Hydrophobicity, Hydrophilicity and Silane Surface Modification

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Front Cover Photos: Water rolls off a duck’s back. Lotus leaves exhibit superhydrophobicity. Biological systems are dependent on water, but at the same time must control the interaction. In a sense, all living organisms exhibit behaviors that can be described as both hydrophobic and hydrophilic.
Hydrophobicity, Hydrophilicity and Silane Surface Modification

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Hydrophobicity, Hydrophilicity and Silane Surface Modification
by Barry Arkles

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Silanes and Surface Modification

Silanes are silicon chemicals that possess a hydrolytically sensitive center that can react with inorganic substrates such as glass to form stable covalent bonds and possess an organic substitution that alters the physical interactions of treated substrates.

![Silane Structure](image)

**Property modifications include:**
- Hydrophobicity
- Release
- Dielectric
- Absorption
- Orientation
- Hydrophilicity
- Charge Conduction

**Applications include:**
- Architectural Coatings
- Water-Repellents
- Anti-stiction Coatings for MEMs
- Mineral Surface Treatments
- Fillers for Composites
- Pigment Dispersants
- Dielectric Coatings
- Anti-fog Coatings
- Release Coatings
- Optical (LCD) Coatings
- Bonded Phases
- Self-Assembled Monolayers (SAMs)
- Crosslinkers for Silicones
- Nanoparticle Synthesis

In contrast with silanes utilized as coupling agents in adhesive applications, silanes used to modify the surface energy or wettability of substrates under normal conditions do not impart chemical reactivity to the substrate. They are often referred to as non-functional silanes. The main classes of silanes utilized to effect surface energy modification without imparting reactivity are:

**Hydrophobic Silanes**
- Methyl
- Linear Alkyl
- Branched Alkyl
- Fluorinated Alkyl
- Aryl
- Dipodal

**Hydrophilic Silanes**
- Polar
- Hydroxylic
- Ionic
- Charge inducible/charge switchable
- Embedded Hydrophilicity
- Masked
**Water, Hydrophobicity and Hydrophilicity**

Hydrophobic and Hydrophilic are frequently used descriptors of surfaces. A surface is hydrophobic if it tends not to adsorb water or be wetted by water. A surface is hydrophilic if it tends to adsorb water or be wetted by water. More particularly, the terms describe the interaction of the boundary layer of a solid phase with liquid or vapor water. Silanes can be used to modify the interaction of boundary layers of solids with water with a high degree of control, effecting variable degrees of hydrophobicity or hydrophilicity.

Since the interaction of water with surfaces is frequently used to define surface properties, a brief review of its structure and properties can be helpful. Although the structure of water is a subject of early discussion in the study of physical sciences, it is interesting to note that the structure of liquid water is still not solved and, even so, most technologists lose appreciation of what is known about its structure and properties.

The quantum calculation of the structure of an isolated H₂O molecule has evolved to the currently accepted model which demonstrates a strong dipole, but no lone electron pairs associated with sp³ hybridized orbitals of oxygen. This model of isolated H₂O conforms most closely to the vapor state and extrapolation often leads to the conclusion that water is a collection of individual molecules which associate with each other primarily through dipole interactions. The polar nature of water, with its partial positive and partial negative dipole, explains why bulk water readily dissolves many ionic species and interacts with ionic surfaces. The difference between isolated vapor phase water and bulk liquid water is much more extreme than can be accounted for by a model relying only on dipole interaction. The properties of bulk liquid water are strongly influenced by hydrogen bond interactions. In the liquid state, in spite of 80% of the electrons being concerned with bonding, the three atoms of a water molecule do not stay together as discrete molecules. The hydrogen atoms are constantly exchanging between water molecules in a protonation-deprotonation process. Both acids and bases catalyze hydrogen exchange and, even when at its slowest rate of exchange (at pH 7), the average residence time of a hydrogen atom is only about a millisecond. In the liquid state, water molecules are bound to each other by an average of three hydrogen bonds. Hydrogen bonds arise when a hydrogen that is covalently bound to an oxygen in one molecule of water nears another oxygen from another water molecule. The electrophilic oxygen atom “pulls” the hydrogen closer to itself. The end result is that the hydrogen is now shared (unequally) between the oxygen to which it is covalently bound and the electrophilic oxygen to which it is attracted (O-H···O). Each hydrogen bond has an average energy of 20 kJ/mol. This is much less than an O-H covalent bond, which is 460 kJ/mol. Even though an individual hydrogen bond is relatively weak, the large number of hydrogen bonds that exist in water which pull the molecules together have a significant role in giving water its special bulk properties. In ice, water molecules are highly organized with four hydrogen bonds. Liquid water is thought to be a combination of domains of molecules with 3-4 hydrogen bonds separated by domains with 2-3 hydrogen bonds, subject to constant turnover - the flickering cluster model.

This brief description of water is provided in order to give the insight that whenever a solid surface interacts with bulk water it is interacting with a soft matter structure, not simply a collection of individual molecules. Surface interactions with water must compete with a variety of internal interactions of liquid phase water: van der Waals forces, dipole interactions, hydrogen bonding and proton exchange.
Wettability and Contact Angle

A surface is said to be wetted if a liquid spreads over the surface evenly without the formation of droplets. When the liquid is water and it spreads over the surface without the formation of droplets, the surface is said to be hydrophilic. In terms of energetics, this implies that the forces associated with the interaction of water with the surface are greater than the cohesive forces associated with bulk liquid water. Water droplets form on hydrophobic surfaces, implying that cohesive forces associated with bulk water are greater than the forces associated with the interaction of water with the surface. Practically, hydrophobicity and hydrophilicity are relative terms. A simple quantitative method for defining the relative degree of interaction of a liquid with a solid surface is the contact angle of a liquid droplet on a solid substrate. If the contact angle of water is less than 30°, the surface is designated hydrophilic since the forces of interaction between water and the surface nearly equal the cohesive forces of bulk water and water does not cleanly drain from the surface. If water spreads over a surface and the contact angle at the spreading front edge of the water is less than 10°, the surface is often designated as superhydrophilic provided that the surface is not absorbing the water, dissolving in the water or reacting with the water. On a hydrophobic surface, water forms distinct droplets. As the hydrophobicity increases, the contact angle of the droplets with the surface increases. Surfaces with contact angles greater than 90° are designated as hydrophobic. The theoretical maximum contact angle for water on a smooth surface is 120°. Micro-textured or micro-patterned surfaces with hydrophobic asperities can exhibit apparent contact angles exceeding 150° and are associated with superhydrophobicity and the "lotus effect".

Contact Angle Defines Wettability

Water droplets form on hydrophobic surfaces, implying that cohesive forces associated with bulk water are greater than the forces associated with the interaction of water with the surface. Practically, hydrophobicity and hydrophilicity are relative terms. A simple quantitative method for defining the relative degree of interaction of a liquid with a solid surface is the contact angle of a liquid droplet on a solid substrate. If the contact angle of water is less than 30°, the surface is designated hydrophilic since the forces of interaction between water and the surface nearly equal the cohesive forces of bulk water and water does not cleanly drain from the surface. If water spreads over a surface and the contact angle at the spreading front edge of the water is less than 10°, the surface is often designated as superhydrophilic provided that the surface is not absorbing the water, dissolving in the water or reacting with the water. On a hydrophobic surface, water forms distinct droplets. As the hydrophobicity increases, the contact angle of the droplets with the surface increases. Surfaces with contact angles greater than 90° are designated as hydrophobic. The theoretical maximum contact angle for water on a smooth surface is 120°. Micro-textured or micro-patterned surfaces with hydrophobic asperities can exhibit apparent contact angles exceeding 150° and are associated with superhydrophobicity and the "lotus effect".

### Contact Angle of Water on Smooth Surfaces

<table>
<thead>
<tr>
<th>Substance</th>
<th>Contact Angle</th>
</tr>
</thead>
<tbody>
<tr>
<td>heptadecafluorodecyltrimethoxysilane*</td>
<td>115°</td>
</tr>
<tr>
<td>poly(tetrafluoroethylene)</td>
<td>108-112°</td>
</tr>
<tr>
<td>poly(propylene)</td>
<td>108°</td>
</tr>
<tr>
<td>octadecyldimethylchlorosilane*</td>
<td>110°</td>
</tr>
<tr>
<td>octadecylichlorosilane*</td>
<td>102-109°</td>
</tr>
<tr>
<td>tris(trimethylsiloxy)-silylethylchlorosilane</td>
<td>104°</td>
</tr>
<tr>
<td>octyldimethylchlorosilane*</td>
<td>104°</td>
</tr>
<tr>
<td>dimethylchlorosilane*</td>
<td>95-105°</td>
</tr>
<tr>
<td>butyldimethylchlorosilane*</td>
<td>100°</td>
</tr>
<tr>
<td>trimethylchlorosilane*</td>
<td>90-100°</td>
</tr>
<tr>
<td>poly(ethylene)</td>
<td>88-103°</td>
</tr>
<tr>
<td>poly(styrene)</td>
<td>94°</td>
</tr>
<tr>
<td>poly(chlorotrifluoroethylene)</td>
<td>90°</td>
</tr>
<tr>
<td>human skin</td>
<td>75-90°</td>
</tr>
<tr>
<td>diamond</td>
<td>87°</td>
</tr>
<tr>
<td>graphite</td>
<td>86°</td>
</tr>
<tr>
<td>silicon (etched)</td>
<td>86-88°</td>
</tr>
<tr>
<td>talc</td>
<td>50-55°</td>
</tr>
<tr>
<td>chitosan</td>
<td>80-81°</td>
</tr>
<tr>
<td>steel</td>
<td>70-75°</td>
</tr>
<tr>
<td>methacryloxypropyltrimethoxysilane</td>
<td>70°</td>
</tr>
<tr>
<td>gold, typical (see gold, clean)</td>
<td>66°</td>
</tr>
<tr>
<td>intestinal mucosa</td>
<td>50-60°</td>
</tr>
<tr>
<td>glycidoxypropyltrimethoxysilane*</td>
<td>49°</td>
</tr>
<tr>
<td>kaolin</td>
<td>42-46°</td>
</tr>
<tr>
<td>platinum</td>
<td>40°</td>
</tr>
<tr>
<td>silicon nitride</td>
<td>28-30°</td>
</tr>
<tr>
<td>silver iodide</td>
<td>17°</td>
</tr>
<tr>
<td>soda-lime glass</td>
<td>&lt;15°</td>
</tr>
<tr>
<td>gold, clean</td>
<td>&lt;10°</td>
</tr>
</tbody>
</table>

*Note: Contact angles for silanes refer to smooth treated surfaces.

---

Ordinary Surface-“typical wetting”

Hydrophobic-“poor wetting”

Hydrophilic-“good wetting”
Critical Surface Tension and Adhesion

While the contact angle of water on a substrate is a good indicator of the relative hydrophobicity or hydrophilicity of a substrate, it is not a good indicator for the wettability of the substrate by other liquids. Critical surface tension is associated with the wettability or release properties of a solid. It serves as a better predictor of the behavior of a solid with a range of liquids.

Liquids with a surface tension below the critical surface tension ($\gamma_c$) 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:

$$\gamma_{SV} - \gamma_{SL} = \gamma_{LV} \cdot \cos \theta_c$$

where $\gamma_{SL}$ = interfacial surface tension, $\gamma_{LV}$ = surface tension of liquid.

Hydrophilic behavior is generally observed by surfaces with critical surface tensions greater than 45 dynes/cm. As the critical surface tension increases, the expected decrease in contact angle is accompanied with stronger adsorptive behavior and with increased exotherms associated with the adsorption.

Hydrophobic behavior is generally observed by surfaces with critical surface tensions less than 35 dynes/cm. At first, the decrease in critical surface tension is associated with oleophilic behavior, i.e. the wetting of the surfaces by hydrocarbon oils. As the critical surface tensions decrease below 20 dynes/cm, the surfaces resist wetting by hydrocarbon oils and are considered oleophobic as well as hydrophobic.

Silane treatment has allowed control of thixotropic activity of silica and clays in paint and coating 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.

### Critical surface tensions

<table>
<thead>
<tr>
<th>Material</th>
<th>$\gamma_c$ (dynes/cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>heptadecafluorodecyltrichlorosilane</td>
<td>12.0</td>
</tr>
<tr>
<td>poly(tetrafluoroethylene)</td>
<td>18.5</td>
</tr>
<tr>
<td>octadecyltrichlorosilane</td>
<td>20-24</td>
</tr>
<tr>
<td>methyltrimethoxysilane</td>
<td>22.5</td>
</tr>
<tr>
<td>nonafluorohexyltrimethoxysilane</td>
<td>23.0</td>
</tr>
<tr>
<td>vinyltetriethoxysilane</td>
<td>25</td>
</tr>
<tr>
<td>paraffin wax</td>
<td>25.5</td>
</tr>
<tr>
<td>ethyltrimethoxysilane</td>
<td>27.0</td>
</tr>
<tr>
<td>propyltrimethoxysilane</td>
<td>28.5</td>
</tr>
<tr>
<td>glass, soda-lime (wet)</td>
<td>30.0</td>
</tr>
<tr>
<td>poly(chlorotrifluoroethylene)</td>
<td>31.0</td>
</tr>
<tr>
<td>poly(propylene)</td>
<td>31.0</td>
</tr>
<tr>
<td>propylene oxide</td>
<td>32</td>
</tr>
<tr>
<td>polyethylene</td>
<td>33.0</td>
</tr>
<tr>
<td>trifluoropropyltrimethoxysilane</td>
<td>33.5</td>
</tr>
<tr>
<td>3-(2-aminoethyl)-aminopropyltrimethoxysilane</td>
<td>33.5</td>
</tr>
<tr>
<td>poly(styrene)</td>
<td>34</td>
</tr>
<tr>
<td>p-tolyltrimethoxysilane</td>
<td>34</td>
</tr>
<tr>
<td>cyanoethyltrimethoxysilane</td>
<td>34</td>
</tr>
<tr>
<td>aminopropyltrimethoxysilane</td>
<td>35</td>
</tr>
<tr>
<td>polymethylmethacrylate</td>
<td>39</td>
</tr>
<tr>
<td>poly(vinyl chloride)</td>
<td>39</td>
</tr>
<tr>
<td>phenyltrimethoxysilane</td>
<td>40.0</td>
</tr>
<tr>
<td>chloropropyltrimethoxysilane</td>
<td>40.5</td>
</tr>
<tr>
<td>mercaptopropyltrimethoxysilane</td>
<td>41</td>
</tr>
<tr>
<td>glycidoxypropyltrimethoxysilane</td>
<td>42.5</td>
</tr>
<tr>
<td>poly(ethylene oxide)</td>
<td>43</td>
</tr>
<tr>
<td>copper (dry)</td>
<td>44</td>
</tr>
<tr>
<td>aluminum (dry)</td>
<td>45</td>
</tr>
<tr>
<td>iron (dry)</td>
<td>46</td>
</tr>
<tr>
<td>nylon 6/6</td>
<td>45-6</td>
</tr>
<tr>
<td>glass, soda-lime (dry)</td>
<td>47</td>
</tr>
<tr>
<td>silica, fused</td>
<td>78</td>
</tr>
<tr>
<td>titanium dioxide (anatase)</td>
<td>91</td>
</tr>
<tr>
<td>ferric oxide</td>
<td>107</td>
</tr>
<tr>
<td>tin oxide</td>
<td>111</td>
</tr>
</tbody>
</table>

**Note:** Critical surface tensions for silanes refer to smooth treated surfaces.
How does a Silane Modify a Surface?

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.
Selecting A Silane for Surface Modification - Inorganic Substrate Perspective

Factors influencing silane surface modification 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

Surface modification is maximized when silanes react with the substrate surface and present the maximum number of accessible sites with appropriate surface energies. 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.

