Gelest

Silane Coupling Agents:

Connecting Across Boundaries

Enhance Adhesion

Increase Mechanical Properties

Improve Dispersion

Provide Crosslinking

Immobilize Catalysts

Bind Biomaterials

Version 2.0:

New Coupling Agents for Metal Substrates !

New Coupling Agents for Vapor Phase Deposition !

New Coupling Agents for Proteins !

アヅマックス株式会社

Gelest, Inc.

Telephone: General 215-547-1015
Order Entry 888-734-8344
FAX: 215-547-2484
Internet: www.gelest.com
Correspondence:
11 East Steel Road
Morrisville, PA 19067, USA

In Europe: ABCR GmbH & Co. KG
Im Schlehert
D-76187 Karlsruhe
Germany
Tel: +49 - 721 - 950610
Fax: +49 - 721 - 9506180
e-mail: info@abcr.de
on-line catalog: www.abcr.de

In Japan: AZmax Co. Ltd. Tokyo Office
Matsuda Yaesudori Bld F8
1-10-7 Hatchoubori, Chuo-Ku
Tokyo 104-0032
Tel: 81-3-5543-1630
Fax: 81-3-5543-0312
email: sales@azmax.co.jp
on-line catalog: www.azmax.co.jp

In South-East Asia:
Altus Technologies Pte Ltd
196 Pandan Loop #06-09
Pantech Industrial Complex Singapore 128384
Tel: (65) 6779 7666 Fax: (65) 6779-7555
www.altus.com.sg

For further information consult our website at: www.gelest.com

Sales of all products listed are subject to the published terms and conditions of Gelest, Inc.

Gelest

Silane Coupling Agents

Connecting Across Boundaries

TABLE OF CONTENTS

What is a Silane Coupling Agent? 2

How Does a Silane Coupling Agent Work? 3

Selecting a Silane Coupling Agent - Inorganic Substrate Perspective 4

Selecting a Silane Coupling Agent - Polymer Applications 5

Selecting a Silane Coupling Agent - Interphase Considerations 9

Special Topics:

- Dipodal Silanes 11
- Linker Length 12
- Cyclic Azasilanes 13
- Thermal Stability of Silanes 14
- Aqueous Systems & Water-Borne Silanes 15
- Masked Silanes - Latent Functionality 16
- Coupling Agents for Metal Substrates 17
- Difficult Substrates 18

Applying a Silane Coupling Agent 19

Silane Coupling Agents for Polymers - Selection Chart 21

Silane Coupling Agents for Biomaterials - Selection Chart 24

Silane Coupling Agents - Properties 25

Organosilane-Modified Silica Nanoparticles 54

Further Information - Other Resources 55

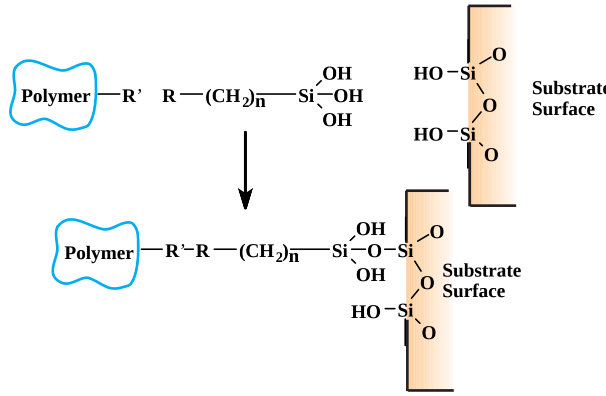
Index 56

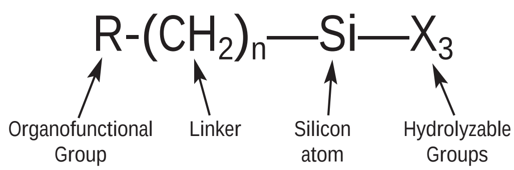
Silane Coupling Agents: Connecting Across Boundaries v2.0

by Barry Arkles

What is a Silane Coupling Agent?

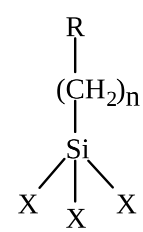
Silane coupling agents have the ability to form a durable bond between organic and inorganic materials. Encounters between dissimilar materials often involve at least one member that's siliceous or has surface chemistry with siliceous properties; silicates, aluminates, borates, etc., are the principal components of the earth's crust. Interfaces involving such materials have become a dynamic area of chemistry in which surfaces have been modified in order to generate desired heterogeneous environments or to incorporate the bulk properties of different phases into a uniform composite structure.



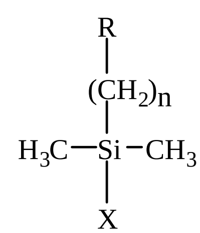


The general formula for a silane coupling agent typically shows the two classes of functionality. X is a hydrolyzable group typically alkoxy, acyloxy, halogen or amine. Following hydrolysis, a reactive silanol group is formed, which can condense with other silanol groups, for example, those on the surface of siliceous fillers, to form siloxane linkages. Stable condensation products are also formed with other oxides such as those of aluminum, zirconium, tin, titanium, and nickel. Less stable bonds are formed with oxides of boron, iron, and carbon. Alkali metal oxides and carbonates do not form stable bonds with Si-O-. The R group is a nonhydrolyzable organic radical that may posses a functionality that imparts desired characteristics.

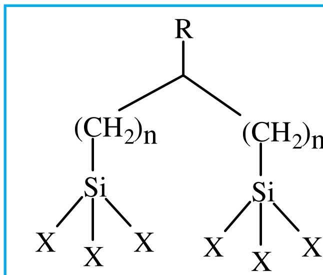
The final result of reacting an organosilane with a substrate ranges from altering the wetting or adhesion characteristics of the substrate, utilizing the substrate to catalyze chemical transformations at the heterogeneous interface, ordering the interfacial region, and modifying its partition characteristics. Significantly, it includes the ability to effect a covalent bond between organic and inorganic materials.



Trialkoxysilane



Monoalkoxysilane



Dipodal Silane

How does a Silane Coupling Agent Work?

Most of the widely used organosilanes have one organic substituent and three hydrolyzable substituents. In the vast majority of surface treatment applications, the alkoxy groups of the trialkoxysilanes are hydrolyzed to form silanol-containing species. Reaction of these silanes involves four steps. Initially, hydrolysis of the three labile groups occurs. Condensation to oligomers follows. The oligomers then hydrogen bond with OH groups of the substrate. Finally during drying or curing, a covalent linkage is formed with the substrate with concomitant loss of water. Although described sequentially, these reactions can occur simultaneously after the initial hydrolysis step. At the interface, there is usually only one bond from each silicon of the organosilane to the substrate surface. The two remaining silanol groups are present either in condensed or free form. The R group remains available for covalent reaction or physical interaction with other phases.

Silanes can modify surfaces under anhydrous conditions consistent with monolayer and vapor phase deposition requirements. Extended reaction times (4-12 hours) at elevated temperatures (50°-120°C) are typical. Of the alkoxysilanes, only methoxysilanes are effective without catalysis. The most effective silanes for vapor phase deposition are cyclic azasilanes.

Hydrolysis Considerations

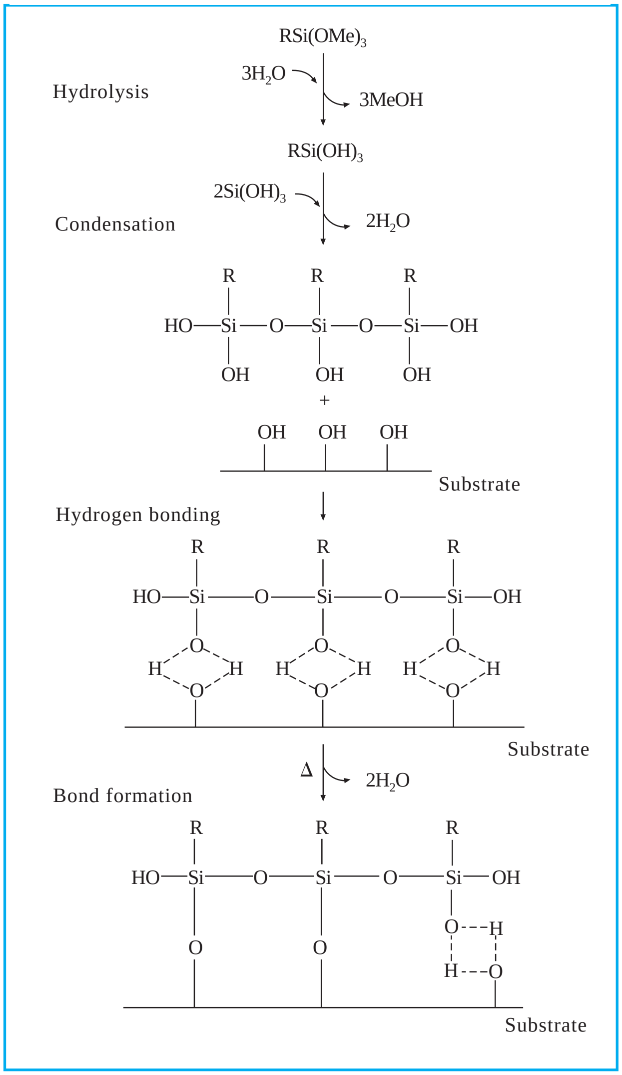
Water for hydrolysis may come from several sources. It may be added, it may be present on the substrate surface, or it may come from the atmosphere.

The degree of polymerization of the silanes is determined by the amount of water available and the organic substituent. If the silane is added to water and has low solubility, a high degree of polymerization is favored. Multiple organic substitution, particularly if phenyl or tertiary butyl groups are involved, favors formation of stable monomeric silanols.

The thickness of a polysiloxane layer is also determined by the concentration of the siloxane solution. Although a monolayer is generally desired, multilayer adsorption results from solutions customarily used. It has been calculated that deposition from a 0.25% silane solution onto glass could result in three to eight molecular layers. These multilayers could be either interconnected through a loose network structure, or intermixed, or both, and are, in fact, formed by most deposition techniques. The orientation of functional groups is generally horizontal, but not necessarily planar, on the surface of the substrate.

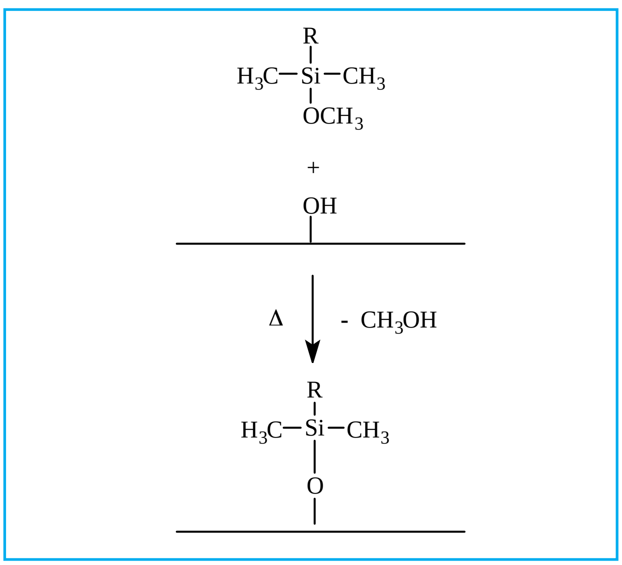
The formation of covalent bonds to the surface proceeds with a certain amount of reversibility. As water is removed generally by heating to 120°C for 30 to 90 minutes or evacuation for 2 to 6 hours, bonds may form, break, and reform to relieve internal stress. The same mechanism can permit a positional displacement of interface components.

Hydrolytic Deposition of Silanes

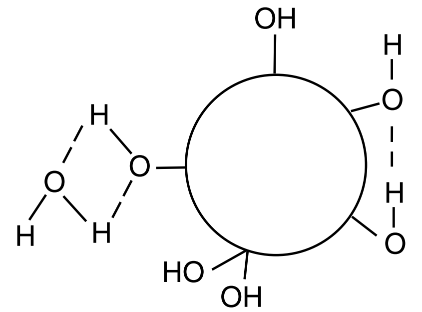


B. Arkles, CHEMTECH, 7, 766, 1977

Anhydrous Deposition of Silanes



Selecting A Silane Coupling Agent -
Inorganic Substrate Perspective



Factors influencing silane coupling agent selection include:

Concentration of surface hydroxyl groups
Type of surface hydroxyl groups
Hydrolytic Stability of the bond formed
Physical dimensions of the substrate or substrate features

Coupling is maximized when silanes react with the substrate surface and present the maximum number of sites with reactivity specific and accessible to the matrix phase. An additional consideration is the physical and chemical properties of the interphase region. The interphase can promote or detract from total system properties depending on its physical properties such as modulus or chemical properties such as water/hydroxyl content.

Hydroxyl-containing substrates vary widely in concentration and type of hydroxyl groups present. Freshly fused substrates stored under neutral conditions have a minimum number of hydroxyls. Hydrolytically derived oxides aged in moist air have significant amounts of physically adsorbed water which can interfere with coupling. Hydrogen bonded vicinal silanols react more readily with silane coupling agents, while isolated or free hydroxyls react reluctantly.

Silane coupling agents with three alkoxy groups are the usual starting point for substrate modification. These materials tend to deposit as polymeric films, effecting total coverage and maximizing the presentation of organic functionality. They are the primary materials utilized in composites, adhesives, sealants, and coatings. Limitations intrinsic in the utilization of a polylayer deposition are significant for nano-particles or nano-composites where the interphase dimensions generated by polylayer deposition may approach those of the substrate. Residual (non-condensed) hydroxyl groups from alkoxysilanes can also interfere in activity. Monoalkoxysilanes provide a frequently used alternative for nano-featured substrates since deposition is limited to a monolayer.

If the hydrolytic stability of the oxane bond between the silane and the substrate is poor or the application is an aggressive aqueous environment, dipodal silanes often exhibit substantial performance improvements. These materials form tighter networks and may offer up to 10^5x greater hydrolysis resistance making them particularly appropriate for primer applications.

Amino-silanes couple fiberglass to phenolic or urea-formaldehyde resins

Silane Effectiveness on Inorganics

	SUBSTRATES
EXCELLENT	Silica
	Quartz
	Glass
	Aluminum (AlO(OH))
	Alumino-silicates (e.g. clays)
	Silicon
GOOD	Copper
	Tin (SnO)
	Talc
	Inorganic Oxides (e.g. Fe_2O_3, TiO_2, Cr_2O_3)
	Steel, Iron
	Asbestos
	Nickel
	Zinc
	Lead
SLIGHT	Marble, Chalk ($CaCO_3$)
	Gypsum ($CaSO_4$)
	Barytes ($BaSO_4$)
POOR	Graphite
	Carbon Black

Estimates for Silane Loading on Siliceous Fillers

Average Particle Size	Amount of Silane (minimum of monolayer coverage)
<1 micron	1.5%
1-10 microns	1.0%
10-20 microns	0.75%
>100 microns	0.1% or less

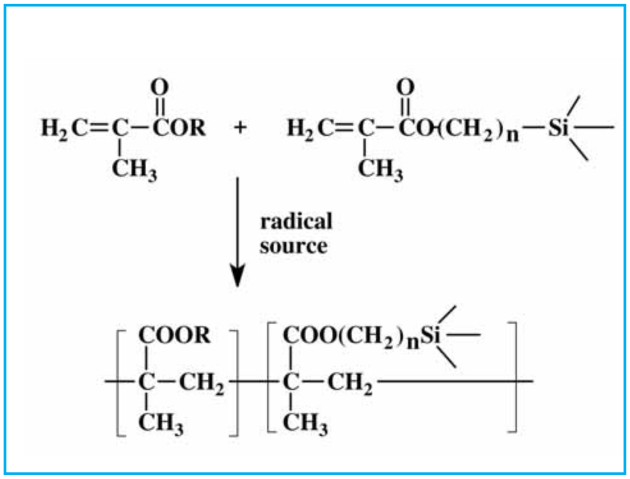
Selecting A Silane Coupling Agent -
Polymer Applications

Coupling agents find their largest application in the area of polymers. Since any silane that enhances the adhesion of a polymer is often termed a coupling agent, regardless of whether or not a covalent bond is formed, the definition becomes vague. In this discussion, the parochial outlook will be adopted, and only silanes that form covalent bonds directly to the polymer will be considered. The covalent bond may be formed by reaction with the finished polymer or copolymerized with the monomer. Thermoplastic bonding is achieved through both routes, although principally the former. Thermosets are almost entirely limited to the latter. The mechanism and performance of silane coupling agents is best discussed with reference to specific systems. The most important substrate is E-type fiberglass, which has 6-15 silanol groups per mμ².

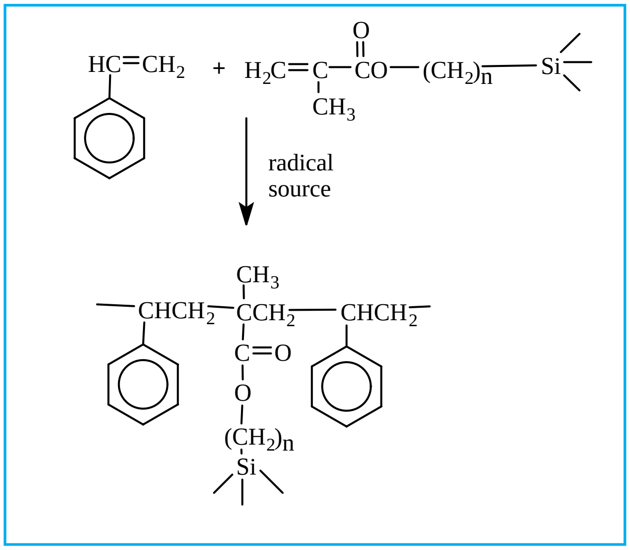
Thermosets

Acrylates, methacrylates and Unsaturated Polyesters, owing to their facility for undergoing free-radical polymerization, can be modified by copolymerization with silanes that have unsaturated organic substitution. The usual coupling agents for thermoset polyesters undergo radical copolymerization in such systems. These resins, usually of loosely defined structure, often have had their viscosity reduced by addition of a second monomer, typically styrene. In general, better reinforcement is obtained when the silane monomer matches the reactivity of the styrene rather than the maleate portion of the polyester.

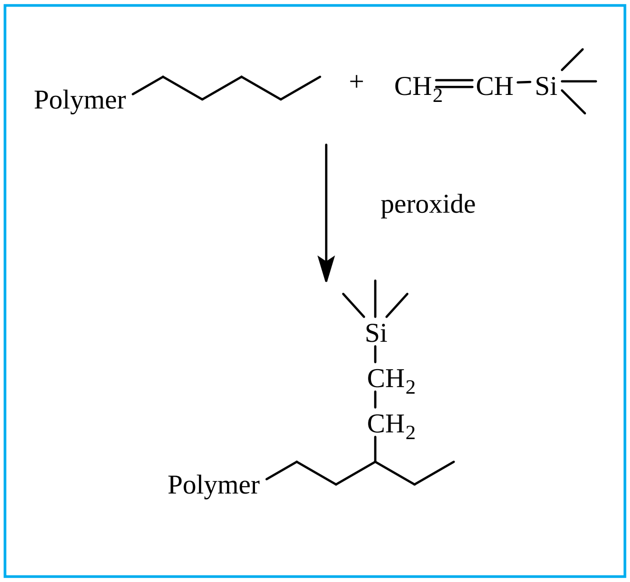
Methacrylyl and styryl functional silanes undergo addition much more readily than vinylsilanes A direct approach to selecting the optimum silane uses the e and Q parameters of the Alfrey-Price treatment of polymerization. Here e indicates the polarity of the monomer radical that forms at the end of a growing chain, while Q represents the resonance stabilization of a radical by adjacent groups. Optimum random copolymerization is obtained from monomers with similar orders of reactivity. Vinyl functional silanes mismatch the reactionary parameters of most unsaturated polyesters. However, they can be used in direct high pressure polymerization with olefins such as ethylene, propylene and dienes.



Acrylate Coupling Reaction



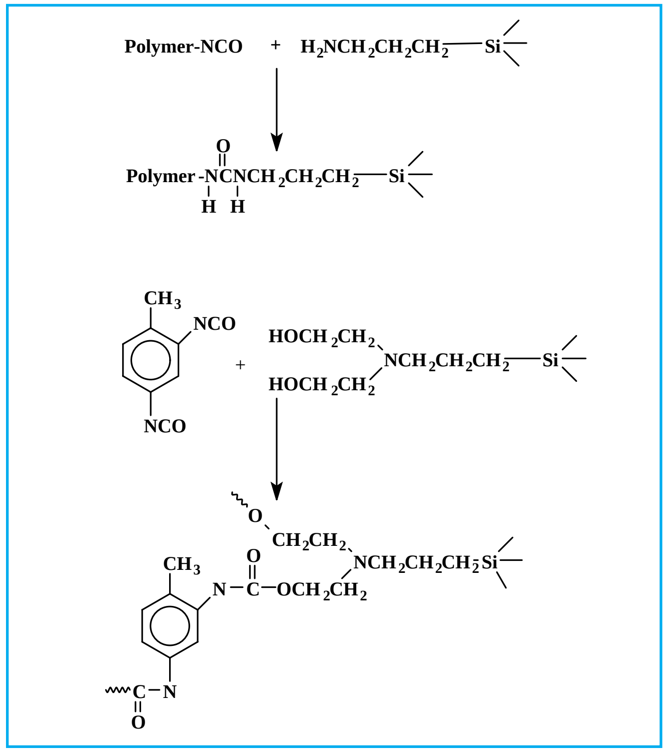
Unsaturated Polyester (Styrene) Coupling Reaction



Polyethylene Graft Coupling Reaction

Urethanes

Thermoset urethane can be effectively coupled with two types of silanes. The first type, including isocyanate functional silanes, may be used to treat the filler directly or integrally blended with the diisocyanate (TDI, MDI, etc.) prior to cure. Amine and alkanolamine functional silanes, on the other hand, are blended with the polyol rather than the diisocyanate. Isocyanate functional silanes couple with the polyol. Alkanolamine functional silanes react with the isocyanate to form urethane linkages, while amine silanes react with the isocyanates to yield urea linkages. A typical application for coupled urethane system is improving bond strength with sand in abrasion-resistant, sand-filled flooring resins.



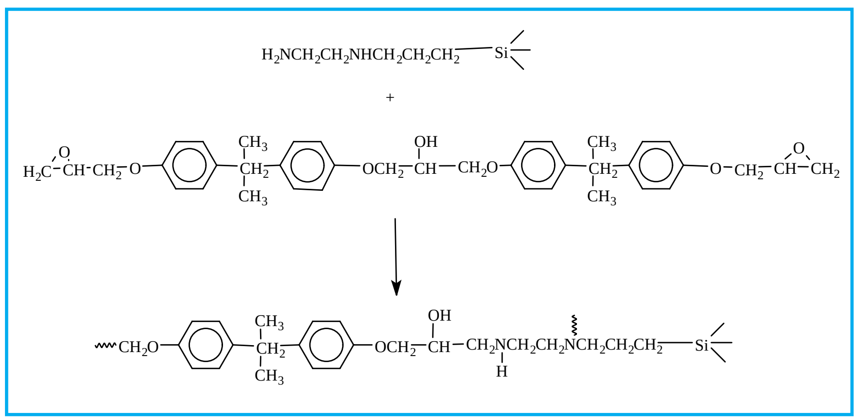
Polyurethane Coupling Reactions

Moisture-Cureable Urethanes

Aminosilanes have the general ability to convert isocyanate functional urethane prepolymers to systems that crosslink in the presence of water and a tin catalyst. The preferred aminosilanes are secondary containing methyl, ethyl or butyl substitutions on nitrogen.

Epoxies

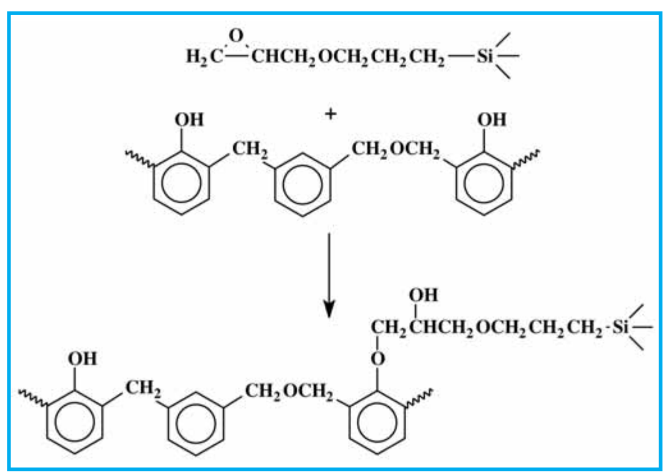
Epoxycyclohexyl and glycidoxy functional silanes are used to pretreat the filler or blended with the glycidylbisphenol-A ether. Amine functional silanes can likewise be used to pretreat the filler or blended with the hardener portion. Treatment of fillers in epoxy adhesives improves their dispersibility and increases the mechanical properties of the cured resin. A large application area is glass cloth-reinforced epoxy laminates and prepregs in aerospace and electrical printed circuit board applications.



Epoxy Coupling Reaction

Phenolics

Phenolic resins are divided into base catalyzed single-step resins called resols or better known acid catalyzed two-step systems called novolaks. Although foundry and molds are formulated with resols such as aminopropylmethyldialkoxysilanes, the commercial utilization of silanes in phenolic resins is largely limited to novolak/glass fabric laminates and molding compounds. The phenolic hydroxyl group of the resins readily react with the oxirane ring of epoxy silanes to form phenyl ether linkages. When phenolic resins are compounded with rubbers, as in the case with nitrile/phenolic or vinyl butyral/phenolic adhesives, or impact-resistant molding compounds, additional silanes, particularly mercapto-functional silanes, have been found to impart greater bond strength than silanes that couple to the phenolic portion.



Phenolic Coupling Reaction

Thermoplastics

Thermoplastics provide a greater challenge in promoting adhesion through silane coupling agents than thermosets. The silanes must react with the polymer and not the monomeric precursors, which not only limits avenues for coupling, but also presents additional problems in rheology and thermal properties during composite formulation. Moreover mechanical requirements here are stringently determined. Polymers that contain regular sites for covalent reactivity either in the backbone or in a pendant group include polydienes, polyvinylchloride, polyphenylene sulfide, acrylic homopolymers, maleic anhydride, acrylic, vinyl acetate, diene-containing copolymers, and halogen or chlorosulfonyl-modified homopolymers. A surprising number of these are coupled by aminoalkylsilanes. Chlorinated polymers readily form quaternary compounds while the carboxylate and sulfonate groups form amides and sulfonamides under process conditions. At elevated temperatures, the amines add across many double bonds although mercaptoalkylsilanes are the preferred coupling agents. The most widely used coupling agents, the aminoalkylsilanes, are not necessarily the best. Epoxysilanes, for example, are successfully used with acrylic acid and maleic acid copolymers.

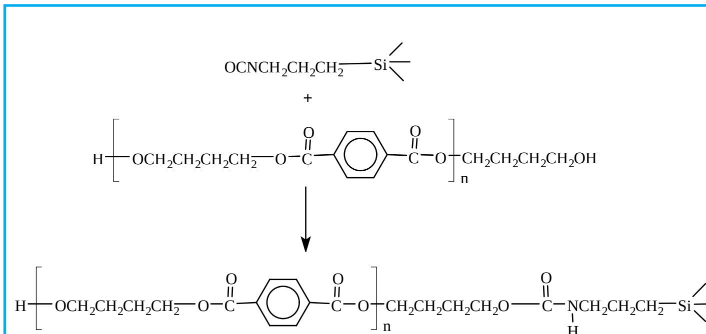
Thermoplastic Condensation Polymers

The group of polymers that most closely approaches theoretical limits of composite strength does not appear to contain regular opportunities for covalent bond formation to substrate. Most of the condensation polymers including polyamides, polyesters, polycarbonates, and polysulfones are in this group. Adhesion is promoted by introducing high energy groups and hydrogen bond potential in the interphase area or by taking advantage of the relatively low molecular weight of these polymers, which results in a significant opportunity for end-group reactions. Aminoalkylsilanes, chloroalkylsilanes, and isocyanatosilanes are the usual candidates for coupling these resins. This group has the greatest mechanical strength of the thermoplastics, allowing them to replace the cast metals in such typical uses as gears, connectors and bobbins.

Scanning electron micrograph at a broken gear tooth from a non-coupled glass fiber/acetal composite. Note that cleavage occurred between fibers.

Scanning electron micrograph at a broken gear tooth from an aminosilane-coupled glass fiber/nylon 6/6 composite. Note how fibers have broken as well as matrix.

Chopped fiberglass strand sized with aminosilanes is a commonly used reinforcement for high temperature thermoplastics.



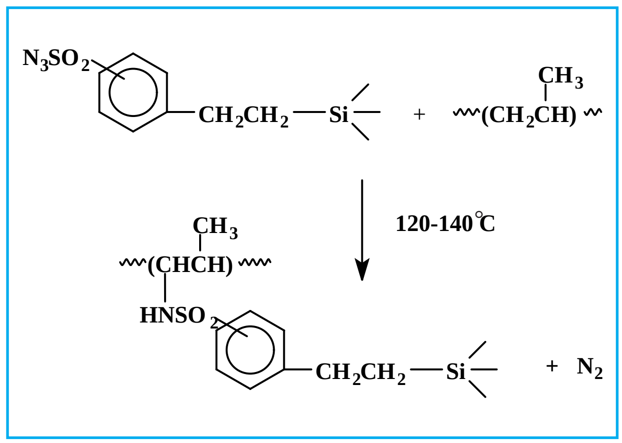
Thermoplastic Polyester Coupling Reaction

Polyolefins

The polyolefins and polyethers present no direct opportunity to covalent coupling. Until recently, the principal approach for composite formulation was to match the surface energy of the filler surface, by treating it with an alkyl-substituted silane, with that of the polymer. For optimum reinforcement, preferred resins should be of high molecular weight, linear, and have low melt viscosity. Approaches to improved composite strength have been through compatibility with long-chain alkylsilanes or aminosilanes. Far more effective is coupling with vinyl or methacryloxy groups, particularly if additional coupling sites are created in the resin by addition of peroxides. Dicumyl peroxide and bis(t-butylperoxy) compounds at levels of 0.15% to 0.25% have been introduced into polyethylene compounded with vinylsilane-treated glass fibers for structural composites or vinylsilane-treated clay for wire insulation. Increases of 50% in tensile and flexural properties have been observed in both cases when compared to the same silane systems without peroxides.

Another approach for coupling polypropylene and polyethylene is through silylsulfonylazides. Unlike azide bound to silicon, sulfonyl azides decompose above 150°C to form a molecule of nitrogen and a reactive nitrene that is capable of insertion into carbon-hydrogen bonds, forming sulfonamides, into carbon-carbon double bonds, forming triazoles, and into aromatic bonds, forming sulfonamides. Fillers are treated first with the silane and then the treated filler is fluxed rapidly with polymer melt.

Vinylsilanes are used in PE and EPDM insulated wire and cable



Polypropylene Coupling Reaction

Selecting a Silane Coupling Agent -
Interphase Considerations

The space between homogeneous phases is sometimes called the interphase. In this region there is a steep gradient in local properties of the system. By treating a substrate with silanes the interphase can acquire specific surface energy, partition characteristics, mechanical and chemical properties.

Hydrophobicity and Wetting

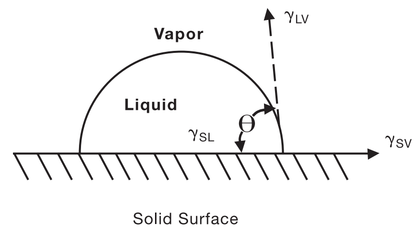
Alkyl- and arylsilanes are not considered coupling agents. Surface modification with these non-functional materials can have profound effects on the interphase. They are used to alter surface energy or wetting characteristics of the substrate. In the simplest cases, methyltrichlorosilane, dimethyldichlorosilane, trimethylchlorosilane, their alkoxy derivatives, and hexamethyldisilazane are used to render substrates water repellent. For example, glassware can be dipped into a 5% to 10% solution of dimethyldiethoxysilane and heated for ten minutes at 120° C to render the surface hydrophobic. Laboratory pipettes and graduated cylinders so treated exhibit a flat meniscus and completely transfer aqueous solutions. GC packing of diatomaceous earth or silica are often treated with dimethyldichlorosilane or trimethylchlorosilane to reduce tailing. Masonry can be treated with propyl-, isobutyl- or octyltrialkoxysilanes to render it water repellent while glass surfaces of metal-glass capacitors treated with alkylsilanes exhibit reduced electrical leakage in humid conditions.

Silanes can alter the critical surface tension of a substrate in a well-defined manner. Critical surface tension is associated with the wettability or release qualities of a substrate. Liquids with a surface tension below the critical surface tension (γ_c) of a substrate will wet the surface, i.e., show a contact angle of 0 ($\cos\theta_c = 1$). The critical surface tension is unique for any solid, and is determined by plotting the cosine of the contact angles of liquids of different surface tensions and extrapolating to 1. The contact angle is given by Young's equation:

$$\gamma_{sv} - \gamma_{sl} = \cos\theta_e$$

where γ_{sl} = interfacial surface tension, γ_{lv} = surface tension of liquid, and ($\gamma_{sv} = \gamma_l$ when $\gamma_{sl} = 0$ and $\cos\theta_e = 1$)

Contact Angle Defines Wettability



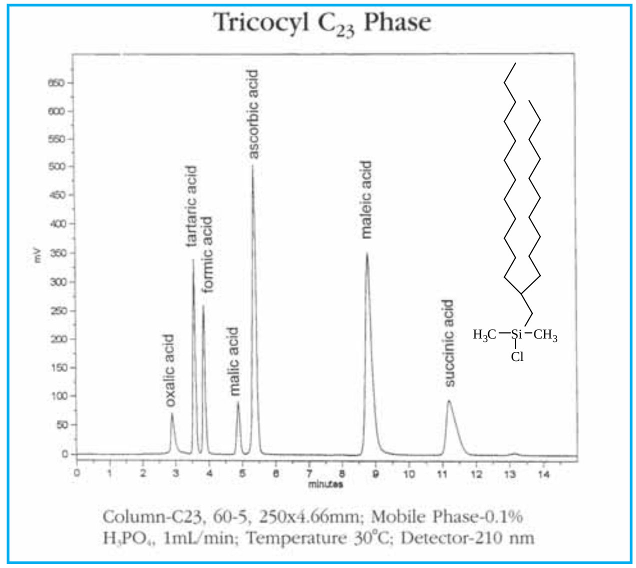
Critical surface tensions

	γ_c
Heptadecafluorodecyltrichlorosilane	12.0
Polytetrafluoroethylene	18.5
Methyltrimethoxysilane	22.5
Vinyltriethoxysilane	25
Paraffin wax	25.5
Ethyltrimethoxysilane	27.0
Propyltrimethoxysilane	28.5
Glass, soda-lime (wet)	30.0
Polychlorotrifluoroethylene	31.0
Polypropylene	31.0
Polyethylene	33.0
Trifluoropropyltrimethoxysilane	33.5
3-(2-aminoethyl)-aminopropyltrimethoxysilane	33.5
Polystyrene	34
Cyanoethyltrimethoxysilane	34
Aminopropyltriethoxysilane	35
Polyvinylchloride	39
Phenyltrimethoxysilane	40.0
Chloropropyltrimethoxysilane	40.5
Mercaptopropyltrimethoxysilane	41
Glycidoxypropyltrimethoxysilane	42.5
Polyethyleneterephthalate	43
Copper (dry)	44
Aluminum (dry)	45
Iron (dry)	46
Nylon 6/6	46
Glass, soda-lime (dry)	47
Silica, fused	78
Titanium dioxide (Anatase)	91
Ferric oxide	107
Tin oxide	111

Note: Critical surface tensions for silanes refer to treated surfaces.

