polymer
- Electrical properties
- Mechanical properties

Figure 8: Filler surface treatment



Product Name	Functionality	Chemical Description	Application/Features	Dispersing Agent	Reactive Treatment
Dow Corning® 11-100 Additive	Alkyl	Alkyl functional siloxane	Filler dispersion aid with extended shelf life • Impart hydrophobicity to inorganic filler surface • Improve inorganic filler de-agglomeration	•	
XIAMETER® Z-6341 Silane	Alkyl	n-Octyltriethoxysilane; $C_8H_{17}Si(OC_2H_5)_3$; nOTES	Hydrophobic surface treatment • Organic modification of surfaces • Formulating penetrating treatments that provide water repellency and prevent water absorption into concrete	•	
XIAMETER® OFS-6011 Silane	Amino/Ethoxysilane	Aminopropyltriethoxysilane; $H_2NC_3H_6$-$Si(OC_2H_5)_3$	Coupling agent for thermoset resins with glass or mineral fillers		•
XIAMETER® OFS-6020 Silane	Amino/Methoxysilane	Aminoethylaminopropyl-trimethoxysilane; $H_2NC_2H_4NHC_3H_6$-$Si(OCH_3)_3$	Coupling agent for many thermoset and thermoplastic resins with glass or mineral fillers		•
XIAMETER® OFS-6030 Silane	Methacryl/ Methoxysilane	Methacryloxypropyl-trimethoxysilane; $H_2C{=}CH(CH_3)C(O)OC_3H_6$-$Si(OCH_3)_3$	Coupling agent for many thermoset and thermoplastic resins with glass or mineral fillers		•
XIAMETER® OFS-6040 Silane	Epoxy/Methoxysilane	Glycidoxypropyltrimethoxysilane; $CH_2(O)CHCH_2OC_3H_6$-$Si(OCH_3)_3$	Used for silica treatment for EMC application		•
XIAMETER® OFS-6300 Silane	Vinyl/Methoxy-silyl	Vinyltrimethoxysilane; 99% actives	Coupling agent in filled rubbers and plastics and for crosslinking polyethylene	•	•
XIAMETER® OFS-6518 Silane	Vinyl/Ethoxysilane	Vinyltriethoxysilane; $H_2C{=}CH$-$Si(OC_2H_5)_3$; VTES	Coupling agent in filled rubbers and plastics and for crosslinking polyethylene	•	•
XIAMETER® OFS-6124 Silane	Phenyl	Phenyltrimethoxysilane; $(C_6H_5$-$Si(OCH_3)_3)$	Hydrophobic surface treatment • Hydrophobic additive to other silane coupling agents • Thermal stability additive to other silanes	•	
XIAMETER® Q1-6083 Antifreeze Additive	Phosphonate Sodium Siliconate	40% Sodium (trihydroxysilyl)-propylmethylphosponate in water			• (Engine coolant)

Solutions wherever you need them

Silanes bring performance-enhancing and problem-solving benefits to a wide array of specialty applications. No matter your application, Dow Corning can provide the silane solution and technical support you need.

Based in Midland, Michigan, USA, Dow Corning has manufacturing, customer service and science and technology resources located worldwide, as well as full-service, global technical support. With a full range of silane product and application solutions, Dow Corning offers you innovation, expertise, technical knowledge and a global reach backed with local support.

For more information on our silane selection and capabilities, visit **dowcorning.com/silanes** or contact us today by visiting **dowcorning.com/ContactUs**.

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