Silanes 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 introduction 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 alkoxy silanes can also interfere in activity. Monoalkoxy-silanes 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 in an aggressive aqueous environment, dipodal silanes often exhibit substantial performance improvements. These materials form tighter networks and may offer up to 10^x greater hydrolysis resistance making them particularly appropriate for primer applications.

![Silica, Quartz, Glass, Aluminum (AlO(OH)), Alumino-silicates (e.g. clays), Silicon, Copper, Tin (SnO), Talc, Inorganic Oxides (e.g. Fe₂O₃, TiO₂, Cr₂O₃), Steel, Iron, Asbestos, Nickel, Zinc, Lead, Marble, Chalk (CaCO₃), Gypsum (CaSO₄), Barytes (BaSO₄), Graphite, Carbon Black](image)

Water droplets on a (heptadecafluoro-1,1,2,2-tetrahydrodecyl)trimethoxysilane-treated silicon wafer exhibit high contact angles, indicative of the low surface energy. Surfaces are both hydrophobic and resist wetting by hydrocarbon oils. (water droplets contain dye for photographic purposes).

# Silane Effectiveness on Inorganics

<table>
<thead>
<tr>
<th>SUBSTRAATES</th>
<th>EXCELLENT</th>
<th>GOOD</th>
<th>SLIGHT</th>
<th>POOR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Silica</td>
<td>Quartz</td>
<td>Glass</td>
<td>Aluminum (AlO(OH))</td>
<td>Alumino-silicates (e.g. clays)</td>
</tr>
<tr>
<td></td>
<td>Silicon</td>
<td>Copper</td>
<td>Tin (SnO)</td>
<td>Talc</td>
</tr>
<tr>
<td></td>
<td>Inorganic Oxides (e.g. Fe₂O₃, TiO₂, Cr₂O₃)</td>
<td>Steel, Iron</td>
<td>Asbestos</td>
<td>Nickel</td>
</tr>
<tr>
<td></td>
<td>Zinc</td>
<td>Lead</td>
<td>Marble, Chalk (CaCO₃)</td>
<td>Gypsum (CaSO₄)</td>
</tr>
<tr>
<td></td>
<td>Barytes (BaSO₄)</td>
<td>Graphite</td>
<td>Carbon Black</td>
<td></td>
</tr>
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</table>

# Estimates for Silane Loading on Silicaous Fillers

<table>
<thead>
<tr>
<th>Average Particle Size</th>
<th>Amount of Silane (minimum of monolayer coverage)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;1 micron</td>
<td>1.5%</td>
</tr>
<tr>
<td>1-10 microns</td>
<td>1.0%</td>
</tr>
<tr>
<td>10-20 microns</td>
<td>0.75%</td>
</tr>
<tr>
<td>&gt;100 microns</td>
<td>0.1% or less</td>
</tr>
</tbody>
</table>
Hydrophobic Silane Surface Treatments

Factors which contribute to the ability of an organosilane to generate a hydrophobic surface are its organic substitution, the extent of surface coverage, residual unreacted groups (both from the silane and the surface) and the distribution of the silane on the surface.

Aliphatic hydrocarbon substituents or fluorinated hydrocarbon substituents are the hydrophobic entities which enable silanes to induce surface hydrophobicity. Beyond the simple attribute that in order to generate a hydrophobic surface the organic substitution of the silane must be non-polar, more subtle distinctions can be made. The hydrophobic effect of the organic substitution can be related to the free energy of transfer of hydrocarbon molecules from an aqueous phase to a homogeneous hydrocarbon phase. For non-polar entities, van der Waals interactions are predominant factors in interactions with water and such interactions compete with hydrogen bonding in ordering of water molecules. Van der Waals interactions for solid surfaces are primarily related to the instantaneous polarizability of the solid which is proportional to the dielectric constant or permittivity at the primary UV absorption frequency and the refractive index of the solid. Entities which present sterically closed structures that minimize van der Waals contact are more hydrophobic than open structures that allow van der Waals contact. Thus, in comparison to polyethylene, polypropylene and polytetrafluoroethylene are more hydrophobic. Similarly methyl-substituted alkylsilanes and fluorinated alkylsilanes provide better hydrophobic surface treatments than linear alkyl silanes.

Surfaces to be rendered hydrophobic usually are polar with a distribution of hydrogen bonding sites. A successful hydrophobic coating must eliminate or mitigate hydrogen bonding and shield polar surfaces from interaction with water by creating a non-polar interphase. Hydroxyl groups are the most common sites for hydrogen bonding. The hydrogens of hydroxyl groups can be eliminated by oxane bond formation with an organosilane. The effectiveness of a silane in reacting with hydroxyls impacts hydrophobic behavior not only by eliminating the hydroxyls as water adsorbing sites, but also by providing anchor points for the non-polar organic substitution of the silane which shields the polar substrates from interaction with water.

Strategies for silane surface treatment depend on the population of hydroxyl groups and their accessibility for bonding. A simple conceptual case is the reaction of organosilanes to form a monolayer. If all hydroxyl groups are capped by the silanes and the surface is effectively shielded, a hydrophobic surface is achieved. Practically, not all of the hydroxyl groups may react leaving residual sites for hydrogen bonding. Further, there may not be enough anchor points on the surface to allow the organic substituents to effectively shield the substrate. Thus the substrate reactive groups of the silane, the conditions of deposition, the ability of the silane to form monomeric or polymeric layers and the nature of the organic substitution all play a role in rendering a surface hydrophobic. The minimum requirements of hydrophobicity and economic restrictions for different applications further complicate selection.
Hydrophobicity is frequently associated with oleophilicity, the affinity of a substance for oils, since non-polar organic substitution is often hydrocarbon in nature and shares structural similarities with many oils. The hydrophobic and oleophilic effect can be differentiated and controlled. At critical surface tensions of 20-30, surfaces are wetted by hydrocarbon oils and are water repellent. At critical surface tensions below 20, hydrocarbon oils no longer spread and the surfaces are both hydrophobic and oleophobic. The most oleophobic silane surface treatments have fluorinated long-chain alkyl silanes and methylated medium chain alkyl silanes.

Superhydrophobic surfaces are those surfaces that present apparent contact angles that exceed the theoretical limit for smooth surfaces, i.e. >120°. The most common examples of super-hydrophobicity are associated with surfaces that are rough on a sub-micron scale and contact angle measurements are composites of solid surface asperities and air denoted the Cassie state. Perfectly hydrophobic surfaces (contact angles of 180°) have been prepared by hydrolytic deposition of methylchlorosilanes as microfibrillar structures.

Automotive side windows are treated with fluoroalkylsilanes to provide self-cleaning properties. Water beads remove soil as they are blown over the glass substrate during acceleration.
Hydrophilic Silane Surface Treatments

The vast majority of surfaces are hydrophilic and water is omnipresent in the environment, yet the precise nature of interaction of water with specific surfaces is largely unknown. Water adsorption may be uniform or in isolated patches. It may be driven by a number of different physical and chemical processes. The adsorption of water by a surface may be assisted or retarded by other adsorbents present in the environment. The purpose of applying a hydrophilic surface treatment is to control the nature and extent of interaction of water with a surface.

The controlled interaction of water with substrates can offer various degrees of hydrophilicity ranging from physisorption to chemisorption and centers for ion-interaction. The utility of hydrophilic surfaces varies widely. Anti-fog coatings exploit high surface energies to flatten water droplets rather than allowing them to form light-scattering droplets. In biological systems hydrophilic surfaces can reduce nonspecific bonding of proteins. Hydrophilic coatings with hydrogen bonding sites allow formation of tightly adherent layers of water with high lubricity in biological systems and the ability to resist oil adsorption in anti-graffiti coatings. They can also be used to disperse particles in aqueous coatings and oil-in-water emulsions. Hydrophilic coatings with ionic sites form antistatic coatings, dye receptive surfaces and can generate conductive or electrophoretic pathways. Thick films can behave as polymeric electrolytes in battery and ion conduction applications.

In general, surfaces become more hydrophilic in the series: non-polar < polar, no hydrogen-bonding < polar, hydrogen-bonding < hydroxylic, < ionic. The number of sites and the structure and density of the interphase area also have significant influence on hydrophilicity.

Much of the discussion of hydrophobicity centers around high contact angles and their measurement. As a corollary, low or 0° contact angles of water are associated with hydrophilicity, but practically the collection of consistent data is more difficult. Discriminating between surfaces with a 0° contact angle is impossible. The use of heat of immersion is a method that generates more consistent data for solid surfaces, provided they do not react with, dissolve or absorb the tested liquid. Another important consideration is whether water adsorbed is “free” or “bound.” Free water is water that is readily desorbed under conditions of less than 100% relative humidity. If water remains bound to a substrate under conditions of less than 100% relative humidity, the surface is considered hygroscopic. Another description of hygroscopic water is a boundary layer of water adsorbed on a surface less than 200nm thick that cannot be removed without heating. A measure of the relative hygroscopic nature of surfaces is given by the water activity, the ratio of the fugacity, or escaping tendency, of water from a surface compared to the fugacity of pure water.

The hydrophilicity of a surface as measured or determined by contact angle is subject to interference by loosely bound oils and other contaminants. Heats of immersion and water activity measurements are less subject to this interference. Measurements of silane-modified surfaces demonstrate true modification of the intrinsic surface properties of substrates. If the immobilized hydrophilic layer is in fact a thin hydrogel film, then swelling ratios at equilibrium water absorption can provide useful comparative data.
Hydrophilic Silane Surface Treatments (continued)

Controlling hydrophilic interaction with silane surface treatments is accomplished by the selection of a silane with the appropriate hydrophilic substitution. The classes of substitution are:

- Polar, Non-Hydrogen Bonding
- Polar, Hydrogen-Bonding
- Hydroxylic
- Ionic-Charged

The selection of the class of hydrophilic substitution is dependent on the application. If it is sufficient for water to spread evenly over a surface to form a thin film that washes away and dries off quickly without leaving ‘drying spots’, then a polar aprotic silane is preferred. If a coating is desired that reduces non-specific binding of proteins or other biofoulants, then a polar hydrogen-bonding material such as a polyether functional silane is preferred. A very different application for a polar non-hydroxylic materials is thin film proton conduction electrolytes. Lubricious coatings are usually hydroxylic since they require a restrained adsorbed phase of water. Antistatic coatings are usually charged or charge-inducible as are ion-conductive coatings used in the construction of thin-film batteries. A combination of hydrophilicity and hydrophobicity may be a requirement in coatings which are used as primers or in selective adsorption applications such as chromatography. Formulation limitations may require that hydrophilicity is latent and becomes unmasked after application.

Factors affecting the intrinsic hydrolytic stability of silane treated surfaces are magnified when the water is drawn directly into the interface. Even pure silicon dioxide is ultimately soluble in water (at a level of 2-6ppm), but the kinetics, low concentration for saturation and phase separation, make this a negligible consideration in most applications. The equilibrium constant for the rupture of a Si-O-Si bond by water to two Si-OH bonds is estimated at $10^{-3}$. Since at minimum 3 Si-O-Si bonds must be simultaneously broken under equilibrium conditions to dissociate an organosilane from a surface, in hydrophobic environments the long-term stability is a minor consideration. Depending on the conditions of exposure to water of a hydrophilic coating, the long-term stability can be an important consideration. Selection of a dipodal, polydodal or other network forming silane as the basis for inducing hydrophilicity or as a component in the hydrophilic surface treatment is often obligatory.