Silane treatment has allowed control of thixotropic activity of silica and clays in grease and oil applications. In the reinforcement of thermosets and thermoplastics with glass fibers, one approach for optimizing reinforcement is to match the critical surface tension of the silylated glass surface to the surface tension of the polymer in its melt or uncured condition. This has been most helpful in resins with no obvious functionality such as polyethylene and polystyrene. Immobilization of cellular organelles, including mitochondria, chloroplasts, and microsomes, has been effected by treating silica with alkylsilanes of C_8 or greater substitution.

Normal Phase HPLC of Carboxylic Acids with a C_{23}-Silane Bonded Phase

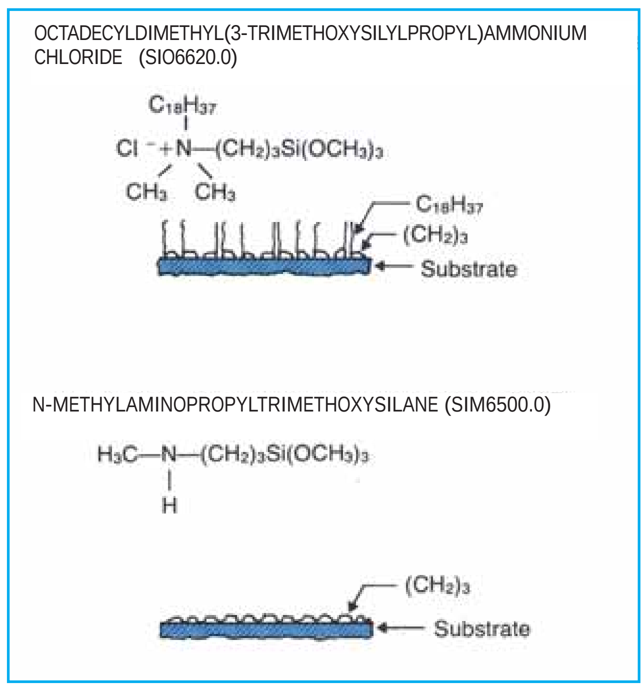


Chromatography

Octadecyl, cyanopropyl and branched tricocyl silanes provide bonded phases for liquid chromatography. Reverse-phase thin-layer chromatography can be accomplished by treating plates with dodecyltrichlorosilane.

By forming complexes of copper ions with aminoalkylsilylated surfaces, an interphase results that can selectively absorb ethylene, propylene and other gases.

Orientation effects of silanes for passive LCDs



F. Kahn., Appl. Phys. Lett. *22*, 386, 1973

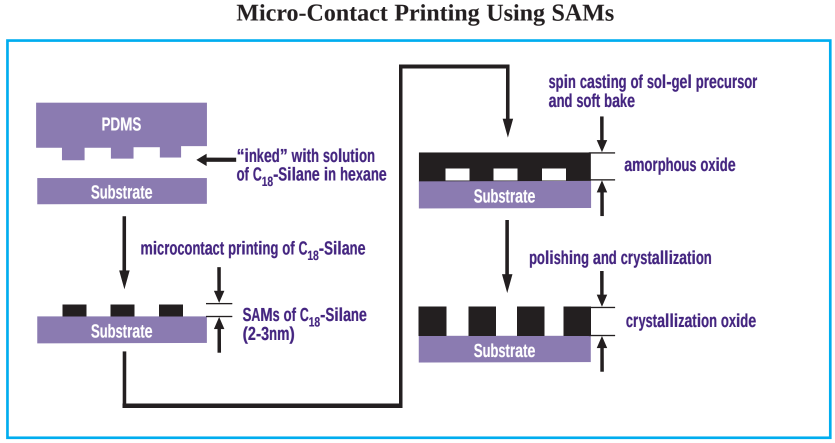
Liquid Crystal Displays

The interphase can also impose orientation of the bulk phase. In liquid crystal displays, clarity and permanence of image are enhanced if the display can be oriented parallel or perpendicular to the substrate. The use of surfaces treated with octadecyl(3-(trimethoxysilyl)propyl) ammonium chloride (perpendicular) or methylaminopropyltrimethoxysilane (parallel) has eliminated micromachining operations The oriented crystalline domains often observed in reinforced nylons have also been attributed to orientation effects of the silane in the interphase.

Self-Assembled Monolayers (SAMs)

The perpendicular orientation of silanes with C_{10} or greater length can be utilized in micro-contact printing and other soft lithography methods. Here the silane may effect a simple differential adsorption, or if functionalized have a direct sensor effect.

Micro-Contact Printing Using SAMs

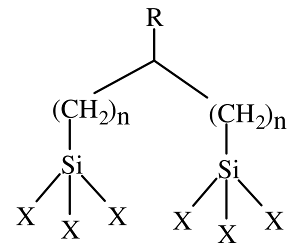


Special Topics

Dipodal Silanes

Functional dipodal silanes and combinations of non-functional dipodal silanes with functional silanes have significant impact on substrate bonding, hydrolytic stability and mechanical strength of many composites systems. They possess enabling activity in many coatings, particularly primer systems and aqueous immersion applications. The effect is thought to be a result of both the increased crosslink density of the interphase and a consequence of the fact that the resistance to hydrolysis of dipodal materials (with the ability to form six bonds to a substrate) is estimated at close to 100,000 times greater than conventional coupling agents (with the ability to form only three bonds to a substrate).

Both because dipodal silanes may not have functional groups identical to conventional coupling agents or because of economic considerations, conventional coupling agents are frequently used in combination with a non-functional dipodal silanes. In a typical application a dipodal material such as bis(triethoxysilyl)ethane (SIB1817.0) is combined at a 1:5 to 1:10 ratio with a traditional coupling agent. It is then processed in the same way as the traditional silane coupling agent.



Dipodal tetrasulfide silanes are used in "green" tires

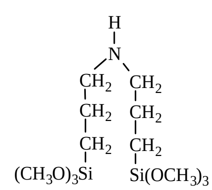
Effect of dipodal -SiCH2CH2Si- on the bond strength of a crosslinkable ethylene-vinyl acetate primer formulation

Primer on metal 10% in *i*-PrOH	Wet adhesion to metals (N/cm) Titanium	Wet adhesion to metals (N/cm) Cold-rolled steel
No silane	Nil	Nil
Methacryloxypropylsilane	0.25	7.0
Methacryloxypropylsilane + 10% dipodal	10.75	28.0 (cohesive failure)

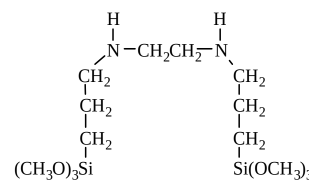
90° peel strength after 2 h in 80°C water.

P. Pape et al, in Silanes and Other Coupling Agents, ed. K. Mittal, 1992, VSP, p105

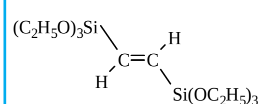
Functional Dipodals



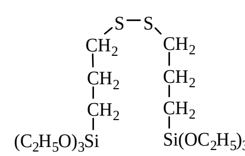
SIB1833.0



SIB1834.0



SB1820..0



SIB1824.6

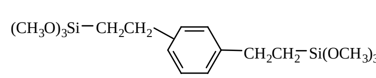
Non-Functional Dipodals

$(C_2H_5O)_3Si-CH_2CH_2-Si(OC_2H_5)_3$

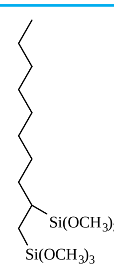
SIB1817.0

$(C_2H_5O)_3Si-CH_2CH_2CH_2CH_2CH_2CH_2CH_2CH_2-Si(OC_2H_5)_3$

SIB1824.0



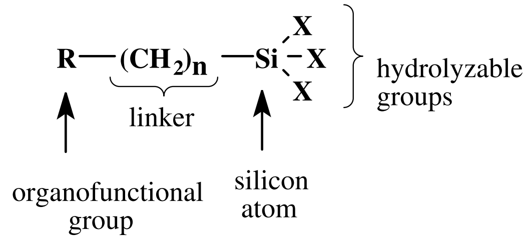
SIB1831.0



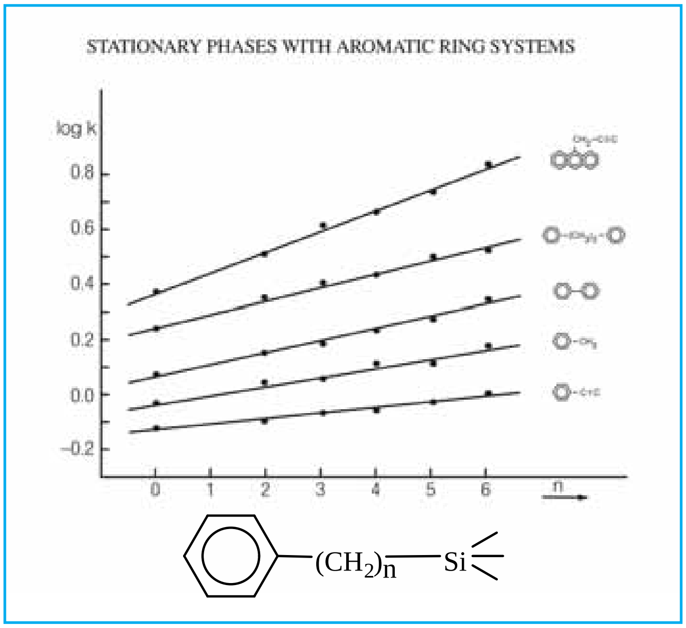
SIB1829.0

Linker Length

An important factor in controlling the effectiveness and properties of a coupled system is the linker between the organic functionality and the silicon atom. The linker length imposes a number of physical property and reactivity limitations. The desirability of maintaining the reactive centers close to the substrate are most important in sensor applications, in heterogeneous catalysis, fluorescent materials and composite systems in which the interfacing components are closely matched in modulus and coefficient of thermal expansion. On the other hand, inorganic surfaces can impose enormous steric constraints on the accessibility of organic functional groups in close proximity. If the linker length is long the functional group has greater mobility and can extend further from the inorganic substrate. This has important consequences if the functional group is expected to react with a single component in a multi-component organic or aqueous phases found in homogeneous and phase transfer catalysis, biological diagnostics or liquid chromatography. Extended linker length is also important in oriented applications such as self-assembled monolayers (SAMs). The typical linker length is three carbon atoms, a consequence of the fact that the propyl group is synthetically accessible and has good thermal stability.



Effect of linker length on the separation of aromatic hydrocarbons



T. Den et al, in "Silanes, Surfaces, Interfaces" D. Leyden ed., 1986 p403.

Silanes with short linker length

$H_2NCH_2CH_2CH_2CH_2CH_2CH_2N(H)-CH_2-Si(OCH_2CH_3)_3$

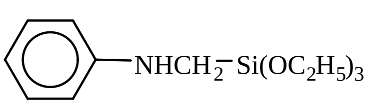
SIA0592.6

$Cl-CH_2-Si(OC_2H_5)_3$

SIC2298.4

$OCN-CH_2-Si(OCH_3)_3$

SII6453.8



SIP6723.7

Silanes with extended linker length

$H_2NCH_2CH_2N(H)-CH_2CH_2CH_2CH_2CH_2CH_2CH_2CH_2CH_2CH_2CH_2-Si(OCH_3)_3$

SIA0595.0

$HC(=O)-CH_2CH_2CH_2CH_2CH_2CH_2CH_2CH_2CH_2CH_2-Si(OC_2H_5)_3$

SIT8194.0

$Br-CH_2CH_2CH_2CH_2CH_2CH_2CH_2CH_2CH_2CH_2CH_2-Si(OCH_3)_3$

SIB1909.0

$HS-CH_2CH_2CH_2CH_2CH_2CH_2CH_2CH_2CH_2CH_2CH_2-Si(OCH_3)_3$

SIM6480.0

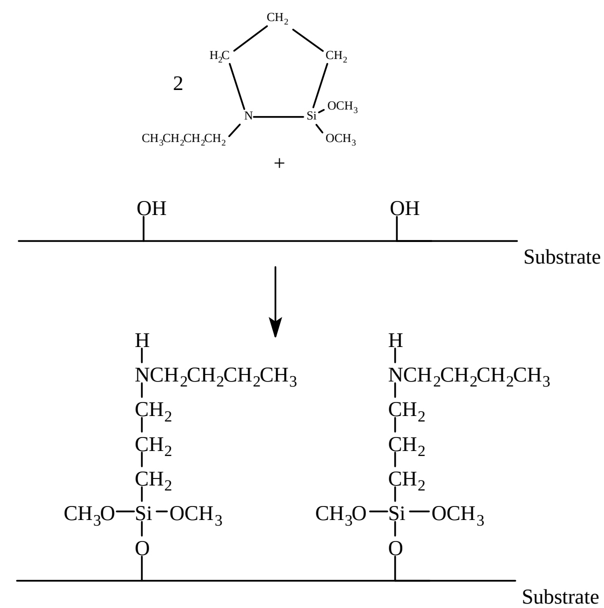
$H_2C=CH-CH_2CH_2CH_2CH_2CH_2CH_2CH_2CH_2CH_2-Si(OCH_3)_3$

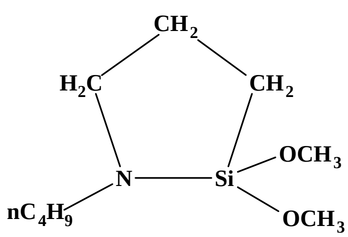
SIU9049.0

Cyclic Azasilanes

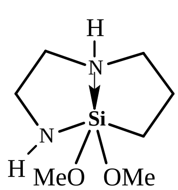
Volatile cyclic azasilanes are of particular interest in the surface modification of hydroxyl-containing surfaces, particularly inorganic surfaces such as nanoparticles and other nano-featured substrates. In these applications the formation of high functional density monolayers is critical. The cyclic azasilanes react with hydroxyl groups of a wide range of substrates at low temperatures by a ring-opening reaction that does not require water as a catalyst. Significantly, no byproducts of reaction form. The reactions of cyclic azasilanes are rapid at room temperature, even in the vapor phase. They also react rapidly at room temperature with isolated non-hydrogen bonded hydroxyls which do not undergo reaction with alkoxysilanes under similar conditions. The three most common cyclic azasilanes structures are depicted. (see p.35)

Anhydrous deposition with Cyclic Azasilanes

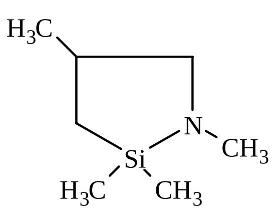




SIB1932.4

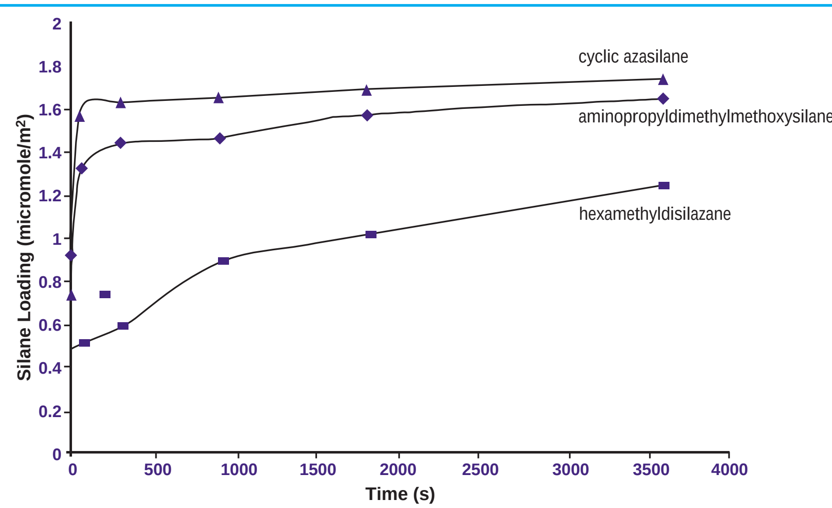


SID3543.0



SIM6501.4

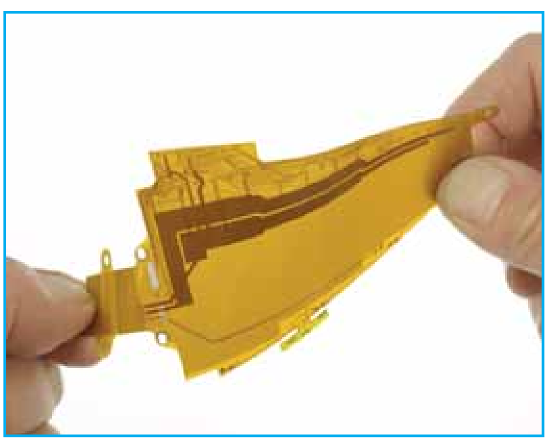
Extent of reaction of organosilanes with fumed silica



M. Vedamuthu et al, J. Undergrad., Chem. Res., *1*, 5, 2002

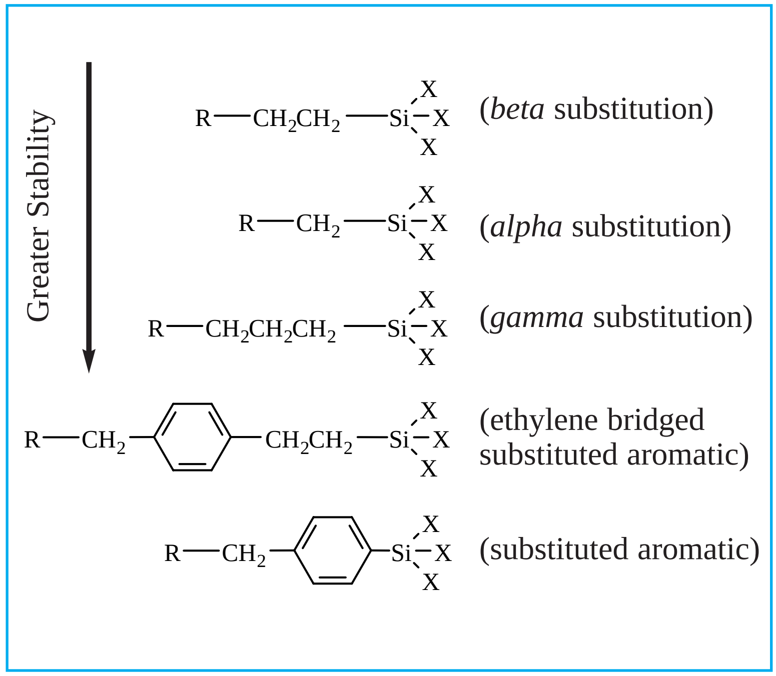
Thermal Stability of Silane Coupling Agents

The general order of thermal stability for silane coupling agents is depicted. Most commercial silane coupling agents have organic functionality separated from the silicon atom by three carbon atoms and are referred to as gamma-substituted silanes. The gamma-substituted silanes have sufficient thermal stability to withstand short-term process conditions of 350°C and long-term continuous exposure of 160°C. In some applications gamma-substituted silanes have insufficient thermal stability or other system requirements that can eliminate them from consideration. In this context, some comparative guidelines are provided for the thermal stability of silanes. Thermogravimetric Analysis (TGA) data for hydrolysates may be used for bench-marking. The specific substitution also plays a significant role in thermal stability. Electron withdrawing substitution reduces thermal stability, while electropositive groups enhance thermal stability.

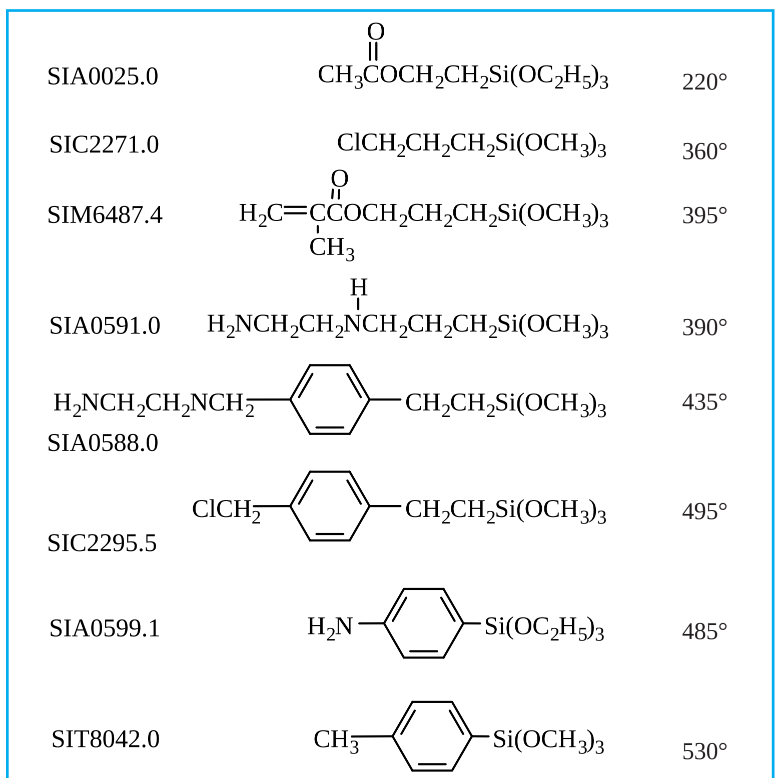


Flexible multi-layer circuit boards for cell-phones utilize polyimide films coupled w/chloromethylaromatic silanes.

Relative Thermal Stability of Silanes



Thermal Stability of Silanes



25% weight loss of dried hydrolysates as determined by TGA

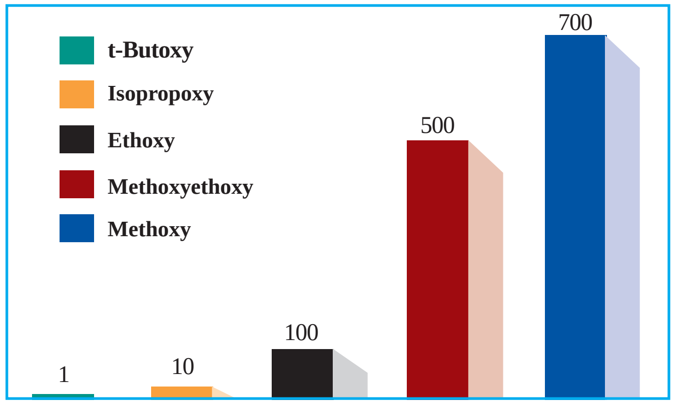
Aqueous Systems & Water-borne Silanes

Before most surface modification processes, alkoxysilanes are hydrolyzed forming silanol-containing species. The silanol-containing species are highly reactive intermediates which are responsible for bond formation with the substrate. In principal, if silanol species were stable, they would be preferred for surface treatments. Silanols condense with other silanols or with alkoxysilanes to form siloxanes. This can be observed when preparing aqueous treatment solutions. Initially, since most alkoxysilanes have poor solubility in water, two phases are observed. As the hydrolysis proceeds, a single clear phase containing reactive silanols forms. With aging, the silanols condense forming siloxanes and the solution becomes cloudy. Eventually, as molecular weight of the siloxanes increases, precipitation occurs.

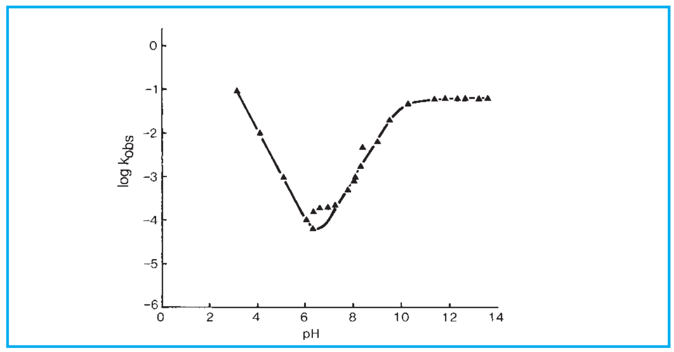
Hydrolysis and condensation of alkoxysilanes is dependent on both pH and catalysts. The general objective in preparing aqueous solutions is to devise a system in which the rate of hydrolysis is substantially greater than the rate of condensation beyond the solubility limit of the siloxane oligomers. Other considerations are the work-time requirements for solutions and issues related to byproduct reactivity, toxicity or flammability. Stable aqueous solutions of silanes are more readily prepared if byproduct or additional alcohol is present in the solution since they contribute to an equilibrium condition favoring monomeric species.

Water-borne coupling agent solutions are usually free of VOCs and flammable alcohol byproducts. Most water-borne silanes can be described as hydroxyl-rich silsesquioxane copolymers. Apart from coupling, silane monomers are included to control water-solubility and extent of polymerization. Water-borne silanes act as primers for metals, additives for acrylic latex sealants and as coupling agents for siliceous surfaces.

Relative Hydrolysis Rates of Hydrolyzable Groups

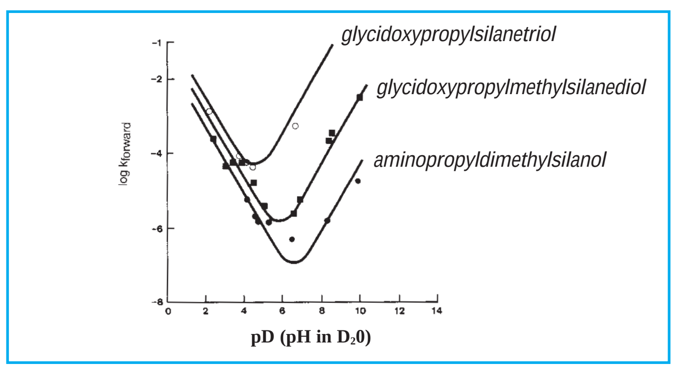


Hydrolysis Profile of Phenylbis(2-methoxyethoxy)silanol

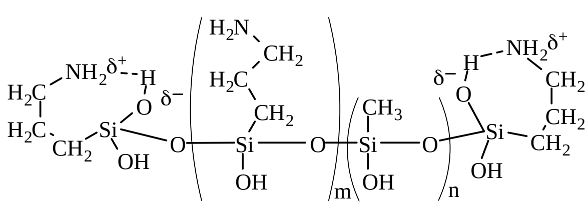


F. Osterholtz et al in Silanes and Other Coupling Agents ed K. Mittal, VSP, 1992, p119

Profile for Condensation of Silanols to Disiloxanes



E. Pohl et al in Silanes Surfaces and Interfaces ed., D. Leyden, Gordon and Breach, 1985, p481.



Water-borne Silsesquioxane Oligomers

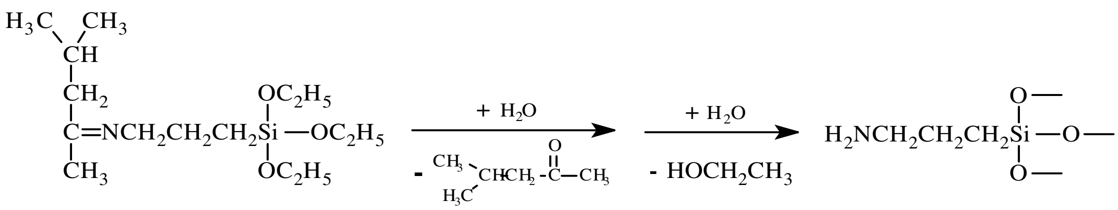
Code	Functional Group	Mole %	Molecular Weight	Weight % in solution
WSA-7011	Aminopropyl	65-75	250-500	25-28
WSA-9911	Aminopropyl	100	270-550	22-25
WSA-7021	Aminoethylaminopropyl	65-75	370-650	25-28
WSAV-6511	Aminopropyl, Vinyl	60-65	250-500	25-28

Masked Silanes - Latent Functionality

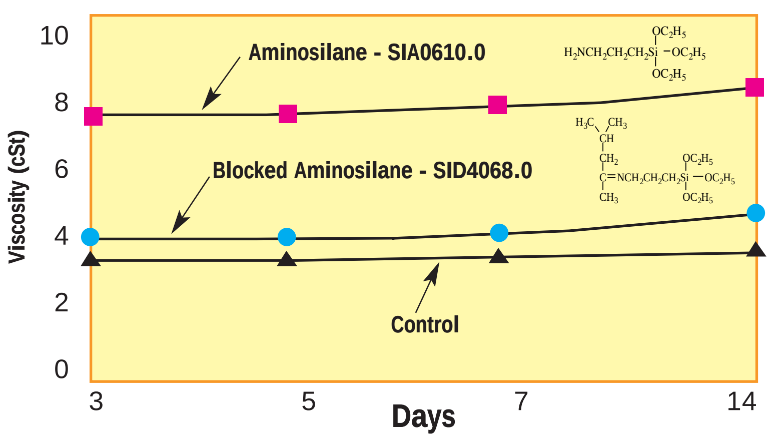
Maximum bond strength in some adhesion and bonding systems requires that the organic functionality of a silane coupling agent becomes available during a discrete time period of substrate - matrix contact. Examples are epoxy adhesives in which reaction of the silane with the resin increases viscosity of an adhesive to the extent that substrate wet-out is inhibited and pretreated fillers for composites which can react prematurely with moisture before melt compounding or vulcanization. A general approach is to mask the organic functionality of the silane which converts it to a storage-stable form and then to trigger the demasking with moisture, or heat concomitant with bonding or composite formation.

Masked Silanes - Moisture Triggered

Single-component liquid-cure epoxy adhesives and coatings employ dimethylbutylidene blocked amino silanes. These materials show excellent storage stability in resin systems, but are activated by moisture provided by water adsorbed on substrate surfaces or from humidity. Deblocking begins in minutes and is generally complete within two hours in sections with a diffusional thickness of less than 1mm.



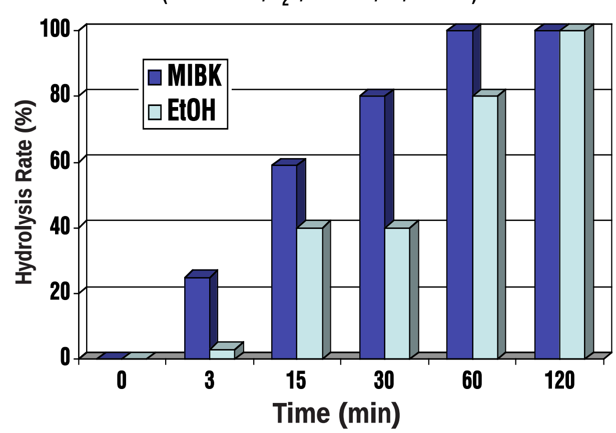
Storage Stability of Epoxy Coating Solutions
with blocked and unblocked aminosilanes



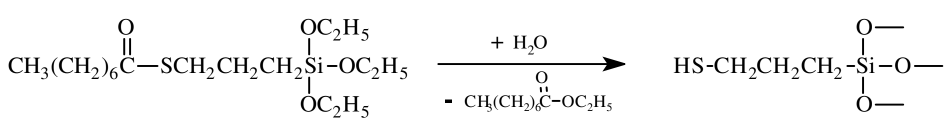
Epoxy Resin Solution: 50 parts bisphenol A epoxide, 5 parts SID4068.0 or SIA0610.0, 50 parts toluene.

Hydrolysis of Blocked Aminosilane

($SID4068.0/H_2O/THF = 1/10/20wt\%$)

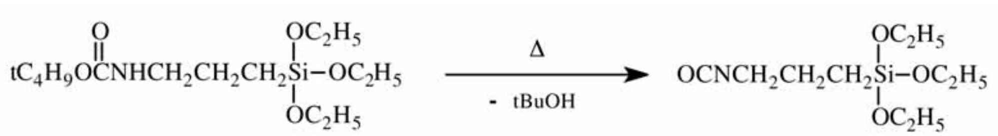


An alternative is to use the moisture adsorbed onto fillers to liberate alcohol which, in turn, demasks the organic functionality.



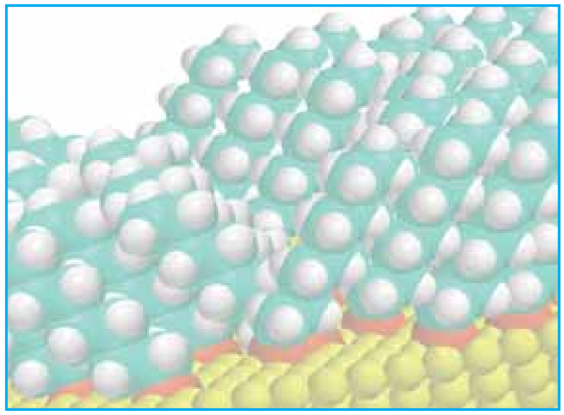
Masked Silanes - Heat Triggered

Isocyanate functionality is frequently delivered to resin systems during elevated temperature bonding or melt processing steps. Demasking temperatures are typically 160-200°C.



Coupling Agents for Metal Substrates

The optimum performance of silane coupling agents is associated with siliceous substrates. While the use of silanes has been extended to metal substrates, both the effectiveness and strategies for bonding to these less-reactive substrates vary. Four approaches of bonding to metals have been used with differing degrees of success. In all cases, selecting a dipodal or polymeric silane is preferable to a conventional trialkoxy silane.

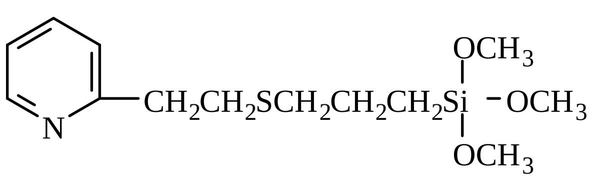


Octysilane adsorbed on titanium — figure courtesy of M. Banazak-Holl

Metals that form hydrolytically stable surface oxides, e.g. aluminum, tin, titanium. These oxidized surfaces tend to have sufficient hydroxyl functionality to allow coupling under the same conditions applied to the siliceous substrates discussed earlier.

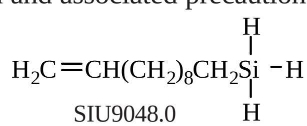
Metals that form hydrolytically or mechanically unstable surface oxides, e.g. iron, copper, zinc. These oxidized surfaces tend to dissolve in water leading to progressive corrosion of the substrate or form a passivating oxide layer without mechanical strength. The successful strategies for coupling to these substrates typically involves two or more silanes. One silane is a chelating agent such as a diamine, polyamine or polycarboxylic acid. A second silane is selected which has a reactivity with the organic component and reacts with the first silane by co-condensation. If a functional dipodal or polymeric silane is not selected, 10-20% of a non-functional dipodal silane typically improves bond strength.

Metals that do not readily form oxides, e.g. nickel, gold and other precious metals. Bonding to these substrates requires coordinative bonding, typically a phosphine, sulfur (mercapto), or amine functional silane. A second silane is selected which has a reactivity with the organic component. If a functional dipodal or polymeric silane is not selected, 10-20% of a non-functional dipodal silane typically improves bond strength.



SIP6926.2

Metals that form stable hydrides, e.g. titanium, zirconium, nickel. In a significant departure from traditional silane coupling agent chemistry, the ability of certain metals to form so-called amorphous alloys with hydrogen is exploited in an analogous chemistry in which hydride functional silanes adsorb and then coordinate with the surface of the metal. Most silanes of this class possess only simple hydrocarbon substitution such as octylsilane. However they do offer organic compatibility and serve to markedly change wet-out of the substrate. Both hydride functional silanes and treated metal substrates will liberate hydrogen in the presence of base or with certain precious metals such as platinum and associated precautions must be taken. *(see p 53.)*



SIU9048.0

Coupling Agents for Metals*

Metal	Class	Screening Candidates	
Copper	Amine	SSP-060	SIT8398.0
Gold	Sulfur	SIT7908.0	SIP6926.2
	Phosphorus	SID4558.0	SIB1091.0
Iron	Amine	SIB1834.0	WSA-7011
	Sulfur	SIB1824.6	SIM6476.0
Tin	Amine	SIB1835.5	
Titanium	Epoxy	SIG5840.0	SIE6668.0
	Hydride	SIU9048.0	
Zinc	Amine	SSP-060	SIT8398.0
	Carboxylate	SIT8402.0	SIT8192.6

*These coupling agents are almost always used in conjunction with a second silane with organic reactivity or a dipodal silane.