Range of Water Interaction with Surfaces

<table>
<thead>
<tr>
<th>interaction</th>
<th>description</th>
<th>surface example</th>
<th>measurement - parameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>low</td>
<td>superhydrophobic</td>
<td>fluorocarbon</td>
<td>contact angle</td>
</tr>
<tr>
<td></td>
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<td></td>
<td></td>
</tr>
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</tr>
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<td></td>
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</tr>
<tr>
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<td>lipophilic</td>
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<td></td>
</tr>
<tr>
<td></td>
<td>hydrophobic</td>
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<td></td>
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<tr>
<td>moderate</td>
<td>polar</td>
<td>polymer</td>
<td>heat of immersion</td>
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<tr>
<td></td>
<td>hydrophilic</td>
<td>oxide surface</td>
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</tr>
<tr>
<td></td>
<td>hygroscopic</td>
<td>polyhydroxylic</td>
<td></td>
</tr>
<tr>
<td>strong</td>
<td>hydrogel film</td>
<td></td>
<td>equilibrium water absorption</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>swell</td>
</tr>
</tbody>
</table>
Reacting with the Substrate

Leaving Groups

The reaction of an organofunctional silane with a surface bearing hydroxyl group results in a substitution reaction at silicon and the formation of the silylated surface where the silicon is covalently attached to the surface via an oxygen linkage. This connection may be formed directly or in the presence of water through a reactive silanol intermediate. In general the reactivity of hydroxylated surfaces with organofunctional silanes decreases in the order: Si-NR2 > Si-Cl > Si-NH-Si > Si-O2CCH3 > Si-OCH3 > Si-OCH2CH3. An analysis of the relevant bond energies indicates that the formation of the Si-O-surface bond is the driving force for the reaction under dry and aprotic conditions. Secondary factors contributing to the reactivity of organofunctional silanes with a surface are the volatility of the byproducts, the ability of the byproduct to hydrogen bond with the hydroxyls on the surface, the ability of the byproduct to catalyze further reactions, e.g. HCl or acetic acid, and the steric bulk of the groups on the silicon atom.

Although they are not the most reactive organosilanes, the methoxy and ethoxysilanes are the most widely used organofunctional silanes for surface modification. The reasons for this include the fact that they are easily handled and the alcohol byproducts are non-corrosive and volatile. The methoxysilanes are capable of reacting with substrates under dry, aprotic conditions, while the less reactive ethoxysilanes require catalysis for suitable reactivity. The low toxicity of ethanol as a byproduct of the reaction favors the ethoxysilanes in many commercial applications. The vast majority of organofunctional silane surface treatments are performed under conditions in which water is a part of the reaction medium, either directly added or contributed by adsorbed water on the substrate or atmospheric moisture.
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.

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

<table>
<thead>
<tr>
<th>Primer on metal 10% in i-PrOH</th>
<th>Wet adhesion to metals (N/cm)</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Titanium</td>
</tr>
<tr>
<td>No silane</td>
<td>Nil</td>
</tr>
<tr>
<td>Methacryloxypropylsilane</td>
<td>0.25</td>
</tr>
<tr>
<td>Methacryloxypropylsilane + 10% dipodal</td>
<td>10.75</td>
</tr>
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</table>

90º peel strength after 2 h in 80ºC water.

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

Hydrophobic Dipodal Silanes

90º peel strength after 2 h in 80ºC water.

Hydrophilic Dipodal Silanes

Hydrophobic coatings applied to antennas inhibit the formation of adsorbed water layers which become dielectric layers that absorb signals and cause high losses. If the water is in beads, the energy will be slightly diffracted because the water droplets have dimensions much less than a wavelength at these frequencies.

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

**Silanes with short linker length**

<table>
<thead>
<tr>
<th>Formula</th>
<th>Name</th>
<th>Molecular Weight</th>
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<td>SIT8572.6</td>
<td>85.83</td>
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<tr>
<td>H₃C-Si-O-Si-Cl</td>
<td>CH₃Cl</td>
<td>118.90</td>
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<tr>
<td>N≡C-CH₂CH₂Si-OCH₂CH₃</td>
<td>SIC2445.0</td>
<td>120.90</td>
</tr>
<tr>
<td>HO-CH₂Si-OC₂H₅</td>
<td>SIH6175.0</td>
<td>131.90</td>
</tr>
<tr>
<td>CH₃COCH₂Si-OCH₃</td>
<td>SIA0055.0</td>
<td>125.90</td>
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</table>

**Silanes with extended linker length**

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<tr>
<td>HO-CH₂Si-OC₂H₅</td>
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<td>255.90</td>
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<tr>
<td>CH₂OCH₂CH₂O-CH₂CH₂CH₂CH₂CH₂CH₂CH₂CH₂CH₂CH₂CH₂CH₂CH₂</td>
<td>SIM6491.5</td>
<td>898.50</td>
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</table>
Partition, Orientation and Self-Assembly in Bonded Phases

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.

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 methyaminopropyltrimethoxysilane (parallel) has eliminated micromachining operations. The oriented crystalline domains often observed in reinforcednylons have also been attributed to orientation effects of the silane in the interphase.

Self-Assembled Monolayers (SAMs)

A Self-Assembled Monolayer (SAM) is a one molecule thick layer of material that bonds to a surface in an ordered way as a result of physical or chemical forces during a deposition process. Silanes can form SAMs by solution or vapor phase deposition processes. Most commonly, chlorosilanes or alkoxysilanes are used and once deposition occurs a chemical (oxane) bond forms with the surface rendering a permanent modification of the substrate. Applications for SAMs include micro-contact printing, soft lithography, dip-pen nanolithography, anti-stiction coatings and orientation layers involved in nanofabrication of MEMs, fluidic microassemblies, semiconductor sensors and memory devices.

Common long chain alkyl silanes used in the formation of SAMs are simple hydrocarbon, fluoroalkyl and end-group substituted silanes. Silanes with one hydrolyzeable group maintain interphase structure after deposition by forming a single oxane bond with the substrate. Silanes with three hydrolyzeable groups form siloxane (silsesquioxane) polymers after deposition, bonding both with each other as well as the substrate. For non-oxide metal substrates, silyl hydrides may be used, reacting with the substrate by a dehydrogenative coupling.

The perpendicular orientation of silanes with C10 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

Normal Phase HPLC of Carboxylic Acids with a C23-Silane Bonded Phase

Orientation effects of silanes for passive LCDs

Modification of Metal Substrates

The optimum performance of silanes 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.

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.

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 p72.)

Coupling Agents for Metals*

<table>
<thead>
<tr>
<th>Metal</th>
<th>Class</th>
<th>Screening Candidates</th>
</tr>
</thead>
<tbody>
<tr>
<td>Copper</td>
<td>Amine</td>
<td>SSP-060 SIT8398.0</td>
</tr>
<tr>
<td>Gold</td>
<td>Sulfur</td>
<td>SIT7908.0 SIP6926.2</td>
</tr>
<tr>
<td></td>
<td>Phosphorus</td>
<td>SID4558.0 SIB1091.0</td>
</tr>
<tr>
<td>Iron</td>
<td>Amine</td>
<td>SIB1834.0 WSA-7011</td>
</tr>
<tr>
<td></td>
<td>Sulfur</td>
<td>SIB1824.6 SIM6476.0</td>
</tr>
<tr>
<td>Tin</td>
<td>Amine</td>
<td>SIB1835.5</td>
</tr>
<tr>
<td>Titanium</td>
<td>Epoxy</td>
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<tr>
<td></td>
<td>Hydride</td>
<td>SIU9048.0</td>
</tr>
<tr>
<td>Zinc</td>
<td>Amine</td>
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</tr>
<tr>
<td></td>
<td>Carboxylate</td>
<td>SIT8402.0 SIT8192.6</td>
</tr>
</tbody>
</table>

*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.

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. K. Shirai et al, J. Biomed. Mater. Res. 53, 304-2000.

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 benzylidimethylamine or diamines such as ethylenediamine. The more effective amines, however, are more difficult to remove after reaction. 1. S. Kanen et al, Langmuir, 18, 18623, 2002.

Hydroxylation by Water Plasma & Steam Oxidation

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).

**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.

**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 benzyltrimethylamine 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.

**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

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.

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.

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.
Hydrophobic Silane Selection Guide

Hydrophobic silanes employed in surface modification form the following major categories:

- Methyl-Silanes ........................................................... 20
- Linear Alkyl-Silanes .................................................... 22
- Branched Alkyl-Silanes ............................................... 24
- Aromatic-Silanes ....................................................... 26
- Fluorinated Alkyl-Silanes ........................................... 28
- Dialkyl-Silanes .......................................................... 28

**Methyl-Silanes** very hydrophobic, hydrolysates stable to 425°C, acceptable performance to 600°C reported, volatile

### 3 Hydrolyzable Groups

<table>
<thead>
<tr>
<th>Hydrolyzable Groups</th>
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<th>Product Name</th>
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**Methyl-SiloxanylSilanes**

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Fumed silica treated with hexamethyldisilazane floats on water.

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Space Shuttle tiles are treated with dimethylethoxysilane to reduce water absorption.
# Hydrophobic Silane Selection Guide

## Linear Alkyl-Silanes

### 3 Hydrolyzable Groups

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<tr>
<th>Hydrolyzable Groups</th>
<th>Product Code</th>
<th>Product Name</th>
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<td><strong>C₂</strong> hydrophobic, treatment for microporous mineral powders used as fillers for plastics</td>
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Surface conductivity of glass substrates is reduced by application of hydrophobic coatings. Surface arc-tracking is eliminated on fluorescent light bulbs.
## Hydrophobic Silane Selection Guide

### Branched and Cyclic Alkyl-Silanes

#### 3 Hydrolyzeable Groups

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<td>SII6453.5</td>
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<td>SIB1985.0</td>
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<tr>
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<td></td>
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<tr>
<td>chloro</td>
<td>SIC2555.0</td>
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</tr>
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<tr>
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<tr>
<td>chloro</td>
<td>SID4069.0</td>
<td>(3,3-dimethylbutyl)trichlorosilane</td>
</tr>
<tr>
<td>chloro</td>
<td>SIT7906.6</td>
<td>thexyltrichlorosilane</td>
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<td>chloro</td>
<td>SIC2480.0</td>
<td>cyclohexyltrichlorosilane</td>
</tr>
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<td>methoxy</td>
<td>SIC2482.0</td>
<td>cyclohexyltrimethoxysilane</td>
</tr>
<tr>
<td>C&lt;sub&gt;7&lt;/sub&gt;</td>
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<td></td>
</tr>
<tr>
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<td>SIB0997.0</td>
<td>bicycloheptylchiorosilane</td>
</tr>
<tr>
<td>chloro</td>
<td>SIC2470.0</td>
<td>(cyclohexylmethyl)trichlorosilane</td>
</tr>
<tr>
<td>C&lt;sub&gt;8&lt;/sub&gt;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>chloro</td>
<td>SII6457.0</td>
<td>isoctyltrichlorosilane</td>
</tr>
<tr>
<td>methoxy</td>
<td>SII6458.0</td>
<td>isoctyltrimethoxysilane</td>
</tr>
<tr>
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<td>SIC2490.0</td>
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<td></td>
</tr>
<tr>
<td>C&lt;sub&gt;12&lt;/sub&gt;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SIA0325.0</td>
<td>adamantylethyltrichlorosilane</td>
<td></td>
</tr>
<tr>
<td>C&lt;sub&gt;16&lt;/sub&gt;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SIT8162.4</td>
<td>7-(trichlorosilylmethyl)pentadecane</td>
<td></td>
</tr>
<tr>
<td>C&lt;sub&gt;18&lt;/sub&gt;</td>
<td>silahydrocarbon</td>
<td></td>
</tr>
<tr>
<td>chloro</td>
<td>SID4401.5</td>
<td>(di-n-octylmethysilyl)ethyltrichlorosilane</td>
</tr>
<tr>
<td>C&lt;sub&gt;24&lt;/sub&gt;</td>
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<td></td>
</tr>
<tr>
<td>chloro</td>
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<td></td>
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<td>C&lt;sub&gt;28&lt;/sub&gt;</td>
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<td></td>
</tr>
<tr>
<td>chloro</td>
<td>SIT8162.0</td>
<td>13-(trichlorosilylmethyl)heptacosane</td>
</tr>
</tbody>
</table>
### 2 Hydrolyzeable Groups

<table>
<thead>
<tr>
<th>Product Code</th>
<th>Product Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>SII6463.0</td>
<td>isopropylmethyldichlorosilane</td>
</tr>
<tr>
<td>SII6452.8</td>
<td>isobutylmethyldimethoxysilane</td>
</tr>
<tr>
<td>SIB1972.2</td>
<td>t-butyilmethyldichlorosilane</td>
</tr>
<tr>
<td>SIC2468.0</td>
<td>cyclohexylmethyldichlorosilane</td>
</tr>
<tr>
<td>SIC2469.0</td>
<td>cyclohexylmethyldimethoxysilane</td>
</tr>
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</table>

### 1 Hydrolyzeable Group

<table>
<thead>
<tr>
<th>Product Code</th>
<th>Product Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>SII6462.0</td>
<td>isopropylidimethylchlorosilane</td>
</tr>
<tr>
<td>SII6452.5</td>
<td>isobutyldimethylchlorosilane</td>
</tr>
<tr>
<td>SIB1935.0</td>
<td>t-butyldimethylchlorosilane</td>
</tr>
<tr>
<td>SID4065.0</td>
<td>(3,3-dimethylbutyl)dimethylchlorosilane</td>
</tr>
<tr>
<td>SIT7706.0</td>
<td>t-ethylidimethylchlorosilane</td>
</tr>
<tr>
<td>SIC2465.0</td>
<td>cyclohexylidimethylchlorosilane</td>
</tr>
<tr>
<td>SIB0994.0</td>
<td>bicycloheptyldimethylchlorosilane</td>
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<tr>
<td>SII6456.6</td>
<td>isooctyldimethylchlorosilane</td>
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<tr>
<td>SID4074.0</td>
<td>(dimethylchlorosilyl)methylpinane</td>
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<tr>
<td>SID4401.0</td>
<td>(di-n-octylmethylsilyl)ethylidimethylchlorosilane</td>
</tr>
<tr>
<td>SIC2266.5</td>
<td>11-(chlorodimethylsilylmethyl)tricosane</td>
</tr>
<tr>
<td>SIC2266.0</td>
<td>13-(chlorodimethylsilylmethyl)heptacosane</td>
</tr>
</tbody>
</table>

Isobutyltriethoxysilane solutions in ethanol are applied by spray to protect architecture.
# Hydrophobic Silane Selection Guide