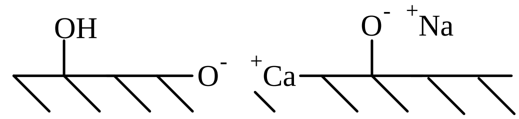
Difficult Substrates

Silane coupling agents are generally recommended for applications in which an inorganic surface has hydroxyl groups and the hydroxyl groups can be converted to stable oxane bonds by reaction with the silane. Substrates such as calcium carbonate, copper and ferrous alloys, and high phosphate and sodium glasses are not recommended substrates for silane coupling agents. In cases where a more appropriate technology is not available a number of strategies have been devised which exploit the organic functionality, film-forming and crosslinking properties of silane coupling agents as the primary mechanism for substrate bonding in place of bonding through the silicon atom. These approaches frequently involve two or more coupling agents.

Calcium carbonate fillers and marble substrates do not form stable bonds with silane coupling agents. Applications of mixed silane systems containing a dipodal silane or tetraethoxysilane in combination with an organofunctional silane frequently increases adhesion. The adhesive mechanism is thought to be due to the low molecular weight and low surface energy of the silanes which allows them initially to spread to thin films and penetrate porous structures followed by the crosslinking which results in the formation of a silica-rich encapsulating network. The silica-rich encapsulating network is then susceptible to coupling chemistry comparable to siliceous substrates. Marble and calciferous substrates can also benefit from the inclusion of anhydride-functional silanes which, under reaction conditions, form dicarboxylates that can form salts with calcium ions.

Metals and many metal oxides can strongly adsorb silanes if a chelating functionality such as diamine or dicarboxylate is present. A second organofunctional silane with reactivity appropriate to the organic component must be present. Precious metals such as gold and rhodium form weak coordination bonds with phosphine and mercaptan functional silanes.

High phosphate and sodium content glasses are frequently the most frustrating substrates. The primary inorganic constituent is silica and would be expected to react readily with silane coupling agents. However alkali metals and phosphates not only do not form hydrolytically stable bonds with silicon, but, even worse, catalyze the rupture and redistribution of silicon-oxygen bonds. The first step in coupling with these substrates is the removal of ions from the surface by extraction with deionized water. Hydrophobic dipodal or multipodal silanes are usually used in combination with organofunctional silanes. In some cases polymeric silanes with multiple sites for interaction with the substrate are used. Some of these, such as the polyethylenimine functional silanes can couple to high sodium glasses in an aqueous environment.



Substrates with low concentrations of non-hydrogen bonded hydroxyl groups, high concentrations of calcium, alkali metals or phosphates pose challenges for silane coupling agents.

Removing Surface Impurities

Eliminating non-bonding metal ions such as sodium, potassium and calcium from the surface of substrates can be critical for stable bonds. Substrate selection can be essential. Colloidal silicas derived from tetraethoxysilane or ammonia sols perform far better than those derived from sodium sols. Bulk glass tends to concentrate impurities on the surface during fabrication. Although sodium concentrations derived from bulk analysis may seem acceptable, the surface concentration is frequently orders of magnitude higher. Surface impurities may be reduced by immersion in 5% hydrochloric acid for 4 hours, followed by a deionized water rinse, and then immersion in deionized water overnight followed by drying.

Oxides with high isoelectric points can adsorb carbon dioxide, forming carbonates. These can usually be removed by a high temperature vacuum bake.

Increasing Hydroxyl Concentration

Hydroxyl functionalization of bulk silica and glass may be increased by immersion in a 1:1 mixture of 50% aqueous sulfuric acid : 30% hydrogen peroxide for 30 minutes followed by rinses in D.I. water and methanol and then air drying. Alternately, if sodium ion contamination is not critical, boiling with 5% aqueous sodium peroxodisulfate followed by acetone rinse is recommended[1].

1. K. Shirai et al, J. Biomed. Mater. Res. *53*, 204, 2000.

Catalyzing Reactions in Water-Free Environments

Hydroxyl groups without hydrogen bonding react slowly with methoxy silanes at room temperature. Ethoxy silanes are essentially non-reactive. The methods for enhancing reactivity include transesterification catalysts and agents which increase the acidity of hydroxyl groups on the substrate by hydrogen bonding. Transesterification catalysts include tin compounds such as dibutyldiacetoxytin and titanates such as titanium isopropoxide. Incorporation of transesterification catalysts at 2-3 weight % of the silane effectively promotes reaction and deposition in many instances. Alternatively, amines can be premixed with solvents at 0.01-0.5 weight % based on substrate prior or concurrent to silane addition. Volatile primary amines such as butylamine can be used, but are not as effective as tertiary amines such as benzyldimethylamine or diamines such as ethylenediamine. The more effective amines, however, are more difficult to remove after reaction[1].

1. S. Kanan et al, Langmuir, *18*, 6623, 2002.

Hydroxylation by Water Plasma & Steam Oxidation

Various metals and metal oxides including silicon and silicon dioxide can achieve high surface concentrations of hydroxyl groups after exposure to H_2O/O_2 in high energy environments including steam at 1050° and water plasma[1].

1. N. Alcanter et al, in "Fundamental & Applied Aspects of Chemically Modified Surfaces" ed. J. Blitz et al, 1999, Roy. Soc. Chem., p212.

Applying Silanes

Deposition from aqueous alcohol solutions is the most facile method for preparing silylated surfaces. A 95% ethanol-5% water solution is adjusted to pH 4.5-5.5 with acetic acid. Silane is added with stirring to yield a 2% final concentration. Five minutes should be allowed for hydrolysis and silanol formation. Large objects, e.g. glass plates, are dipped into the solution, agitated gently, and removed after 1-2 minutes. They are rinsed free of excess materials by dipping briefly in ethanol. Particles, e.g. fillers and supports, are silylated by stirring them in solution for 2-3 minutes and then decanting the solution. The particles are usually rinsed twice briefly with ethanol. Cure of the silane layer is for 5-10 mins at 110°C or 24 hours at room temperature (<60% relative humidity).

Fig. 1 Reactor for slurry treatment of powders. Separate filtration and drying steps are required.

Deposition from aqueous solution is employed for most commercial fiberglass systems. The alkoxysilane is dissolved at 0.5-2.0% concentration in water. For less soluble silanes, 0.1% of a non-ionic surfactant is added prior to the silane and an emulsion rather than a solution is prepared. The solution is adjusted to pH 5.5 with acetic acid. The solution is either sprayed onto the substrate or employed as a dip bath. Cure is at 110-120°C for 20-30 minutes.
Stability of aqueous silane solutions varies from 2-12 hours for the simple alkyl silanes.
Poor solubility parameters limit the use of long chain alkyl and aromatic silanes by this method.
Distilled water is not necessary, but water containing fluoride ions must be avoided.

Bulk deposition onto powders, e.g. filler treatment, is usually accomplished by a spray-on method. It assumes that the total amount of silane necessary is known and that sufficient adsorbed moisture is present on the filler to cause hydrolysis of the silane. The silane is prepared as a 25% solution in alcohol. The powder is placed in a high intensity solid mixer, e.g. twin cone mixer with intensifier. The methods are most effective. If the filler is dried in trays, care must be taken to avoid wicking or skinning of the top layer of treated material by adjusting heat and air flow.

Fig. 2 Vacuum tumble dryers can be used for slurry treatment of powders.

Integral blend methods are used in composite formulations. In this method the silane is used as a simple additive. Composites can be prepared by the addition of alkoxysilanes to dry-blends of polymer and filler prior to compounding. Generally 0.2 to 1.0 weight percent of silane (of the total mix) is dispersed by spraying the silane in an alcohol carrier onto a pre-blend. The addition of the silane to non-dispersed filler is not desirable in this technique since it can lead to agglomeration. The mix is dry-blended briefly and then melt compounded. Vacuum devolatization of byproducts of silane reaction during melt compounding is necessary to achieve optimum properties. Properties are sometimes enhanced by adding 0.5-1.0% of tetrabutyl titanate or benzyldimethylamine to the silane prior to dispersal.

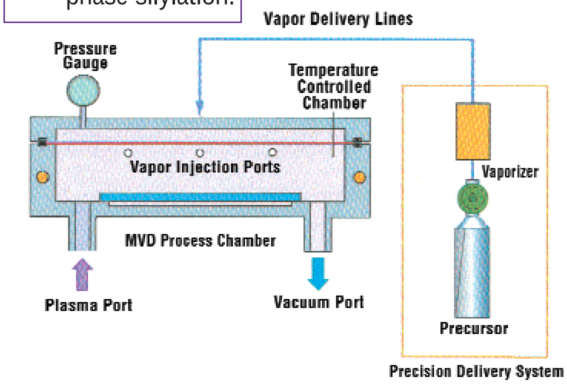
Anhydrous liquid phase deposition of chlorosilanes, methoxysilanes, aminosilanes and cyclic azasilanes is preferred for small particles and nano-featured substrates. Toluene, tetrahydrofuran or hydrocarbon solutions are prepared containing 5% silane. The mixture is refluxed for 12-24 hours with the substrate to be treated. It is washed with the solvent. The solvent is then removed by air or explosion-proof oven drying. No further cure is necessary. This reaction involves a direct nucleophilic displacement of the silane chlorines by the surface silanol. If monolayer deposition is desired, substrates should be predried at 150°C for 4 hours. Bulk deposition results if adsorbed water is present on the substrate. This method is cumbersome for large scale preparations and rigorous controls must be established to ensure reproducible results. More reproducible coverage is obtained with monochlorosilanes.

Fig. 3 Twin-cone blenders with intensive mixing bars are used for bulk deposition of silanes onto powders.

Chlorosilanes can also be deposited from alcohol solution. Anhydrous alcohols, particularly ethanol or isopropanol are preferred. The chlorosilane is added to the alcohol to yield a 2-5% solution. The chlorosilane reacts with the alcohol producing an alkoxysilane and HCl. Progress of the reaction is observed by halt of HCl evolution. Mild warming of the solution (30-40°C) promotes completion of the reaction. Part of the HCl reacts with the alcohol to produce small quantities of alkyl halide and water. The water causes formation of silanols from alkoxysilanes. The silanols condense on the substrate. Treated substrates are cured for 5-10 mins. at 110°C or allowed to stand 24 hours at room temperature.

Applying Silanes

Figure 4. Apparatus for vapor phase silylation.



Vapor Phase Deposition

Silanes can be applied to substrates under dry aprotic conditions by chemical vapor deposition methods. These methods favor monolayer deposition. Although under proper conditions almost all silanes can be applied to substrates in the vapor phase, those with vapor pressures >5 torr at 100°C have achieved the greatest number of commercial applications. In closed chamber designs, substrates are supported above or adjacent to a silane reservoir and the reservoir is heated to sufficient temperature to achieve 5mm vapor pressure. Alternatively, vacuum can be applied until silane evaporation is observed. In still another variation the silane can be prepared as a solution in toluene, and the toluene brought to reflux allowing sufficient silane to enter the vapor phase through partial pressure contribution. In general, substrate temperature should be maintained above 50° and below 120° to promote reaction. Cyclic azasilanes deposit the quickest-usually less than 5 minutes. Amine functional silanes usually deposit rapidly (within 30 minutes) without a catalyst. The reaction of other silanes requires extended reaction times, usually 4-24 hours. The reaction can be promoted by addition of catalytic amounts of amines.

Figure 5. Spin-coater for deposition on wafers.

Spin-On

Spin-On applications can be made under hydrolytic conditions which favor maximum functionalization and polylayer deposition or dry conditions which favor monolayer deposition. For hydrolytic deposition 2-5% solutions are prepared (see deposition from aqueous alcohol). Spin speed is low, typically 500 rpm. Following spin-deposition a hold period of 3-15 minutes is required before rinse solvent. Dry deposition employs solvent solutions such as methoxypropanol or ethyleneglycol monoacetate (EGMA). Aprotic systems utilize toluene or THF. Silane solutions are applied at low speed under a nitrogen purge. If strict monolayer deposition is preferred, the substrate should be heated to 50°. In some protocols, limited polylayer formation is induced by spinning under an atmospheric ambient with 55% relative humidity.

Figure 6. Spray application of silanes on large structures.

Spray application

Formulations for spray applications vary widely depending on end-use. They involve alcohol solutions and continuously hydrolyzed aqueous solutions employed in architectural and masonry applications. The continuous hydrolysis is effected by feeding mixtures of silane containing an acid catalyst such as acetic acid into a water stream by means of a venturi (aspirator). Stable aqueous solutions (see water-borne silanes), mixtures of silanes with limited stability (4-8 hours) and emulsions are utilized in textile and fiberglass applications. Complex mixtures with polyvinyl acetates or polyesters enter into the latter applications as sizing formulations.

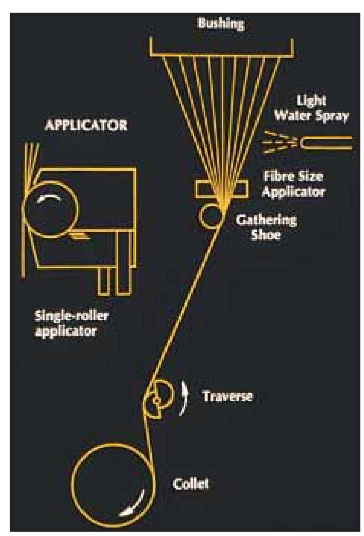
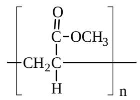
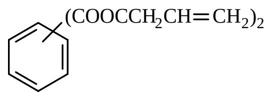
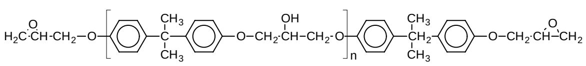
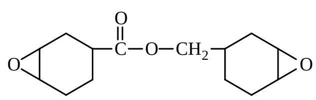
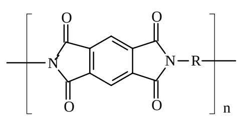
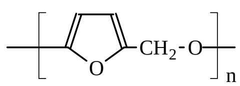
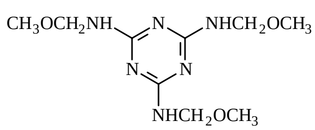
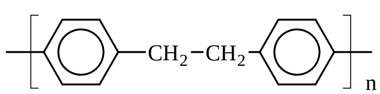
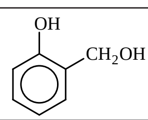
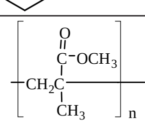
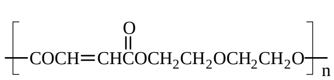
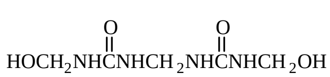
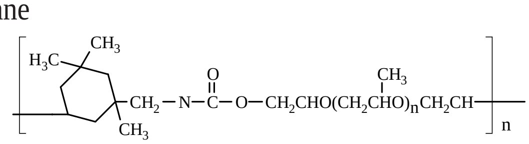


Figure 7. Spray & contact roller application of silanes on fiberglass.

Acrylate-silanes in dental restorative composites.

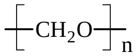
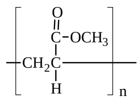
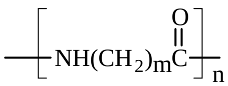
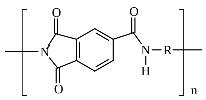
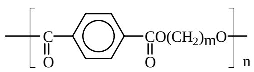
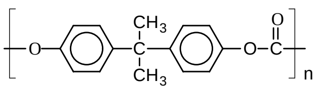
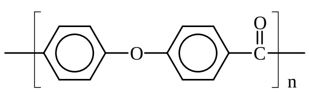
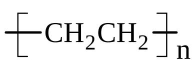
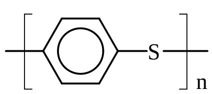
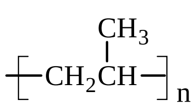
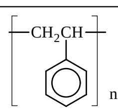
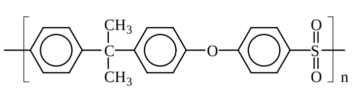
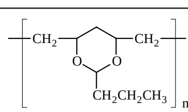
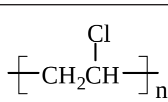
Silane Coupling Agents for Thermosets

Selection Chart

Thermoset	Structure	Coupling Agent Class	Suggestions for Primary Screening	
Acrylate, UV cure		Acrylate	SIA0200.0	SIM6487.4
		Vinyl/Olefin	SIS6964.0	
Diallylphthalate		Amine	SIA0591.0	SIA0610.0
		Vinyl/Olefin	SIS6964.0	
Epoxy		Amine	SIA0591.0	SIT8398.0
		Anhydride	SIT8192.6	
		Epoxy	SIG5840.0	
Epoxy, UV Cure		Amine	SIA0591.0	SIT8398.0
		Epoxy	SIE4668.0	SIE4670.0
Polyimide		Amine	SIA0599.2	SIA0591.0
		Halogen	SIC2295.5	SIC2296.2
		Dipodal	SIB1833.0	
Furan		Amine	SIA0611.0	SIA0599.0
		Epoxy	SIG5840.0	
Melamine		Amine	SIA0611.0	SIA0599.0
		Hydroxyl	SIB1140.0	
		Dipodal	SIB1833.0	SIT8717.0
Parylene		Halogen	SIC2295.5	
		Vinyl/Olefinic	SIS6990.0	SIM6487.4
		Dipodal	SIB1832.0	VMM-010
Phenol-formaldehyde		Amine	SIA0611.0	SIT8187.5
		Epoxy	SIE4670.0	SIG5840.0
Methylmethacrylate, cast		Acrylate	SIM6487.4	SIA0200.0
		Amine	SIB1828.0	
Polyester, unsaturated		Acrylate	SIM6487.4	
		Vinyl/Olefin	SIS6994.0	SIV9112.0
Urea-formaldehyde		Amine	SIA0610.0	SIU9055.0
		Hydroxyl	SIB1140.0	
Urethane		Amine	SIA0610.0	SIM6500.0
		Isocyanate	SII6455.0	
		Sulfur	SIM6476.0	

Diamine-silanes couple polycarbonate in CDs

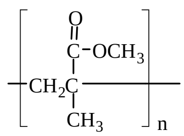
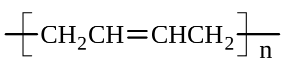
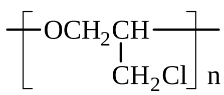
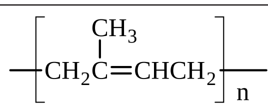
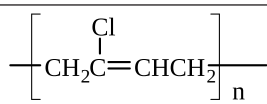
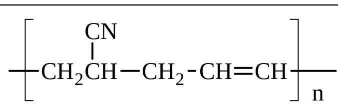
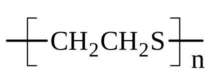
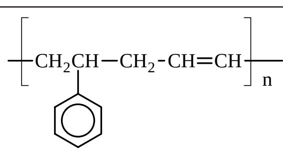
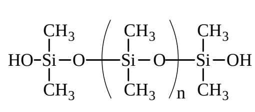
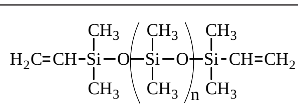
Silane Coupling Agents for Thermoplastics
Selection Chart

		Coupling Agent Class	Suggestions for Primary Screening	
Polyacetal		Vinyl/Olefin	SIS6994.0	
Polyacrylate		Amine	SIU9058.0	SIA0610.0
Polyamide		Amine Dipodal Water-borne	SIA0610.0 SIB1834.1 WSA-7011	SIA0614.0 SSP-060
Polyamide-imide		Amine Halogen	SIA0610.0 SIC2295.5	
Polybutylene terephthalate		Amine Isocyanate	SIA0610.0 SII6455.0	
Polycarbonate		Amine	SIA0591.0	SIA0610.0
Polyether ketone		Amine Dipodal	SIA0591.0 SIT8717.0	
Polyethylene		Amine Vinyl/Olefin	SIA0591.0 SSP-055	SIT8398.0 SIV9112.0
Polyphenylene sulfide		Amine Halogen Sulfur	SIA0605.0 SIC2295.5 SIM6476.0	
Polypropylene		Acrylate Azide Vinyl/Olefin	SIM6487.4 SIA0780.0 VEE-005	 SSP-055
Polystyrene		Acrylate Dipodal	SIM6487.4 SIB1831.0	
Polysulfone		Amine	SIA0591.0	SIU9055.0
Polyvinyl butyral		Amine	SIA0611.0	SIU9058.0
Polyvinyl chloride		Amine Sulfur	SIA0605.0 SIM6474.0	 SIB1825.0

Silane Coupling Agents for Sealants & Elastomers

Selection Chart

Water-borne aminosilanes increase bonding of acrylic latex sealants

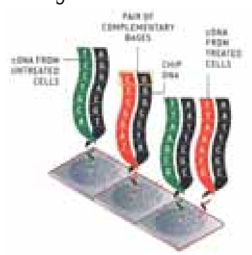
		Coupling Agent Class	Suggestions for Primary Screening	
Acrylic latex		Acrylate Vinyl/Olefin Water-borne	SIM6487.4 SIV9210.0 WSA-7021	 SIV9218.0 WSA-6511
Butyl		Acrylate Sulfur Vinyl/Olefin	SIM6487.4 SIB1825.0 SSP-055	 SIM6476.0 VEE-005
Epichlorohydrin		Amine Sulfur	SIA0605.0 SIM6474.0	
Fluorocarbon	$-(CF_2CF_2)_m(CH_2CF_2)_n-$	Amine Dipodal	SIB1834.1 SIT8717.0	
Isoprene		Sulfur Vinyl/Olefin	SIM6474.0 SSP-055	SIM6476.0 VEE-005
Neoprene		Sulfur Vinyl/Olefin	SIM6474.0 SSP-055	SIM6476.0 VEE-005
Nitrile		Epoxy Sulfur	SIG5840.0 SIB1825.0	
Polysulfide		Epoxy Sulfur	SIG5840.0 SIB1825.0	 SIM6476.0
SBR		Amine Sulfur	SIA0605.0 SIB1825.0	 SIM6486.0
Silicone (hydroxyl terminated)		Amine Vinyl/Olefin Dipodal	SIA0605.0 SIV9098.0 SIB1824.0	SIA0589.0 VMM-010
Silicone (vinyl terminated)		Acrylate Vinyl/Olefin	SIM6487.4 SIA0540.0	 VMM-010

aldehyde-, amino-, and hydroxyl-silanes couple DNA in array technology

Silane Coupling Agents for Biomaterials

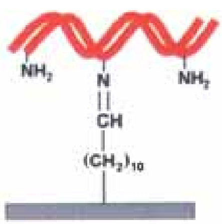
Selection Chart

	Site/Type	*Coupling Class*	*Co-reactant*	*Suggestions for Screening*	
Oligonucleotides		*hydroxyl*		*SIB1140.0*	
		diamine	*cobalt ethylenediamine*	*SIA0591.0*	



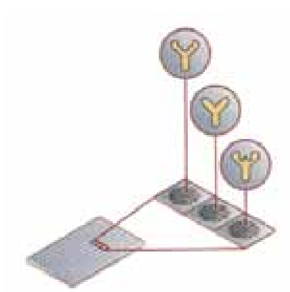
G. McGall et al, J. Am. Chem. Soc., *119*, 5081, 1997. **F. Chow**, in "Silylated Surfaces" D. Leyden ed., Gordon & Breach, 1978, p.301.

	Site/Type	*Coupling Class*	*Co-reactant*	*Suggestions for Screening*	
DNA	*terminal favored*	*vinyl/olefin*		*SIO6708.0*	*SIU9049.0*
	pendant amine	*aldehyde*		*SIT8194.0*	
	pendant amine	*diamine*		*SIA0594.0*	*SID3543.0*
	pendant amine	*epoxy*		*SIE4675.0*	*SIG5838.0*



A. Bensimon, Science, *265*, 2096, 1994. **J. Grobe** et al, J. Chem. Soc. Chem. Commun, 2323, 1995. **C. Kneuer** et al, Int'l J. Pharmaceutics, *196(2)*, 257, 2000.

	Site/Type	*Coupling Class*	*Co-reactant*	*Suggestions for Screening*	
Protein	*lysine*	*aldehyde*		*SIT8194.0*	
	lysine	*amine*	*glutaraldehyde*	*SIA0611.0*	*SIA0595.0*
	lysine	*amine*	*thiophosgene*	*SIA0611.0*	
	cysteine	*sulfur*	*dithionite*	*SIM6476.0*	
	tyrosine	*nitrobenzamide*	*$NaNO_2$/HCl*	*SIT8191.0*	*SIA0599.0*
	heparinated	*amine/quat*		*SSP-060*	*SIT8415.0*
	immunoglobin	*pyridyl-thio*		*SIP6926.4*	
	antibody	*cyano*		*SIC2456.0*	



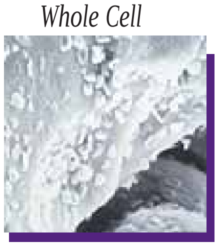
J. Grobe et al, J. Chem. Soc. Chem. Commun, 2323, 1995. **H. Weetall**, US Pat. 3,652,761. **G. Royer**, CHEMTECH, *4*, 699, 1974. **S. Bhatia** et al, Anal. Biochem., *178*, 408, 1989. **J. Venter** et al, Proc. Nat. Acad. Soc., *69(5)*, 1141, 1972. **R. Merker** et al, Proc. Artificial Heart Prog. Conf., June 9-13, 1969 HEWNIH, p29. **S. Falipou**, Fundamental & Applied Aspects of Chemically Modified Surfaces, p389, 1999.

	Site/Type	*Coupling Class*	*Co-reactant*	*Suggestions for Screening*
Cell-Organelle	*chloroplast*	*alkyl*		*SIO6645.0*
	mitochondria	*alkyl*		*SIO6645.0*

mitochondria on silica bead

B. Arkles et al, in "Silylated Surfaces" D. Leyden ed., Gordon & Breach, 1978, p363. **B. Arkles** et al, J. Biol. Chem., *250*, 8856, 1975.

	Site/Type	*Coupling Class*	*Co-reactant*	*Suggestions for Screening*
Whole Cell	*erythrocytes*	*short alkyl*		*SIE4901.4*



erythrocytes on glass wall

B. Arkles et al, in "Silylated Surfaces" D. Leyden ed., Gordon & Breach, 1978, p363.

	Site/Type	*Coupling Class*	*Co-reactant*	*Suggestions for Screening*	
Whole Cell (causing lysis)	*procaryotic*	*alkyl-quat*		*SIO6620.0*	
				SID3392.0	
Tissue	*histological samples*			*SIA0611.0*	*SIA0610.0*

W. White et al in "Silanes, Surfaces & Interfaces" ed. D. Leyden, Gordon & Breach, 1986, p. 107.

Gelest

SILANE COUPLING AGENT PROPERTIES

Lactase is immobilized with aminosilanes and glutaraldehyde.

Acrylate & Methacrylate functional 26
Aldehyde functional 27
Amino functional 28
Anhydride functional. 36
Azide functional 36
Carboxylate, Phosphonate and Sulfonate functional 36
Epoxy functional. 37
Ester functional. 38
Halogen functional 38
Hydroxyl functional. 40
Isocyanate and Masked Isocyanate functional. 41
Phosphine and Phosphate functional 42
Sulfur functional. 43
Vinyl and Olefin functional 45
Multi-functional and Polymeric Silanes. 49
Water-borne Coupling Agents 49
Non-functional Dipodal Silanes. 50
UV Active and Fluorescent Silanes. 51
Chiral Silanes 52
Biomolecular Probes 53
Silyl Hydrides 53

Epoxy-silanes are essential for performance of epoxy resin encapsulants for microchips.

Methacrylate-silanes couple fiberglass to unsaturated polyester in corroson resistant rooftop ductwork at Gelest, Inc.

Commercial Status - produced on a regular basis for inventory

Developmental Status - available to support development and commercialization

AZmax TEL: 03-5543-1630 | FAX: 03-5543-0312 | www.azmax.co.jp
(215) 547-1015 | FAX: (215) 547-2484 | www.gelest.com

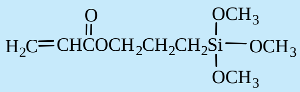
Methacrylate-silanes couple fiberglass to unsaturated polyester

Acrylate & Methacrylate Functional Silanes

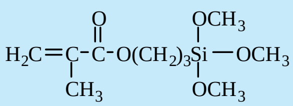
name	MW	bp/mm (mp)	D_4^{20}	n_D^{20}

Acrylate & Methacrylate Functional Silanes - Trialkoxy

Commercial

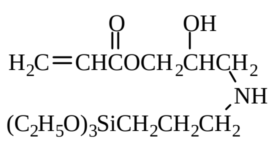


SIA0200.0
(3-ACRYLOXYPROPYL)TRIMETHOXYSILANE, 95% inhibited with MEHQ — MW 234.32 — bp 68°/0.4 — D_4^{20} 1.00 — n_D^{20} 1.4155
flashpoint: 123°C (253°F)
$C_9H_{18}O_5Si$
aqueous solutions more stable than methacrylate analog
coupling agent for epoxies, UV cure coatings; employed in optical fiber coatings[1].
1. M. Yokoshima et al, CA113, 15746d; Jap. Pat. 02133338, 1990
[4369-14-6] TSCA-S HMIS: 3-1-1-X store <5° — 25g/¥21,600 100g/¥70,200 2.0kg/¥203,000

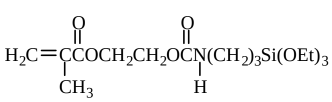


SIM6487.4
METHACRYLOXYPROPYLTRIMETHOXYSILANE *MEMO* inhibited with MEHQ, HQ — MW 248.35 — bp 78-81°/1 (-48°)mp — D_4^{20} 1.045 — n_D^{20} 1.4310
$C_{10}H_{20}O_5Si$
TOXICITY- oral rat, LD50: 3,000mg/kg
viscosity: 2 cSt.
flashpoint: 108°C (226°F)
Primary Irritation Index: 1.19
copolymerization parameters-e,Q: 0.07, 2.7
specific wetting surface: 314m²/g
widely used coupling agent for unsaturated polyester-fiberglass composites[1].
copolymerized with styrene in formation of sol-gel composites[2].
1. B. Arkles, Chemtech, *7*, 713, 1977
2. Y. Wei et al, J. Mater. Res., *8*, 1143, 1993
[2530-85-0] TSCA HMIS: 3-2-1-X store <5° — 100g/¥4,400 1kg/¥8,800

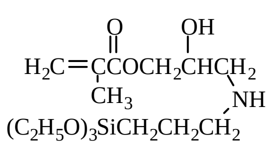
Developmental



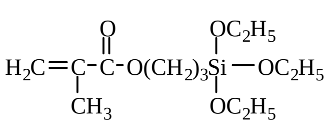
SIA0180.0
N-(3-ACRYLOXY-2-HYDROXYPROPYL)-3-AMINOPROPYLTRIETHOXYSILANE, 50% in ethanol — MW 349.50 — D_4^{20} 0.931 — n_D^{20} 1.4084
$C_{15}H_{31}NO_6Si$ inhibited with MEHQ
flashpoint: 8°C (48°F)
[123198-57-2] HMIS: 3-4-1-X store <5° — 25g/¥63,000



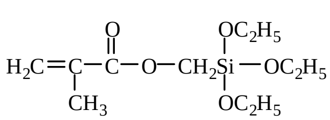
SIM6480.8
O-(METHACRYLOXYETHYL)-N-(TRIETHOXYSILYLPROPYL)URETHANE, 90% — MW 377.51 — inhibited with MEHQ — D_4^{25} 1.051 — n_D^{25} 1.446
$C_{16}H_{31}NO_7Si$
HYDROLYTIC SENSITIVITY: 7 Si-OR reacts slowly with water/moisture
[115396-93-5] HMIS: 3-2-1-X store <5° — 25g/¥18,900 100g/¥61,200



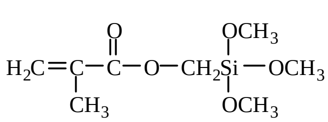
SIM6481.1
N-(3-METHACRYLOXY-2-HYDROXYPROPYL)-3-AMINOPROPYLTRIETHOXYSILANE, 50% in ethanol — MW 363.53 — D_4^{20} 0.91 — n_D^{20} 1.4084
$C_{16}H_{33}NO_6Si$ inhibited with MEHQ
flashpoint: 8°C (48°F)
employed in conservation/consolidation of stone[1].
1. G. Wheeler, in "Ninth Int'l Cong. on Deteriorat'n and Conservat'n of Stone "ed. V Fassina, *2*, 541, Elsevier 2000.
[96132-98-8] HMIS: 3-4-1-X store <5° — 25g/¥22,100 100g/¥72,000



SIM6487.3
METHACRYLOXYPROPYLTRIETHOXYSILANE — MW 290.43 — bp 130°/4 — D_4^{20} 0.985 — n_D^{20} 1.4277
$C_{13}H_{26}O_5Si$ inhibited with MEHQ
flashpoint: 128°C (262°F)
[21142-29-0] HMIS: 3-1-1-X store <5° — 10g/¥17,600 50g/¥70,200



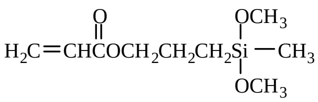
SIM6482.0
METHACRYLOXYMETHYLTRIETHOXYSILANE — MW 262.38 — bp 65-8°/2
$C_{11}H_{22}O_5Si$ inhibited with MEHQ
treatment of fumed silica in acrylic casting compositions accelerates polymerization[1].
1. E. Morozova et al, CA 95,98753g; Plast. Massy, 7, 1981
[5577-72-0] HMIS: 3-2-1-X store <5° — 10g/¥18,000 50g/¥72,000



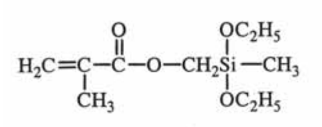
SIM6483.0
METHACRYLOXYMETHYLTRIMETHOXYSILANE — MW 220.30 — bp 48-50°/2 — D_4^{20} 1.07 — n_D^{20} 1.4271
$C_8H_{16}O_5Si$ inhibited with MEHQ
modification of novolac resins afford bilevel resists having attributes of trilevel resists[1].
1. E. Reichmanis et al, US Pat. 4,481,049,1984
[54586-78-6] HMIS: 3-2-1-X store <5° — 10g/¥14,400 50g/¥57,600

name	MW	bp/mm (mp)	D_4^{20}	n_D^{20}

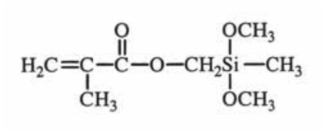
Acrylate & Methacrylate Functional Silanes - Dialkoxy



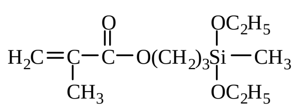
SIA0198.0
(3-ACRYLOXYPROPYL)METHYLDIMETHOXY SILANE, 95% inhibited w/ MEHQ — MW 218.33 — bp 65°/0.35 — D_4^{20} 1.0 — n_D^{20} 1.431
$C_9H_{18}O_4Si$
employed in fabrication of photoimageable, low shrinkage multimode waveguides[1].
1. C. Xu et al, Chem. Mater., *8*, 2701, 1996
[13732-00-8] HMIS: 3-2-1-X store <5° — 50g/¥20,700 — 250g/¥82,800



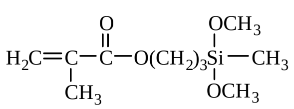
SIM6481.43
(METHACRYLOXYMETHYL)METHYL-DIETHOXYSILANE — MW 232.4 — bp 221° — D_4^{20} 0.977
$C_{10}H_{20}O_4Si$
flashpoint: 88°C (190°F)
TOXICITY oral-rat, LD50: >2000mg/kg
[121177-93-3] HMIS: 2-2-1-X store <5° — 25g/¥11,700 — 100g/¥37,800



SIM6481.46
(METHACRYLOXYMETHYL)METHYL-DIMETHOXYSILANE — MW 204.30 — bp 205° — D_4^{20} 1.020 — n_D^{20} 1.4274
$C_8H_{16}O_4Si$
viscosity: 1.4 cSt
flashpoint: 82°C (180°F)
autoignition temp: 300°C
TOXICITY oral-rat, LD50: >2000mg/kg
[3978-58-3] HMIS: 3-2-1-X store <5° — 25g/¥9,900 — 100g/¥32,400

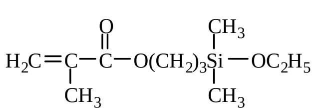


SIM6486.8
METHACRYLOXYPROPYLMETHYLDI-ETHOXYSILANE, 95% inhibited w/ MEHQ — MW 260.40 — bp 95°/1 — D_4^{20} 0.965 — n_D^{20} 1.433
$C_{12}H_{24}O_4Si$
flashpoint 136°C (277°F)
[65100-04-1] HMIS: 3-1-1-X store <5° — 10g/¥17,600 — 50g/¥70,200

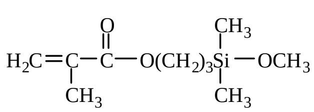


SIM6486.9
METHACRYLOXYPROPYLMETHYLDI-METHOXYSILANE, 95% inhibited w/MEHQ — MW 235.69 — bp 83°/3 — D_4^{20} 1.00 — n_D^{20} 1.4351
$C_{10}H_{20}O_4Si$
flashpoint: 115°C (190°F)
monomer for hybrid inorganic-organic composites[1].
1. R. Taylor-Smith, Polym. Mat. Sci. Eng., Preprints, *77*, 503, 1997
[14513-34-9] HMIS: 3-2-1-X store <5° — 25g/¥20,300 — 100g/¥65,700

Acrylate & Methacrylate Functional Silanes - Monoalkoxy



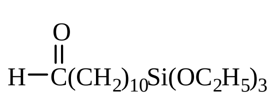
SIM6486.4
METHACRYLOXYPROPYLDIMETHYLETHOXY-SILANE , 95% inhibited with MEHQ — MW 230.38 — bp 75-6°/0.4 — D_4^{20} 0.926 — n_D^{20} 1.4371
$C_{11}H_{22}O_3Si$
[13731-98-1] HMIS: 3-2-1-X store <5° — 10g/¥35,100



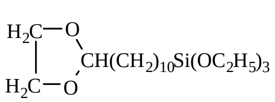
SIM6486.5
METHACRYLOXYPROPYLDIMETHYL-METHOXYSILANE, 95% inhibited with MEHQ — MW 216.35 — bp 70-2°/0.5 — D_4^{20} 0.944 — n_D^{20} 1.4381
$C_{10}H_{20}O_3Si$
[66753-64-8] HMIS: 3-2-1-X store <5° — 10g/¥21,600 — 50g/¥86,400

Aldehyde Functional Silanes

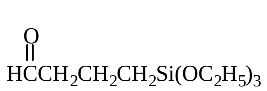
Aldehyde Functional Silanes - Trialkoxy



SIT8194.0
TRIETHOXYSILYLUNDECANAL — MW 332.56 — bp 150-5°/0.5 — n_D^{20} 1.4343
$C_{17}H_{36}O_4Si$ coupling agent for DNA
HMIS: 2-2-1-X — 5.0g/¥49,500



SIT8194.5
TRIETHOXYSILYLUNDECANAL, ETHYLENE GLYCOL ACETAL — MW 366.60 — bp 160-5°/0.25
$C_{19}H_{40}O_5Si$
HMIS: 2-2-1-X — 5.0g/¥49,500



SIT8185.3
TRIETHOXSILYLBUTYRALDEHYDE, tech-90 — MW 234.37 — bp 85-7°/1 — D_4^{20} 0.96 — n_D^{20} 1.414
$C_{10}H_{22}O_4Si$
contains 3-TRIETHOXYSILYL-2-METHYLPROPANAL isomer and cyclic siloxy acetal, 2,2,6-TRIETHOXY-1-OXA-2-SILACYCLOHEXANE
[88276-92-0] HMIS: 3-3-1-X — 10g/¥63,000

Developmental

Developmental

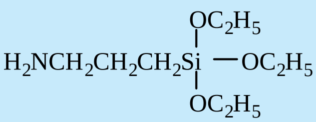
A variety of composite materials utilizing methacrylate and aminosilanes are used in laser-printers.

Amino Functional Silanes

name	MW	bp/mm (mp)	D_4^{20}	n_D^{20}

Monoamine Functional Silanes - Trialkoxy

Commercial



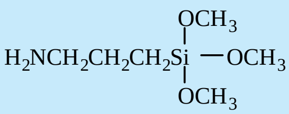
SIA0610.0

3-AMINOPROPYLTRIETHOXYSILANE	221.37	122-3°/30	0.951	1.4225

$C_9H_{23}NO_3Si$ *AMEO, GAPS*
flashpoint: 104°C (220°F)
ΔHvap: 11.8 kcal/mole
viscosity: 1.6 cSt.
versatile coupling agent
effects immobilization of enzymes[1].
1. Enzymes, *84*, 55915, 1976

TOXICITY- oral rat, LD50: 1780mg/kg
primary irritation index: 6.50
γc of treated surface: 37.5 dynes/cm
specific wetting surface: 353m²/g
vapor pressure, 100°: 10mm

[919-30-2] TSCA HMIS: 3-1-1-X — 100g/¥4,400 — 1kg/¥8,800



SIA0611.0

3-AMINOPROPYLTRIMETHOXYSILANE	179.29	80°/8	1.027	1.4240

$C_6H_{17}NO_3Si$ — flashpoint: 83°C (182°F)
hydrolysis rate vs AMEO (SIA0610.0): 6:1 — vapor pressure, 67°: 5mm
[13822-56-5] TSCA HMIS: 3-2-1-X — 25g/¥4,500 — 500g/¥21,600

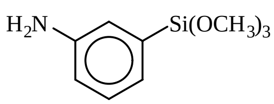
Developmental

$H_2NCH_2CH_2CH_2CH_2Si(OC_2H_5)_3$

SIA0587.0

4-AMINOBUTYLTRIETHOXYSILANE, 95%	235.40	114-6°/14	0.941^{25}	1.4270^{25}

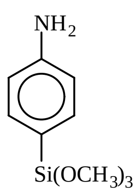
$C_{10}H_{25}NO_3Si$ — flashpoint: 109°C (225°F)
TOXICITY- oral rat, LD50: 1620mg/kg
[3069-30-5] HMIS: 2-2-1-X — 10g/¥16,700 — 50g/¥66,600



SIA0599.0

m-AMINOPHENYLTRIMETHOXYSILANE, 90%	213.31	110-4°/0.6	1.19	1.5187

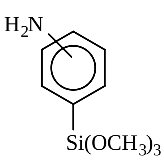
$C_9H_{15}NO_3Si$ contains other isomers — flashpoint: 180°C (356°F)
[70411-42-6] HMIS: 3-1-1-X — 5.0g/¥34,200



SIA0599.1

p-AMINOPHENYLTRIMETHOXYSILANE, 90%	213.31	110-4°/0.6 (60-2°) mp		

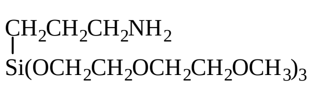
$C_9H_{15}NO_3Si$ contains other isomers
flashpoint: 180°C (356°F)
coupler for silica-poly(phenyleneterephthalamide) composite films.[1]
1. J. Mark et al, J. Mater. Chem. *7*, 259, 1997
[33976-43-1] HMIS: 3-1-1-X — 5.0g/¥36,900



SIA0599.2

AMINOPHENYLTRIMETHOXYSILANE,	213.31	110-4°/0.6	1.19	

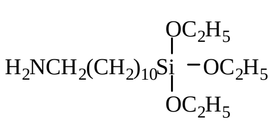
mixed isomers — typically 60-70% para, 30-40% meta
$C_9H_{15}NO_3Si$ — flashpoint: 180°C (356°F)
for pure isomers, see SIA0559.0, SIA0559.1
[33976-43-1] HMIS: 3-1-1-X — 5.0g/¥28,800 — 25g/¥115,000



SIA0614.0

3-AMINOPROPYLTRIS(METHOXYETHOXY-ETHOXY)SILANE, 95%	443.61		1.066	1.448

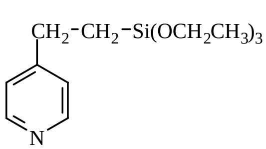
flashpoint: 68°C (155°F)
$C_{18}H_{41}NO_9Si$
for melt compounding of polyamide composites
[87794-64-7] HMIS: 3-2-1-X — 25g/¥18,000



SIA0630.0

11-AMINOUNDECYLTRIETHOXYSILANE	333.59	130-2°/1	0.895^{25}	1.4352^{25}

$C_{17}H_{39}NO_3Si$ contains ~5% isomers
[116821-45-5] HMIS: 2-2-1-X — 1.0g/¥55,800



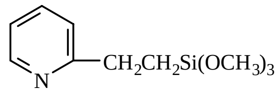
SIP6928.0

2-(4-PYRIDYLETHYL)TRIETHOXYSILANE	269.43	105°/0.9	1.00	1.4624^{24}

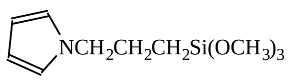
$C_{13}H_{23}NO_3Si$ — amber liquid
see also SIT8396.0, SIP6926.4
HMIS: 3-2-1-X — 10g/¥50,400

PLEASE INQUIRE ABOUT BULK QUANTITIES

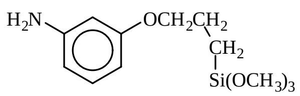
	name	MW	bp/mm (mp)	D_4^{20}	n_D^{20}



SIT8396.0
2-(TRIMETHOXYSILYLETHYL)PYRIDINE — 227.33 — 105°/0.3 — 1.06 — 1.4755
$C_{10}H_{17}NO_3Si$ — flashpoint: >110°C (>230°F)
[27326-65-4] HMIS: 3-2-1-X — 10g/¥17,600 — 50g/¥70,200



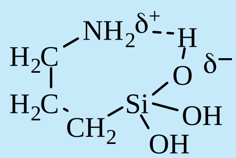
SIT8410.0
N-(3-TRIMETHOXYSILYLPROPYL)PYRROLE — 229.35 — 105-7°/1 — 1.017 — 1.463
$C_{10}H_{19}NO_3Si$ — flashpoint: >110°C (>230°F)
for electrode modification, polypyrrole adhesion[1]
1. R. Simon et al. J. Am. Chem. Soc. *104*, 2031,1982.
[80906-67-8] HMIS: 3-1-1-X — 5.0g/¥38,700



SIA0598.0
3-(m-AMINOPHENOXY)PROPYLTRIMETHOXY-SILANE, 95% — amber liquid — 271.39 — 1.02 — 1.495
$C_{12}H_{21}NO_4Si$
[55648-29-8] HMIS: 3-1-1-X — 10g/¥23,900 — 50g/¥95,400

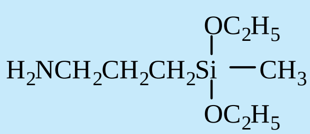
Developmental

Monoamine Functional Silanes - Water-borne



SIA0608.0
AMINOPROPYLSILANETRIOL, 22-25% in water — 137.21 — 1.06
$C_3H_{11}NO_3Si$ mainly oligomers — flashpoint: >110°C (230°F)
pH: 10.0-10.5
internal hydrogen bonding stabilizes solution
[29159-37-3] TSCA HMIS: 2-0-0-X — 25g/¥4,500 — 2.0kg/¥42,000 — 18kg/inquire

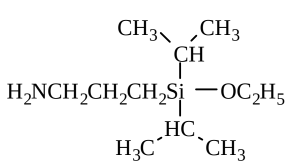
Monoamine Functional Silanes - Dialkoxy



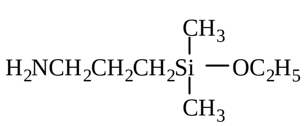
SIA0605.0
3-AMINOPROPYLMETHYLDIETHOXYSILANE — 191.34 — 85-8°/8 — 0.916 — 1.4272
$C_8H_{21}NO_2Si$ — TOXICITY- oral rat, LD50: 4760mg/kg
coupling agent for foundry resins — flashpoint: 85°C (185°F)
[3179-76-8] TSCA HMIS: 3-2-1-X — 25g/¥4,500 — 2.0kg/¥60,200

Commercial

Monoamine Functional Silanes - Monoalkoxy



SIA0602.0
3-AMINOPROPYLDIISOPROPYLETHOXY-SILANE — 217.43 — 78-80°/0.4 — 0.872^{25} — 1.4489
$C_{11}H_{27}NOSi$
[17559-36-1] HMIS: 3-2-0-X — 5.0g/¥20,300 — 25g/¥81,000



SIA0603.0
3-AMINOPROPYLDIMETHYLETHOXYSILANE — 161.32 — 78-9°/24 — 0.857^{25} — 1.427^{25}
$C_7H_{19}NOSi$ — flashpoint: 73°C (163°F)
Δ Hform: 147.6 kcal/mole
[18306-79-1] TSCA HMIS: 3-2-1-X — 5.0g/¥21,600 — 25g/¥86,400

Developmental

Diamine Functional Silanes - Trialkoxy

$H_2NCH_2CH_2NHCH_2CH_2CH_2Si(OCH_3)_3$

SIA0591.0
N-(2-AMINOETHYL)-3-AMINOPROPYLTRI-METHOXYSILANE *N-[3-(TRIMETHOXYSILYL)PROPYL]ETHYLENEDIAMINE DAMO* — 226.36 — 140°/15 — 1.019^{25} — 1.450^{25}
$C_8H_{22}N_2O_3Si$ — TOXICITY- oral rat, LD50: 7460mg/kg
visc: 6.5 cSt — flashpoint: 150°C (302°F)
Ce: 0.8 — specific wetting surface: 358 m^2/g
γc, treated surface: 36.5 dynes/cm
coupling agent for polyamides and polyesters with good film forming properties
coupling agent for brass and copper substrants
[1760-24-3] TSCA HMIS: 3-1-1-X — 100g/¥3,900 — 1kg/¥8,800

Commercial

$H_2NCH_2CH_2NHCH_2CH_2CH_2Si(OC_2H_5)_3$

SIA0590.5
N-(2-AMINOETHYL)-3-AMINOPROPYLTRI-ETHOXYSILANE, 95% — 264.5 — 156°/15 — 0.994 — 1.4367^{25}
$C_{11}H_{28}N_2O_3Si$ — flashpoint: 148°C (298°F)
[5089-72-5] TSCA HMIS: 3-1-1-X — 25g/¥27,000

name	MW	bp/mm (mp)	D_4^{20}	n_D^{20}

$H_2NCH_2CH_2CH_2CH_2CH_2CH_2NHCH_2Si(OC_2H_5)_3$

SIA0592.6
N-(6-AMINOHEXYL)AMINOMETHYL-TRIETHOXYSILANE, 95% — 292.49 — 160°/0.1 — 0.928^{25} — 1.4385^{25}
flashpoint: >110°C (>230°F)
$C_{13}H_{32}N_2O_3Si$
[15129-36-9] HMIS: 3-2-1-X — 25g/¥13,100 — 100g/¥42,300

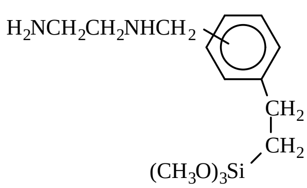
$H_2N(CH_2)_6NHCH_2CH_2CH_2Si(OCH_3)_3$

SIA0594.0
N-(6-AMINOHEXYL)AMINOPROPYL-TRIMETHOXYSILANE, 95% — 278.47 — 160-5°/0.15 — 1.11 — 1.4501
flashpoint: >110°C (>230°F)
$C_{12}H_{30}N_2O_3Si$
employed in immobilization of DNA[1].
immobilizes PCR primers on glass beads[2].
1. C. Kneuer et al, Int'l J. Pharmaceutics, *196(2)*, 257, 2000.
2. J. Andreadis et al, Nuc. Acid Res., *28*, E-5, 2000.
[51895-58-0] HMIS: 3-2-1-X — 10g/¥14,000 — 50g/¥55,800

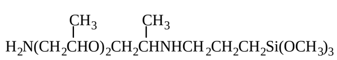
$H_2NCH_2CH_2NH(CH_2)_{11}Si(OCH_3)_3$

SIA0595.0
N-(2-AMINOETHYL)-11-AMINOUNDECYL-TRIMETHOXYSILANE — 334.57 — 155-9°/0.4 — 0.873^{25} — 1.4515
$C_{16}H_{38}N_2O_3Si$
coupling agent with extended spacer-group for remote substrate binding
HMIS: 3-1-1-X — 5.0g/¥58,500

Developmental

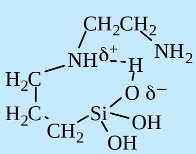


SIA0588.0
(AMINOETHYLAMINOMETHYL)PHENETHYL-TRIMETHOXYSILANE, 90% mixed m,p isomers — 298.46 — 126-30°/0.2 — 1.02 — 1.5083
flashpoint: > 110°C (>230°F)
$C_{14}H_{26}N_2O_3Si$
coupling agent for polyimides
photochemically sensitive (194nm)[1] self-assembled monolayers[2].
1. W. Dressick et al, Thin Solid Films, *284*, 568, 1996
2. C. Harnett et al, Appl. Phys. Lett., *76*, 2466, 2000.
[74113-77-2] TSCA HMIS: 3-1-1-X — 25g/¥36,900 — 100g/¥120,000



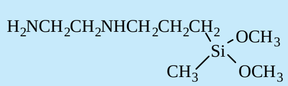
SIA0599.4
N-3-[(AMINO(POLYPROPYLENOXY)]AMINO-PROPYLTRIMETHOXYSILANE 60-65% — 337-435 — 0.984 — 1.4508
3-4 propyleneoxy units
contains 30-35% amine terminated polypropylene oxide
coupling agent with film-forming capability
HMIS: 2-2-1-X — 25g/¥32,400

Diamine Functional Silanes - Water-borne



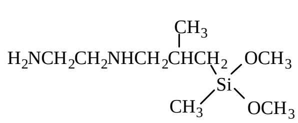
SIA0590.0
N-(2-AMINOETHYL)-3-AMINOPROPYL-SILANETRIOL, 25% in water mainly oligomers — 180.28 — 1.00
flashpoint: >110°C (230°F)
$C_5H_{17}N_2O_3Si$ — pH: 10.0-10.5
internal hydrogen bonding stabilizes solution
[68400-09-9] TSCA HMIS: 2-0-0-X — 100g/¥4,500 — 2.0kg/¥45,500

Diamine Functional Silanes - Dialkoxy



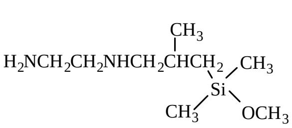
SIA0589.0
N-(2-AMINOETHYL)-3-AMINOPROPYLMETHYL-DIMETHOXYSILANE — 206.36 — 265° — 0.975^{25} — 1.4447^{25}
flashpoint: 90°C (194°F)
$C_8H_{22}N_2O_2Si$
autoignition temp: 280°C
specific wetting surface: 380 m^2/g
comonomer for silicones in textile softeners and haircare formulations
[3069-29-2] TSCA HMIS: 3-1-1-X — 100g/¥4,300 — 1kg/¥8,800

Commercial



SIA0587.5
N-(2-AMINOETHYL)-3-AMINOISOBUTYL-METHYLDIMETHOXYSILANE, 95% — 220.39 — 131°/15 — 0.960 — 1.4518
flashpoint: 96°C (205°F)
$C_9H_{24}N_2O_2Si$
[23410-40-4] TSCA HMIS: 3-2-1-X — 25g/¥40,500

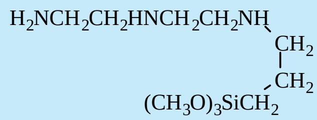
Diamine Functional Silanes - Monoalkoxy



SIA0587.2
(AMINOETHYLAMINO)-3-ISOBUTYLDI-METHYLMETHOXYSILANE, 95% — 204.39 — 85-9°/2 — 0.900^{25} — 1.4513^{25}
$C_9H_{24}N_2OSi$
[31024-49-4] HMIS: 3-2-1-X — 25g/¥37,800

name	MW	bp/mm (mp)	D_4^{20}	n_D^{20}

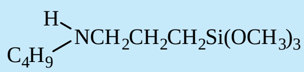
Triamine Functional



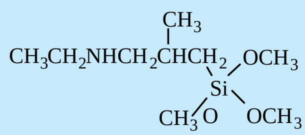
SIT8398.0
(3-TRIMETHOXYSILYLPROPYL)DIETHYLENE-TRIAMINE, 95% — 265.43 — 114-8°/2 — 1.030 — 1.4590
flashpoint: 137°C (279°F)
$C_{10}H_{27}N_3O_3Si$ — γc of treated surface: 37.5 dynes/cm
hardener, coupling agent for epoxies
[35141-30-1] TSCA HMIS: 3-1-1-X — 100g/¥8,600 — 2.0kg/¥86,800

Secondary Amine Functional

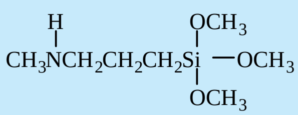
Commercial



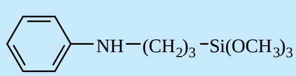
SIB1932.2
n-BUTYLAMINOPROPYLTRIMETHOXY-SILANE — 235.40 — 102°/3.5 — 0.947 — 1.4246^{25}
flashpoint: 110°C (230°F)
$C_{10}H_{25}NO_3Si$
coupling agent for urethane coatings
[31024-56-3] TSCA HMIS: 2-2-1-X — 25g/¥5,400 — 2.0kg/¥84,000



SIE4886.0
N-ETHYLAMINOISOBUTYLTRIMETHOXY-SILANE — 221.37 — 95°/10 — 0.952^{25} — 1.4234
flashpoint: 91°C (196°F)
$C_9H_{23}NO_3Si$
adhesion promoter for polyurethane coatings
[227085-51-0] TSCA HMIS: 3-2-1-X — 25g/¥8,100 — 2.0kg/¥126,000



SIM6500.0
N-METHYLAMINOPROPYLTRIMETHOXY-SILANE — 193.32 — 106°/30 — 0.978^{25} — 1.4194
flashpoint: 82°C (179°F)
$C_7H_{19}NO_3Si$ — γc of treated surface: 31 dynes/cm
$pK_b{}^{25}H_2O$: 5.18
orients liquid crystals
[3069-25-8] TSCA HMIS: 3-2-1-X — 25g/¥9,500 — 2.0kg/¥147,000

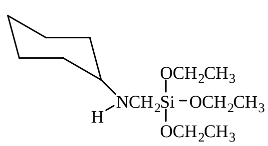


SIP6724.0
N-PHENYLAMINOPROPYLTRIMETHOXY-SILANE, 95% — 255.38 — 132-5°/0.3 — 1.07 — 1.504
flashpoint: 165°C (329°F)
$C_{12}H_{21}NO_3Si$ — specific wetting surface: 307m^2/g
oxidatively stable coupling agent for polyimides, phenolics, epoxies
[3068-76-6] TSCA HMIS: 3-1-1-X — 25g/¥4,500 — 2.0kg/¥63,000

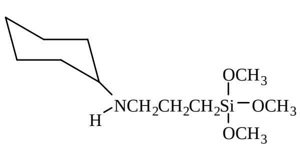
Developmental

$H_2C=CHCH_2NHCH_2CH_2CH_2Si(OCH_3)_3$

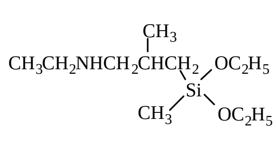
SIA0400.0
3-(N-ALLYLAMINO)PROPYLTRIMETHOXY-SILANE, 95% — 219.36 — 106-9°/25 — 0.989^{25} — 1.4990^{25}
flashpoint: 88°C (190°F)
$C_9H_{21}NO_3Si$ coupling agent for polyesters
coupling agent for acrylic coatings for glass containers[1].
1. Y. Hashimoto et al, Eur. Pat. Appl. EP 289,325, 1988
[31024-46-1] HMIS: 3-2-1-X — 10g/¥18,000 — 50g/¥72,000



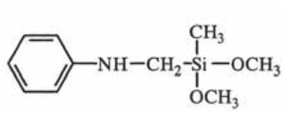
SIC2464.2
(CYCLOHEXYLAMINOMETHYL)TRI-ETHOXYSILANE, 95% — 275.46 — 236° — 0.95 — 1.4377
flashpoint: 119°C (246°F)
$C_{13}H_{29}NO_3Si$
[26495-91-0] HMIS: 2-1-1-X — 25g/¥12,600 — 100g/¥41,000



SIC2464.4
N-CYCLOHEXYLAMINOPROPYLTRIMETH-OXYSILANE — 261.43 — 114°/3 — 0.99 — 1.486^{25}
$C_{12}H_{27}NO_3Si$
[3068-78-8] HMIS: 3-2-1-X — 25g/¥20,300

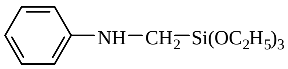


SIE4885.8
N-ETHYLAMINOISOBUTYLMETHYL-DIETHOXYSILANE — 233.43 — 89°/27
$C_{11}H_{27}NO_2Si$
HMIS: 3-2-1-X — 25g/¥32,400

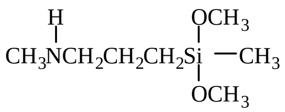


SIP6723.67
(PHENYLAMINOMETHYL)METHYL-DIMETHOXYSILANE, 95% — 211.34 — 255° — 1.04 — 1.5147
flashpoint: 106°C (223°F)
$C_{10}H_{17}NO_2Si$
converts isocyanate terminated polymers to moisture-cureable resins
[17890-10-7] HMIS: 3-2-1-X — 25g/¥13,100 — 100g/¥42,300

name	MW	bp/mm (mp)	D_4^{20}	n_D^{20}

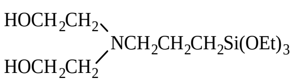


SIP6723.7
N-PHENYLAMINOMETHYLTRIETHOXYSILANE — 269.42 — 135-7°/4 — 1.004^{25} — 1.485^{25}
$C_{13}H_{23}NO_3Si$
[3473-76-5] HMIS: 3-2-1-X — 25g/¥13,100 — 100g/¥42,300

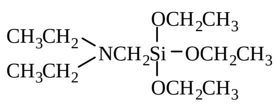


SIM6498.0
N-METHYLAMINOPROPYLMETHYL-DIMETHOXYSILANE — 177.32 — 93°/25 — 0.9173^{25} — 1.4224^{25}
flashpoint: 80°C (176°F)
$C_7H_{19}NO_2Si$
[31024-35-8] HMIS: 3-2-1-X — 25g/¥27,500 — 100g/¥89,100

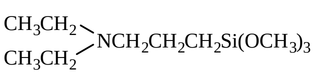
Tertiary Amine Functional Silanes



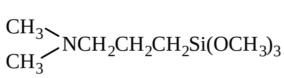
SIB1140.0
BIS(2-HYDROXYETHYL)-3-AMINOPROPYL-TRIETHOXYSILANE, 62% in ethanol — 309.48 — 0.92 — 1.409^{25}
flashpoint: 24°C (75°F)
$C_{13}H_{31}NO_5Si$
specific wetting surface: 252m^2/g
contains 2-3% hydroxyethylaminopropyltriethoxysilane
urethane polymer coupling agent
employed in surface modification for preparation of oligonucleotide arrays[1].
1. G. McGall et al, Proc. Nat'l Acad. Sci., 93, 1355, 1996
[7538-44-5] TSCA HMIS: 3-4-0-X — 25g/¥13,500 — 100g/¥44,100



SID3395.4
DIETHYLAMINOMETHYLTRIETHOXYSILANE — 249.43 — 74-6°/3 — 0.9336^{25} — 1.4142^{25}
$C_{11}H_{27}NO_3Si$
catalyst for neutral cure 1-part RTV's
[15180-47-9] HMIS: 2-2-1-X — 25g/¥22,100

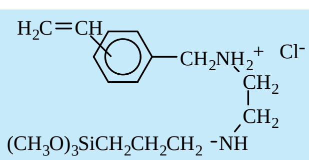


SID3396.0
(N,N-DIETHYL-3-AMINOPROPYL)TRI-METHOXYSILANE — 235.40 — 120°/20 — 0.934 — 1.4245
flashpoint: 100°C (212°F)
$C_{10}H_{25}NO_3Si$
[41051-80-3] TSCA HMIS: 2-2-1-X — 25g/¥26,100 — 100g/¥84,600

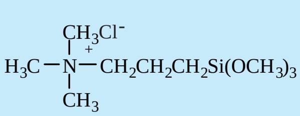


SID3547.0
3-(N,N-DIMETHYLAMINOPROPYL)TRIMETHOXY-SILANE — 207.34 — 106°/30 — 0.948^{25} — 1.4150
flashpoint: 99°C (210°F)
$C_8H_{21}NO_3Si$
derivatized silica catalyzes Michael reactions[1].
1. J. Mdoe et al, Synlett., 625, 1998
[2530-86-1] TSCA HMIS: 2-2-1-X — 10g/¥13,500 — 50g/¥54,000

Quaternary Amine Functional Silanes



SIS6994.0
3-(N-STYRYLMETHYL-2-AMINOETHYLAMINO)-PROPYLTRIMETHOXYSILANE HYDROCHLORIDE, 40% in methanol, inhibited with BHT — 374.98 — 0.91 — 1.395
flashpoint: 13°C (55°F)
$C_{17}H_{31}ClN_2O_3Si$
viscosity: 2.3 cSt
see also SIS6993.0
[34937-00-3] TSCA HMIS: 3-4-1-X store <5° — 100mL/¥4,400 — 1L/¥8,800



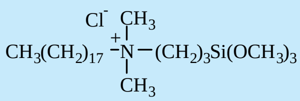
SIT8415.0
N-TRIMETHOXYSILYLPROPYL-N,N,N-TRI-METHYLAMMONIUM CHLORIDE (50% in methanol) — 257.83 — 0.927 — 1.3966
N,N,N-TRIMETHYL-3-(TRIMETHOXYSILYL)-1-PROPANAMINIUM CHLORIDE
$C_9H_{24}ClNO_3Si$
flashpoint: 16°C (61°F)
employed for bonded chromatographic phases
anti-static agent
used to treat glass substrates employed in electroblotting
[35141-36-7] TSCA HMIS: 2-4-1-X — 25g/¥7,700 — 2.0kg/¥133,000

Developmental

Commercial

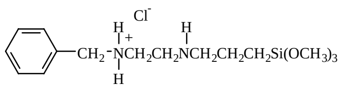
name	MW	bp/mm (mp)	D_4^{20}	n_D^{20}

Commercial

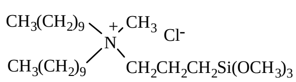


SIO6620.0
OCTADECYLDIMETHYL(3-TRIMETHOXYSILYL-PROPYL)AMMONIUM CHLORIDE, 60% in methanol — 496.29 — 0.89
$C_{26}H_{58}ClNO_3Si$ contains 3-5% $Cl(CH_2)_3Si(OMe)_3$ — flashpoint: 15°C (59°F)
employed as lubricant/ anti-static surface treatment
orients liquid crystals
dispersion/coupling agent for high density magnetic recording media[1].
application as immobilizeable antimicrobial reported[2].
1. H. Vincent in "Chemically Modified Oxide Surfaces," ed.D. Leyden, Gordon & Breach,1990, p.305
2. W. White et al in "Silanes, Surfaces & Interfaces" ed.D. Leyden, Gordon & Breach, 1986, p.107
[27668-52-6] TSCA HMIS: 3-4-0-X — 25g/¥10,800 — 2.0kg/¥98,000

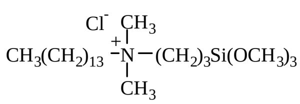
Developmental



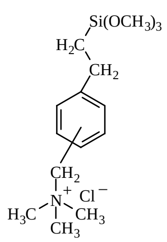
SIB0957.0
(2-N-BENZYLAMINOETHYL)-3-AMINOPROPYL-TRIMETHOXYSILANE, hydrochloride 50% in methanol — 348.25 — 0.942 — 1.4104
$C_{15}H_{28}N_2O_3Si.HCl$ amber liquid — flashpoint: 9°C (48°F)
[623938-90-9] TSCA HMIS: 3-3-1-X — 25g/¥7,200 — 100g/¥23,400



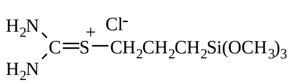
SID3392.0
N,N-DIDECYL-N-METHYL-N-(3-TRIMETHOXYSILYL-PROPYL)AMMONIUM CHLORIDE, 42% in methanol — 510.32 — flashpoint: 13°C (55°F) — 0.863 — 1.4085
$C_{27}H_{60}ClNO_3Si$ contains 3-5% $Cl(CH_2)_3Si(OMe)_3$
[68959-20-6] TSCA HMIS: 3-4-0-X — 25g/¥20,700



SIT7090.0
TETRADECYLDIMETHYL(3-TRIMETHOXYSILYL-PROPYL)AMMONIUM CHLORIDE, 50% in methanol — 440.18 — 0.88 — 1.397
$C_{22}H_{50}ClNO_3Si$ contains 3-5% $Cl(CH_2)_3Si(OMe)_3$ — flashpoint: 11°C (52°F)
[41591-87-1] TSCA HMIS: 3-4-0-X — 25g/¥21,600



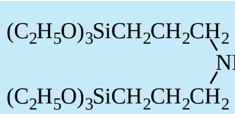
SIT8395.0
N-(TRIMETHOXYSILYLETHYL)BENZYL-N,N,N-TRIMETHYLAMMONIUM CHLORIDE, 60% in methanol — 333.93 — 0.966
$C_{15}H_{28}ClNO_3Si$ — flashpoint: 25°C (77°F)
candidate for exchange resins and extraction phases
HMIS: 3-3-1-X — 25g/¥36,000



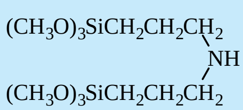
SIT8405.0
N-(TRIMETHOXYSILYLPROPYL)ISOTHIO-URONIUM CHLORIDE, 50% in water — 274.84 — essentially silanetriol — 1.190 — 1.441
TRIHYDROXYPROPYLCARBAMIDOTHIOIC ACID HYDROCHLORIDE
$C_7H_{19}ClN_2O_3SSi$ — pH: 6
antimicrobial activity reported
[84682-36-0] TSCA HMIS: 2-0-0-X — 25g/¥18,900

Dipodal Amine Functional Silanes

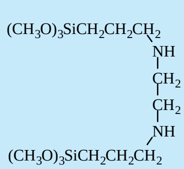
Commercial



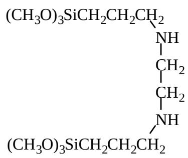
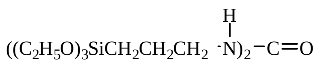
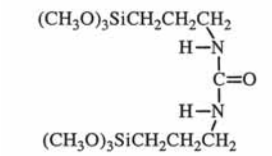
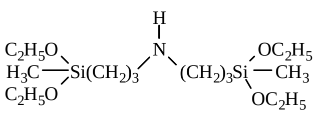
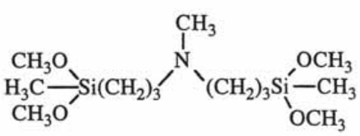
SIB1824.5
BIS(TRIETHOXYSILYLPROPYL)AMINE, 95% — 425.71 — 160°/0.6 — 0.97 — 1.4265
$C_{18}H_{43}NO_6Si_2$ — flashpoint: >162°C (328°F)
HYDROLYTIC SENSITIVITY: 7 Si-OR reacts slowly with water/moisture
[13497-18-2] TSCA HMIS: 3-1-1-X — 25g/¥7,200 — 100g/¥23,400