## Phenyl- and Phenylalkyl-Silanes

### 3 Hydrolyzeable Groups

<table>
<thead>
<tr>
<th>Hydrolyzeable Groups</th>
<th>Product Code</th>
<th>Product Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>phenyltrichlorosilane</td>
<td>SIP6810.0</td>
<td>phenyltrimethoxysilane</td>
</tr>
<tr>
<td>phenyltriacetoxysilane</td>
<td>SIP6821.0</td>
<td>phenyltris(methylethylketoximino)silane</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>spacer atoms = 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>chloro</td>
</tr>
<tr>
<td>ethoxy</td>
</tr>
<tr>
<td>chloro</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>spacer atoms = 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>chloro</td>
</tr>
<tr>
<td>methox</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>spacer atoms = 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>chloro</td>
</tr>
<tr>
<td>chloro</td>
</tr>
</tbody>
</table>

### Substituted Phenyl- and Phenylalkyl-Silanes

<table>
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<tr>
<th>spacer atoms = 0</th>
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<tbody>
<tr>
<td>chloro</td>
</tr>
<tr>
<td>methox</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>spacer atoms = 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>methyl/chloro</td>
</tr>
<tr>
<td>ethyl/methoxy</td>
</tr>
<tr>
<td>t-butyl/chloro</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>spacer atoms = 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>chloro</td>
</tr>
</tbody>
</table>

### Napthyl-Silanes

| methox            | SIN6597.0    | 1-napthyltrimethoxysilane |
| chloro            | SIN6596.0    | (1-naphthylmethyl)trichlorosilane |

### Specialty Aromatic- Silanes

<table>
<thead>
<tr>
<th>spacer atoms = 0</th>
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</thead>
<tbody>
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<td>chloro</td>
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</table>

<table>
<thead>
<tr>
<th>spacer atoms = 4</th>
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<tbody>
<tr>
<td>chloro</td>
</tr>
<tr>
<td>Product Code</td>
</tr>
<tr>
<td>--------------</td>
</tr>
<tr>
<td>SIP6738.0</td>
</tr>
<tr>
<td>SIP6740.0</td>
</tr>
<tr>
<td>SIP6739.0</td>
</tr>
<tr>
<td>SIP6736.8</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
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</tr>
<tr>
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</tr>
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<tr>
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</tr>
</tbody>
</table>
Hydrophobic Silane Selection Guide

### Fluorinated Alkyl-Silanes

#### 3 Hydrolyzeable Groups

<table>
<thead>
<tr>
<th>Hydrolyzeable Groups</th>
<th>Product Code</th>
<th>Product Name</th>
</tr>
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<tbody>
<tr>
<td>C₃</td>
<td></td>
<td></td>
</tr>
<tr>
<td>chloro</td>
<td>SIT8371.0</td>
<td>(3,3,3-trifluoropropyl)trichlorosilane</td>
</tr>
<tr>
<td>methoxy</td>
<td>SIT8372.0</td>
<td>(3,3,3-trifluoropropyl)trimethoxysilane</td>
</tr>
<tr>
<td>aminesilazane</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C₆</td>
<td></td>
<td></td>
</tr>
<tr>
<td>chloro</td>
<td>SIN6597.6</td>
<td>nonafluorohexyltrichlorosilane</td>
</tr>
<tr>
<td>methoxy</td>
<td>SIN6597.7</td>
<td>nonafluorohexyltrimethoxysilane</td>
</tr>
<tr>
<td>ethoxy</td>
<td>SIN6597.65</td>
<td>nonafluorohexyltriethoxysilane</td>
</tr>
<tr>
<td>amino</td>
<td>SIN6597.4</td>
<td>nonafluorohexyltris(dimethylamino)silane</td>
</tr>
<tr>
<td>C₈</td>
<td></td>
<td></td>
</tr>
<tr>
<td>chloro</td>
<td>SIT8174.0</td>
<td>(tridecafluoro-1,1,2,2-tetrahydrooctyl)trichlorosilane</td>
</tr>
<tr>
<td>methoxy</td>
<td>SIT8176.0</td>
<td>(tridecafluoro-1,1,2,2-tetrahydrooctyl)trimethoxysilane</td>
</tr>
<tr>
<td>ethoxy</td>
<td>SIT8175.0</td>
<td>(tridecafluoro-1,1,2,2-tetrahydrooctyl)triethoxysilane</td>
</tr>
<tr>
<td>C₁₀</td>
<td></td>
<td></td>
</tr>
<tr>
<td>chloro</td>
<td>SIH5841.0</td>
<td>(heptadecafluoro-1,1,2,2-tetrahydrodecyl)trichlorosilane</td>
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<tr>
<td>methoxy</td>
<td>SIH5841.5</td>
<td>(heptadecafluoro-1,1,2,2-tetrahydrodecyl)trimethoxysilane</td>
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<tr>
<td>ethoxy</td>
<td>SIH5841.2</td>
<td>(heptadecafluoro-1,1,2,2-tetrahydrodecyl)triethoxysilane</td>
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### DiAlkyl Silanes

#### 2 Hydrolyzeable Groups

<table>
<thead>
<tr>
<th>Highest Carbon #</th>
<th>Next Carbon #</th>
<th>Hydrolyzeable Groups</th>
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<th>Product Name</th>
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<tbody>
<tr>
<td>C₂</td>
<td>C₂</td>
<td>chloro</td>
<td>SID3402.0</td>
<td>diethyldichlorosilane</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ethoxy</td>
<td>SID3404.0</td>
<td>diethyldiethoxysilane</td>
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<tr>
<td>C₃</td>
<td>C₃</td>
<td>chloro</td>
<td>SID3537.0</td>
<td>diisopropylidichlorosilane</td>
</tr>
<tr>
<td></td>
<td></td>
<td>methoxy</td>
<td>SID3538.0</td>
<td>diisopropylidimethoxysilane</td>
</tr>
<tr>
<td>C₄</td>
<td>C₄</td>
<td>chloro</td>
<td>SID3903.0</td>
<td>di-n-butylidichlorosilane</td>
</tr>
<tr>
<td></td>
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<td>methoxy</td>
<td>SID3914.0</td>
<td>di-n-butyldimethoxysilane</td>
</tr>
<tr>
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<td>methoxy</td>
<td>SID3930.0</td>
<td>diisobutylidimethoxysilane</td>
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<td>SID3928.0</td>
<td>diisobutyldiethoxysilane</td>
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<tr>
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<td>C₃</td>
<td>methoxy</td>
<td>SII6452.6</td>
<td>isobutylisopropylidimethoxysilane</td>
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<tr>
<td>C₅</td>
<td>C₅</td>
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<td>SID3390.0</td>
<td>dicyclopentylidichlorosilane</td>
</tr>
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<td></td>
<td>methoxy</td>
<td>SID3391.0</td>
<td>dicyclopentylidimethoxysilane</td>
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<tr>
<td>C₆</td>
<td>C₆</td>
<td>chloro</td>
<td>SID3510.0</td>
<td>di-n-hexylidichlorosilane</td>
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<tr>
<td></td>
<td></td>
<td>chloro</td>
<td>SID3382.0</td>
<td>dicyclohexylidichlorosilane</td>
</tr>
<tr>
<td>C₈</td>
<td>C₈</td>
<td>chloro</td>
<td>SID4400.0</td>
<td>di-n-octyldichlorosilane</td>
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</table>
## 2 Hydrolyzeable Groups

<table>
<thead>
<tr>
<th>Product Code</th>
<th>Product Name</th>
<th>Product Code</th>
<th>Product Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>SIT8369.0</td>
<td>(3,3,3-trifluoropropyl)methyldichlorosilane</td>
<td>SIT8364.0</td>
<td>(3,3,3-trifluoropropyl)dimethylchlorosilane</td>
</tr>
<tr>
<td>SIT8370.0</td>
<td>(3,3,3-trifluoropropyl)methyldimethoxysilane</td>
<td>SIB1828.4</td>
<td>bis(trifluoropropyl)tetramethyldisilazane</td>
</tr>
<tr>
<td>SIN6597.5</td>
<td>nonafluorohexymethyldichlorosilane</td>
<td>SIN6597.3</td>
<td>nonafluorohexyldimethylchlorosilane</td>
</tr>
<tr>
<td>SIT8172.0</td>
<td>(tridecafluoro-1,1,2,2-tetrahydrooctyl)methyldichlorosilane</td>
<td>SIT8170.0</td>
<td>(tridecafluoro-1,1,2,2-tetrahydrooctyl)dimethylchlorosilane</td>
</tr>
<tr>
<td>SH5840.6</td>
<td>(heptadecafluoro-1,1,2,2-tetrahydrodecyl)methyldichlorosilane</td>
<td>SIH5840.4</td>
<td>(heptadecafluoro-1,1,2,2-tetrahydrodecyl)dimethylchlorosilane</td>
</tr>
</tbody>
</table>

## 1 Hydrolyzeable Group

<table>
<thead>
<tr>
<th>Product Code</th>
<th>Product Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>SIT8170.0</td>
<td>(tridecafluoro-1,1,2,2-tetrahydrooctyl)dimethylchlorosilane</td>
</tr>
<tr>
<td>SH5840.4</td>
<td>(heptadecafluoro-1,1,2,2-tetrahydrodecyl)dimethylchlorosilane</td>
</tr>
</tbody>
</table>

Pigments treated with hydrophobic silanes resist agglomeration in highly polar vehicle and film-forming compositions such as those used in nail polish.
# Hydrophobic Silane Properties

## Conventional Surface Bonding

<table>
<thead>
<tr>
<th>Name</th>
<th>MW</th>
<th>bp/mm (mp)</th>
<th>D&lt;sub&gt;4&lt;/sub&gt;</th>
<th>n&lt;sub&gt;0&lt;/sub&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>SIA0110.0 ACETOXYTRIMETHYLSILANE</td>
<td>132.23</td>
<td>103-4°</td>
<td>0.891</td>
<td>1.3890</td>
</tr>
<tr>
<td>O-TRIMETHYLSILYLCETATE</td>
<td>C&lt;sub&gt;6&lt;/sub&gt;H&lt;sub&gt;12&lt;/sub&gt;O&lt;sub&gt;2&lt;/sub&gt;Si</td>
<td>flashpoint: 4°C (39°F)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SIA0325.0 ADAMANTYLETHYLTRICHLOROSILANE</td>
<td>297.73</td>
<td>135'/3 (36-7')</td>
<td>1.2204</td>
<td>1.5135</td>
</tr>
<tr>
<td>SIB0962.0 BENZYLDIMETHYLCHLOROSILANE</td>
<td>184.74</td>
<td>75-6°/15</td>
<td>0.949</td>
<td>1.5040</td>
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<tr>
<td>SIB0970.0 BENZYLTRICHLOROSILANE</td>
<td>225.58</td>
<td>140-2°/10</td>
<td>1.288</td>
<td>1.527</td>
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<tr>
<td>SIB0971.0 BENZYLTRIETHOXYSILANE</td>
<td>254.40</td>
<td>148°/26</td>
<td>0.986</td>
<td>1.4628</td>
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<tr>
<td>SIB0994.0 2-(BICYCLOHEPTYL)DIMETHYLCHELOISILANE</td>
<td>188.77</td>
<td>52-5°/4</td>
<td>0.99</td>
<td></td>
</tr>
<tr>
<td>SIB0997.0 2-(BICYCLOHEPTYL)TRICHLOROSILANE</td>
<td>229.61</td>
<td>63-4°/4.5</td>
<td>1.2678</td>
<td>1.4919</td>
</tr>
<tr>
<td>SIB1068.0 BIS(DIETHYLAMINO)DIMETHYLSILANE</td>
<td>202.42</td>
<td>192-5°</td>
<td>0.826</td>
<td>1.435</td>
</tr>
<tr>
<td>SIB1072.0 BIS(DIMETHYLAMINO)DIMETHYLSILANE</td>
<td>146.31</td>
<td>128-9°</td>
<td>0.810</td>
<td>1.4169</td>
</tr>
<tr>
<td>SIB1828.4 BIS(TRIFLUOROPROPYL)TETRAMETHYL-DISILAZANE, 95%</td>
<td>325.45</td>
<td>76-8°/10</td>
<td>1.110</td>
<td>1.3860</td>
</tr>
</tbody>
</table>

*HYDROLYTIC SENSITIVITY: 4 no reaction under neutral conditions*

*HYDROLYTIC SENSITIVITY: 8 reacts rapidly with moisture, water, protic solvents*

*HYDROLYTIC SENSITIVITY: 7 reacts slowly with water/moisture*
<table>
<thead>
<tr>
<th>Name</th>
<th>MW</th>
<th>bp/mm (mp)</th>
<th>D&lt;sub&gt;4&lt;/sub&gt;</th>
<th>n&lt;sub&gt;20&lt;/sub&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIS(TRIMETHYLSILoxy)DICHLOROSILANE</td>
<td>277.37</td>
<td>173°</td>
<td>1.0017</td>
<td>1.3983</td>
</tr>
<tr>
<td>SIB1843.0</td>
<td>252.53</td>
<td>82°/47</td>
<td>0.862</td>
<td>1.3883</td>
</tr>
<tr>
<td>N,O-BIS(TRIMETHYLSILyL)ACETAMIDE</td>
<td>203.43</td>
<td>71-3°/35</td>
<td>0.832</td>
<td>1.418</td>
</tr>
<tr>
<td>N-BUTYLDIMETHYLCHLOROSILANE</td>
<td>150.72</td>
<td>138°</td>
<td>0.8751</td>
<td>1.4205</td>
</tr>
<tr>
<td>t-BUTYLISOPROPYLDIMETHOXYSILANE</td>
<td>190.36</td>
<td>75°/20</td>
<td>0.871</td>
<td>1.4189</td>
</tr>
<tr>
<td>n-BUTYLMETHYLDICHLOROSILANE</td>
<td>171.14</td>
<td>148°</td>
<td>1.0424</td>
<td>1.4312</td>
</tr>
<tr>
<td>t-BUTYLISOPROPYLDIMETHYLCHLOROSILANE</td>
<td>171.14</td>
<td>130°-2°</td>
<td>1.0424</td>
<td>1.4312</td>
</tr>
</tbody>
</table>

**HYDROLYTIC SENSITIVITY**:
- 1: Slowly reacts with water/moisture
- 2: Reacts rapidly with water/moisture
- 3: Reacts rapidly with water/moisture, protic solvents
- 4: Reacts rapidly with moisture, water, protic solvents
- 5: Reacts rapidly with moisture, water, non-protic solvents
- 6: Reacts rapidly with moisture, non-protic solvents
- 7: Reacts rapidly with moisture
- 8: Reacts rapidly with moisture, water, moisture

**COMMERCIAL**

- [1000-50-6] TSCA HIMS: 3-3-1-X 100g/$430.00
- [18162-48-6] TSCA-HIMS: 3-4-1-X 25g/$49.00
- [181231-67-4] TSCA-L HIMS: 3-3-1-X 10g/$38.00
- [18147-23-4] TSCA-HMS: 3-3-1-X 10g/$35.00
- [18147-18-7] HIMS: 3-3-1-X 5.0g/$89.00
<table>
<thead>
<tr>
<th>Name</th>
<th>MW</th>
<th>bp/mm (mp)</th>
<th>D&lt;sub&gt;4&lt;/sub&gt;</th>
<th>n&lt;sub&gt;20&lt;/sub&gt;</th>
<th>Comments</th>
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<tbody>
<tr>
<td>SIB1972.5 p-(t-BUTYL)PHENETHYLDIMETHYLMETHYLCHLOROSILANE</td>
<td>254.87</td>
<td>122-3°/2</td>
<td>0.95</td>
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<td>HYDROLYTIC SENSITIVITY: 8 reacts rapidly with water/moisture, protic solvents</td>
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<tr>
<td>SIB1973.0 p-(t-BUTYL)PHENETHYLTRICHLOROSILANE</td>
<td>295.71</td>
<td>124-9°/2.5</td>
<td>1.16</td>
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<td>HYDROLYTIC SENSITIVITY: 8 reacts rapidly with water/moisture, protic solvents</td>
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<tr>
<td>SIB1982.0 n-BUTYLTRICHLOROSILANE</td>
<td>191.56</td>
<td>142-3°</td>
<td>1.1608</td>
<td>1.4364</td>
<td>HYDROLYTIC SENSITIVITY: 8 reacts rapidly with water/moisture, protic solvents</td>
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<tr>
<td>SIB1985.0 t-BUTYLTRICHLOROSILANE</td>
<td>191.56</td>
<td>142-3°</td>
<td>1.1608</td>
<td>1.436</td>
<td>HYDROLYTIC SENSITIVITY: 8 reacts rapidly with water/moisture, protic solvents</td>
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<tr>
<td>SIB1988.0 n-BUTYLTRIMETHOXYSILANE</td>
<td>178.30</td>
<td>164-5°</td>
<td>0.9312</td>
<td>1.3979</td>
<td>HYDROLYTIC SENSITIVITY: 7 Si-OR reacts slowly with water/moisture</td>
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<tr>
<td>SIB1989.0 t-BUTYLTRIMETHOXYSILANE</td>
<td>178.30</td>
<td>140-1°</td>
<td>0.903</td>
<td>1.3941</td>
<td>HYDROLYTIC SENSITIVITY: 7 Si-OR reacts slowly with water/moisture</td>
</tr>
<tr>
<td>SIC2266.0 13-(CHLOROMETHYLISILYLMETHYL)-HEPTACOSANE, 95%</td>
<td>487.37</td>
<td>200-210°/0.01</td>
<td>0.848&lt;sup&gt;20&lt;/sup&gt;</td>
<td>1.4542&lt;sup&gt;20&lt;/sup&gt;</td>
<td>HYDROLYTIC SENSITIVITY: 8 reacts rapidly with water/moisture, protic solvents</td>
</tr>
<tr>
<td>SIC2266.5 11-(CHLOROMETHYLISILYLMETHYL)-TRICOSANE</td>
<td>431.27</td>
<td>170°/0.075</td>
<td></td>
<td>1.4575&lt;sup&gt;20&lt;/sup&gt;</td>
<td>forms self-assembled oleophilic monolayers employed as bonded phase in HPLC</td>
</tr>
<tr>
<td>SIC2465.0 CYCLOHEXYLDIMETHYLCHLOROSILANE</td>
<td>176.76</td>
<td>52-3°/2</td>
<td>0.956</td>
<td>1.4626</td>
<td>HYDROLYTIC SENSITIVITY: 8 reacts rapidly with moisture, water, protic solvents</td>
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<tr>
<td>SIC2468.0 CYCLOHEXYLMDICHLOROSILANE</td>
<td>197.18</td>
<td>83°/15</td>
<td>1.095</td>
<td>1.4724</td>
<td>HYDROLYTIC SENSITIVITY: 8 reacts rapidly with moisture, water, protic solvents</td>
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### Names and Properties

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<thead>
<tr>
<th>Name</th>
<th>MW</th>
<th>bp/mm (mp)</th>
<th>D₄₀⁰</th>
<th>n₀⁰</th>
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<tbody>
<tr>
<td>CYCLOHEXYLMETHYLDIMETHOXYSIDILANE</td>
<td>188.34</td>
<td>196°</td>
<td>0.9472</td>
<td>1.4354</td>
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<tr>
<td>CYCLOHEXYLNECYCLOHEXYLMETHYLDICHLOROSILANE</td>
<td>231.62</td>
<td>98-9/11</td>
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<td>CYCLOHEXYLNECYCLOHEXYLMETHYLDICHLOROSILANE</td>
<td>204.34</td>
<td>207-9°</td>
<td>1.222</td>
<td>1.4774</td>
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<tr>
<td>CYCLOHEXYLMETHYLDICHLOROSILANE</td>
<td>204.34</td>
<td>195°</td>
<td>1.222</td>
<td>1.4774</td>
</tr>
<tr>
<td>CYCLOHEXYLNECYCLOHEXYLMETHYLDICHLOROSILANE</td>
<td>190.31</td>
<td>85-9°/1.25</td>
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<tr>
<td>CYCLOHEXYLMETHYLDICHLOROSILANE</td>
<td>245.65</td>
<td>111-4°/3</td>
<td>1.960</td>
<td>1.4940</td>
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<tr>
<td>CYCLOHEXYLMETHYLDICHLOROSILANE</td>
<td>275.72</td>
<td>133-7°/5</td>
<td>1.054</td>
<td>1.4528</td>
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<tr>
<td>CYCLOHEXYLMETHYLDICHLOROSILANE</td>
<td>304.54</td>
<td>150°/8</td>
<td>0.8790</td>
<td>1.4220</td>
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</tbody>
</table>

**HYDROLYTIC SENSITIVITY:**
- 7 Si-OR reacts slowly with water/moisture
- 8 reacts rapidly with moisture, water, protic solvents

**Vapor Pressure and Flashpoint:**
- 20°C: 12 mm
- Flashpoint: 66°C (151°F)
- Flashpoint: 77°C (171°F)
- Flashpoint: 91°C (195°F)
- Flashpoint: 110°C (230°F)
- Flashpoint: >110°C (>230°F)

**TSCA:**
- HMIS: 2-3-1-X
- TSCA: HMIS: 3-1-1-X
- TSCA: HMIS: 3-3-1-X

**SIC Numbers:**
- 2469.0
- 2470.0
- 2480.0
- 2482.0
- 2490.0
- 2555.0
- 2557.0
- 2660.0
- 2662.0
- 2663.0
- 2665.0
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<tr>
<th>name</th>
<th>MW</th>
<th>bp/mm (mp)</th>
<th>D$_4^{20}$</th>
<th>n$_o^{20}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>DI-n-BUTYLDICHLOROSILANE, 95%</td>
<td>213.22</td>
<td>212°</td>
<td>0.991</td>
<td>1.4448</td>
</tr>
<tr>
<td>C$<em>8$H$</em>{18}$Cl$_2$Si</td>
<td></td>
<td>flashpoint: 64°C (147°F)</td>
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<tr>
<td>HYDROLYTIC SENSITIVITY: 8 reacts rapidly with moisture, water, protic solvents</td>
<td>[3449-28-3]</td>
<td>TSCA HMIS: 3-2-1-X</td>
<td>10g/$52.00</td>
<td>50g/$208.00</td>
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<tr>
<td>DI-n-BUTYLDIMETHOXYSILANE</td>
<td>204.39</td>
<td>125°/50</td>
<td>0.861</td>
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<tr>
<td>C$<em>{10}$H$</em>{24}$O$_2$Si</td>
<td></td>
<td>flashpoint: 103°C (217°F)</td>
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<tr>
<td>HYDROLYTIC SENSITIVITY: 7 Si-OR reacts slowly with water/moisture</td>
<td>[18132-63-3]</td>
<td>TSCA-L HMIS: 3-2-1-X</td>
<td>25g/$64.00</td>
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<tr>
<td>DI-n-BUTYLTETRAMETHYLDISILAZANE</td>
<td>245.55</td>
<td>81°/2</td>
<td>0.80</td>
<td>1.4353</td>
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<tr>
<td>C$<em>{12}$H$</em>{31}$NSi$_2$</td>
<td></td>
<td>flashpoint: 86°C (187°F)</td>
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<tr>
<td>HYDROLYTIC SENSITIVITY: 7 reacts slowly with water/moisture</td>
<td>[82356-80-7]</td>
<td>TSCA HMIS: 3-2-1-X</td>
<td>25g/$74.00</td>
<td>100g/$240.00</td>
</tr>
<tr>
<td>1,5-DICHLOROHEXAMETHYLTRISILOXANE, 95%</td>
<td>277.37</td>
<td>184°</td>
<td>1.018</td>
<td>1.4071</td>
</tr>
<tr>
<td>C$<em>6$H$</em>{18}$Cl$_2$O$_2$Si</td>
<td></td>
<td>(-53°) mp flashpoint: 76°C (169°F)</td>
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<tr>
<td>ΔHvap: 11.4 kcal/mole</td>
<td></td>
<td>vapor pressure: 50°; 1mm</td>
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<tr>
<td>HYDROLYTIC SENSITIVITY: 8 reacts rapidly with moisture, water, protic solvents</td>
<td>[3582-71-6]</td>
<td>TSCA HMIS: 3-2-1-X</td>
<td>25g/$37.00</td>
<td>100g/$120.00</td>
</tr>
<tr>
<td>DICHLOROPHENYLTRICHLOROSILANE, 95%</td>
<td>280.44</td>
<td>260°-1°</td>
<td>1.553</td>
<td>1.564</td>
</tr>
<tr>
<td>C$_6$H$_3$Cl$_5$Si-isomeric mixture</td>
<td></td>
<td>flashpoint: 150°C (302°F)</td>
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<tr>
<td>HYDROLYTIC SENSITIVITY: 8 reacts rapidly with water/moisture</td>
<td>[27137-85-5]</td>
<td>TSCA HMIS: 3-1-1-X</td>
<td>25g/$45.00</td>
<td>100g/$146.00</td>
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<tr>
<td>1,3-DICHLOROTETRAMETHYLDISILOXANE</td>
<td>203.22</td>
<td>138°</td>
<td>1.039</td>
<td>1.4054</td>
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<tr>
<td>C$<em>4$H$</em>{12}$Cl$_2$OsSi$_2$</td>
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<td>(-37°) mp flashpoint: 15°C (59°F)</td>
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<td>blocking agent</td>
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<td>vapor pressure: 8mm</td>
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<td>HYDROLYTIC SENSITIVITY: 8 reacts rapidly with moisture, water, protic solvents</td>
<td>[2401-73-2]</td>
<td>TSCA HMIS: 3-4-1-X</td>
<td>25g/$36.00</td>
<td>100g/$117.00</td>
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<tr>
<td>DICYCLOHEXYLDICHLOROSILANE</td>
<td>265.30</td>
<td>123°/0.4</td>
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<tr>
<td>C$<em>{12}$H$</em>{22}$Cl$_2$Si</td>
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<td>flashpoint: 149°C (300°F)</td>
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<td>[18035-74-0]</td>
<td>HMIS: 3-1-1-X</td>
<td>25g/$60.00</td>
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<tr>
<td>DICYCLOPENTYLDICHLOROSILANE</td>
<td>237.24</td>
<td>105°-7°/10</td>
<td>1.110</td>
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<tr>
<td>C$<em>{10}$H$</em>{18}$Cl$_2$Si</td>
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<td>HYDROLYTIC SENSITIVITY: 8 reacts rapidly with moisture, water, protic solvents</td>
<td>[139147-73-2]</td>
<td>HMIS: 3-2-1-X</td>
<td>10g/$29.00</td>
<td>50g/$116.00</td>
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<tr>
<td>DICYCLOPENTYLDIMETHOXYSILANE</td>
<td>228.40</td>
<td>120°/6</td>
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<td>1.4663</td>
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<tr>
<td>C$<em>{10}$H$</em>{22}$O$_2$Si</td>
<td></td>
<td>flashpoint: 102°C (216°F)</td>
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<tr>
<td>HYDROLYTIC SENSITIVITY: 7 Si-OR reacts slowly with water/moisture</td>
<td>[126990-35-0]</td>
<td>TSCA HMIS: 3-1-1-X</td>
<td>10g/$24.00</td>
<td>50g/$96.00</td>
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<tr>
<td>1,5-DIETHOXYHEXAMETHYLTRISILOXANE</td>
<td>296.59</td>
<td>51°-2°/0.8</td>
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<td>1.3889</td>
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<tr>
<td>C$<em>{10}$H$</em>{28}$O$_4$Si</td>
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<td>flashpoint: 15°C (59°F)</td>
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<tr>
<td>HYDROLYTIC SENSITIVITY: 8 reacts rapidly with moisture, water, protic solvents</td>
<td>[17928-13-1]</td>
<td>HMIS: 2-2-1-X</td>
<td>25g/$118.00</td>
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<tr>
<td>(DIETHYLAMINO)TRIMETHYLSILANE</td>
<td>145.32</td>
<td>126°-7° (-10°) mp</td>
<td>0.7627</td>
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<tr>
<td>C$<em>7$H$</em>{19}$NSi</td>
<td></td>
<td>flashpoint: 10°C (50°F)</td>
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<tr>
<td>ΔHform: -87.7kcal/mole</td>
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<td>silylation reagent: F&amp;F: 3, 317; 4, 544; 6, 634; 18, 382</td>
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<tr>
<td>HYDROLYTIC SENSITIVITY: 7 Si-OR reacts slowly with water/moisture</td>
<td>[996-50-9]</td>
<td>TSCA HMIS: 3-4-1-X</td>
<td>25g/$28.00</td>
<td>100g/$90.00</td>
</tr>
<tr>
<td>Name</td>
<td>MW</td>
<td>bp/mm (mp)</td>
<td>D⁴⁰</td>
<td>n²⁰</td>
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<tr>
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<tr>
<td><strong>DIETHYLDICHLOROSILANE</strong></td>
<td>157.11</td>
<td>130°</td>
<td>1.0504</td>
<td>1.4309</td>
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<tr>
<td>C₂H₄Cl₂Si</td>
<td>ΔHvap: 10.0 kcal/mole</td>
<td>TOXICITY- oral rat, LD₂₀: 1000mg/kg</td>
<td>flashpoint: 27°C (81°F)</td>
<td>thermal conductivity: 0.134 W/m°C</td>
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<td>vapor pressure, 21°: 10mm</td>
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<td>HYDROLYTIC SENSITIVITY: 8 reacts rapidly with moisture, water, protic solvents</td>
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<tr>
<td><strong>DIETHYLDIETHOXYSILANE</strong></td>
<td>176.33</td>
<td>157°</td>
<td>0.8622</td>
<td>1.4022</td>
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<tr>
<td>C₈H₁₀O₂Si</td>
<td>vapor pressure, 73°: 38mm</td>
<td>TOXICITY-</td>
<td>flashpoint: 43°C (109°F)</td>
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<tr>
<td>HYDROLYTIC SENSITIVITY: 7 Si-OR reacts slowly with water/moisture</td>
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<tr>
<td><strong>DI-n-HEXYLDICHLOROSILANE</strong></td>
<td>269.33</td>
<td>111-3°/6</td>
<td>0.962</td>
<td>1.4518</td>
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<tr>
<td>C₁₂H₂₆Cl₂Si</td>
<td>flashpoint: 88°C (190°F)</td>
<td>TOXICITY-</td>
<td>flashpoint: 102°C (216°F)</td>
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<tr>
<td>HYDROLYTIC SENSITIVITY: 8 reacts rapidly with moisture, water, protic solvents</td>
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<tr>
<td><strong>DIISOBUTYLCHLOROSILANE</strong></td>
<td>178.78</td>
<td>166-7°</td>
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<td>1.4340</td>
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<tr>
<td>C₈H₁₉ClSi</td>
<td>flashpoint: 42°C (108°F)</td>
<td>TOXICITY-</td>
<td>flashpoint: 102°C (216°F)</td>
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<td>HYDROLYTIC SENSITIVITY: 8 reacts rapidly with moisture, water, protic solvents</td>
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<tr>
<td><strong>DIISOBUTYLDIETHOXYSILANE</strong></td>
<td>232.44</td>
<td>221°</td>
<td>0.8450</td>
<td>1.4179</td>
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<td>C₁₂H₂₈O₂Si</td>
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<td>flashpoint: 43°C (109°F)</td>
<td>flashpoint: 43°C (109°F)</td>
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<tr>
<td>HYDROLYTIC SENSITIVITY: 7 Si-OR reacts slowly with water/moisture</td>
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<tr>
<td><strong>DIISOBUTYLDIMETHOXYSILANE</strong></td>
<td>204.39</td>
<td>120°/6</td>
<td>0.87</td>
<td>1.4167</td>
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<tr>
<td>C₁₀H₂₄O₂Si</td>
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<td>flashpoint: 102°C (216°F)</td>
<td>flashpoint: 102°C (216°F)</td>
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<tr>
<td>HYDROLYTIC SENSITIVITY: 7 Si-OR reacts slowly with water/moisture</td>
<td></td>
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</tr>
<tr>
<td><strong>DIISOPROPYLCHLOROSILANE</strong></td>
<td>185.17</td>
<td>64-5°/25</td>
<td>1.026</td>
<td>1.4450</td>
</tr>
<tr>
<td>C₆H₁₄Cl₂Si</td>
<td>forms bis(blocked) or tethered alcohols¹.</td>
<td>TOXICITY-</td>
<td>forms bis(blocked) or tethered alcohols¹.</td>
<td></td>
</tr>
<tr>
<td>HYDROLYTIC SENSITIVITY: 8 reacts rapidly with moisture, water, protic solvents</td>
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</tr>
<tr>
<td><strong>DIISOPROPYLDIETHOXYSILANE</strong></td>
<td>232.44</td>
<td>221°</td>
<td>0.8450</td>
<td>1.4179</td>
</tr>
<tr>
<td>C₁₀H₂₀O₂Si</td>
<td>TOXICITY-</td>
<td>flashpoint: 43°C (109°F)</td>
<td>flashpoint: 43°C (109°F)</td>
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<td>HYDROLYTIC SENSITIVITY: 7 Si-OR reacts slowly with water/moisture</td>
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<tr>
<td><strong>DIISOPROPYLDIMETHOXYSILANE</strong></td>
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<td>120°/6</td>
<td>0.87</td>
<td>1.4167</td>
</tr>
<tr>
<td>C₁₀H₂₀O₂Si</td>
<td>TOXICITY-</td>
<td>flashpoint: 102°C (216°F)</td>
<td>flashpoint: 102°C (216°F)</td>
<td></td>
</tr>
<tr>
<td>HYDROLYTIC SENSITIVITY: 7 Si-OR reacts slowly with water/moisture</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>3,5-DIMETHOXYPHENYLTRIETHOXYSILANE</strong></td>
<td>300.43</td>
<td>136-8°/0.6</td>
<td>1.050</td>
<td></td>
</tr>
</tbody>
</table>
**DIMETHYLBISS(s-BUTYLAMINO)SILANE 95%**