SIB1833.0
BIS(TRIMETHOXYSILYLPROPYL)AMINE, 95% — 341.56 — 152°/4 — 1.040 — 1.4320
$C_{12}H_{31}NO_6Si_2$ — flashpoint: 113°C (235°)
dipodal coupling agent
[82985-35-1] TSCA HMIS: 3-1-1-X — 25g/¥5,400 — 2.0kg/¥109,000 — 18kg/inquire

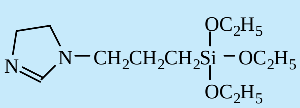
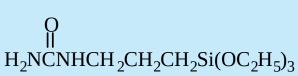
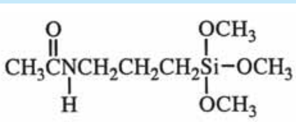
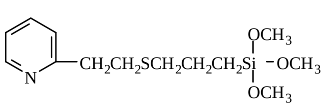


SIB1834.0
BIS[(3-TRIMETHOXYSILYL)PROPYL]-ETHYLENEDIAMINE, 62% in methanol — 384.62 — 0.89
flashpoint: 11°C (52°F)
$C_{14}H_{36}N_2O_6Si_2$
dipodal coupling agent for polyamides with enhanced hydrolytic stability
provides improved solder resistance for printed circuit boards
[68845-16-9] TSCA HMIS: 3-4-1-X — 25g/¥10,800 — 2.0kg/¥144,000

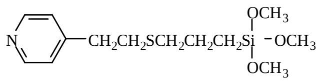
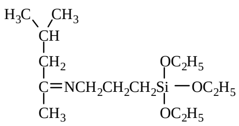
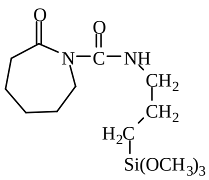
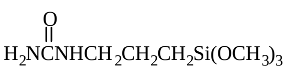
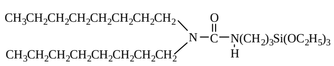
	name	MW	bp/mm (mp)	D_4^{20}	n_D^{20}
	SIB1834.1 BIS[(3-TRIMETHOXYSILYL)PROPYL]- ETHYLENEDIAMINE, 95% $C_{14}H_{36}N_2O_6Si_2$ coupling agent for polyamides with enhanced hydrolytic stability [68845-16-9] TSCA HMIS: 3-2-1-X	384.62 flashpoint: >110°C (>230°F) 10g/¥16,200		1.050 50g/¥64,800	1.443
	SIB1828.0 BIS[3-(TRIETHOXYSILYL)PROPYL]UREA, 60% in ethanol $C_{19}H_{44}N_2O_7Si_2$ [69465-84-5] HMIS: 2-4-1-X	468.73 flashpoint: 24°C (75°F) 25g/¥14,400		0.923 100g/¥46,800	
	SIB1835.5 BIS(TRIMETHOXYSILYLPROPYL)UREA, 95% $C_{13}H_{32}N_2O7Si_2$ *amber liquid* [18418-53-6] TSCA HMIS: 3-2-1-X	384.58 flashpoint: >110°C (>230°F) viscosity: 200-250 cSt. 25g/¥8,600		100g/¥27,900	
	SIB1620.0 BIS(METHYLDIETHOXYSILYLPROPYL)AMINE, 95% $C_{16}H_{39}NO_4Si_2$ dipodal coupling agent [31020-47-0] HMIS: 2-1-1-X	365.66 25g/¥16,200	155°/0.6	0.937 100g/¥52,700	1.4385
	SIB1645.0 BIS(METHYLDIMETHOXYSILYLPROPYL)- N-METHYLAMINE, 95% $C_{13}H_{33}NO_4Si_2$ HMIS: 3-2-1-X	323.58 viscosity: 6-7 cSt.	140°/2 25g/¥21,600	0.951	1.4368

Developmental

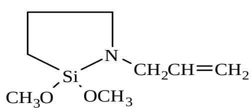
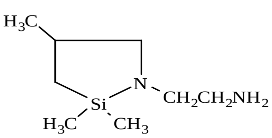
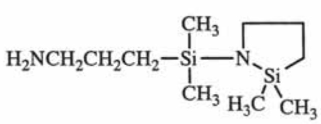
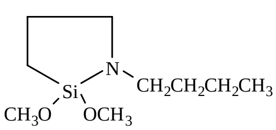
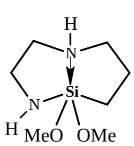
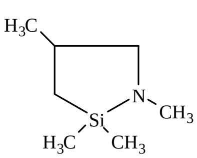
Specialty Amine Functional Silanes

	name	MW	bp/mm (mp)	D_4^{20}	n_D^{20}
	SIT8187.5 N-(3-TRIETHOXYSILYLPROPYL)- 4,5-DIHYDROIMIDAZOLE *3-(2-IMIDAZOLIN-1-YL)PROPYLTRIETHOXYSILANE* $C_{12}H_{26}N_2O_3Si$ coupling agent for elevated temperature cure epoxies utilized in HPLC of metal chelates[1]. forms proton vacancy conducting polymers w/sulfonamides by sol-gel[2]. ligand for molecurlarly imprinting silica w/ chymotrypsin transition state analog[3]. 1. T. Suzuki et al, Chem. Lett, 881, 1994 2. V. De Zea Bermudez et al, Sol-Gel Optics II, SPIE Proc. *1728*, 180, 1992 3. M. Markowitz et al, Langmuir, 1989. [58068-97-6] TSCA HMIS: 2-1-1-X	274.43 flashpoint: >110°C (>230°F) viscosity: 5 cSt. 25g/¥8,100	134°/2 100g/¥27,900	1.005 2.0kg/¥238,000	1.452
	SIU9055.0 UREIDOPROPYLTRIETHOXYSILANE, 50% in methanol $C_{10}H_{24}N_2O_4Si$ contains ureidopropyltrimethoxysilane and related transesterification products coupling agent for polyamides, area-formaldehyde resins [23779-32-0] TSCA HMIS: 2-3-1-X	264.40 flashpoint:14°C (58°F) 25g/¥4,500	(-97°)mp	0.92 2.0kg/¥67,500	1.386
	SIA0006.0 ACETAMIDOPROPYLTRIMETHOXYSILANE $C_8H_{19}NO_4Si$ [57757-66-1] HMIS: 3-2-1-X	221.33	162-5°/2-3 10g/¥54,000		1.4410
	SIP6926.2 2-(2-PYRIDYLETHYL)THIOPROPYLTRI- METHOXYSILANE $C_{13}H_{23}NO_3SSi$ chelates metal ions [29098-72-4] HMIS: 3-2-1-X	301.48	156-7°/0.25 10g/¥53,100	1.089	1.498

Commercial

	name	MW	bp/mm (mp)	D_4^{20}	n_D^{20}
	SIP6926.4 2-(4-PYRIDYLETHYL)THIOPROPYLTRI- METHOXYSILANE $C_{13}H_{23}NO_3SSi$ immobilizeable ligand for immunoglobulin IgG separation using hydrophobic charge induction chromatography (HCIC) [198567-47-4] HMIS: 3-2-1-X	301.48	160-2°/0.2 10g/¥55,800	1.09	1.5037
	SID4068.0 3-(1,3-DIMETHYLBUTYLIDENE)AMINO- PROPYLTRIETHOXYSILANE $C_{15}H_{33}NO_3Si$ [116229-43-7] TSCA HMIS: 2-2-1-X	303.52 flashpoint: 131°C (268°F) blocked amine - moisture deblocked 25g/¥13,100	134°/5	0.93 100g/¥42,300	1.437^{25}
	SIT8394.0 N-[5-(TRIMETHOXYSILYL)-2-AZA-1-OXO- PENTYL]CAPROLACTAM, 95% *N-TRIMETHOXYSILYLPROPYLCARBAMOYLCAPROLACTAM* patterns in vitro growth of neurons[1]. 1. J. Hickman et al, J. Vac. Sci Tech., *12*, 607, 1994 $C_{13}H_{26}N_2O_5Si$ [106996-32-1] HMIS: 3-1-1-X	318.45 flashpoint: 136°C (276°F) 25g/¥10,800	(-39°)mp	1.14 100g/¥35,100	1.4739
	SIU9058.0 UREIDOPROPYLTRIMETHOXYSILANE $C_7H_{18}N_2O_4Si$ [23843-64-3] TSCA HMIS: 2-3-1-X	222.32 flashpoint: 99°C (210°F) 25g/¥4,500	217-225°	1.150 100g/¥14,400	1.386^{25}
	SID4465.0 N,N-DIOCTYL-N'-TRIETHOXYSILYLPROPYL- UREA $C_{26}H_{56}N_2O_4Si$ [259727-10-1] HMIS: 2-2-1-X	488.83	 25g/¥36,900	0.924^{25}	1.4521^{25}

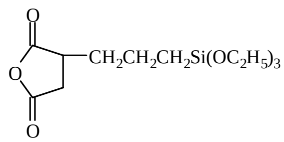
Cyclic Azasilanes

	name	MW	bp/mm (mp)	D_4^{20}	n_D^{20}
	SIA0380.0 N-ALLYL-AZA-2,2-DIMETHOXYSILA- CYCLOPENTANE $C_8H_{17}NO_2Si$ [618914-49-1] HMIS: 3-3-1-X	187.31	52-4°/3 10g/¥49,500		
	SIA0592.0 N-AMINOETHYL-AZA-2,2,4-TRIMETHYL- SILACYCLOPENTANE $C_8H_{21}NSi$ [18246-33-8] HMIS: 3-2-1-X	156.28	54-6°/2 10g/¥27,000	0.905	1.4768
	SIA0604.0 N-(3-AMINOPROPYLDIMETHYLSILA)AZA- 2,2-DIMETHYL-2-SILACYCLOPENTANE tech-90 $C_{10}H_{26}N_2Si_2$ employed in vapor-phase derivatization of porous sol-gel silica[1]. 1. D. Brandhuber et al, J. Mater. Chem., 2005 [388606-32-4] HMIS: 3-1-1-X	230.50	 10g/¥32,400		1.4705
	SIB1932.4 N-n-BUTYL-AZA-2,2-DIMETHOXYSILA- CYCLOPENTANE $C_9H_{21}NO_2Si$ vapor phase deposition coupling agent for nanoparticles[1]. 1. B. Arkles et al in "Silanes and Other Coupling Agents, Vol. 3," K. Mittal (Ed.) VSP-Brill, 2004, p179. [618914-44-6] HMIS: 3-2-1-X	203.36 flashpoint: 85°C (185°F)	69-71°/3 25g/¥28,800	0.941	1.438
	SID3543.0 2,2-DIMETHOXY-1,6-DIAZA-2-SILACYCLO- OCTANE $C_7H_{18}N_2O_2Si$ [182008-07-7] HMIS: 3-2-1-X	190.32	71-3°/2.5 (61-2°)mp 25g/¥36,000		
	SIM6501.4 N-METHYL-AZA-2,2,4-TRIMETHYLSILA- CYLCOPENTANE $C_7H_{17}NSi$ coupling agent for nanoparticles [18387-19-4] TSCA HMIS: 3-3-1-X	143.30 25g/¥21,600	137°	0.813 100g/¥70,200	1.4308

Developmental

Anhydride Functional Silanes

name	MW	bp/mm (mp)	D_4^{20}	n_D^{20}



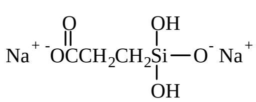
SIT8192.6
3-(TRIETHOXYSILYL)PROPYLSUCCINIC ANHYDRIDE, 95% — 304.41 — 135°/0.2 — 1.070 — 1.4405
flashpoint: >100°C (>212°F)
3-(TRIETHOXYSILYLPROPYL)DIHYDRO-3,5-FURANDIONE
$C_{13}H_{24}O_6Si$ — viscosity: 20 cSt.
coupling agent for dibasic surfaces
acetic acid-catalyzed hydrolysis yields succinic acid derivative.
[93642-68-3] HMIS: 2-1-1-X — 25g/¥20,300 — 100g/¥65,700

Azide Functional Silanes

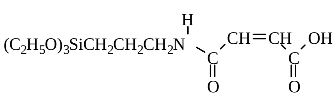
$N_3SO_2(CH_2)_6Si(OC_2H_5)_3$

SIA0780.0
6-AZIDOSULFONYLHEXYLTRIETHOXYSILANE, 95% — 353.51 — 1.147 — 1.4634
flashpoint: 114°C (237°F)
1-TRIETHOXYSILYL-6-SULFONAZIDE-n-HEXANE
$C_{12}H_{27}N_3O_5SSi$
inserts nitrenes into aliphatics and aromatics at temperatures >110°C
[96550-26-4] HMIS: 3-2-1-X — 25g/¥54,000

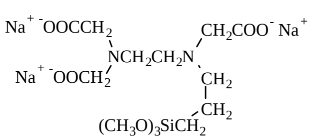
Carboxylate, Phosphonate and Sulfonate Functional Silanes



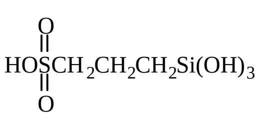
SIC2263.0
CARBOXYETHYLSILANETRIOL, SODIUM SALT, 25% in water — 196.14 — 1.17^{25}
pH:12-12.5
$C_3H_6O_5Na_2Si$
[18191-40-7] HMIS: 2-0-0-X — 25g/¥18,900 — 100g/¥61,200



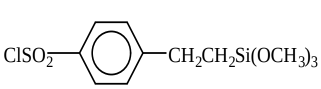
SIT8189.8
TRIETHOXYSILYLPROPYLMALEAMIC ACID, tech 90 — 319.43 — 1.11 — 1.472
$C_{13}H_{25}NO_6Si$
viscosity: 600-900 cSt.
may be imidized by heating after deposition
[33525-68-7] TSCA HMIS: 3-2-1-X — 25g/¥21,600



SIT8402.0
N-(TRIMETHOXYSILYLPROPYL)ETHYLENEDIAMINE TRIACETIC ACID, TRISODIUM SALT, 45% in water — 462.42 — 1.26
$C_{14}H_{25}N_2Na_3O_9Si$ — essentially silanetriol, contains NaCl
chelates metal ions
[128850-89-5] TSCA HMIS: 2-0-0-X — 25g/¥18,000 — 100g/¥58,500



SIT8378.3
3-(TRIHYDROXYSILYL)-1-PROPANESULFONIC ACID 30-35% in water — 202.26 — (-62°)mp — 1.12
pH: <1
$C_3H_{10}O_6SSi$
[70942-24-4] TSCA HMIS: 3-0-0-X — 25g/¥21,600



SIC2417.0
2-(4-CHLOROSULFONYLPHENYL)ETHYLTRIMETHOXYSILANE, 50% in methylene chloride — 324.85 — 1.3025
$C_{11}H_{17}ClO_5SSi$ — contains free sulfonic acid; amber color
treated silica acts as etherification catalyst[1].
treatment of surface oxidized PMDSO supports electroosmotic flow[2].
1. B. Sow et al, Microporous & Mesoporous Materials, *79*, 129, 2005
2. B. Wang et al, Micro Total Analysis Systems 2004 Vol 2., Roy Soc. Chem., 297, p109
[126519-89-9] HMIS: 3-2-1-X — 25g/¥30,600 — 100g/¥99,500

Masked Carboxylates - See Anhydride and Ester Functional Silanes

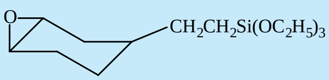
Developmental

Epoxy Functional Silanes

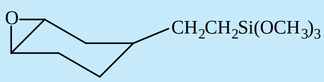
name | MW | bp/mm (mp) | D_4^{20} | n_D^{20}

Epoxy Functional Silanes - Trialkoxy

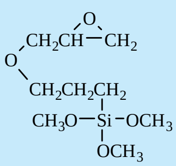
Commercial



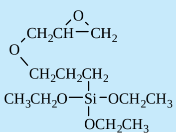
SIE4668.0
2-(3,4-EPOXYCYCLOHEXYL)ETHYL-TRIETHOXYSILANE — 288.46 — 114-7°/0.4 — 1.015 — 1.4455
flashpoint: 104°C (220°F)
$C_{14}H_{28}O_4Si$
[10217-34-2] TSCA HMIS: 2-1-1-X — 25g/¥6,300 100g/¥20,700 2.0kg/¥112,000



SIE4670.0
2-(3,4-EPOXYCYCLOHEXYL)ETHYL-TRIMETHOXYSILANE — 246.38 — 95-7°/0.25 — 1.065 — 1.449
TOXICITY- oral rat, LD50: 12,300mg/kg
flashpoint: 146°C (295°F)
$C_{11}H_{22}O_4Si$
viscosity: 5.2 cSt
γc of treated surface: 39.5 dynes/cm
coefficient of thermal expansion: 0.8 x 10^{-3}
specific wetting surface: 317 m^2/g
vapor pressure, 152°: 10mm
ring epoxide more reactive than glycidoxypropyl systems.
UV initiated polymerization of epoxy group with weak acid donors.
forms UV-cureable coating resins by controlled hydrolysis[1].
1. J. Crivello et al, Chem. Mater. *9*, 1554, 1997.
[3388-04-3] TSCA HMIS: 3-1-1-X — 100g/¥4,400 1kg/¥8,800

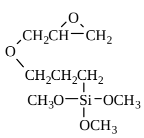


SIG5840.0
(3-GLYCIDOXYPROPYL)TRIMETHOXYSILANE — 236.34 — 120°/2 (<-70°)mp — 1.070 — 1.4290
3-(2,3-EPOXYPROPOXY)PROPYLTRIMETHOXYSILANE
$C_9H_{20}O_5Si$
TOXICITY- oral rat, LD50: 8,400 mg/kg
coupling agent for epoxy composites employed in electronic "chip" encapsulation.
[2530-83-8] TSCA HMIS: 3-1-1-X — 100g/¥4,400 1kg/¥8,800

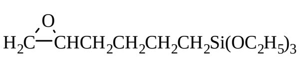


SIG5839.0
(3-GLYCIDOXYPROPYL)TRIETHOXYSILANE — 278.4 — 124°/3 — 1.00 — 1.425
$C_{12}H_{26}O_5Si$
flashpoint: 144°C (291°F)
[2602-34-8] TSCA HMIS:3-2-1-X — 25g/¥17,100 100g/¥55,800 2.0kg/¥203,000

Developmental



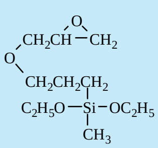
SIG5840.1
(3-GLYCIDOXYPROPYL)TRIMETHOXYSILANE 99+% — 236.34 — 120°/2 (<-70°)mp — 1.070 — 1.4290
3-(2,3-EPOXYPROPOXY)PROPYLTRIMETHOXYSILANE
$C_9H_{20}O_5Si$
TOXICITY- oral rat, LD50: 8,400 mg/kg
[2530-83-8] TSCA HMIS: 3-1-1-X — 25g/¥81,000 in fluoropolymer bottle



SIE4675.0
5,6-EPOXYHEXYLTRIETHOXYSILANE — 262.42 — 115-9°/1.5 — 0.960^{25} — 1.4254^{25}
$C_{12}H_{26}O_4Si$
flashpoint: 99°C (210°F)
[86138-01-4] HMIS: 3-2-1-X — 10g/¥37,800

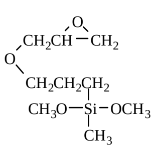
Epoxy Functional Silanes - Dialkoxy

Commercial



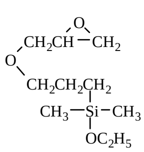
SIG5832.0
(3-GLYCIDOXYPROPYL)METHYLDIETHOXY-SILANE — 248.39 — 122-6°/5 — 0.978^{25} — 1.431
TOXICITY- oral rat, LD50: >2000mg/kg
$C_{11}H_{24}O_4Si$
flashpoint: 122°C (252°F)
viscosity: 3.0 cSt
employed in scratch-resistant coatings for eyeglasses.
[2897-60-1] TSCA HMIS: 2-1-1-X — 25g/¥17,100 100g/¥55,800 2.0kg/¥203,000

Developmental



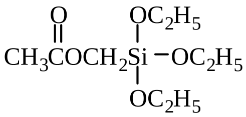
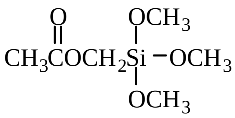
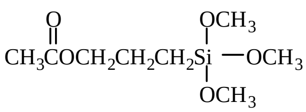
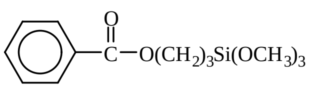
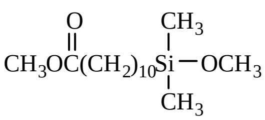
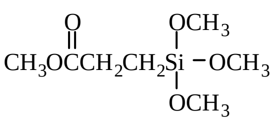
SIG5836.0
(3-GLYCIDOXYPROPYL)METHYLDIMETHOXY-SILANE — 220.34 — 100°/4 — 1.02 — 1.431^{25}
flashpoint: 105°C (221°F)
$C_9H_{20}O_4Si$
relative hydrolysis rate vs. SIG5840.0: 7.5:1
[65799-47-5] TSCA-L HMIS: 3-1-1-X — 25g/¥22,500 100g/¥72,900

Epoxy Functional Silanes - Monoalkoxy



SIG5825.0
(3-GLYCIDOXYPROPYL)DIMETHYLETHOXY-SILANE — 218.37 — 100°/3 — 0.950 — 1.4337^{25}
flashpoint: 87°C (189°F)
$C_{10}H_{22}O_3Si$
[17963-04-1] TSCA HMIS: 3-2-1-X — 10g/¥17,100 50g/¥68,400

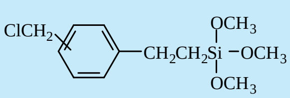
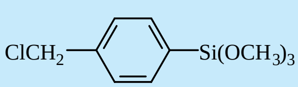
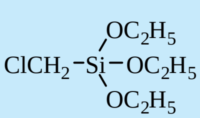
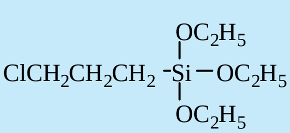
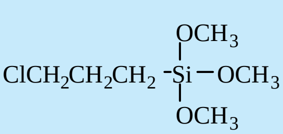
Ester Functional Silanes

	name	MW	bp/mm (mp)	D_4^{20}	n_D^{20}
	SIA0050.0 ACETOXYMETHYLTRIETHOXYSILANE $C_9H_{20}O_5Si$ hydrolyzes to form stable silanol solutions in neutral water [5630-83-1] HMIS: 2-2-1-X	236.34 25g/¥24,800	106°/15	1.042^{25} 100g/¥80,600	1.4092
	SIA0055.0 ACETOXYMETHYLTRIMETHOXYSILANE, 95% $C_6H_{14}O_5Si$ [65625-39-0] TSCA-L HMIS: 3-3-1-X	194.26 flashpoint: 56°C (133°F) 10g/¥20,300	190-1°	1.085 50g/¥81,000	1.4031
	SIA0100.0 ACETOXYPROPYLTRIMETHOXYSILANE $C_8H_{18}O_5Si$ γc of treated surface: 37.5 dynes/cm [59004-18-1] HMIS: 3-1-1-X	222.31 flashpoint: 93°C (200°F) 25g/¥8,100	92°/2	1.062 100g/¥26,100	1.4146
	SIB0959.0 BENZOYLOXYPROPYLTRIMETHOXYSILANE $C_{13}H_{20}O_5Si$ [76241-02-6] TSCA-L HMIS: 3-2-1-X	284.38	145°/0.2 25g/¥28,800	1.104	1.4806
	SIC2067.0 10-(CARBOMETHOXY)DECYLDIMETHYL-METHOXYSILANE $C_{15}H_{32}O_3Si$ HMIS: 2-1-1-X	288.50 10g/¥21,600	130°/0.3	0.903 50g/¥86,400	1.4399
	SIC2072.0 2-(CARBOMETHOXY)ETHYLTRIMETHOXY-SILANE, 95% contains ~ 20% 1-(carbomethoxy)ethyltrimethoxysilane isomer *METHYL(3-TRIMETHOXYSILYLPROPIONATE)* $C_7H_{16}O_5Si$ [76301-00-3] HMIS: 3-3-1-X	208.29 flashpoint: > 43°C (>110°F)	 10g/¥39,600		

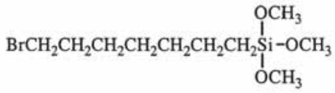
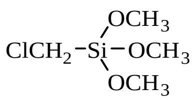
Developmental

Halogen Functional Silanes

Halogen Functional Silanes - Trialkoxy

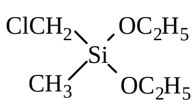
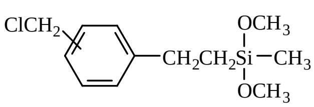
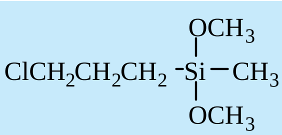
	name	MW	bp/mm (mp)	D_4^{20}	n_D^{20}
	SIC2295.5 ((CHLOROMETHYL)PHENYLETHYL)-TRIMETHOXYSILANE, mixed m,p isomers $C_{12}H_{19}ClO_3Si$ employed as a high temperature coupling agent[1]. 1. B. Arkles et al, Modern Plastics, *57*(11), 64, 1980. [68128-25-6] TSCA HMIS: 3-1-1-X	274.82 flashpoint: 130°C (282°F) 25g/¥17,600	115°/1.5	1.09^{25} 100g/¥56,700	1.4930^{25}
	SIC2296.2 (p-CHLOROMETHYL)PHENYLTRIMETHOXY-SILANE $C_{10}H_{15}ClO_3Si$ coupling agent for polyimides [24413-04-5] TSCA HMIS: 3-2-1-X	246.77 flashpoint: 183°C (361°F) 25g/¥27,900	134-43°/10	1.14 100g/¥90,900	1.4965
	SIC2298.4 CHLOROMETHYLTRIETHOXYSILANE $C_7H_{17}ClO_3Si$ Grignard reacts with chlorosilanes or intramolecularly to form carbosilanes[1]. 1. D. Brondani et al, Tet. Lett., *34*, 2111, 1993 [15267-95-5] TSCA HMIS: 2-3-1-X	212.75 TOXICITY- oral rat, LD50: 2400mg/kg flashpoint: 47°C (117°F) 25g/¥12,200	90-1°/25 100g/¥39,600	1.048 2.0kg/¥273,000	1.4069
	SIC2407.0 3-CHLOROPROPYLTRIETHOXYSILANE $C_9H_{21}ClO_3Si$ [5089-70-3] TSCA HMIS: 2-2-0-X	240.80 flashpoint: 74°C (172°F) 25g/¥4,500	100-2°/10	1.009 2.0kg/¥38,500	1.420
	SIC2410.0 3-CHLOROPROPYLTRIMETHOXYSILANE $C_6H_{15}ClO_3Si$ vapor pressure, 100°: 40mm viscosity, 20°C: 0.56 cSt γc of treated surface: 40.5 dynes/cm [2530-87-2] TSCA HMIS: 3-2-1-X	198.72 flashpoint: 78°C (172°F) TOXICITY- oral rat, LD50: 5628mg/kg specific wetting surface: 394m²/g 25g/¥4,500	195-6° 2.0kg/¥33,600	1.077^{25} 18kg/inquire	1.4183^{25}

Commercial

	name	MW	bp/mm (mp)	D_4^{20}	n_D^{20}
	SIB1886.0				
	7-BROMOHEPTYLTRIMETHOXYSILANE	299.28			
	$C_{10}H_{23}BrO_3Si$				
	HMIS: 3-2-1-X		10g¥32,400		
$BrCH_2CH_2CH_2Si(OCH_3)_3$	SIB1906.0				
	3-BROMOPROPYLTRIMETHOXYSILANE	243.17	130°/45	1.293	1.440
	$C_6H_{15}BrO_3Si$	flashpoint: 82°C (180°F)			
	forms self-assembled monolayers which can be modified w/ pyridine ligands[1].				
	1. S. Paulson et al, J. Chem. Soc., Chem. Commun., 1615, 1992.				
	[51826-90-5] HMIS: 2-2-1-X		10g/¥28,800		
$BrCH_2(CH_2)_{10}Si(OCH_3)_3$	SIB1909.0				
	11-BROMOUNDECYLTRIMETHOXYSILANE, 95%	355.39	158°/0.8	1.119	1.4559
	$C_{14}H_{31}BrO_3Si$ contains undecyltrimethoxysilane				
	[17947-99-8] HMIS: 2-1-0-X		10g/¥36,000		
	SIC2298.6				
	CHLOROMETHYLTRIMETHOXYSILANE	170.67	156°	1.125	1.4070
	$C_4H_{11}ClO_3Si$	flashpoint: 26°C (79°F)			
	[5926-26-1] HMIS: 3-4-1-X	10g/¥11,300		50g/¥45,000	
$ICH_2CH_2CH_2Si(OCH_3)_3$	SII6452.0				
	3-IODOPROPYLTRIMETHOXYSILANE	290.17	79-80°/2	1.475	1.4714
	$C_6H_{15}IO_3Si$	flashpoint: 78°C (172°F)			
	couples zeolite monolayers to glass[1]				
	1. K. Ha et al, Adv. Mater., *12(15)*, 1114, 2002.				
	[14867-28-8] HMIS: 3-2-1-X	10g/¥8,600		50g/¥34,200	
$ICH_2CH_2CH_2Si(OCH_3)_3$	SIT8397.0				
	3-(TRIMETHOXYSILYPROPYL)-2-BROMO-2-METHYLPROPIONATE	329.27	90-5°/0.5	1.243^{25}	
	$C_{10}H_{21}BrO_5Si$				
	for surface initiated ATRP polymerization[1].				
	1. M. Mulvihill et al, J. Am. Chem. Soc., *127*, 16040, 2005				
	[314021-97-1] HMIS: 2-2-1-X		5.0g/¥81,000		

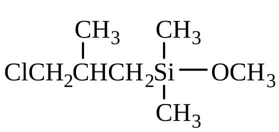
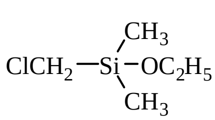
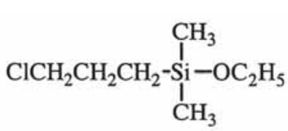
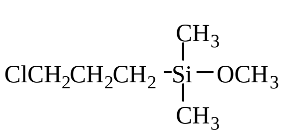
Developmental

Halogen Functional Silanes - Dialkoxy

	name	MW	bp/mm (mp)	D_4^{20}	n_D^{20}
	SIC2292.0				
	CHLOROMETHYLMETHYLDIETHOXYSILANE	182.72	160-1°	1.000^{25}	1.407
	$C_6H_{15}ClO_2Si$	TOXICITY:oral rat, LD50: 1300mg/kg			
	vapor pressure, 70°: 20mm	flashpoint: 38°C (100°F)			
	[2212-10-4] TSCA HMIS: 3-3-1-X		100g/¥49,500		
	SIC2295.2				
	((CHLOROMETHYL)PHENYLETHYL)-METHYLDIMETHOXYSILANE mixed m,p isomers	258.82	120-5°/0.5		
	$C_{12}H_{19}ClO_2Si$				
	intermediate for silicone analog of Merrifield resins.				
	HMIS: 2-1-1-X		25g/¥54,000		
	SIC2355.0				
	3-CHLOROPROPYLMETHYLDIMETHOXY-SILANE	182.72	70-2°/11	1.0250	1.4253
	$C_6H_{15}ClO_2Si$	flashpoint: 80°C (176°F)			
		specific wetting surface: 428m²/g			
	[18171-19-2] TSCA HMIS: 3-2-1-X	100g/¥6,800		2.0kg/¥64,400	

Commercial

Halogen Functional Silanes - Monoalkoxy

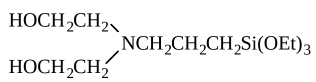
	name	MW	bp/mm (mp)	D_4^{20}	n_D^{20}
	SIC2278.0				
	3-CHLOROISOBUTYLDIMETHYLMETHOXY-SILANE	180.75	182°	0.950	1.4331^{25}
	$C_7H_{17}ClOSi$	flashpoint: 52°C (125°F)			
	[18244-08-1] TSCA HMIS: 3-2-1-X		25g/¥23,400		
	SIC2286.0				
	CHLOROMETHYLDIMETHYLETHOXYSILANE	152.70	132-3°	0.944^{25}	1.412^{25}
	$C_5H_{13}ClOSi$	TOXICITY- oral rat, LD50: 1550mg/kg			
	dipole moment: 2.14 debye	flashpoint: 26°C (79°F)			
	[13508-53-7] TSCA HMIS: 3-3-1-X		25g/¥27,900		
	SIC2337.0				
	3-CHLOROPROPYLDIMETHYLETHOXYSILANE	180.75	87°/30	0.932^{25}	1.4270^{25}
	$C_7H_{17}ClOSi$	flashpoint: 46°C (115°F)			
	[13508-63-9] HMIS: 2-3-1-X		25g/¥21,600		
	SIC2338.0				
	3-CHLOROPROPYLDIMETHYLMETHOXY-SILANE, 95%	166.73	170-1°	0.9413	1.4278
	$C_6H_{15}ClOSi$ see also SIC2278.0	flashpoint: 39°C (102°F)			
	[18171-14-7] HMIS: 3-3-1-X		10g/¥24,300		

Developmental

Hydroxyl Functional Silanes

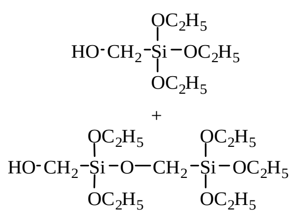
name | **MW** | **bp/mm (mp)** | **D_4^{20}** | **n_D^{20}**

Hydroxyl Functional Silanes - Trialkoxy

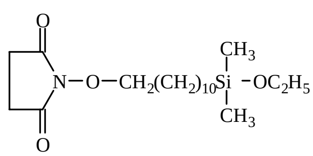


SIB1140.0
BIS(2-HYDROXYETHYL)-3-AMINOPROPYL-TRIETHOXYSILANE, 62% in ethanol — 309.48 — 0.92 — 1.409^{25}
flashpoint: 24°C (75°F)
$C_{13}H_{31}NO_5Si$ — specific wetting surface: 252m²/g
contains 2-3% hydroxyethylaminopropyltriethoxysilane
urethane polymer coupling agent
employed in surface modification for preparation of oligonucleotide arrays[1].
1. G. McGall et al, Proc. Nat'l Acad. Sci., 93, 1355, 1996
[7538-44-5] TSCA HMIS: 3-4-0-X — 25g/¥13,500 — 100g/¥44,100

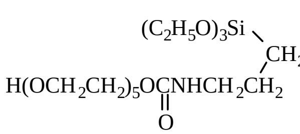
SIH6172.0
N-(HYDROXYETHYL)-N-METHYLAMINO-PROPYLTRIMETHOXYSILANE, 75% in methanol — 237.37 — 0.99 — 1.417
$C_9H_{23}NO_4Si$ — flashpoint: 16°C (61°F)
HMIS: 3-3-1-X — 25g/¥23,400 — 100g/¥76,100



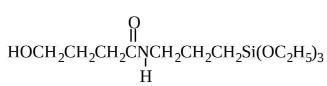
SIH6175.0
HYDROXYMETHYLTRIETHOXYSILANE, 50% in ethanol — 194.31 — 0.866
TRIETHOXYSILYLMETHANOL
$C_7H_{18}O_4Si$ — contains equilibrium condensation oligomers
hydrolysis yields analogs of silica- hydroxymethylsilanetriol polymers[1].
1. B. Arkles, US Pat. 5,371,262, 1994
[162781-73-9] HMIS: 2-4-0-X — 25g/¥43,200