**C₁₀H₂₇N₂Si**

MW: 202.42  
bp/mm (mp): 82°/15 (<-50°)mp

Chain-extender for silicones

| TOXICITY | oral rat, LD₅₀: 907mg/kg |
| flashpoint: 40°C (104°F) |

**DIMETHYLBIS(s-BUTYLAMINO)SILANE 95%**

**C₁₀H₂₇N₂Si**

MW: 202.42  
bp/mm (mp): 82°/15 (<-50°)mp

Flashpoint: 38°C (100°F)

*Hydrotic Sensitive: 8* reacts rapidly with moisture, water, protic solvents

**NEOHEXYLDIMETHYLSILANEL**

**C₈H₁₉Cl₂Si**

Flashpoint: 38°C (100°F)

Reagent for the preparation of cis-diols and corticosteroids

**NEOHEXYLTRICHLOROSILANE**

**C₆H₁₋Cl₃Si**

Flashpoint: 183°4

HYDROTIC SENSITIVITY: 8 reacts rapidly with moisture, water, protic solvents
<table>
<thead>
<tr>
<th>Name</th>
<th>MW</th>
<th>bp/mm (mp)</th>
<th>D&lt;sub&gt;4&lt;/sub&gt;&lt;sup&gt;20&lt;/sup&gt;</th>
<th>n&lt;sub&gt;0&lt;/sub&gt;&lt;sup&gt;20&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>SID 4121.0</strong> DIMETHYLDIETHOXY SILANE</td>
<td>148.28</td>
<td>114-5°</td>
<td>0.8395</td>
<td>1.3805</td>
</tr>
<tr>
<td>C&lt;sub&gt;6&lt;/sub&gt;H&lt;sub&gt;16&lt;/sub&gt;O&lt;sub&gt;2&lt;/sub&gt;Si</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>viscosity: 0.53cSt</td>
<td>vapor pressure, 25°: 15mm</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ΔHvap: 9.8 kcal/mole</td>
<td>ΔHcomb: 200 kcal/mole</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>coefficient of thermal expansion: 1.3 x 10&lt;sup&gt;3&lt;/sup&gt;</td>
<td>dipole moment: 1.39</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>hydrophobic surface treatment and release agent</td>
<td>HYDROLYTIC SENSITIVITY: 7 Si-OR reacts slowly with water/moisture</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>[78-62-6] TSCA HMIS: 2-4-1-X</td>
<td>100g/$12.00</td>
<td>2kg/$144.00</td>
<td>15kg/$930.00</td>
<td></td>
</tr>
<tr>
<td><strong>SID 4123.0</strong> DIMETHYLDIMETHOXY SILANE</td>
<td>120.22</td>
<td>82°</td>
<td>0.8646</td>
<td>1.3708</td>
</tr>
<tr>
<td>C&lt;sub&gt;4&lt;/sub&gt;H&lt;sub&gt;10&lt;/sub&gt;O&lt;sub&gt;2&lt;/sub&gt;Si</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ΔHcomb: 832 kcal/mole</td>
<td>vapor pressure, 36°: 100mm</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>coefficient of thermal expansion: 1.3 x 10&lt;sup&gt;3&lt;/sup&gt;</td>
<td>dipole moment: 1.33</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HYDROLYTIC SENSITIVITY: 7 Si-OR reacts slowly with water/moisture</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>[1112-39-6] TSCA HMIS: 3-4-1-X</td>
<td>25g/$10.00</td>
<td>2kg/$110.00</td>
<td>15kg/$600.00</td>
<td></td>
</tr>
<tr>
<td><strong>SID 4123.1</strong> DIMETHYLDIMETHOXY SILANE, 99+%</td>
<td>120.22</td>
<td>82°</td>
<td>0.8646</td>
<td>1.3708</td>
</tr>
<tr>
<td>C&lt;sub&gt;4&lt;/sub&gt;H&lt;sub&gt;10&lt;/sub&gt;O&lt;sub&gt;2&lt;/sub&gt;Si</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ΔHcomb: (-90°)mp</td>
<td>vapor pressure, 36°: 100mm</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HYDROLYTIC SENSITIVITY: 7 Si-OR reacts slowly with water/moisture</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>[1112-39-6] TSCA HMIS: 3-4-1-X</td>
<td>500g/$89.00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>SID 4125.0</strong> DIMETHYLTHIOXY SILANE</td>
<td>104.22</td>
<td>54-5°</td>
<td>0.757</td>
<td>1.3683</td>
</tr>
<tr>
<td>C&lt;sub&gt;4&lt;/sub&gt;H&lt;sub&gt;10&lt;/sub&gt;OSi</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TOXICITY: oral rat, LD50: 5000mg/kg</td>
<td>flashpoint: 15°C (59°F)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HYDROLYTIC SENSITIVITY: 7 Si-OR reacts slowly with water/moisture</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>[14857-34-2] TSCA HMIS: 2-4-1-X</td>
<td>25g/$30.00</td>
<td>100g/$98.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>SID 4210.0</strong> DIMETHYLMETHYXCHLOROSILANE, 90%</td>
<td>124.64</td>
<td>77°</td>
<td>0.953</td>
<td>1.3865</td>
</tr>
<tr>
<td>C&lt;sub&gt;4&lt;/sub&gt;H&lt;sub&gt;9&lt;/sub&gt;ClOSi</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HYDROLYTIC SENSITIVITY: 8 reacts rapidly with moisture, water, protic solvents</td>
<td>flashpoint: 9°C (16°F)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>[1825-68-9] TSCA HMIS: 3-4-1-X</td>
<td>25g/$48.00</td>
<td>100g/$150.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>SID 4236.0</strong> 1,3-DIMETHYLTRIMETHOXYDISILOXANE, 95%</td>
<td>226.38</td>
<td>165°</td>
<td>1.010</td>
<td>1.3834</td>
</tr>
<tr>
<td>C&lt;sub&gt;6&lt;/sub&gt;H&lt;sub&gt;13&lt;/sub&gt;O&lt;sub&gt;2&lt;/sub&gt;Si</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>flashpoint: 30°C (86°F)</td>
<td>flashpoint: 30°C (86°F)</td>
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</tr>
<tr>
<td>HYDROLYTIC SENSITIVITY: 7 Si-OR reacts slowly with water/moisture</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>[18186-97-5] HMIS: 3-3-1-X</td>
<td>10g/$30.00</td>
<td>50g/$120.00</td>
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</tr>
<tr>
<td><strong>SID 4400.0</strong> DI-n-OCTYLDICHLOROSILANE</td>
<td>325.44</td>
<td>145°/0.2</td>
<td>0.940</td>
<td></td>
</tr>
<tr>
<td>C&lt;sub&gt;16&lt;/sub&gt;H&lt;sub&gt;34&lt;/sub&gt;Cl&lt;sub&gt;2&lt;/sub&gt;Si</td>
<td></td>
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<tr>
<td>HYDROLYTIC SENSITIVITY: 8 reacts rapidly with moisture, water, protic solvents</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>[18410-07-4] HMIS: 3-2-1-X</td>
<td>25g/$38.00</td>
<td>100g/$124.00</td>
<td></td>
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</tr>
<tr>
<td><strong>SID 4401.0</strong> (DI-n-OCTYL METHYLISILYL)ETHYLDIMETHYLCHLOROSILANE</td>
<td>391.23</td>
<td>165°/0.1</td>
<td>0.859</td>
<td></td>
</tr>
<tr>
<td>C&lt;sub&gt;21&lt;/sub&gt;H&lt;sub&gt;47&lt;/sub&gt;Cl&lt;sub&gt;2&lt;/sub&gt;Si</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>forms bonded phases for reverse phase chromatography</td>
<td>HYDROLYTIC SENSITIVITY: 8 reacts rapidly with moisture, water, protic solvents</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>[472513-03-7] HMIS: 3-2-1-X</td>
<td>25g/$117.00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>name</td>
<td>MW</td>
<td>bp/mm (mp)</td>
<td>$D_4^{20}$</td>
<td>$n_0^{20}$</td>
</tr>
<tr>
<td>-----------------------------------------------------------</td>
<td>--------</td>
<td>------------</td>
<td>------------</td>
<td>------------</td>
</tr>
<tr>
<td>SID4401.5 (Di-n-OCTYLMETHYLSILYL)ETHYLTRI-CHLOROSILANE</td>
<td>432.06</td>
<td>166-8°/0.1</td>
<td>0.966</td>
<td></td>
</tr>
<tr>
<td>forms bonded phases for reverse phase HPLC</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HYDROLYTIC SENSITIVITY: 8 reacts rapidly with moisture,</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>water, protic solvents</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HMIS: 3-2-1-X</td>
<td>25g/$117.00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SID4404.0 1, 3-Di-n-OCTYLTETRAMETHYLDISILAZANE</td>
<td>357.77</td>
<td>160-5°/1</td>
<td>0.826</td>
<td>1.4500</td>
</tr>
<tr>
<td>C_{20}H_{47}NSi_{2}</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>HYDROLYTIC SENSITIVITY: 7 reacts slowly with water/moisture</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>[69519-51-3] HMIS: 2-1-0-X</td>
<td>10g/$49.00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SID4510.0 DIPHENYLDICHLOROSILANE, 95%</td>
<td>253.20</td>
<td>304-5°</td>
<td>1.2216</td>
<td>1.5819</td>
</tr>
<tr>
<td>C_{12}H_{10}Cl_{2}Si</td>
<td>(-22°)mp</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>vapor pressure, 125°: 2mm</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\Delta H_{\text{vap}}$: 15.0 kcal/mole</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>coefficient of thermal expansion: 0.7 x 10$^{-3}$</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>specific heat: 0.30</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>silicone monomer; forms diol on contact with water</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HYDROLYTIC SENSITIVITY: 8 reacts rapidly with moisture,</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>water, protic solvents</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>[80-10-4] TSCA HMIS: 3-1-1-X</td>
<td>100g/$19.00</td>
<td>2kg/$90.00</td>
<td>20kg/$720.00</td>
<td></td>
</tr>
<tr>
<td>SID4510.1 DIPHENYLDICHLOROSILANE, 99%</td>
<td>253.20</td>
<td>304-5°</td>
<td>1.2216</td>
<td>1.5819</td>
</tr>
<tr>
<td>C_{12}H_{10}Cl_{2}Si</td>
<td>(-22°)mp</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TOXICITY- ipr mus, LD50: 383mg/kg</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>flashpoint: 157°C (314°F)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>[80-10-4] TSCA HMIS: 3-1-1-X</td>
<td>25g/$11.00</td>
<td>100g/$36.00</td>
<td>2kg/$390.00</td>
<td></td>
</tr>
<tr>
<td>SID4525.0 DIPHENYLDIETHOXYSILANE</td>
<td>272.42</td>
<td>167°/15</td>
<td>1.0329</td>
<td>1.5269</td>
</tr>
<tr>
<td>C_{16}H_{20}O_{2}Si</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>vapor pressure, 125°: 2mm</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>flashpoint: 175°C (347°F)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HYDROLYTIC SENSITIVITY: 7 Si-OR reacts slowly with water/moisture</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>[2553-19-7] TSCA HMIS: 2-1-0-X</td>
<td>25g/$19.00</td>
<td>100g/$58.00</td>
<td>2kg/$265.00</td>
<td></td>
</tr>
<tr>
<td>SID4535.0 DIPHENYLDIMETHOXYSILANE</td>
<td>244.36</td>
<td>161°/15</td>
<td>1.0771</td>
<td>1.5447</td>
</tr>
<tr>
<td>C_{14}H_{16}O_{2}Si</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>viscosity: 25°: 8.4 cSt</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>flashpoint: 121°C (250°F)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HYDROLYTIC SENSITIVITY: 7 Si-OR reacts slowly with water/moisture</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>[6843-66-9] TSCA HMIS: 3-1-1-X</td>
<td>100g/$18.00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SID4552.0 DIPHENYLMETHYLCHLOROSILANE</td>
<td>232.78</td>
<td>295°</td>
<td>1.128</td>
<td>1.5742</td>
</tr>
<tr>
<td>C_{13}H_{13}ClSi</td>
<td>(-22°)mp</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>vapor pressure, 125°: 3mm</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>flashpoint: 141°C (286°F)</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>viscosity: 25°: 5.3 cSt</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>surface tension: 40.0 dynes/cm</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>thermal conductivity: 0.112 W/m°C</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\alpha$ silylates esters, lactones; precursors to $\alpha$ silyl enolates$^1$</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HYDROLYTIC SENSITIVITY: 8 reacts rapidly with moisture,</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>water, protic solvents</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>[144-79-6] TSCA HMIS: 3-1-1-X</td>
<td>25g/$19.00</td>
<td>100g/$62.00</td>
<td>2.5kg/$530.00</td>
<td></td>
</tr>
<tr>
<td>SID4552.5 DIPHENYL METHYL(DIMETHYLAMINO) SILANE</td>
<td>241.41</td>
<td>98-9°/0.25</td>
<td>1.011</td>
<td></td>
</tr>
<tr>
<td>C_{15}H_{19}NSi</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HYDROLYTIC SENSITIVITY: 7 Si-OR reacts slowly with water/moisture</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>[6873-63-1] TSCA-L HMIS: 3-3-1-X</td>
<td>25g/$34.00</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Please inquire about bulk quantities.**