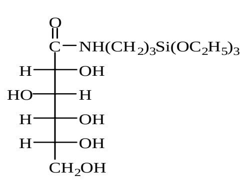
SIS6995.0
11-(SUCCINIMIDYLOXY)UNDECYL-DIMETHYLETHOXYSILANE, 95% — 385.58 — 195-200°/0.6 (28°)mp
$C_{19}H_{35}NO_5Si$
reagent for immobilization of proteins via primary amines
HMIS: 3-2-1-X — 1.0g/¥94,500



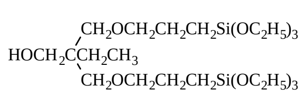
SIT8192.0
N-(TRIETHOXYSILYLPROPYL)-O-POLY-ETHYLENE OXIDE URETHANE, 95% — 400-500 — 1.09
viscosity: 75-125 cSt
$C_{10}H_{22}NO_4SiO(CH_2CH_2O)_{4-6}H$
contains some bis(urethane) analog
HMIS: 2-1-1-X — 25g/¥10,800 — 100g/¥35,100



SIT8189.5
N-(3-TRIETHOXYSILYLPROPYL)-4-HYDROXY-BUTYRAMIDE — 307.47
$C_{13}H_{29}NO_5Si$
anchoring reagent for light directed synthesis of DNA on glass[1].
1. G. McGall et al, J. Am. Chem. Soc., *119*, 5081, 1997
[186543-03-3] HMIS: 2-2-1-X — 10g/¥13,100 — 50g/¥52,200

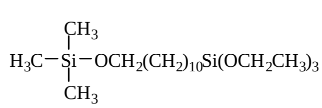


SIT8189.0
N-(3-TRIETHOXYSILYLPROPYL)GLUCONAMIDE 50% in ethanol — 399.51 — 0.951
flashpoint: 8°C (46°F)
$C_{15}H_{33}NO_9Si$
water soluble, hydrophilic silane
[104275-58-3] HMIS: 2-4-1-X — 25g/¥11,700 — 100g/¥37,800



SIB1824.4
2,2-BIS(3-TRIETHOXYSILYLPROPOXY-METHYL)BUTANOL, 50% in ethanol — 542.86 — 0.899
$C_{24}H_{54}O_9Si_2$
for solid state synthesis of oligonucleotides
HYDROLYTIC SENSITIVITY: 7 Si-OR reacts slowly with water/moisture
HMIS: 2-4-1-X — 10g/¥61,200

Masked Hydroxyl



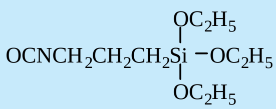
SIT8572.8
11-(TRIMETHYLSILOXY)UNDECYLTRIETHOXY-SILANE — 406.75
$C_{20}H_{46}O_4Si_2$
masked hydroxyl- deprotected after deposition with acidic aqueous ethanol
[75389-03-6] HMIS: 2-1-1-X — 5.0g/¥60,300

Isocyanate and Masked Isocyanate Functional Silanes

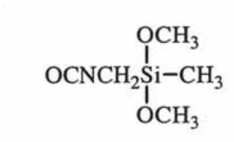
name	MW	bp/mm (mp)	D_4^{20}	n_D^{20}

Isocyanate Functional Silanes - Trialkoxy

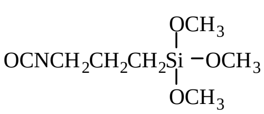
Commercial



SII6455.0
3-ISOCYANATOPROPYLTRIETHOXY-SILANE, 95% — 247.37 — 130°/20 — 0.99 — 1.419
flashpoint: 80°C (176°F)
$C_{10}H_{21}NO_4Si$
component in hybrid organic/inorganic urethanes[1].
1. S. Cuney et al, Better Ceramics Through Chemistry VII (MRS. Symp. Proc.), 435, 143, 1996
[24801-88-5] TSCA HMIS: 3-2-1-X — 25g/¥6,300 — 100g/¥20,300 — 2.0kg/¥77,000



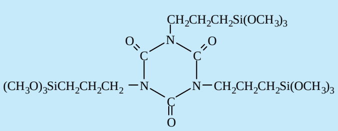
SII6453.8
(ISOCYANATOMETHYL)METHYLDIMETHOXY-SILANE tech-85 — 161.23 — 157° — 1.06 — 1.435
flashpoint: 66°C (151°F)
autoignition temp.: 290°
$C_5H_{11}NO_3Si$
reacts w/polymeric diamines to form moisture-cureable polymers
[406679-89-8] HMIS: 3-4-1-X store <5°C — 25g/¥36,900



SII6456.0
3-ISOCYANATOPROPYLTRIMETHOXY-SILANE, 95% — 205.29 — 95-8°/10 — 1.073 — 1.4219
TOXICITY- oral rat, LD50: 878mg/kg
viscosity: 1.4 cSt.
$C_7H_{15}NO_4Si$
[15396-00-6] TSCA HMIS: 3-2-1-X — 25g/¥13,100 — 100g/¥42,300

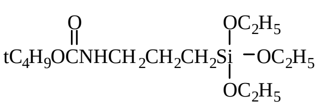
Masked Isocyanate

Commercial

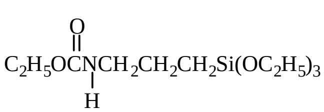


SIT8717.0
TRIS(3-TRIMETHOXYSILYLPROPYL)ISO-CYANURATE, 95% — 615.86 — 1.170 — 1.4610
flashpoint: 102°C (216°F)
viscosity: 325-350 cSt.
$C_{21}H_{45}N_3O_{12}Si_3$
coupling agent for polyimides to silicon metal
[26115-70-8] TSCA HMIS: 2-1-1-X — 25g/¥5,400 — 100g/¥17,600 — 2.0kg/¥133,000

Developmental



SIT8186.5
(3-TRIETHOXYSILYLPROPYL)-t-BUTYLCAR-BAMATE — 321.49 — 0.990 — 1.4334
flashpoint: >65°C (>150°F)
$C_{14}H_{31}NO_5Si$
[137376-38-6] HMIS: 2-1-1-X — 25g/¥16,200 — 100g/¥52,700



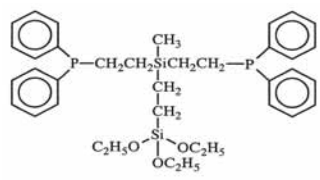
SIT8188.0
TRIETHOXYSILYLPROPYLETHYLCARBAMATE — 293.44 — 124-6°/0.5 — 1.015 — 1.4321
flashpoint: 95°C (203°F)
$C_{12}H_{27}NO_5Si$
masked isocyanate
[17945-05-0] TSCA HMIS: 2-1-1-X — 25g/¥10,800 — 100g/¥36,000

$NCSCH_2CH_2CH_2Si(OC_2H_5)_3$

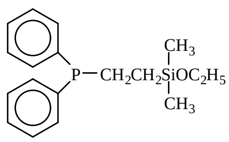
SIT7908.0
3-THIOCYANATOPROPYLTRIETHOXYSILANE — 263.43 — 95°/0.1 — 1.03 — 1.4460
flashpoint: 112°C (234°F)
$C_{10}H_{21}NO_3SSi$
TOXICITY- oral rat, LD50: 1423mg/kg
[34708-08-2] TSCA HMIS: 3-2-1-X — 50g/¥6,800 — 250g/¥27,000

Phosphine and Phosphate Functional Silanes

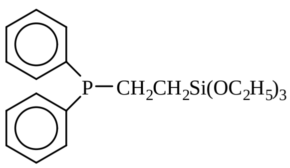
name	MW	bp/mm (mp)	D_4^{20}	n_D^{20}



SIB1091.0
BIS(2-DIPHENYLPHOSPHINOETHYL)-METHYLSILYLETHYLTRIETHOXYSILANE, mixed isomers — MW 660.92 — D_4^{20} 1.07 — n_D^{20} 1.5746
$C_{37}H_{50}O_3P_2Si_2$
analogous structures form ruthenium II complexes w/ high selectivity for hydrogenation[1].
1. D. Wu et al, Chem. Mater., *17*, 3951, 2005
HMIS: 2-2-1 — 1.0g/¥78,300

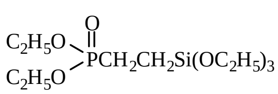


SID4557.5
DIPHENYLPHOSPHINOETHYLDIMETHYL-ETHOXYSILANE — MW 316.46 — 160°/1 — 1.004 — 1.5630
$C_{18}H_{25}OPSi$
[359859-29-3] HMIS: 2-2-1-X — 10g/¥55,800

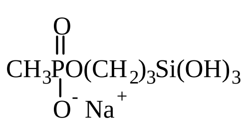


SID4558.0
2-(DIPHENYLPHOSPHINO)ETHYL-TRIETHOXYSILANE — MW 376.50 — 182°/1.3 — 1.05 — 1.5384
flashpoint: 134°C (273°F)
$C_{20}H_{29}O_3PSi$
immobilizing ligand for precious metals
adhesion promoter for gold substrates in microelectronic applications[1].
forms stable bonds to silica and basic alumina suitable for catalyst immobilization[2].
1. J. Helbert, US Pat. 4,497,890, 1985
2. C. H. Merchle et al, Chem. Mater. *13*, 3617, 2001.
[18586-39-5] TSCA HMIS: 3-1-0-X — 5.0g/¥17,600 — 25g/¥70,200

Developmental



SID3412.0
DIETHYLPHOSPHATOETHYLTRIETHOXY-SILANE, 95% — MW 328.41 — 141°/2 — 1.031^{25} — 1.4216
flashpoint: 70°C (158°F)
DIETHOXYPHOSPHORYLETHYLTRIETHOXYSILANE
$C_{12}H_{29}O_6PSi$
water-soluble silane; anti-pilling agent for textiles
hydrolysis product catalytically hydrates olefins, forming alcohols[1].
1. F. Young et al, US Patent 3,816,550, 1974.
[757-44-8] TSCA HMIS: 3-2-1-X — 25g/¥21,600 — 100g/¥72,000

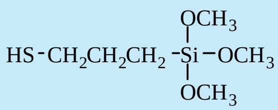


SIT8378.5
3-TRIHYDROXYSILYLPROPYLMETHYL-PHOSPHONATE, SODIUM SALT, 42% in water — MW 238.18 — D_4^{20} 1.25
flashpoint: 79°C (174°F)
$C_4H_{12}O_6NaPSi$ contains 4-5% methanol, sodium methylphosphonate
[84962-98-1] TSCA HMIS: 1-2-0-X — 100g/¥6,800 — 500g/¥27,000

Sulfur Functional Silanes

name	MW	bp/mm (mp)	D_4^{20}	n_D^{20}

Sulfur Functional Silanes - Trialkoxy

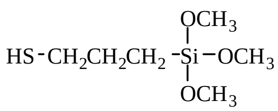


SIM6476.0
3-MERCAPTOPROPYLTRIMETHOXYSILANE — 196.34 — 93°/40 — 1.051^{25} — 1.4502^{25}
$C_6H_{16}O_3SSi$ — TOXICITY- oral rat, LD50: 2380mg/kg
viscosity: 2 cSt — flashpoint: 96°C (205°F)
γc of treated surface: 41 dynes/cm — primary irritation index: 0.19
specific wetting surface: 348 m^2/g
coupling agent for EPDM rubbers and polysulfide adhesives
for enzyme immobilization[1].
treatment of mesoporous silica yield highly efficient heavy metal scavenger[2].
employed in coupling of fluorescent biological tags to CdS nanocrystals[3].

1. Tet. Let., *31*, 5773, 1990
2. J. Liu et al, Science, *276*, 923, 1997
3. M. Bruohez et al, Science, *281*, 2013, 1998.

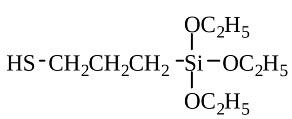
[4420-74-0] TSCA HMIS: 3-2-1-X — 100g/¥4,400 — 1kg/¥8,800

Commercial

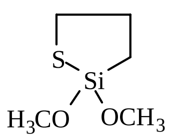


SIM6476.1
3-MERCAPTOPROPYLTRIMETHOXYSILANE 99+% — 196.34 — 93°/40 — 1.051^{25} — 1.4502^{25}
$C_6H_{16}O_3SSi$
low fluorescence grade for high-throughput screening
[4420-74-0] TSCA HMIS: 3-2-1-X — 25g/¥81,000 in fluoropolymer bottle

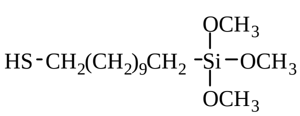
---



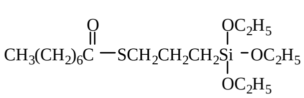
SIM6475.0
3-MERCAPTOPROPYLTRIETHOXYSILANE, 95% — 238.42 — 210° — 0.9325 — 1.4331
$C_9H_{22}O_3SSi$ — flashpoint: 88°C (190°F)
TOXICITY- oral rat, LD50: > 2000mg/kg
[14814-09-6] TSCA HMIS: 2-2-1-X — 25g/¥15,800 — 100g/¥51,300



SID3545.0
2,2-DIMETHOXY-1-THIA-2-SILACYCLO-PENTANE — 164.29 — 57-8°/7 — 1.094
$C_5H_{12}O_2SSi$
reagent for modification of silver and gold surfaces; coupling agent for rubber
[26903-85-5] HMIS: 3-3-1-X — 25g/¥37,800

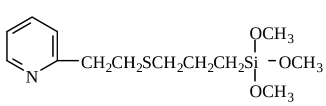


SIM6480.0
11-MERCAPTOUNDECYLTRIMETHOXYSILANE — 308.55 — 150°/0.5 — 0.955 — 1.4523
$C_{14}H_{32}O_3SSi$
HMIS: 3-2-1-X — 2.5g/¥72,900

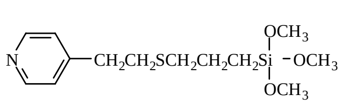


SIO6704.0
S-(OCTANOYL)MERCAPTOPROPYL-TRIETHOXYSILANE tech-95 — 364.62 — 0.9686 — 1.4514
$C_{17}H_{36}O_4SSi$ — TOXICITY- oral rat, LD50: >2000mg/kg
flashpoint: 176°C (349°F)
masked mercaptan - deblocked w/alcohols
latent coupling agent for butadiene rubber
[220727-26-4] TSCA HMIS: 2-1-1-X — 25g/¥8,600 — 100g/¥27,900

Developmental



SIP6926.2
2-(2-PYRIDYLETHYL)THIOPROPYLTRI-METHOXYSILANE — 301.48 — 156-7°/0.25 — 1.089 — 1.498
$C_{13}H_{23}NO_3SSi$
chelates metal ions
[29098-72-4] HMIS: 3-2-1-X — 10g/¥53,100

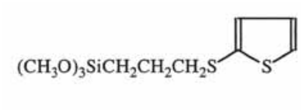


SIP6926.4
2-(4-PYRIDYLETHYL)THIOPROPYLTRI-METHOXYSILANE — 301.48 — 160-2°/0.2 — 1.09 — 1.5037
$C_{13}H_{23}NO_3SSi$
immobilizeable ligand for immunoglobulin IgG separation using hydrophobic charge induction chromatography (HCIC)
[198567-47-4] HMIS: 3-2-1-X — 10g/¥55,800

name	MW	bp/mm (mp)	D_4^{20}	n_D^{20}

$NCSCH_2CH_2CH_2Si(OC_2H_5)_3$

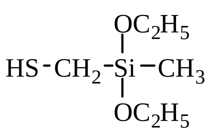
SIT7908.0
3-THIOCYANATOPROPYLTRIETHOXYSILANE — 263.43 — 95°/0.1 — 1.03 — 1.4460
$C_{10}H_{21}NO_3SSi$ — flashpoint: 112°C (234°F)
TOXICITY- oral rat, LD50: 1423mg/kg
coupling agent for butyl rubber in mechanical applications
complexing agent for Ag, Au, Pd, Pt[1].
1. T. Schilling et al, Mikrochemica Acta, *124*, 235, 1996.
[34708-08-2] TSCA HMIS: 3-2-1-X — 50g/¥6,800 — 250g/¥27,000



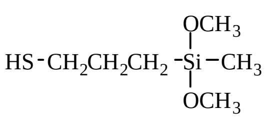
SIT8411.0
2-(3-TRIMETHOXYSILYLPROPYLTHIO)-THIOPHENE — 278.46
$C_{10}H_{18}O_3S_2Si$
HMIS: 3-2-1-X — 10g/¥49,500

Developmental

Sulfur Functional Silanes - Dialkoxy

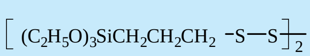


SIM6473.0
MERCAPTOMETHYLMETHYLDIETHOXY-SILANE, 95% — 180.34 — 60°/10 — 0.975 — 1.4446
$C_6H_{16}O_2SSi$ — flashpoint: 58°C (136°F)
HYDROLYTIC SENSITIVITY: 7 reacts slowly with moisture/water
HMIS: 3-2-1-X — 10g/¥40,500



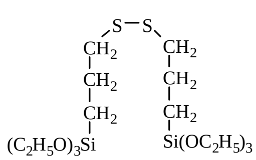
SIM6474.0
3-MERCAPTOPROPYLMETHYLDIMETHOXY-SILANE — 180.34 — 96°/30 — 1.00 — 1.4502
$C_6H_{16}O_2SSi$ — flashpoint: 93°C (199°F)
intermediate for silicones in thiol-ene UV cure systems
[31001-77-1] TSCA HMIS: 3-2-1-X — 100g/¥10,400 — 500g/¥41,400

Sulfur Functional Silanes - Dipodal

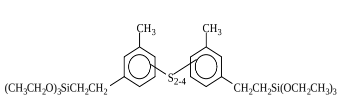


SIB1825.0
BIS[3-(TRIETHOXYSILYL)PROPYL]-TETRASULFIDE, tech-95 *TESPT* — 538.94 — 250°d — 1.095 — 1.49
$C_{18}H_{42}O_6S_4Si_2$
TOXICITY- oral rat, LD50: 16,400mg/kg
flashpoint: 91°C (196°F)
contains distribution of S_n species: n = 2-10, average 3.8
viscosity: 11.2 cSt
coupling agent for “green” tires
adhesion promoter for precious metals
dipodal coupling agent/ vulcanizing agent for rubbers
[40372-72-3] TSCA HMIS: 2-2-1-X — 25g/¥5,400 — 100g/¥17,600 — 2.0kg/¥63,000

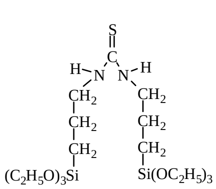
Commercial



SIB1824.6
BIS[3-(TRIETHOXYSILYL)PROPYL]-DISULFIDE, 90% — 474.82 — 1.025 — 1.457
$C_{18}H_{42}O_6S_2Si_2$ contains sulfide and tetrasulfide — flashpoint: 75°C (167°F)
[56706-10-6] TSCA HMIS: 2-2-1-X — 25g/¥14,400 — 100g/¥46,800



SIB1820.5
BIS-[m-(2-TRIETHOXYSILYLETHYL)TOLYL]-POLYSULFIDE tech-85 — 627-691 — 1.10 — 1.533
$C_{30}H_{50}O_6S_{(2-4)}Si_2$ — flashpoint: 55°C (132°F)
dark viscous liquid
TSCA HMIS: 2-2-1-X — 25g/¥14,400



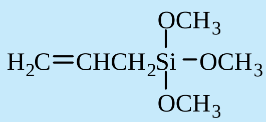
SIB1827.0
BIS[3-(TRIETHOXYSILYL)PROPYL]THIO-UREA tech -90 — 484.40
$C_{19}H_{44}N_2O_6SSi_2$
forms films on electrodes fordetermination of mercury[1].
1. Y. Guo et al, J. Pharm. Biol. Anal., *19*, 175, 1999
[69952-89-2] HMIS: 2-1-1-X — 25g/¥60,300

PLEASE INQUIRE ABOUT BULK QUANTITIES

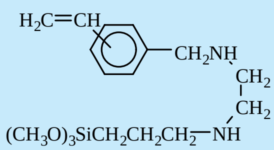
Vinyl and Olefin Functional Silanes

name	MW	bp/mm (mp)	D_4^{20}	n_D^{20}

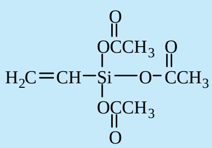
Vinyl and Olefin Functional Silanes - Trialkoxy



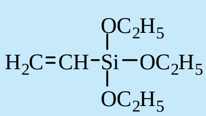
SIA0540.0
ALLYLTRIMETHOXYSILANE — 162.26 — 146-8° — 0.963^{25} — 1.4036^{25}
$C_6H_{14}O_3Si$ — flashpoint: 46°C (115°F)
adhesion promoter for vinyl-addition silicones
[2551-83-9] TSCA HMIS: 3-2-1-X — 10g/¥10,800 — 50g/¥43,200 — 2.0kg/¥252,000



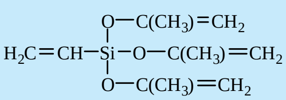
SIS6993.0
3-(N-STYRYLMETHYL-2-AMINOETHYLAMINO)-PROPYLTRIMETHOXYSILANE, 40% in methanol inhibited with BHT — 338.52 — 0.871 — 1.3900
flashpoint: 13°C (55°F)
$C_{17}H_{30}N_2O_3Si$
coupling agent for epoxy composites, primer for epoxy coatings
[34937-00-3] TSCA HMIS: 3-4-1-X store <5° — 25g/¥8,600 — 100g/¥27,900 — 2.0kg/¥103,000



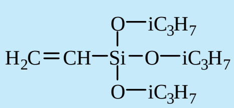
SIV9098.0
VINYLTRIACETOXYSILANE — 232.26 — 112-3°/1 — 1.167 — 1.423
$C_8H_{12}O_6Si$ — flashpoint: 88°C (190°F)
coefficient of thermal expansion: 1.6×10^{-3}
derivatization byproduct is acetic acid
[4130-08-9] TSCA HMIS: 3-2-1-X store <5° — 100g/¥5,600 — 2.0kg/¥55,300



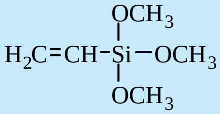
SIV9112.0
VINYLTRIETHOXYSILANE — 190.31 — 160-1° — 0.903 — 1.3960
$C_8H_{18}O_3Si$ — TOXICITY- oral rat, LD50: 22,500mg/kg
vapor pressure, 20°: 5mm — flashpoint: 44°C (111°F)
ΔHvap: 6.8 kcal/mole — autoignition temperature: 268°C (514°F)
specific heat: 0.25 cal/g/° — γc of treated surface: 25 dynes/cm
dipole moment: 1.69 — ΔHform: -463.5 kcal/mole
copolymerization parameters- e,Q: -0.42, 0.028
relative rate of hydrolysis vs SIV9220.0: 0.05
[78-08-0] TSCA HMIS: 1-3-1-X — 100g/¥4,400 — 1kg/¥8,800



SIV9209.0
VINYLTRIISOPROPENOXYSILANE — 226.35 — 73-5°/12 — 0.926 — 1.4373
$C_{11}H_{18}O_3Si$
employed as a crosslinker and in vapor phase; derivatization byproduct is acetone
[15332-99-7] TSCA HMIS: 1-3-1-X — 25g/¥8,600 — 100g/¥27,900



SIV9210.0
VINYLTRIISOPROPOXYSILANE — 232.39 — 179-81° — 0.8659 — 1.3961^{25}
$C_{11}H_{24}O_3Si$ — flashpoint: 51°C (124°F)
copolymerization parameters- e,Q: -0.36, 0.031 — vapor pressure, 60°: 4mm
relative rate of hydrolysis vs SIV9220.0: 0.0015
[18023-33-1] TSCA HMIS: 1-3-1-X — 25g/¥7,200 — 100g/¥23,400

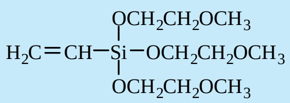


SIV9220.0
VINYLTRIMETHOXYSILANE — 148.23 — 123° — 0.970 — 1.3930
$C_5H_{12}O_3Si$ — TOXICITY- oral rat, LD50: 8,000mg/kg
viscosity: 0.6 cSt — flashpoint: 28°C (82°F)
copolymerization parameters- e,Q: -0.38, 0.031 — autoignition temp: 235°
vapor pressure, 20°: 9mm
employed in two-stage[1] and one-stage[2] graft polymerization/ cross-linking for PE.
copolymerizes with ethylene to form moisture cross-linkable polymers[3].
1. H. Scott US Pat. 3,646,155, 1972
2. P. Swarbrick et al, US Pat. 4,117,195, 1978
3. T. Isaka et al, U.S. Pat. 4,413,066, 1983
[2768-02-7] TSCA HMIS: 3-4-1-X — 100g/¥4,400 — 1kg/¥8,800

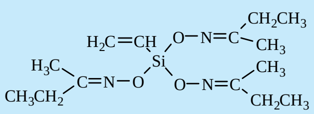
Commercial

name	MW	bp/mm (mp)	D_4^{20}	n_D^{20}

Commercial



SIV9275.0
VINYLTRIS(2-METHOXYETHOXY)SILANE — 280.39 — 284-6° — 1.0336^{25} — 1.4271^{25}
$C_{11}H_{24}O_6Si$ — TOXICITY- oral rat, LD50: 2960mg/kg
vapor pressure, 108°: 2mm — flashpoint: 115°C (239°F)
employed in peroxide graft-moisture crosslinking of polyethylene
relative rate of hydrolysis vs SIV9220.0: 0.50
[1067-53-4] TSCA HMIS: 3-2-1-X — 50g/¥4,500 — 2.0kg/¥44,000



SIV9280.0
VINYLTRIS(METHYLETHYLKETOXIMINO)-SILANE, tech-95 — 313.47 — 113°/0.1 (-22°)mp — 0.982^{25}
$C_{14}H_{27}N_3O_3Si$
neutral cross-linker/ coupling agent for condensation cure silicones; byproduct is methylethylketoxime
[2224-33-1] TSCA HMIS: 3-3-1-X — 50g/¥6,800 — 2.0kg/¥81,000

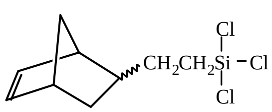
Developmental

$H_2C{=}CHCH_2O(CH_2)_{11}Si(OCH_3)_3$

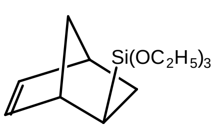
SIA0482.0
ALLYLOXYUNDECYLTRIMETHOXYSILANE — 332.56 — 140°/0.5 — 0.914 — 1.4415
$C_{17}H_{36}O_4Si$
ω-olefin for functional self-assembled monolayers
HMIS: 2-1-0-X — 5.0g/¥55,800

$H_2C{=}CHCH_2Si(OC_2H_5)_3$

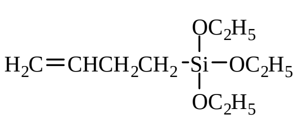
SIA0525.0
ALLYLTRIETHOXYSILANE — 204.34 — 176° — 0.9030 — 1.4074
3-(TRIETHOXYSILYL)-1-PROPENE — flashpoint 47°C (117°F)
$C_9H_{20}O_3Si$ vapor pressure, 100°: 50mm — dipole moment: 1.79 debye
[2550-04-1] TSCA HMIS 2-3-1-X — 10g/¥13,100 — 50g/¥57,600



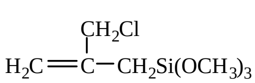
SIB0988.0
[(BICYCLOHEPTENYL)ETHYL]TRIMETHOXY-SILANE, 95% endo/exo isomers — 242.39 — 65°/10
flashpoint: >110°C (>230°F)
$C_{12}H_{22}O_3Si$
[68323-30-8] HMIS: 2-1-1-X — 25g/¥54,000



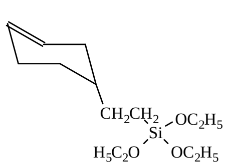
SIB0992.0
5-(BICYCLOHEPTENYL)TRIETHOXYSILANE — 256.42 — 106-8°/8 — 0.960 — 1.4486
NORBORNENYLTRIETHOXYSILANE — flashpoint: 98°C (208°F)
$C_{13}H_{24}O_3Si$
coupling agent for norbornadiene rubbers
component in low dielectric constant films
undergoes ring-opening metathetic polymerization (ROMP) with $RuCl_2(P(C_6H_5)_3)_3$[1].
1. E. Finkelstein, 10th Int'l Organosilicon Symp. Proc. P-120, 1993
[18401-43-9] TSCA HMIS: 2-2-1-X — 10g/¥10,500 — 50g/¥42,000



SIB1928.0
BUTENYLTRIETHOXYSILANE, 95% — 218.37 — 64°/6 (-80°)mp — 0.90
$C_{10}H_{22}O_3Si$ mixed isomers (mainly 3-butenyl)
TOXICITY - oral rat, LD50: >5000mg/kg
flashpoint: 73°C (163°F)
[57813-67-9] HMIS: 2-2-1-X — 25g/¥39,600



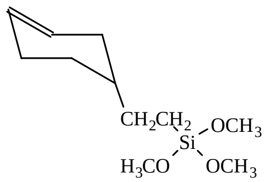
SIC2282.0
2-(CHLOROMETHYL)ALLYLTRIMETHOXY-SILANE — 210.73 — 128°/70 — 1.09
flashpoint: 89°C (192°F)
$C_7H_{15}ClO_3Si$
versatile coupling agent
[39197-94-9] HMIS: 3-2-1-X — 2.5g/¥27,000



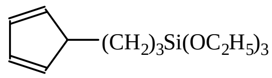
SIC2459.5
[2-(3-CYCLOHEXENYL)ETHYL]TRIETHOXY-SILANE — 272.46 — 0.948 — 1.444
flashpoint: 120°C (248°F)
$C_{14}H_{28}O_3Si$
[77756-79-7] HMIS:: 2-1-1-X — 10g/¥11,300 — 50g/¥45,000

PLEASE INQUIRE ABOUT BULK QUANTITIES

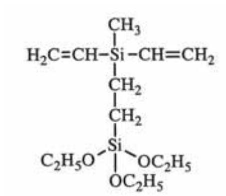
name	MW	bp/mm (mp)	D_4^{20}	n_D^{20}



SIC2460.0
[2-(3-CYCLOHEXENYL)ETHYL]TRIMETHOXY SILANE — MW 230.38 — bp 109°/6 — D_4^{20} 1.02 — n_D^{20} 1.4476
flashpoint: 80°C (176°F)
$C_{11}H_{22}O_3Si$
orients liquid crystals in display devices[1].
coupling agent for aramid fiber reinforced epoxy[2].
1. Sharp, CA101,81758g; Jap. Pat. JP 58122517, 1983
2. U. Lechner, CA112, 218118x; Germ. Offen. DE 3820971, 1989
[67592-36-3] TSCA HMIS: 3-2-1-X — 10g/¥9,500 — 50g/¥37,800



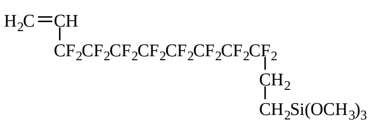
SIC2520.0
(3-CYCLOPENTADIENYLPROPYL)TRI-ETHOXYSILANE - dimer — MW 270.44 — bp 115°/0.5 — D_4^{20} 0.99
flashpoint: 100°C (212°F)
$C_{14}H_{26}O_3Si$
may be cracked to monomer at ~190° at 100mm
employed in silica-supported purification of fullerenes[1].
1. B. Nie et al, J. Org. Chem., *61*, 1870, 1996
[102056-64-4] HMIS: 2-2-1-X — 10g/¥27,000



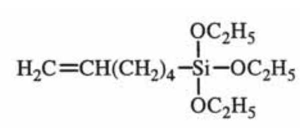
SID4610.3
(DIVINYLMETHYLSILYLETHYL)TRIETHOXYSILANE — MW 288.54 — bp 79-81°/0.15 — D_4^{20} 0.895
$C_{13}H_{28}O_3Si_2$
HMIS: 2-1-1-X — 5.0g/¥82,800

$CH_2{=}CH(CH_2)_{20}Si(OC_2H_5)_3$

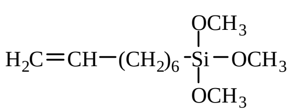
SID4618.0
DOCOSENYLTRIETHOXYSILANE, 95% — MW 470.88 — bp 187-195°/0.05
$C_{28}H_{58}O_3Si$ contains internal isomers
forms self-assembled monolayers that can be modified to hydroxyls[1].
1. J. Peansky et al, Langmuir, *11*, 953, 1995
[330457-44-8] HMIS: 1-1-0-X — 1.0g/¥49,500



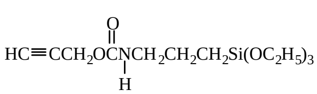
SIH5919.0
HEXADECAFLUORODODEC-11-ENYL-1-TRIMETHOXYSILANE — MW 576.35 — bp 90°/0.5
$C_{15}H_{16}O_3F_{16}Si$
forms self-assembled monolayers/ reagent for immobilization of DNA
HMIS: 3-1-1-X — 1.0g/¥63,900



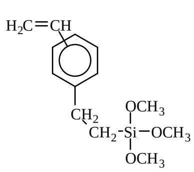
SIH6164.2
HEXENYLTRIETHOXYSILANE — MW 246.43 — bp 97°/1 — D_4^{20} 0.883 — n_D^{20} 1.4185
flashpoint: 86°C (187°F)
$C_{12}H_{26}O_3Si$
primarily α-olefin
[52034-14-7] HMIS: 2-1-1-X — 10g/¥21,600



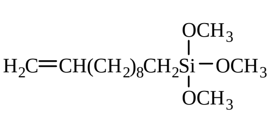
SIO6709.0
7-OCTENYLTRIMETHOXYSILANE, 95% — MW 232.39 — bp 48-9°/0.1 — D_4^{20} 0.940 — n_D^{20} 1.4305
flashpoint: 95°C (203°F)
$C_{11}H_{24}O_3Si$
contains 10-20% internal olefin isomers
coupling agent for "in situ" polymerization of acrylamide for capillary elctrophoresis[1]
1. A. Cifuentes et al, J. Chromatog. A, *830(2),* 423, 1999
[52217-57-9] TSCA HMIS: 3-1-1-X — 5g/¥16,200 — 25g/¥64,800



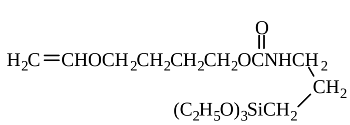
SIP6902.6
O-(PROPARGYLOXY)-N-(TRIETHOXY-SILYLPROPYL)URETHANE, 90% — MW 303.43 — bp 110-20°/0.2 — D_4^{20} 0.99 — n_D^{20} 1.4461[25]
inhibited with MEHQ
flashpoint: 95°C (203°F)
$C_{13}H_{25}NO_5Si$
HMIS: 2-2-1-X — 25g/¥28,800



SIS6990.0
STYRYLETHYLTRIMETHOXYSILANE, 95% — MW 252.38 — bp 98°/0.1 — D_4^{20} 1.02 — n_D^{20} 1.505
flashpoint: 97°C (207°F)
$C_{13}H_{20}O_3Si$ inhibited with t-butylcatechol
mixed m,p isomers and α,β isomers
copolymerization parameter, e,Q: -0.880, 1.500
[134000-44-5] HMIS: 2-1-1-X store <5° — 10g/¥27,000 — 50g/¥108,000



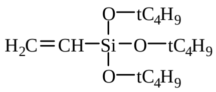
SIU9049.0
10-UNDECENYLTRIMETHOXYSILANE — MW 274.48 — bp 102-5°/1 — D_4^{20} 0.908
$C_{14}H_{30}O_3Si$
HMIS: 2-1-1-X — 5.0g/¥72,000



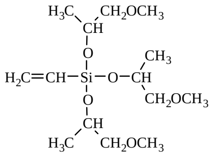
SIV9088.4
O-(VINYLOXYBUTYL)-N-(TRIETHOXYSILYL-PROPYL)URETHANE, 95% inhibited w/ MEHQ — MW 363.53 — D_4^{20} 1.015 — n_D^{20} 1.4454
$C_{16}H_{23}NO_6Si$
UV reactive coupling agent
HMIS: 3-2-1-X — 10g/¥36,900