*HMIS: Hazardous Materials Information System.*

*TOXICITY: Acute oral toxicity (LD₅₀):*

- ipr mus: intraperitoneal mouse
- s.c.: subcutaneous

*HMIS ratings:
- 0: None
- 1: Slight
- 2: Moderate
- 3: Severe
- 4: Extreme
- 5: Extreme
- 6: Fatal
- 7: Reacts slowly with water/moisture
- 8: Reacts rapidly with moisture, water, protic solvents

*Flashpoint: Temperature at which a liquid gives off enough vapor to form an ignitable mixture with air.*
<table>
<thead>
<tr>
<th>Name</th>
<th>MW</th>
<th>bp/mm (mp)</th>
<th>$D_4^20$</th>
<th>$n_0^20$</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>DIPHENYLMETHYLETHOXYSILANE</strong></td>
<td>242.39</td>
<td>100-2°/0.3</td>
<td>1.018</td>
<td>1.5440</td>
</tr>
<tr>
<td>C$<em>{15}$H$</em>{10}$OSi</td>
<td></td>
<td>(-27°)mp</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ΔHvap: 14.8 kcal/mole</td>
<td></td>
<td>flashpoint: 165°C (329°F)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>vapor pressure: 125°, 3mm</td>
<td></td>
<td>viscosity, 25°: 0.5 cSt</td>
<td></td>
<td></td>
</tr>
<tr>
<td>HYDROLYTIC SENSITIVITY: 7 Si-OR reacts slowly with water/moisture</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>[1825-59-8] TSCA HMIS: 2-0-0-X</td>
<td>10g/$23.00</td>
<td>50g/$92.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>1,3-DIPHENYL-1,1,3,3,-TETRAMETHYL-DISILAZANE</strong></td>
<td>285.54</td>
<td>96-9°/0.1</td>
<td>0.985</td>
<td>1.5384</td>
</tr>
<tr>
<td>C$<em>{16}$H$</em>{23}$NSi$_2$</td>
<td></td>
<td>flashpoint: 162°C (324°F)</td>
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<tr>
<td>HYDROLYTIC SENSITIVITY: 7 reacts slowly with water/moisture</td>
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<tr>
<td>[3449-26-1] TSCAHMIS: 3-1-1-X</td>
<td>5.0g/$30.00</td>
<td>25g/$120.00</td>
<td></td>
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</tr>
<tr>
<td><strong>1,3-DI-n-PROPYLTETRAMETHYLDISILAZANE</strong></td>
<td>217.51</td>
<td>84°/9</td>
<td>0.800</td>
<td>1.4290</td>
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<tr>
<td>C$<em>{10}$H$</em>{27}$NSi$_2$</td>
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<td>flashpoint: 65°C (150°F)</td>
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<tr>
<td>HYDROLYTIC SENSITIVITY: 7 reacts slowly with water/moisture</td>
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<tr>
<td>[14579-90-9] HMIS: 3-2-1-X</td>
<td>10g/$37.00</td>
<td>50g/$148.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>DI(p-TOL YL)DICHLOROSILANE, 95%</strong></td>
<td>281.26</td>
<td>225-6°/50</td>
<td>1.10</td>
<td>1.568</td>
</tr>
<tr>
<td>C$<em>{14}$H$</em>{14}$Cl$_2$Si</td>
<td></td>
<td>contains 4-4'dimethylbiphenyl</td>
<td></td>
<td></td>
</tr>
<tr>
<td>forms polymers w/liquid crystal behavior</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>HYDROLYTIC SENSITIVITY: 8 reacts rapidly with moisture, water, protic solvents</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>[18414-38-5] TSCA HMIS: 3-2-1-X</td>
<td>25g/$140.00</td>
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<tr>
<td><strong>DI(p-TOL YL)DIMETHOXYSILANE</strong></td>
<td>272.42</td>
<td>140°/0.5</td>
<td>1.023</td>
<td>1.5355</td>
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<tr>
<td>C$<em>{16}$H$</em>{20}$O$_2$Si</td>
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<tr>
<td>HYDROLYTIC SENSITIVITY: 7 reacts slowly with water/moisture</td>
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</tr>
<tr>
<td>[92779-72-1] HMIS: 3-2-1-X</td>
<td>10g/$37.00</td>
<td>50g/$148.00</td>
<td></td>
<td></td>
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<tr>
<td><strong>DOCOSYLMETHYLDICHLOROSILANE, blend</strong></td>
<td>423.62</td>
<td>218-20°/0.5</td>
<td>0.93</td>
<td>1.445</td>
</tr>
<tr>
<td>C$<em>{23}$H$</em>{46}$Cl$_2$Si</td>
<td></td>
<td>contains C$_20$ to C$_24$ homologs</td>
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<tr>
<td>HYDROLYTIC SENSITIVITY: 8 reacts rapidly with moisture, water, protic solvents</td>
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<tr>
<td>[67892-56-2] TSCA HMIS: 3-1-1-X</td>
<td>50g/$130.00</td>
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<tr>
<td><strong>DOCOSYLTRICHLOROSILANE, blend</strong></td>
<td>444.04</td>
<td>210°/0.2</td>
<td>0.94</td>
<td>1.451</td>
</tr>
<tr>
<td>C$<em>{22}$H$</em>{45}$Cl$_3$Si</td>
<td></td>
<td>contains C$<em>{20}$ to C$</em>{24}$ homologs</td>
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<tr>
<td>HYDROLYTIC SENSITIVITY: 8 reacts rapidly with moisture, water, protic solvents</td>
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<td></td>
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<tr>
<td>[7325-84-0] TSCA HMIS: 3-1-1-X</td>
<td>25g/$85.00</td>
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<tr>
<td><strong>DODECYLCHLOROSILANE</strong></td>
<td>262.94</td>
<td>291-3°</td>
<td>0.865</td>
<td>1.445</td>
</tr>
<tr>
<td>C$<em>{14}$H$</em>{27}$ClSi</td>
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<tr>
<td>HYDROLYTIC SENSITIVITY: 8 reacts rapidly with moisture, water, protic solvents</td>
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<tr>
<td>[66604-31-7] HMIS: 3-2-1-X</td>
<td>25g/$58.00</td>
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<tr>
<td><strong>DODECYLMETHYLCHLOROSILANE</strong></td>
<td>283.36</td>
<td>124-7°/3</td>
<td>0.955</td>
<td>1.4581</td>
</tr>
<tr>
<td>C$<em>{13}$H$</em>{28}$Cl$_2$Si</td>
<td></td>
<td>flashpoint: 143°C (295°F)</td>
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</tr>
<tr>
<td>HYDROLYTIC SENSITIVITY: 8 reacts rapidly with moisture, water, protic solvents</td>
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</tr>
<tr>
<td>[18407-07-3] TSCA HMIS: 3-1-1-X</td>
<td>25g/$48.00</td>
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<tr>
<td><strong>DODECYLMETHYLDIETHOXYSILANE</strong></td>
<td>302.57</td>
<td>140°/0.5</td>
<td>0.845</td>
<td>1.5440</td>
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<tr>
<td>C$<em>{17}$H$</em>{30}$O$_2$Si</td>
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<td>flashpoint: 152°C (305°F)</td>
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<tr>
<td>HYDROLYTIC SENSITIVITY: 7 reacts slowly with water/moisture</td>
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</tr>
<tr>
<td>[60317-40-0] TSCA HMIS: 2-1-0-X</td>
<td>25g/$55.00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Name</td>
<td>MW</td>
<td>Dₚ 20</td>
<td>nₒ 20</td>
<td></td>
</tr>
<tr>
<td>--------------------------------------------------------</td>
<td>------</td>
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<tr>
<td>Dodecyltrimchlorosilane</td>
<td>303.77</td>
<td>1.0242</td>
<td>1.4581</td>
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<tr>
<td>Dodecyltrioctoxysilane</td>
<td>332.60</td>
<td>0.8842</td>
<td>1.4330</td>
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<tr>
<td>Dodecyltrichlorosilane</td>
<td>415.9</td>
<td>1.0630</td>
<td>1.4197</td>
<td></td>
</tr>
<tr>
<td>Eicosyltrimchlorosilane, 95%</td>
<td>413.9</td>
<td>0.9756</td>
<td>1.4050</td>
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<tr>
<td>Ethylidimethylchlorosilane</td>
<td>122.67</td>
<td>0.8756</td>
<td>1.4050</td>
<td></td>
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<tr>
<td>Ethylmethylchlorosilane</td>
<td>143.09</td>
<td>1.0630</td>
<td>1.4197</td>
<td></td>
</tr>
<tr>
<td>(Ethylmethylketoximino)trimethylsilane-O-(trimethylsilyl)oxime-2-butanoine</td>
<td>159.30</td>
<td>0.8260</td>
<td>1.4125</td>
<td></td>
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<tr>
<td>Ethyllithiumchlorosilane</td>
<td>254.40</td>
<td>0.9960</td>
<td>1.4776</td>
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</tr>
<tr>
<td>Ethyllithiumdimethylchlorosilane</td>
<td>243.28</td>
<td>1.1433</td>
<td>1.4123</td>
<td></td>
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<tr>
<td>Ethyllithiumtrichlorosilane</td>
<td>163.51</td>
<td>1.2370</td>
<td>1.4260</td>
<td></td>
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<tr>
<td>Ethyllithiumtrioctoxysilane</td>
<td>178.33</td>
<td>0.8563</td>
<td>1.3955</td>
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<tr>
<td>Ethyllithiumtrichlorosilane</td>
<td>192.33</td>
<td>1.0863</td>
<td>1.4157</td>
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<tr>
<td>Ethyllithiumtrichlorosilane</td>
<td>253.12</td>
<td>1.1433</td>
<td>1.4123</td>
<td></td>
</tr>
<tr>
<td>Ethyllithiumtrichlorosilane</td>
<td>253.12</td>
<td>1.1433</td>
<td>1.4123</td>
<td></td>
</tr>
<tr>
<td>Ethyllithiumtrichlorosilane</td>
<td>253.12</td>
<td>1.1433</td>
<td>1.4123</td>
<td></td>
</tr>
</tbody>
</table>