Developmental

name	MW	bp/mm (mp)	D_4^{20}	n_D^{20}



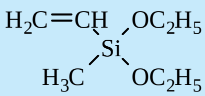
SIV9099.0
VINYLTRI-t-BUTOXYSILANE — MW 274.47 — bp 54°/2 — D 0.869
$C_{14}H_{30}O_3Si$ — flashpoint: 79°C (174°F)
[5356-88-7] HMIS: 2-2-1-X — 10g/¥21,600 — 50g/¥86,400



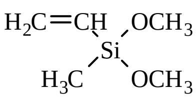
SIV9277.0
VINYLTRIS(METHOXYPROPOXY)SILANE — MW 322.47 — D 0.981 — n 1.424
$C_{14}H_{30}O_6Si$ — flashpoint: 122° (252°F)
[303746-21-6] HMIS: 2-1-1-X — 25g/¥10,800 — 100g/¥35,100

Vinyl and Olefin Functional - Dialkoxy

Commercial

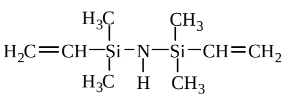


SIV9085.0
VINYLMETHYLDIETHOXYSILANE — MW 160.29 — bp 133-4° — D 0.858 — n 1.4000
$C_7H_{16}O_2Si$ — flashpoint: 16°C (61°F)
copolymerization parameters- e,Q; -0.86, 0.020
dipole moment: 1.27
[5507-44-8] TSCA HMIS: 2-4-1-X — 25g/¥6,300 — 2.0kg/¥112,000

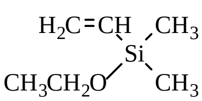


SIV9086.0
VINYLMETHYLDIMETHOXYSILANE — MW 132.23 — bp 104° — D 0.889 — n 1.395
$C_5H_{12}O_2Si$ — flashpoint: 8°C (46°F)
viscosity, 20°: 0.51 cSt
[16753-62-1] TSCA HMIS: 3-4-1-X — 25g/¥8,100 — 100g/¥26,100

Vinyl and Olefin Functional - Monoalkoxy

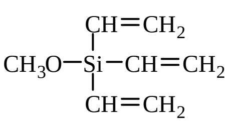


SID4612.0
1,3-DIVINYLTETRAMETHYLDISILAZANE — MW 185.42 — bp 160-1° — D 0.819 — n 1.4405
$C_8H_{19}NSi_2$ — flashpoint: 34°C (93°F)
derivatization byproduct is ammonia
adhesion promoter for negative photoresists
for silylation of glass capillary columns[1]
1. M. Jaroniec et al, J. High Resol. Chromatog, *5*, 3, 1982
[7691-02-3] TSCA HMIS: 3-3-1-X — 50g/¥10,800 — 250g/¥43,200



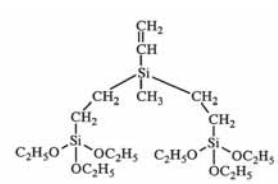
SIV9072.0
VINYLDIMETHYLETHOXYSILANE — MW 130.26 — bp 99-100° — D 0.790 — n 1.3983
$C_6H_{14}OSi$ — flashpoint: 4°C (39°F)
dipole moment: 1.23
[5356-83-2] TSCA HMIS: 2-4-1-X — 10g/¥9,900 — 50g/¥39,600

Developmental

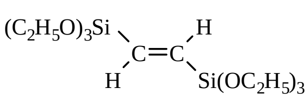


SIT8732.0
TRIVINYLMETHOXYSILANE — MW 140.25 — bp 131-3° — n 1.4400
$C_7H_{12}OSi$
HMIS: 3-4-1-X — 2.5g/¥6,300 — 10g/¥20,700

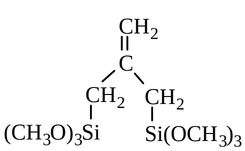
Vinyl and Olefin Functional - Dipodal



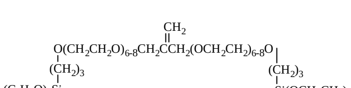
SIB1818.0
BIS(TRIETHOXYSILYLETHYL)VINYLMETHYL-SILANE — MW 452.82 — bp 141-3°/0.15 — D 0.943
$C_{19}H_{44}O_6Si_3$
HMIS: 2-1-1-X — 5.0g/¥54,000



SIB1820.0
BIS(TRIETHOXYSILYL)ETHYLENE, 95% — MW 352.57 — bp 122-5°/4 — D 0.958 — n 1.4168
4,4,7,7-TETRAETHOXY-3,8-DIOXA-4,7-DISILADEC-5-ENE
$C_{14}H_{32}O_6Si_2$ ~80% trans isomer; contains 1,1-isomer
[87061-56-1] HMIS: 2-2-1-X — 5.0g/¥17,600 — 25g/¥70,200



SIB1832.5
BIS(TRIMETHOXYSILYLMETHYL)ETHYLENE — MW 296.47
$C_{10}H_{24}O_6Si_2$
[143727-20-2] HMIS: 3-3-1-X — 5.0g/¥76,500



SIB1824.9
1,3-[BIS(3-TRIETHOXYSILYLPROPYL)POLY-ETHYLENOXY]-2-METHYLENEPROPANE — MW 1113.5
$C_{50}H_{104}O_{20}Si_2$ (average)
vinyl functional hydrophilic dipodal coupling agent for protein immobilization
HMIS: 2-2-1-X — 1.0g/¥124,000

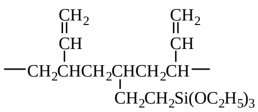
PLEASE INQUIRE ABOUT BULK QUANTITIES

Multi-Functional and Polymeric Silanes

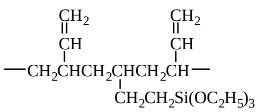
Developmental

name	MW	bp/mm (mp)	D_4^{20}	n_D^{20}

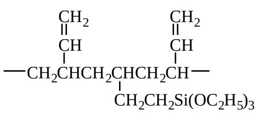
Polybutadiene



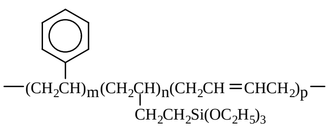
SSP-055
TRIETHOXYSILYL MODIFIED POLY-1,2-BUTADIENE, 50% in toluene — 3500-4500 — 0.90
viscosity: 100-200 cSt.
coupling agent for EPDM resins
[72905-90-9] TSCA HMIS: 2-4-1-X store <5° — 100g/¥27,000 — 2.0kg/¥273,000



SSP-056
TRIETHOXYSILYL MODIFIED POLY-1,2-BUTADIENE, 50% in volatile silicone — 3500-4500 — 0.93
viscosity: 100-200 cSt.
primer coating for silicone rubbers
[72905-90-9] TSCA HMIS: 2-3-1-X store <5° — 100g/¥30,600

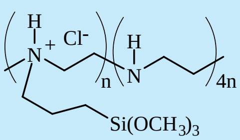


SSP-058
DIETHOXYMETHYLSILYL MODIFIED POLY-1,2-BUTADIENE, 50% in toluene — 3500-4500 — 0.90
viscosity: 75-150 cSt.
water tree resistance additive for crosslinkable HDPE cable cladding
HMIS: 2-4-1-X store <5° — 100g/¥38,700

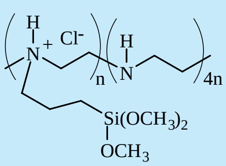


SSP-255
(30-35%TRIETHOXYSILYLETHYL)ETHYLENE-(35-40% 1,4-BUTADIENE) - (25-30% STYRENE) terpolymer, 50% in toluene — 4500-5500
HMIS: 2-3-1-X viscosity: 20-30 cSt. — 100g/¥38,700

Polyamine



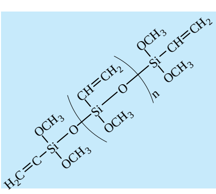
SSP-060
TRIMETHOXYSILYLPROPYL MODIFIED (POLYETHYLENIMINE) 50% in isopropanol — 1500-1800 — 0.92
visc: 125-175 cSt — ~20% of nitrogens substituted
employed as a coupling agent for polyamides[1].
in combination with glutaraldehyde immobilizes enzymes[2].
1. B. Arkles et al, SPI 42nd Composite Inst. Proc., 21-C, 1987
2. S. Cramer et al, Biotech. & Bioeng., *33(3)*, 344, 1989.
[136856-91-2] TSCA HMIS: 2-4-1-X — 100g/¥12,600 — 2.0kg/¥127,000



SSP-065
DIMETHOXYMETHYLSILYLPROPYL MODIFIED (POLYETHYLENIMINE) 50% in isopropanol — 1500-1800 — 0.92
visc: 100-200 cSt — ~20% of nitrogens substituted
primer for brass
[1255441-88-5] TSCA HMIS: 2-4-1-X — 100g/¥17,100 — 2.0kg/¥173,000

Commercial

Vinylalkoxysiloxane Polymers — TSCA



Code	Description	wgt % vinyl	Viscosity, cSt	Density	Refractive Index	Price/100g	Price/1kg
VEE-005*	polyVinylethoxysiloxane	19 - 22	4 - 7	1.02		¥16,200	¥113,000
VMM-010**	polyVinylmethoxysiloxane	22 - 23	8 - 12	1.10	1.428	¥12,600	¥88,200

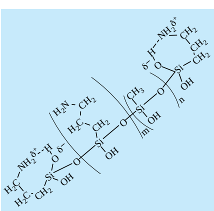
*CAS: [29434-25-1] **CAS: [131298-48-1]

Vinylethoxysiloxane-Propylethoxysiloxane Copolymer — TSCA

Code	Description	Viscosity	Density	Price/100g	Price/1kg
VPE-005*	oligomer	3 - 7	1.02	¥16,200	¥113,000

*9-11 wgt% vinyl

Water-borne Aminoalkyl Silsesquioxane Oligomers — TSCA



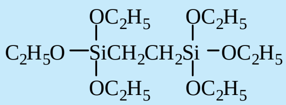
Code	Functional Group	Mole %	Molecular Weight	Weight % in solution	Specific Gravity	Viscosity	pH	Price/100g	3kg
WSA-7011	Aminopropyl	65-75	250-500	25-28	1.10	5-15	10-10.5	¥13,100	¥153,000
WSA-9911*	Aminopropyl	100	270-550	22-25	1.06	5-15	10-10.5	¥10,800	¥126,000
WSA-7021	Aminoethylaminopropyl	65-75	370-650	25-28	1.10	5-10	10-11	¥13,100	¥153,000
WSAV-6511**	Aminopropyl, vinyl	60-65	250-500	25-28	1.11	3-10	10-11	¥15,800	¥168,000

*CAS [29159-37-3] **[207308-27-8]

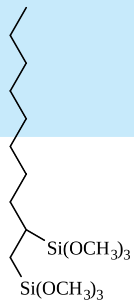
Non-Functional Dipodal Silanes

name	MW	bp/mm (mp)	D_4^{20}	n_D^{20}

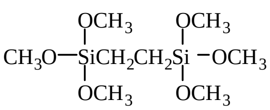
Commercial



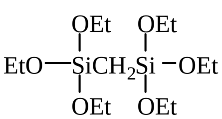
SIB1817.0
BIS(TRIETHOXYSILYL)ETHANE — 354.59 — 96°/0.3 — 0.957 — 1.4052
HEXAETHOXYDISILETHYLENE — flashpoint: 107°C (225°F)
$C_{14}H_{34}O_6Si_2$ — vapor pressure, 150°: 10mm
ΔHvap: 101.5 kj/mole — TOXICITY - oral rat, LD50: 161mg/kg
additive to silane coupling agent formulations that enhances hydrolytic stability
employed in corrosion resistant coatings/primers for steel and aluminum[1,2].
sol-gels of α,ω-bis(trimethoxysilyl)alkanes reported[3].
forms mesoporous, derivatizeable molecular sieves[4].
1. W. Van Ooij et al, J. Adhes. Sci. Tech. *11*, 29, 1997
2. W. Van Ooij et al, Chemtech., *28*, 26, 1998.
3. D. A. Loy et al, J. Am. Chem. Soc., *121*, 5413, 1999.
4. B. Molde et al, Chem. Mat., *11*, 3302, 1999.
[16068-37-4] TSCA-S HMIS: 3-1-1-X — 25g/¥6,800 — 100g/¥22,100 — 2.0kg/¥147,000



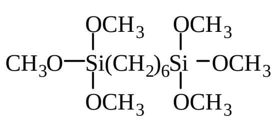
SIB1829.0
1,2-BIS(TRIMETHOXYSILYL)DECANE — 382.65 — 130-2°/0.4 — 0.984 — 1.4303
$C_{16}H_{38}O_6Si_2$ pendant dipodal silane
HMIS: 3-2-1-X — 25g/¥21,600 — 100g/¥70,200



SIB1830.0
BIS(TRIMETHOXYSILYL)ETHANE — 270.43 — 103-4°/5 — 1.068 — 1.4091
$C_8H_{22}O_6Si_2$ — flashpoint: 65° (149°F)
CAUTION: INHALATION HAZARD — vapor pressure, 20°: 0.08mm
employed in fabrication of multilayer printed circuit boards
1. J. Palladino, U.S. Pat. 5,073,456, 1991.
[18406-41-2] TSCA HMIS: 4-2-1-X — inquire



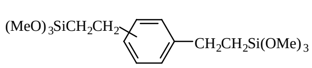
SIB1821.0
BIS(TRIETHOXYSILYL)METHANE — 340.56 — 114-5°/3.5 — 0.9741 — 1.4098
4,4,6,6-TETRAETHOXY-3,7-DIOXA-4,6-DISILANONANE
$C_{13}H_{32}O_6Si_2$
intermediate for sol-gel coatings, hybrid inorganic-organic polymers
[18418-72-9] HMIS: 2-3-0-X — 5.0g/¥16,700 — 25g/¥66,600



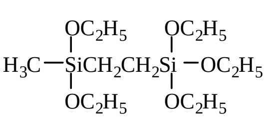
SIB1832.0
BIS(TRIMETHOXYSILYL)HEXANE — 326.54 — 161°/2 — 1.014 — 1.4213
$C_{12}H_{30}O_6Si_2$ — flashpoint: 95°C (203°F)
sol-gels of α,ω-bis(trimethoxysilyl)alkanes reported[1].
1. D. A. Loy et al, J. Am. Chem. Soc., *121*, 5413, 1999.
[87135-01-1] HMIS: 3-2-1-X — 10g/¥16,200 — 50g/¥64,800

$(C_2H_5O)_3Si(CH_2)_8Si(OC_2H_5)_3$

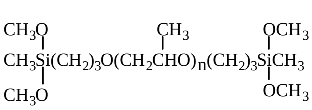
SIB1824.0
BIS(TRIETHOXYSILYL)OCTANE — 438.76 — 172-5°/0.75 — 0.926 — 1.4240
$C_{20}H_{46}O_6Si_2$
employed in sol-gel synthesis of mesoporous structures
[52217-60-4] TSCA-L HMIS: 2-1-1-X — 25g/¥13,500 — 100g/¥44,100



SIB1831.0
BIS(TRIMETHOXYSILYLETHYL)BENZENE — 374.58 — 148-50°/.1 — 1.08 — 1.4734
$C_{16}H_{30}O_6Si_2$ mixture of m&p isomers — flashpoint: 193°C (380°F)
[58298-01-4] TSCA HMIS: 2-1-0-X — 10g/¥14,900 — 50g/¥59,400



SIT8185.8
1-(TRIETHOXYSILYL)-2-(DIETHOXYMETHYLSILYL)ETHANE — 324.56 — 100°/0.5 — 0.946 — 1.4112
flashpoint: 102°C (215°F)
$C_{13}H_{32}O_5Si$
[18418-54-7] TSCA HMIS: 3-2-1-X — 25g/¥18,000 — 100g/¥58,500

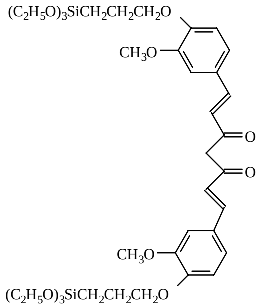


SIB1660.0
BIS[(3-METHYLDIMETHOXYSILYL)PROPYL]-POLYPROPYLENE OXIDE — 600-800 — 1.00
flashpoint: >110°C (>230°F)
viscosity: 6000-10,000 cSt.
w/tin catalyst forms moisture-crosslinkable resins
hydrophilic dipodal silane
[75009-88-0] TSCA HMIS: 3-1-1-X — 100g/¥10,800 — 2.0kg/¥101,000

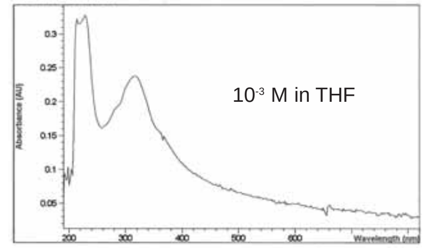
PLEASE INQUIRE ABOUT BULK QUANTITIES

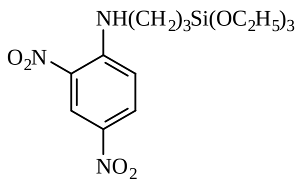
UV Active and Fluorescent Silanes

name | **MW** | **bp/mm (mp)** | n_D^{20}

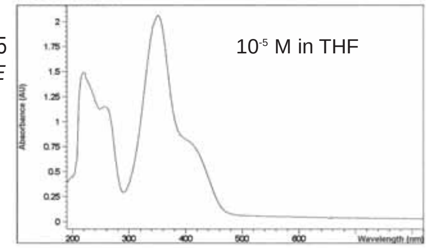


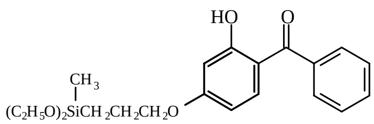
SIB1824.8
BIS(4-TRIETHOXYSILYLPROPYL-3-METHOXY-PHENYL)-1,6-HEPTANE-3,5-DIONE tech-90 — 777.07
$C_{39}H_{60}O_{12}Si_2$
UV: 220, 232(max), 354(broad)
metal chelating chromophore
HMIS: 2-1-1-X — 500mg/¥81,000



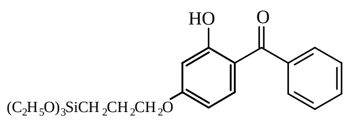


SID4352.0
3-(2,4-DINITROPHENYLAMINO)PROPYL-TRIETHOXYSILANE, 95% *N-[3-(TRIETHOXYSILYL)PROPYL]-2,4-DINITROPHENYLAMINE* — 387.46 — (27-30°)mp — 1.5665
$C_{15}H_{25}N_3O_7Si$ viscous liquid or solid — flashpoint: >110°C (230°F)
UV: 222, 258, 350(max), 410
forms $\chi 2$ non-linear optical sol-gel materials by corona poling[1,2].
1. E. Toussaere et al, Non-Linear Optics, *2*, 37, 1992
2. B. Lebeau et al, J. Mater. Chem., *4*, 1855, 1994
[71783-41-0] HMIS: 2-1-0-X — 25g/¥27,900 — 100g/¥90,900

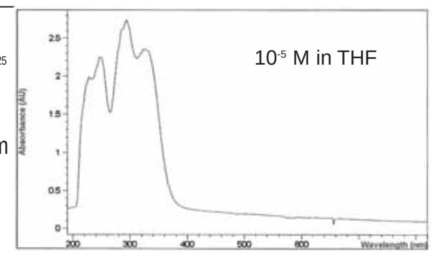


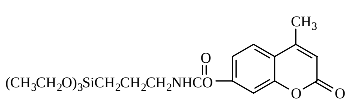


SIH6198.0
2-HYDROXY-4-(3-METHYLDIETHOXYSILYL-PROPOXY)DIPHENYLKETONE, 95% — 388.54 — viscosity, 25°: 100-125 cSt.
$C_{21}H_{28}O_5Si$ monomer for UV opaque fluids
HMIS: 2-1-1-X — 25g/¥38,700

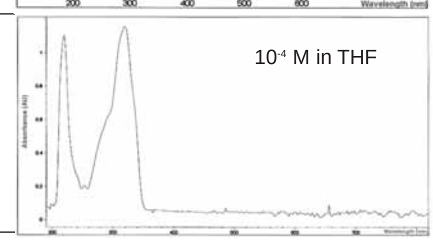


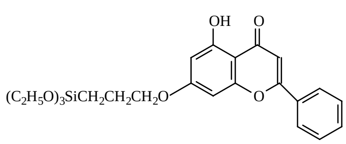
SIH6200.0
2-HYDROXY-4-(3-TRIETHOXYSILYLPROPOXY)-DIPHENYLKETONE, 95% — 418.56 — 1.545^{25}
viscosity, 25°: 125-150 cSt.
$C_{22}H_{30}O_6Si$ density: 1.12 — UV: 230, 248, 296(max), 336
strong UV blocking agent for optically clear coatings, abosrbs from 210-420nm
UV blocking agent[1].
B. Anthony, US Pat. 4,495,360, 1985
[79876-59-8] TSCA HMIS: 2-1-1-X — 25g/¥27,000 — 100g/¥87,800



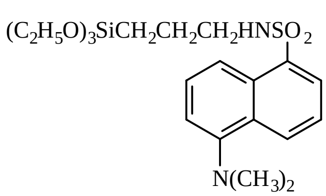


SIM6502.0
O-4-METHYLCOUMARINYL-N-[3-(TRIETHOXY-SILYL)PROPYL]CARBAMATE — 423.54 — (88-90°)mp
UV: 223, 281, 319.5(max)
$C_{20}H_{29}NO_7Si$ — soluble: THF
immobilizeable fluorescent compound[1].
1. B. Arkles, US Pat. 4,918,200, 1990
[129119-78-4] HMIS: 2-2-1-X — 10g/¥54,000

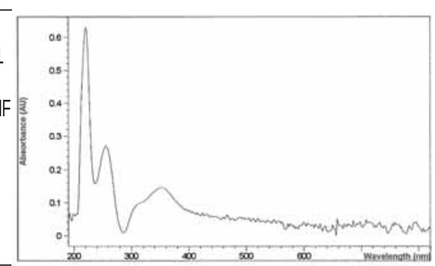


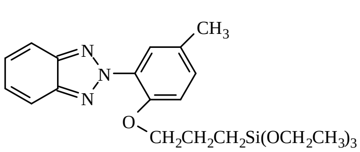


SIT8186.2
7-TRIETHOXYSILYLPROPOXY-5-HYDROXY-FLAVONE — 458.58
UV: 350nm (max)
$C_{24}H_{30}O_7Si$
HMIS: 2-1-1-X — 1.0g/¥21,600 — 5.0g/¥86,400



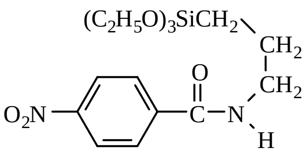
SIT8187.0
N-(TRIETHOXYSILYLPROPYL)DANSYLAMIDE — 454.66 — 115-9°/0.1 — 1.5421
5-DIMETHYLAMINO-N-(3-TRIETHOXYSILYLPROPYL)-NAPTHALENE-1-SULFONAMIDE — viscous liquid - soluble in toluene THF
$C_{21}H_{34}N_2O_5SSi$ density: 1.12 — UV: 222(max), 256, 354
fluorescent- employed as a tracer in UV cure composites
fluorescence probe for crosslinking in silicones[1].
1. P. Leezenberg et al, Chem. Mat., *7*, 1784, 1995
[70880-05-6] TSCA HMIS: 2-1-1-X — 0.5g/¥37,800 — 1.0g/¥66,600



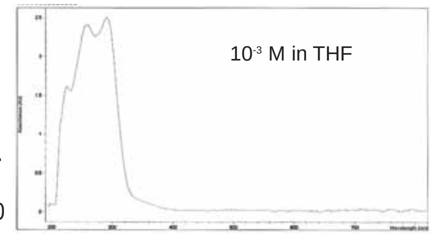


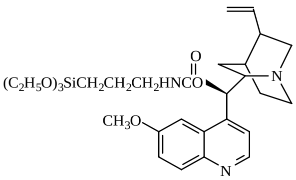
SIT8188.8
2-(2-TRIETHOXYSILYLPROPOXY-5-METHYL-PHENYL)BENZOTRIAZOLE — 429.59
$C_{22}H_{31}N_3O_4Si$ — UV: 300, 330(max)
UV blocking agent/stabilizer
HMIS: 2-1-1-X — 10g/¥42,300

name	MW	bp/mm (mp)	n_D^{20}

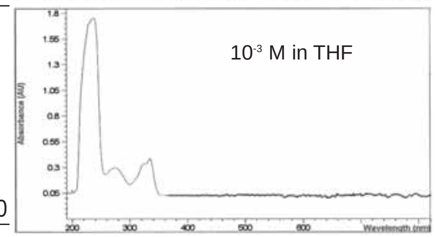


SIT8191.0
3-(TRIETHOXYSILYLPROPYL)-p-NITRO-BENZAMIDE — 370.48 — (54-5°)mp
$C_{16}H_{26}N_2O_6Si$
UV max: 224, 260, 292(s)
used to prepare diazotizable supports for enzyme immobilization[1].
H. Weetall, US Pat., 3,652,761
[60871-86-5] TSCA HMIS: 2-1-1-X — 25g/¥27,000



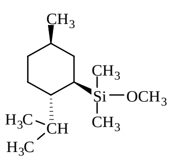


SIT8192.4
(R)-N-TRIETHOXYSILYLPROPYL-O-QUININE-URETHANE, 95% — 571.79 — (82-4°)mp
soluble: warm toluene
$C_{30}H_{45}N_3O_6Si$
UV max: 236(s), 274, 324, 334
fluorescent, optically active silane
[200946-85-6] HMIS: 2-1-1-X — 5.0g/¥54,000

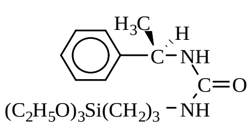


Chiral Silanes

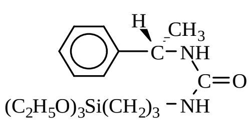
name	MW	bp/mm (mp)	D_4^{20}	n_D^{20}



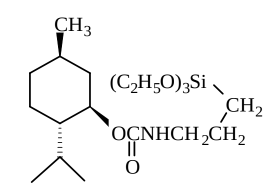
SIM6472.6
(-)-MENTHYLDIMETHYLMETHOXYSILANE — 228.45
$C_{13}H_{28}OSi$
reagent for chiral separations
HMIS: 3-2-1-X — 5.0g/¥84,600



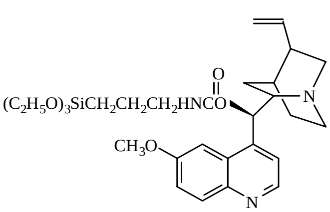
SIP6731.5
(R)-N-1-PHENYLETHYL-N'-TRIETHOXYSILYL-PROPYLUREA — 368.55 — D_4: 1.05^{25}
flashpoint: > 110°C (>230°F)
$C_{18}H_{32}N_2O_4Si$
optically active silane; treated surfaces resolve enantiomers
[68959-21-7] TSCA HMIS: 2-1-0-X — 25g/¥34,200



SIP6731.6
(S)-N-1-PHENYLETHYL-N'-TRIETHOXYSILYL-PROPYLUREA — 368.55 — D_4: 1.05^{25}
flashpoint: > 110°C (>230°F)
$C_{18}H_{32}N_2O_4Si$
optically active silane; treated surfaces resolve enantiomers
[68959-21-7] TSCA HMIS: 2-1-0-X — 25g/¥34,200

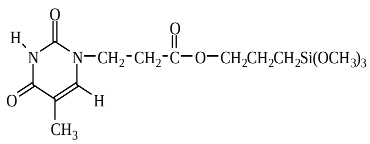
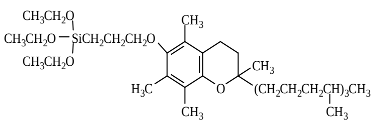


SIT8190.0
(S)-N-TRIETHOXYSILYLPROPYL-O-MENTHO-CARBAMATE — 406.63 — D_4: 0.985^{25} — n_D: 1.4526
flashpoint: > 110°C (>230°F)
$C_{20}H_{41}NO_5Si$ optically active
[68479-61-8] TSCA HMIS: 2-1-1-X — 10g/¥28,800



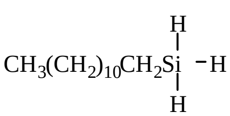
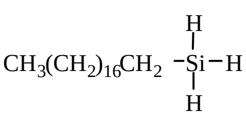
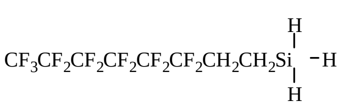
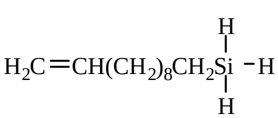
SIT8192.4
(R)-N-TRIETHOXYSILYLPROPYL-O-QUININE-URETHANE, 95% — 571.79 — (82-4°)mp
soluble: warm toluene
$C_{30}H_{45}N_3O_6Si$
fluorescent, optically active silane
HYDROLYTIC SENSITIVITY: 7 Si-OR reacts slowly with moisture/water
[200946-85-6] HMIS: 2-1-1-X — 5.0g/¥54,000

Biomolecular Probes

structure	name	MW	bp/mm (mp)	D_4^{20}	n_D^{20}
	SIA0120.0 (N-ACETYLGLYCYL)-3-AMINOPROPYL-TRIMETHOXYSILANE $C_{10}H_{21}N_2O_7Si$ amino-acid tipped silane HMIS: 3-2-1-X	309.37	5.0g/¥59,400		
	SIT7909.7 3-(N-THYMIDYL)PROPIONOXYPROPYL-TRIMETHOXYSILANE $C_{14}H_{24}N_2O_7Si$ derivatized surfaces bind adenine modified polymers[1]. 1. K. Viswanathan et al, Polymer Preprints, *46(2)*, 1133, 2005 HMIS: 2-2-1-X	360.74	1.0g/¥94,500		
	SIT8012.0 DL-α-TOCOPHEROLOXYPROPYLTRI-ETHOXYSILANE tech-90 $C_{36}H_{64}O_5Si$ HMIS: 2-2-1-X	604.99	10g/¥54,000		

Silyl Hydrides

Silyl Hydrides are a distinct class of silanes that behave and react very differently than conventional silane coupling agents. Their application is limited to deposition on metals (see discussion on p. 17). They liberate hydrogen on reaction and should be handled a with appropriate caution.

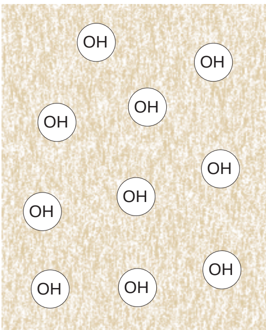
structure	name	MW	bp/mm (mp)	D_4^{20}	n_D^{20}
	SID4629.6 DODECYLSILANE $C_{12}H_{28}Si$ forms SAMS on gold surfaces 872-19-5 HMIS: 2-2-1-X	200.44	80°/7 10g/¥35,100	0.7753	1.4380^{25}
	SIO6635.0 n-OCTADECYLSILANE $C_{18}H_{40}Si$ contains 4-6% C_{18} isomers forms self-assembled monolayers on titanium[1]. 1. A. Fadeau et al, J. Am. Chem. Soc., *121*, 12184, 1999 [18623-11-5] TSCA HMIS: 2-1-1-X	284.60 flashpoint: >110°C (>230°F) 25g/¥18,000	195°/15 (29°)mp	0.794 100g/¥58,500	
	SIT8173.0 (TRIDECAFLUORO-1,1,2,2-TETRA-HYDROOCTYL)SILANE $C_8H_7F_{13}Si$ provides vapor-phase hydrophobic surfaces on titanium, gold, silicon [469904-32-3] HMIS: 3-3-1-X	378.22	75°/251.446 10g/¥85,500	1.3184	
	SIU9048.0 10-UNDECENYLSILANE $C_{11}H_{24}Si$ HMIS: 2-3-1-X	184.40	2.5g/¥81,000	0.78	

Organosilane-Modified Silica Nanoparticles

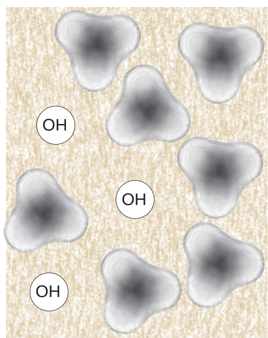
A range of silica structures from 20nm to 1 micron have been modified with silanes to reduce hydroxyl content allowing improved dispersion. Other versions have monolayers with isolated secondary amine functionality, providing controlled interactions with resins. Systems that maintain low levels of hydroxyls have improved electrical properties. Introduction of low levels of secondary amines impart improved mechanical properties particularly in high humidity environments.

name	MW	bp/mm (mp)	D_4^{20}	n_D^{20}

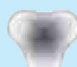
Commercial



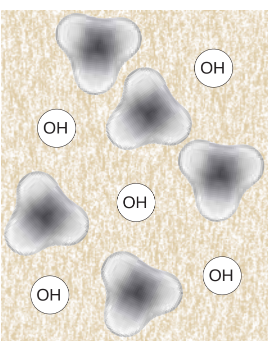
SIS6960.0
SILICON DIOXIDE, amorphous — 60.09 — (>1600°)mp — 2.2 — 1.46
fumed silica — TOXICITY- oral rat, LD50: 8160mg/kg
SiO_2 — ultimate particle size: 0.02μ
surface area, 200m2/g — γc: 44
isoelectric point: 2.2 — pH, (4% aqueous slurry): 3.5-4.5
[112945-52-5] TSCA HMIS: 2-0-0-X — 500g/¥4,500 — 2kg/¥13,500



SIS6962.0
SILICON DIOXIDE, amorphous — 60.09 — (>1600°)mp — 2.2 — 1.45
HEXAMETHYLDISILAZANE TREATED
fumed silica, HMDZ TREATED — surface area, 150-200m²/g
SiO_2 — ultimate particle size: 0.02μ
carbon content: 3%
approximate ratio: $(CH_3)_3Si/HO-Si$: 2/1
[68909-20-6] TSCA HMIS: 2-0-0-X — 500g/¥12,000 — 2kg/¥38,400

 = $(CH_3)_3Si$ - = trimethylsilyl group

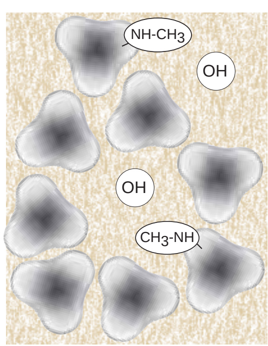
---



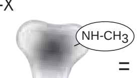
SIS6962.1M30
SILICON DIOXIDE, amorphous — 60.09 — (>1600°)mp — 2.2 — 1.45
HEXAMETHYLDISILAZANE TREATED
fumed silica, HMDZ TREATED — surface area, 150-200m²/g
SiO_2 — ultimate particle size: 0.02μ
carbon content: 2-3%
calculated ratio: $(CH_3)_3Si/HO-Si$: 1/1
[68909-20-6] TSCA HMIS: 2-0-0-X — 500g/¥12,000 — 2kg/¥38,400

 = $(CH_3)_3Si$ - = trimethylsilyl group

Developmental



SIS6962.1N30
SILICON DIOXIDE, amorphous — 60.09 — (>1600°)mp — 2.2 — 1.45
CYCLIC AZASILANE/HEXAMETHYLDISILAZANE TREATED
fumed silica, N-Methylaminopropylfunctional — surface area, 150-200m²/g
SiO_2 — ultimate particle size: 0.02μ
carbon content: 4-7%
calculated ratio: $CH_3NHCH_2CH_2CH_2Si/(CH_3)_3Si:HO-Si$:1/2/1
[68909-20-6] TSCA HMIS: 2-0-0-X — 500g/¥25,200



= $CH_3NHCH_2CH_2CH_2(CH_3)_2Si$

Gelest provides custom surface treatment services. We can handle a wide range of materials with special process considerations including: inert atmospheres, highly flammable and corrosive treatments, as well as thermal and vacuum drying.

Surface Modification with Silanes: What's not covered in "Silane Coupling Agents"?

Polar, hydrophilic and water-dispersible silanes, although important in surface modification, do not have organic functionality and are not discussed with coupling agents. The Gelest brochure entitled "**Hydrophobicity, Hydrophilicity and Silane Surface Modification**" includes these materials.

Chlorosilane, silazane and dialkylaminosilane coupling agents are not discussed in this brochure. These materials can be found in the Gelest catalog entitled "Silanes, Silicones and Metal-Organics." The use of these materials is limited commercially due to the difficulty in handling the corrosive, flammable or toxic byproducts associated with hydrolysis.

Alkyl-silanes and **Aryl-silanes** including **Fluorinated Alkyl-silanes** are important in control of hydrophobicity and surface properties. These materials are discussed in the Gelest brochure "Alkyl-silanes and Aryl-silanes."

Further Reading

Silane Coupling Agents - General References and Proceedings

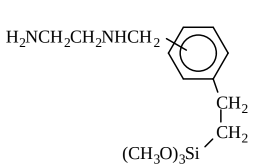
1. B. Arkles, Tailoring Surfaces with Silanes, CHEMTECH, 7, 766-778, 1977
2. E. Plueddemann, "Silane Coupling Agents," Plenum, 1982.
3. K. Mittal, "Silanes and Other Coupling Agents," VSP, 1992
4. D. Leyden and W. Collins, "Silylated Surfaces," Gordon & Breach, 1980.
5. D. E. Leyden, "Silanes, Surfaces and Interfaces," Gordon & Breach 1985.
6. J. Steinmetz and H. Mottola, "Chemically Modified Surfaces," Elsevier, 1992.
7. J. Blitz and C. Little, "Fundamental & Applied Aspects of Chemically Modified Surfaces," Royal Society of Chemistry, 1999.

Substrate Chemistry - General References and Proceedings

8. R. Iler, "The Chemistry of Silica," Wiley, 1979.
9. S. Pantelides, G. Lucovsky, "SiO_2 and Its Interfaces," MRS Proc. 105, 1988.

Product Information

Product Code | Product Name | Molecular Weight | Boiling Point/mm (Melting Point) | Specific Gravity | Refractive Index



SIA0588.0
(AMINOETHYLAMINOMETHYL)PHENETHYL- 298.46 126-30°/0.2 1.02 1.5083
TRIMETHOXYSILANE, 90% mixed m,p isomers flashpoint: > 110°C (>230°F) — Other Physical Properties
$C_{14}H_{26}N_2O_3Si$

coupling agent for polyimides
photochemically sensitive (194nm)[1] self-assembled monolayers[2].
1. W. Dressick et al, Thin Solid Films, *284*, 568, 1996.
2. C Harnett et al, Appl. Phys. Lett., *76*, 2466, 2000.
HYDROLYTIC SENSITIVITY: 7 Si-OR reacts slowly with water/moisture — References

[74113-77-2] TSCA HMIS: 3-1-1-X 25g/¥36,900 100g/¥120,000

CAS#

Hazardous Rating Information (Health-Flammability-Reactivity)

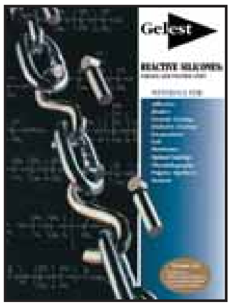
Indicates Product listed in TSCA Inventory (L = Low Volume Exemption; S = Significant New Use Restriction)

PRODUCT NAME	PRODUCT#	PAGE
ACETOXYMETHYLTRIETHOXYSILANE	SIA0050.0	38
ACETOXYMETHYLTRIMETHOXYSILANE	SIA0055.0	38
(3-ACRYLOXYPROPYL)METHYLDIMETHOXYSILANE	SIA0198.0	27
(3-ACRYLOXYPROPYL)TRIMETHOXYSILANE	SIA0200.0	26
N-(3-ACRYLOXY-2-HYDROXYPROPYL)-3-AMINOPROPYLTRIETHOXYSILANE	SIA0180.0	26
3-(N-ALLYLAMINO)PROPYLTRIMETHOXYSILANE	SIA0400.0	31
ALLYLOXYUNDECYLTRIMETHOXYSILANE	SIA0482.0	46
ALLYLTRIETHOXYSILANE	SIA0525.0	46
ALLYLTRIMETHOXYSILANE	SIA0540.0	45
N-ALLYL-AZA-2,2-DIMETHOXYSILACYCLOPENTANE	SIA0380.0	35
AMEO	SIA0610.0	28
4-AMINOBUTYLTRIETHOXYSILANE	SIA0587.0	28
(AMINOETHYLAMINO)-3-ISOBUTYLDIMETHYLMETHOXYSILANE	SIA0587.2	30
(AMINOETHYLAMINOMETHYL)PHENETHYLTRIMETHOXYSILANE	SIA0588.0	30
AMINOPHENYLTRIMETHOXYSILANE, MIXED ISOMERS	SIA0599.2	28
N-(2-AMINOETHYL)-11-AMINOUNDECYLTRIMETHOXYSILANE	SIA0595.0	30
N-(2-AMINOETHYL)-3-AMINOISOBUTYLMETHYLDIMETHOXYSILANE	SIA0587.5	30
N-(2-AMINOETHYL)-3-AMINOPROPYLMETHYLDIMETHOXYSILANE	SIA0589.0	30
N-(2-AMINOETHYL)-3-AMINOPROPYLSILANETRIOL	SIA0590.0	30
N-(2-AMINOETHYL)-3-AMINOPROPYLTRIMETHOXYSILANE	SIA0591.0	29
N-(6-AMINOHEXYL)AMINOMETHYLTRIETHOXYSILANE	SIA0526.0	30
N-(6-AMINOHEXYL)AMINOPROPYLTRIMETHOXYSILANE	SIA0594.0	30
m-AMINOPHENYLTRIMETHOXYSILANE	SIA0599.0	28
N-3-[AMINO(POLYPROPYLENOXY)]AMINOPROPYLTRIMETHOXYSILANE	SIA0599.4	28
3-AMINOPROPYLDIMETHYLETHOXYSILANE	SIA0603.0	28
3-(m-AMINOPHENOXY)PROPYLTRIMETHOXYSILANE	SIA0598.0	29
N-AMINOETHYL-AZA-2,2-DIMETHYL-4-METHYLSILACYCLOPENTANE	SIA0592.0	35
p-AMINOPHENYLTRIMETHOXYSILANE	SIA0599.1	28
3-AMINOPROPYLDIISOPROPYLETHOXYSILANE	SIA0602.0	29
3-AMINOPROPYLDIMETHYLETHOXYSILANE	SIA0603.0	29
3-AMINOPROPYLMETHYLDIETHOXYSILANE	SIA0605.0	29
3-AMINOPROPYLTRIETHOXYSILANE	SIA0610.0	28
3-AMINOPROPYLTRIMETHOXYSILANE	SIA0611.0	28
3-AMINOPROPYLTRIS(METHOXYETHOXYETHOXY)SILANE	SIA0614.0	28
AMINOPROPYLSILANETRIOL	SIA0608.0	29
6-AZIDOSULFONYLHEXYLTRIETHOXYSILANE	SIA0780.0	36
5-(BICYCLOHEPTENYL)TRIETHOXYSILANE	SIB0992.0	46
1,2-BIS(TRIMETHOXYSILYL)DECANE	SIB1829.0	50
3-BROMOPROPYLTRIMETHOXYSILANE	SIB1906.0	39
11-BROMOUNDECYLTRIMETHOXYSILANE	SIB1909.0	39
BIS(TRIMETHOXYSILYLETHYL)BENZENE	SIB1831.0	50
BENZOYLOXYPROPYLTRIMETHOXYSILANE	SIB0959.0	38
BIS(2-HYDROXYETHYL)-3-AMINOPROPYLTRIETHOXYSILANE	SIB1140.0	40
BIS(METHYLDIETHOXYSILYLPROPYL)AMINE	SIB1620.0	34
BIS(TRIETHOXYSILYL)ETHANE	SIB1817.0	50
BIS(TRIETHOXYSILYL)ETHYLENE	SIB1820.0	48
BIS(TRIETHOXYSILYL)OCTANE	SIB1824.0	50
BIS(TRIMETHOXYSILYL)ETHANE	SIB1830.0	50
BIS(TRIMETHOXYSILYL)HEXANE	SIB1832.0	50
BIS(TRIMETHOXYSILYL)METHANE	SIB1821.0	50
BIS(TRIMETHOXYSILYLPROPYL)AMINE	SIB1833.0	33
BIS[(3-METHYLDIMETHOXYSILYL)PROPYL]POLYPROPYLENE OXIDE	SIB1660.0	50
BIS[(3-TRIMETHOXYSILYL)PROPYL]ETHYLENEDIAMINE	SIB1834.1	34
BIS[(3-TRIMETHOXYSILYL)PROPYL]ETHYLENEDIAMINE, 60%	SIB1834.0	33
BIS[3-(TRIETHOXYSILYL)PROPYL]DISULFIDE	SIB1824.6	44
BIS[3-(TRIETHOXYSILYL)PROPYL]TETRASULFIDE	SIB1825.0	44
BIS[3-(TRIETHOXYSILYL)PROPYL]UREA	SIB1826.0	34
3-BROMOPROPYLTRIMETHOXYSILANE	SIB1906.0	39
11-BROMOUNDECYLTRIMETHOXYSILANE	SIB1909.0	39
BUTENYLTRIETHOXYSILANE	SIB1928.0	46
n-BUTYLAMINOPROPYLTRIMETHOXYSILANE	SIB1932.2	31
N-n-BUTYL-AZA-2,2-DIMETHOXYSILACYCLOPENTANE	SIB1932.4	35
10-(CARBOMETHOXY)DECYLDIMETHYLMETHOXYSILANE	SIC2067.0	38
CARBOXYETHYLSILANETRIOL, SODIUM SALT	SIC2263.0	36
((CHLOROMETHYL)PHENYLETHYL)METHYLDIMETHOXYSILANE	SIC2295.2	39
((CHLOROMETHYL)PHENYLETHYL)TRIMETHOXYSILANE	SIC2295.5	38
(p-CHLOROMETHYL)PHENYLTRIMETHOXYSILANE	SIC2296.2	38
2-(4-CHLOROSULFONYLPHENYL)ETHYLTRIMETHOXYSILANE	SIC2417.0	36
2-(CHLOROMETHYL)ALLYLTRIMETHOXYSILANE	SIC2282.0	46
3-CHLOROISOBUTYLDIMETHYLMETHOXYSILANE	SIC2278.0	39
3-CHLOROPROPYLDIMETHYLMETHOXYSILANE	SIC2338.0	39
3-CHLOROPROPYLMETHYLDIMETHOXYSILANE	SIC2355.0	39
3-CHLOROPROPYLTRIETHOXYSILANE	SIC2407.0	38
3-CHLOROPROPYLTRIMETHOXYSILANE	SIC2410.0	38
CHLOROMETHYLDIMETHYLETHOXYSILANE	SIC2286.0	39
CHLOROMETHYLMETHYLDIETHOXYSILANE	SIC2292.0	39
CHLOROMETHYLTRIETHOXYSILANE	SIC2298.4	39
CHLOROMETHYLTRIMETHOXYSILANE	SIC2298.6	39
N-CYCLOHEXYLAMINOPROPYLTRIMETHOXYSILANE	SIC2464.4	31
[2-(3-CYCLOHEXENYL)ETHYL]TRIETHOXYSILANE	SIC2459.5	46
[2-(3-CYCLOHEXENYL)ETHYL]TRIMETHOXYSILANE	SIC2460.0	47
(3-CYCLOPENTADIENYLPROPYL)TRIETHOXYSILANE-dimer	SIC2520.0	47
DAMO	SIA0591.0	29
N,N-DIDECYL-N-METHYL-N-METHYL-N-(3-TRIMETHOXYSILYLPROPYL)AMMONIUM Cl	SID3392.0	33
DIETHOXYMETHYLSILYL MODIFIED POLY-1,2-BUTADIENE	SSP-058	49
DIETHOXYPHOSPHORYLETHYLTRIETHOXYSILANE	SID3412.0	42
DIETHYLAMINOMETHYLTRIETHOXYSILANE	SID3395.4	32
(N.N-DIETHYL-3-AMINOPROPYL)TRIMETHOXYSILANE	SID3396.0	32
DIETHYLPHOSPHATOETHYLTRIETHOXYSILANE	SID3412.0	42
2,2-DIMETHOXY-1,6-DIAZA-2-SILACYCLOOCTANE	SID3543.0	35
3-(N,N-DIMETHYLAMINOPROPYL)TRIMETHOXYSILANE	SID3547.0	32
5-DIMETHYLAMINO-N-(3-TRIETHOXYSILYLPROPYL)NAPTHALENE-1-SULFONAMIDE	SIT8187.0	51
DIMETHOXYMETHYLSILYLPROPYL MODIFIED (POLYETHYLENIMINE)	SSP-065	49
3-(2,4-DINITROPHENYLAMINO)PROPYLTRIETHOXYSILANE	SID4352.0	51
N,N-DIOCTYL-N'-TRIETHOXYSILYLPROPYLUREA	SID4465.0	35
DIPHENYLPHOSPHINOETHYLDIMETHYLETHOXYSILANE	SID4557.5	42
2-(DIPHENYLPHOSPHINO)ETHYLTRIETHOXYSILANE	SID4558.0	42
N-[3-(TRIETHOXYSILYL)PROPYL]-2,4-DINITROPHENYLAMINE	SID4352.0	51
1,3-DIVINYLTETRAMETHYLDISILAZANE	SID4612.0	48
DOCOSENYLTRIETHOXYSILANE	SID4618.0	47

2-(3,4-EPOXYCYCLOHEXYL)ETHYLTRIETHOXYSILANE	SIE4668.0	37
2-(3,4-EPOXYCYCLOHEXYL)ETHYLTRIMETHOXYSILANE	SIE4670.0	37
PRODUCT NAME	**PRODUCT#**	**PAGE**
3-(2,3-EPOXYPROPOXY)PROPYLTRIMETHOXYSILANE	SIG5840.0	37
5,6-EPOXYHEXYLTRIETHOXYSILANE	SIE4675.0	37
N-ETHYLAMINOISOBUTYLTRIMETHOXYSILANE	SIE4886.0	31
(3-GLYCIDOXYPROPYL)DIMETHYLETHOXYSILANE	SIG5825.0	37
(3-GLYCIDOXYPROPYL)METHYLDIETHOXYSILANE	SIG5832.0	37
(3-GLYCIDOXYPROPYL)METHYLDIMETHOXYSILANE	SIG5836.0	37
(3-GLYCIDOXYPROPYL)TRIETHOXYSILANE	SIG5839.0	37
(3-GLYCIDOXYPROPYL)TRIMETHOXYSILANE	SIG5840.0	37
GLYMO	SIG5840.0	37
HEXAETHOXYDISILETHYLENE	SIB1817.0	50
2-HYDROXY-4-(3-TRIETHOXYSILYLPROPOXY)DIPHENYLKETONE	SIH6200.0	51
N-(HYDROXYETHYL)-N-METHYLAMINOPROPYLTRIMETHOXYSILANE	SIH6172.0	40
HYDROXYMETHYLTRIETHOXYSILANE	SIH6175.0	40
3-(2-IMIDAZOLIN-1-YL)PROPYLTRIETHOXYSILANE	SIT8187.5	34
3-IODOPROPYLTRIMETHOXYSILANE	SII6452.0	39
3-ISOCYANATOPROPYLTRIETHOXYSILANE	SII6455.0	41
3-ISOCYANTOPROPYLTRIMETHOXYSILANE	SII6456.0	41
3-MERCAPTOPROPYLMETHYLDIMETHOXYSILANE	SIM6474.0	43
3-MERCAPTOPROPYLTRIETHOXYSILANE	SIM6475.0	43
3-MERCAPTOPROPYLTRIMETHOXYSILANE	SIM6476.0	43
O-(METHACRYLOXYETHYL)-N-(TRIETHOXYSILYLPROPYL)URETHANE	SIM6480.8	43
MEMO	SIM6487.4	26
METHACRYLOXYMETHYLTRIETHOXYSILANE	SIM6482.0	26
METHACRYLOXYMETHYLTRIMETHOXYSILANE	SIM6483.0	26
METHACRYLOXYPROPYLDIMETHYLETHOXYSILANE	SIM6486.4	27
METHACRYLOXYPROPYLDIMETHYLMETHOXYSILANE	SIM6486.5	27
METHACRYLOXYPROPYLMETHYLDIETHOXYSILANE	SIM6486.8	27
METHACRYLOXYPROPYLMETHYLDIMETHOXYSILANE	SIM6486.9	27
METHACRYLOXYPROPYLTRIETHOXYSILANE	SIM6487.3	26
METHACRYLOXYPROPYLTRIMETHOXYSILANE	SIM6487.4	26
N-(3-METHACRYLOXY-2-HYDROXYPROPYL)-3-AMINOPROPYLTRIETHOXYSILANE	SIM6481.1	26
N-METHYLAMINOPROPYLMETHYLDIMETHOXYSILANE	SIM6498.0	32
N-METHYLAMINOPROPYLTRIMETHOXYSILANE	SIM6500.0	31
NORBORNENYLTRIETHOXYSILANE	SIB0992.0	46
O-4-METHYLCOUMARINYL-N-[3-(TRIETHOXYSILYL)PROPYL]CARBAMATE	SIM6502.0	51
7-OCTENYLTRIMETHOXYSILANE	SIO6709.0	47
OCTADECYLDIMETHYL(3-TRIMETHOXYSILYLPROPYL)AMMONIUM Cl	SIO6620.0	34
N-PHENYLAMINOMETHYLTRIETHOXYSILANE	SIP6723.7	31
N-PHENYLAMINOPROPYLTRIMETHOXYSILANE	SIP6724.0	31
O-(PROPARGYLOXY)-N-(TRIETHOXYSILYLPROPYL)URETHANE	SIP6902.6	47
2-(4-PYRIDYLETHYL)TRIETHOXYSILANE	SIP6928.0	28
STYRYLETHYLTRIMETHOXYSILANE	SIS6990.0	47
3-(N-STYRYLMETHYL-2-AMINOETHYLAMINO)PROPYLTRIMETHOXYSILANE	SIS6993.0	45
3-(N-STYRYLMETHYL-2-AMINOETHYLAMINO)PROPYLTRIMETHOXYSILANE HCl	SIS6994.0	32
TETRADECYLDIMETHYL(3-TRIMETHOXYSILYLPROPYL)AMMONIUM Cl	SIT7090.0	33
4,4,6,6-TETRAETHOXY-3,7-DIOXA-4,6-DISILANONANE	SIB1821.0	50
4,4,7,7-TETRAETHOXY-3,8-DIOXA-4,7-DISILADEC-5-ENE	SIB1820.0	48
3-THIOCYANATOPROPYLTRIETHOXYSILANE	SIT7908.0	43
TRIETHOXSILYLBUTYRALDEHYDE	SIT8185.3	27
(3-TRIETHOXYSILYLPROPYL)-t-BUTYLCARBAMATE	SIT8186.5	41
1-(TRIETHOXYSILYL)-2-(DIETHOXYMETHYLSILYL)ETHANE	SIT8185.8	50
1-TRIETHOXYSILYL-6-SUFONAZIDE-n-HEXANE	SIA0780.0	36
3-(TRIETHOXYSILYL)PROPYLSUCCINIC ANHYDRIDE	SIT8192.6	36
3-(TRIETHOXYSILYLPROPYL)DIHYDRO-3,5-FURANDIONE	SIT8192.6	36
3-(TRIETHOXYSILYLPROPYL)-p-NITROBENZAMIDE	SIT8191.0	51
7-TRIETHOXYSILYLPROPOXY-5-HYDROXYFLAVONE	SIT8186.2	51
N-(3-TRIETHOXYSILYLPROPYL)-4,5-DIHYDROIMIDAZOLE	SIT8187.5	34
N-(3-TRIETHOXYSILYLPROPYL)-4-HYDROXYBUTYRAMIDE	SIT8189.5	40
N-(3-TRIETHOXYSILYLPROPYL)GLUCONAMIDE	SIT8189.0	40
N-(TRIETHOXYSILYLPROPYL)DANSYLAMIDE	SIT8187.0	51
N-(TRIETHOXYSILYLPROPYL)-O-POLYETHYLENE OXIDE URETHANE	SIT8192.0	40
N-TRIETHOXYSILYLPROPYL-O-QUININE URETHANE	SIT8192.4	51
TRIETHOXYSILYLMETHANOL	SIH6175.0	40
TRIETHOXYSILYL MODIFIED POLY-1,2-BUTADIENE	SSP-055	49
TRIETHOXYSILYL MODIFIED POLY-1,2-BUTADIENE	SSP-056	49
TRIETHOXYSILYLPROPYLETHYLCARBAMATE	SIT8188.0	41
TRIETHOXYSILYLUNDECANAL	SIT8194.0	27
TRIETHOXYSILYLUNDECANAL, ETHYLENE GLYCOL ACETAL	SIT8194.5	22
TRIHYDROXYPROPYLCARBAMIDOTHIOIC ACID HCl	SIT8405.0	33
3-(TRIHYDROXYSILYL)-1-PROPANE-SULFONIC ACID	SIT8378.3	36
3-TRIHYDROXYSILYLPROPYLMETHYLPHOSPHONATE, SODIUM SALT	SIT8378.5	36
2-(TRIMETHOXYSILYLETHYL)PYRIDINE	SIT8396.0	29
N-[3-(TRIMETHOXYSILYL)PROPYL]ETHYLENEDIAMINE	SIA0591.0	29
(3-TRIMETHOXYSILYLPROPYL)DIETHYLENETRIAMINE	SIT8398.0	31
N-(3-TRIMETHOXYSILYLETHYLPROPYL)PYRROLE	SIT8410.0	29
N-(TRIMETHOXYSILYLETHYL)BENZYL-N,N,N-TRIMETHYLAMMONIUM Cl	SIT8395.0	33
N-(TRIMETHOXYSILYLPROPYL)ETHYLENEDIAMINE, TRIACETIC ACID, TRISODIUM SALT	SIT8402.0	36
N-(TRIMETHOXYSILYLPROPYL)ISOTHIOURONIUM CHLORIDE	SIT8405.0	33
N,N,N-TRIMETHYL-3-(TRIMETHOXYSILYL)-1-PROPANAMINIUM Cl	SIT8415.0	32
N-TRIMETHOXYSILYLPROPYL-N,N,N-TRIMETHYLAMMONIUM Cl	SIT8415.0	32
TRIMETHOXYSILYLPROPYL MODIFIED (POLYETHYLENIMINE)	SSP-060	49
TRIS(3-TRIMETHOXYSILYLPROPYL)ISOCYANURATE	SIT8717.0	41
TRIVINYLMETHOXYSILANE	SIT8732.0	48
10-UNDECENYLSILANE	SIU9048.0	53
10-UNDECENYLTRIMETHOXYSILANE	SIU9049.0	47
UREIDOPROPYLTRIETHOXYSILANE	SIU9055.0	34
UREIDOPROPYLTRIMETHOXYSILANE	SIU9058.0	34
VINYLDIMETHYLETHOXYSILANE	SIV9072.0	48
VINYLMETHYLDIETHOXYSILANE	SIV9085.0	48
VINYLMETHYLDIMETHOXYSILANE	SIV9086.0	48
VINYLTRIACETOXYSILANE	SIV9098.0	45
VINYLTRIETHOXYSILANE	SIV9112.0	45
VINYLTRIISOPROPENOXYSILANE	SIV9209.0	45
VINYLTRIISOPROPOXYSILANE	SIV9210.0	45
VINYLTRIMETHOXYSILANE	SIV9220.0	45
VINYLTRIS(2-METHOXYETHOXY)SILANE	SIV9275.0	46
VINYLTRIS(METHOXYPROPOXY)SILANE	SIV9277.0	48
VINYLTRIS(METHYLETHYLKETOXIMINO)SILANE	SIV9280.0	46

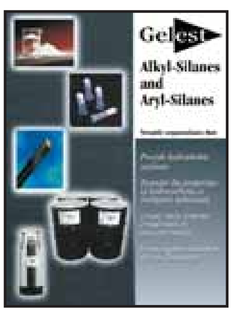
Gelest Product Lines

Silicon Compounds: Silanes & Silicones
Detailed chemical properties and reference articles for over 2000 compounds. The 560 page Gelest catalog of silicon and metal-organic chemistry includes scholarly reviews as well as detailed application information. Physical properties, references, structures, CAS numbers as well as HMIS (Hazardous Material Rating Information) of metal-organic and silicon compounds enable chemists to select materials to meet process and performance criteria.

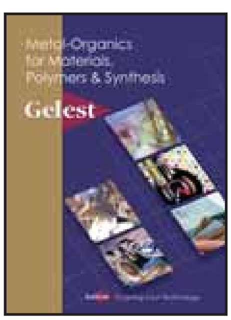


Reactive Silicones - Forging New Polymer Links
The 48 page brochure describes reactive silicones that can be formulated into coatings, membranes, cured rubbers and adhesives for mechanical, optical, electronic and ceramic applications. Information on reactions and cures of silicones as well as physical properties shortens product development time for chemists and engineers. The detailed text provides starting-point formulations, references and application information. Vinyl, hydride, silanol and alkoxy functional silicones are provided for conventional silicone cure systems. Amine, epoxy, methacrylate, hydroxy and mercapto silicones are provided for hybrid organic-silicone cure systems.

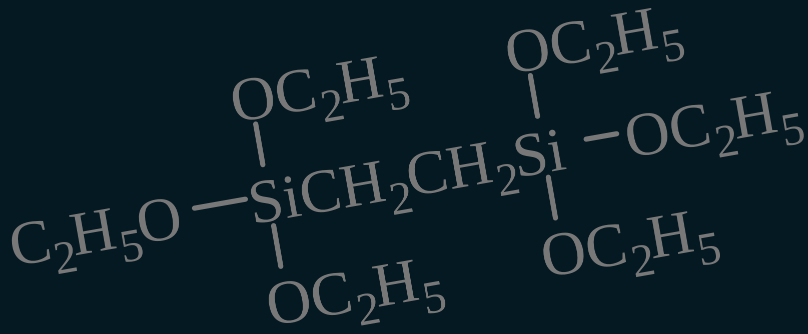
Silicone Fluids - Stable, Inert Media
Design and Engineering properties for conventional silicone fluids as well as thermal, fluorosilicone, hydrophilic and low temperature grades are presented in a 24 page selection guide. The brochure provides data on thermal, rheological, electrical, mechanical and optical properties for silicones. Silicone fluids are available in viscosities ranging from 0.65 to 2,500,000 cSt.

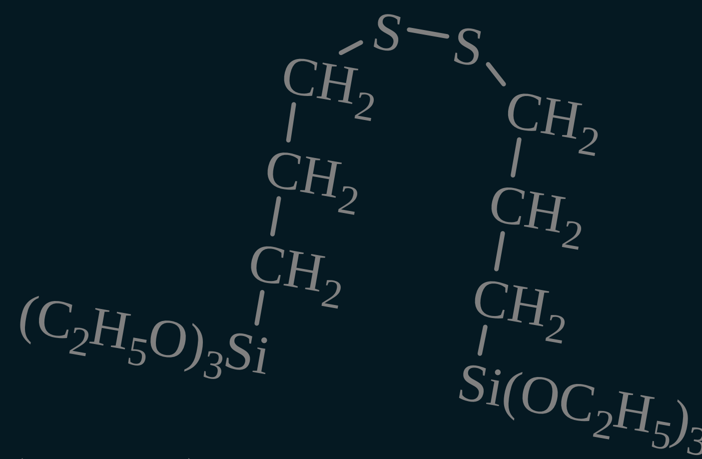


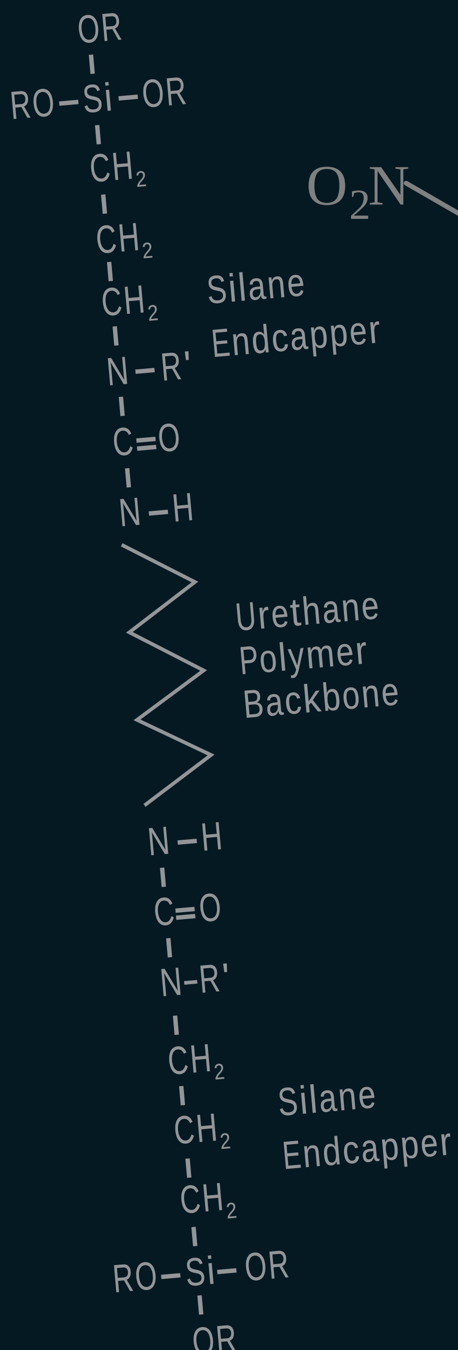
Alkyl-Silanes and Aryl-Silanes
A description of non-functional silanes that are used to prepare hydrophobic and water repellent surfaces, specialty resins and modified ceramics is given in an 8 page brochure. The emphasis is on distinguishing the features and benefits of the entire range of commercial alkyl-silanes and aryl-silanes, including fluorinated alkyl-silanes.

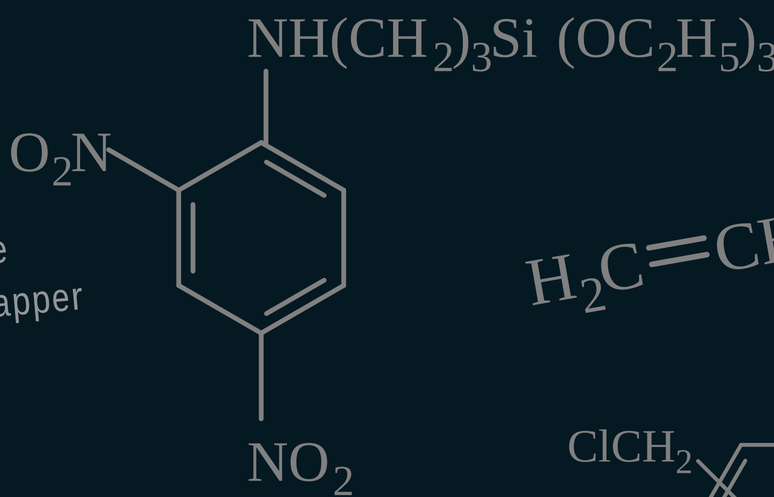


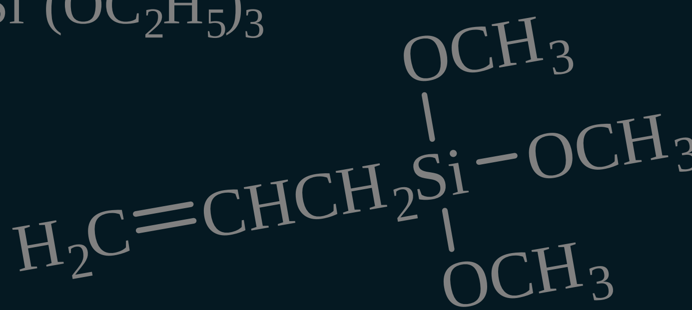
Metal-Organics for Material & Polymer Technology
A reference manual for optical and electronic and nanotechnology applications. The literature provides information on metallization, electroceramic, and dielectric applications of silicon, germanium, aluminum, gallium, copper and other metal chemistries. Deposition techniques include ALD, CVD, spin coating and self-assembled monolayers (SAMs). Presents chemistry and physics in the context of device applications ranging from ULSI semiconductors to DNA array devices to flat-panel displays.

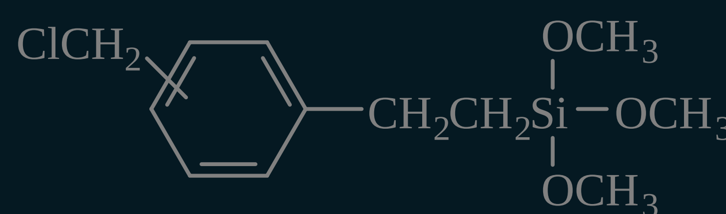


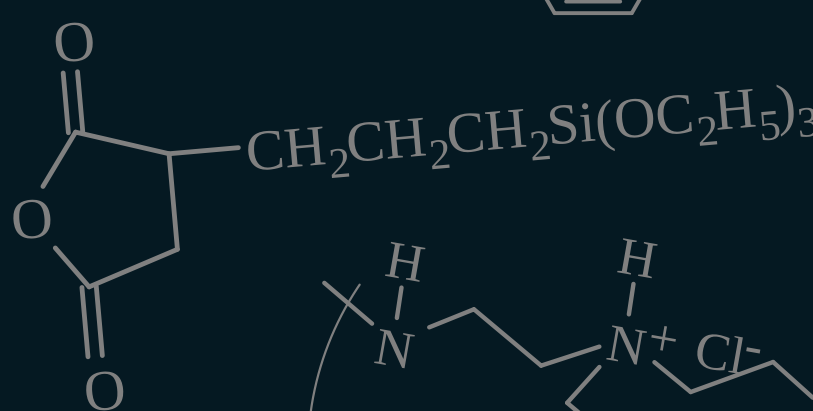


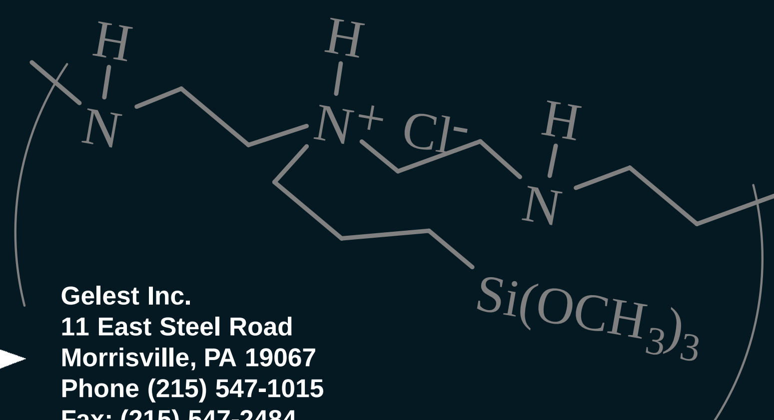












Gelest

Gelest Inc.
11 East Steel Road
Morrisville, PA 19067
Phone (215) 547-1015
Fax: (215) 547-2484
www.gelest.com

アヅマックス株式会社

東京営業所　〒104-0032 東京都中央区八丁堀1-10-7
マツダ八重洲通りビル８階
Tel：03-5543-1630 Fax：03-5543-0312
http://www.azmax.co.jp　E-mail:sales@azmax.co.jp