**Properties:**
- Flashpoint: 165°C (329°F)
- Hydrotropic sensitivity: 8, reacts rapidly with moisture, water, protic solvents

**Other Properties:**
- Flashpoint: >110°C (230°F)
- D dipole moment: 2.32 debye
- ΔHvap: 7.8 kcal/mole
- Viscosity: 0.70 cSt
- Vapor pressure: 50°: 10mm
- Coefficient of thermal expansion: 1.5×10⁻³
- Critical temperature: 287°
<table>
<thead>
<tr>
<th>name</th>
<th>MW</th>
<th>bp/mm (mp)</th>
<th>D₄°</th>
<th>nₒ°</th>
</tr>
</thead>
<tbody>
<tr>
<td>SIE4901.4 ETHYLTRIMETHOXYSILANE</td>
<td>150.25</td>
<td>124-5°</td>
<td>0.9488</td>
<td>1.3838</td>
</tr>
<tr>
<td>C₃H₇O₃Si viscosity: 0.5 cSt</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HYDROLYTIC SENSITIVITY: 7 reacts slowly with water/moisture</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>[5314-55-6] TSCA HMIS: 3-3-1-X</td>
<td>25g/$10.00</td>
<td>2kg/$120.00</td>
<td>17kg/$816.00</td>
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</tr>
<tr>
<td>PP1-GC18 GLASSCLAD® 18 OCTADECYL FUNCTIONAL SILANE</td>
<td></td>
<td></td>
<td>0.88</td>
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<tr>
<td>flashpoint: 10°C(50°F)</td>
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<td></td>
</tr>
<tr>
<td>20% in n-BUTYL ALCOHOL and DIACETONE ALCOHOL amber liquid</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>γ of treated glass surface: 31 dynes/cm</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>coefficient of friction of treated glass surface: 0.2-0.3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>surface resistivity of treated surface: 1.2 x 10⁶ ohms</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>reduces blood protein adsorption¹</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>[5314-55-6] TSCA HMIS: 2-3-1-X</td>
<td>100g/$19.00</td>
<td>1.5kg/$148.00</td>
<td>15kg/$399.00</td>
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<tr>
<td>SIEH5840.4 (HEPTADECASILICLYLOXY)TETRAMETHYLSILANE</td>
<td>540.72</td>
<td>197-8°</td>
<td>1.51</td>
<td>1.3410</td>
</tr>
<tr>
<td>C₁₂H₂₄Cl₄O₃Si derivatizing agent for fluorous phase synthesis</td>
<td></td>
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</tr>
<tr>
<td>HYDROLYTIC SENSITIVITY: 8 reacts rapidly with water/moisture, protic solvents</td>
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<tr>
<td>[74612-30-9] HMIS: 3-2-1-X</td>
<td>5.0g/$41.00</td>
<td>25g/$164.00</td>
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<tr>
<td>SIEH5840.6 (HEPTADECASILICLYLOXY)TETRAMETHYLSILANE</td>
<td>561.14</td>
<td>205-7°</td>
<td>1.63</td>
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<tr>
<td>C₁₁H₂₂Cl₂F₄O₃Si HYDROLYTIC SENSITIVITY: 8 reacts rapidly with water/moisture, protic solvents</td>
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<tr>
<td>[3102-79-2] HMIS: 3-2-1-X</td>
<td>5.0g/$48.00</td>
<td>25g/$192.00</td>
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<tr>
<td>SIEH5841.0 (HEPTADECASILICLYLOXY)TRIMETHYLSILANE</td>
<td>581.56</td>
<td>216-8°</td>
<td>1.703</td>
<td>1.3490</td>
</tr>
<tr>
<td>C₁₀H₂₀Cl₃O₃Si TOXICITY- oral rat, LD50: &gt;5000 mg/kg</td>
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<td></td>
<td></td>
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<tr>
<td>HYDROLYTIC SENSITIVITY: 8 reacts rapidly with water/moisture, protic solvents</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>[78560-44-8] TSCA HMIS: 3-2-1-X</td>
<td>5.0g/$36.00</td>
<td>25g/$144.00</td>
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<tr>
<td>SIEH5841.2 (HEPTADECASILICLYLOXY)TRIMETHYLSILANE</td>
<td>610.38</td>
<td>103-6°/3</td>
<td>1.407²</td>
<td>1.3419</td>
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<tr>
<td>C₁₀H₂₀Cl₃O₃Si hydrolysis in combination with polydimethoxysiloxane gives hard hydrophobic coatings²</td>
<td></td>
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<tr>
<td>HYDROLYTIC SENSITIVITY: 7 reacts slowly with water/moisture</td>
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<tr>
<td>[101947-16-4] HMIS: 3-2-1-X</td>
<td>5g/$42.00</td>
<td>25g/$168.00</td>
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<tr>
<td>SIEH5841.5 (HEPTADECASILICLYLOXY)TRIMETHYLSILANE</td>
<td>568.30</td>
<td>247°</td>
<td>1.54</td>
<td>1.331²</td>
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<tr>
<td>C₁₁H₂₂Cl₃O₃Si HYDROLYTIC SENSITIVITY: 7 reacts slowly with water/moisture</td>
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<tr>
<td>[83048-65-1] HMIS: 3-2-1-X</td>
<td>5g/$42.00</td>
<td>25g/$168.00</td>
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<tr>
<td>SIEH5842.0 (3-HEPTAFLUOROPROPYLOXY)PROPYLEDTETRAMETHYLSILANE</td>
<td>361.55</td>
<td>85-7°/35</td>
<td>1.497</td>
<td>1.3710</td>
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<tr>
<td>C₆H₁₃Cl₂F⁵O₃Si HYDROLYTIC SENSITIVITY: 8 reacts rapidly with water/moisture, protic solvents</td>
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<tr>
<td>[15538-93-9] HMIS: 3-3-1-X</td>
<td>5.0g/$64.00</td>
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<tr>
<td>SIEH5845.0 n-HEPTYLTRIMETHYLSILANE</td>
<td>213.22</td>
<td>207-8°</td>
<td>0.978</td>
<td>1.4396²</td>
</tr>
<tr>
<td>C₉H₁₈O₃Si flashpoint: 66°C (150°F)</td>
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<tr>
<td>HYDROLYTIC SENSITIVITY: 8 reacts rapidly with water/moisture, protic solvents</td>
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</tr>
<tr>
<td>[18395-93-2] TSCA HMIS: 3-2-1-X</td>
<td>25g/$74.00</td>
<td></td>
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</tr>
<tr>
<td>Name</td>
<td>MW</td>
<td>bp/mm (mp)</td>
<td>D&lt;sub&gt;4&lt;/sub&gt;&lt;sup&gt;20&lt;/sup&gt;</td>
<td>n&lt;sub&gt;0&lt;/sub&gt;&lt;sup&gt;20&lt;/sup&gt;</td>
</tr>
<tr>
<td>-------------------------------------------</td>
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<td>--------------------------</td>
</tr>
<tr>
<td>n-HEPTYLTRICHLOROSILANE</td>
<td>233.64</td>
<td>211.2°</td>
<td>1.087</td>
<td>1.4439&lt;sup&gt;25&lt;/sup&gt;</td>
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<td>flashpoint: 64°C (146°F)</td>
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<tr>
<td>SIH5846.0</td>
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<tr>
<td>C&lt;sub&gt;7&lt;/sub&gt;H&lt;sub&gt;15&lt;/sub&gt;Cl&lt;sub&gt;3&lt;/sub&gt;Si</td>
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<tr>
<td>HYDOLYTIC SENSITIVITY: 8 reacts rapidly with water/moisture, protic solvents</td>
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<tr>
<td>[871-41-0]</td>
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<td>HMIS: 3-2-1-X</td>
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<td>25g/$74.00</td>
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<tr>
<td>HEXADECACFLUORODECE-11-ENE-1-YL-</td>
<td>589.61</td>
<td>94-6°/0.6</td>
<td>1.262</td>
<td>1.3713</td>
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<tr>
<td>TRICHLOROSILANE</td>
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<tr>
<td>C&lt;sub&gt;12&lt;/sub&gt;H&lt;sub&gt;23&lt;/sub&gt;Cl&lt;sub&gt;3&lt;/sub&gt;F&lt;sub&gt;16&lt;/sub&gt;Si</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>forms self-assembled monolayers/ reagent for immobilization of DNA</td>
<td></td>
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<td></td>
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<tr>
<td>HYDOLYTIC SENSITIVITY: 7 reacts slowly with water/moisture</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HMIS: 3-1-1-X</td>
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<td>HEXADECYLTRICHLOROSILANE, 95%</td>
<td>359.88</td>
<td>202/10</td>
<td>0.98</td>
<td>1.4592</td>
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<td>flashpoint: 154°C (309°F)</td>
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<td>SIH5920.0</td>
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<tr>
<td>HEXADECYLDIETHOXYSILANE, 95%</td>
<td>388.71</td>
<td>160-1°/1</td>
<td>0.888</td>
<td>1.4370</td>
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<tr>
<td>(-9°)mp</td>
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<td>HEXADECYLTRIMETHOXYSILANE, 95%</td>
<td>346.63</td>
<td>155°/0.2</td>
<td>0.89</td>
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<td>C&lt;sub&gt;19&lt;/sub&gt;H&lt;sub&gt;32&lt;/sub&gt;O&lt;sub&gt;3&lt;/sub&gt;Si</td>
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<td>viscosity: 7 cSt</td>
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<tr>
<td>HYDOLYTIC SENSITIVITY: 7 reacts slowly with water/moisture</td>
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<td>HMIS: 2-1-1-X</td>
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<td>HEXADECYLTRICHLOROSILANE, 99%</td>
<td>219.51</td>
<td>186-8°</td>
<td>0.922</td>
<td>1.4448</td>
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<td>C&lt;sub&gt;6&lt;/sub&gt;H&lt;sub&gt;11&lt;/sub&gt;N&lt;sub&gt;3&lt;/sub&gt;S&lt;sub&gt;2&lt;/sub&gt;</td>
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<td>ΔHform: 132 kcal/mole</td>
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<td>viscosity, 20°: 1.7 cSt</td>
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<td>ΔHvap: 8.3 kcal/mole</td>
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<td>pKa: 7.55</td>
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<td>surface tension: 18.2 dynes/cm</td>
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<td>vapor pressure, 50°: 55 mmol/cm</td>
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<td>Ea, reaction w/SiO&lt;sub&gt;2&lt;/sub&gt; surface: 17.6 kcal/mole</td>
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<td>Ea, reaction w/SiO&lt;sub&gt;2&lt;/sub&gt; surface: 17.6 kcal/mole</td>
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<td>versatile silylation reagent; creates hydrophobic surfaces</td>
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<td>HEXADECYLTRICHLOROSILANE, 99%</td>
<td>161.39</td>
<td>126-7°</td>
<td>0.7742</td>
<td>1.4080</td>
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<tr>
<td>C&lt;sub&gt;9&lt;/sub&gt;H&lt;sub&gt;19&lt;/sub&gt;Cl&lt;sub&gt;2&lt;/sub&gt;Si</td>
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<tr>
<td>TOXICITY- oral rat, LD50: 850mg/kg</td>
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<tr>
<td>TOXICITY- ipr mus, LDLo: 650mg/kg</td>
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<td>flashpoint: 14°C (57°F)</td>
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<td>HMIS: 2-4-1-X</td>
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<td>1,1,3,3,5,5-Hexamethycyclotrisilazane</td>
<td>161.39</td>
<td>126-7°</td>
<td>0.7742</td>
<td>1.4080</td>
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<td>C&lt;sub&gt;9&lt;/sub&gt;H&lt;sub&gt;19&lt;/sub&gt;Cl&lt;sub&gt;2&lt;/sub&gt;Si</td>
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<td>TOXICITY- oral rat, LD50: 850mg/kg</td>
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<td>TOXICITY- ipr mus, LDLo: 650mg/kg</td>
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<td>25g/$10.00</td>
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<td>SIH6110.0</td>
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<td>HEXAMETHYLDIISILAZANE</td>
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<td>126-7°</td>
<td>0.7742</td>
<td>1.4080</td>
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<td>126-7°</td>
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<td>TOXICITY- oral rat, LD50: 850mg/kg</td>
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<td>HEXYL-METHYLDICHLOROSILANE</td>
<td>199.19</td>
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<td>HYDOLYTIC SENSITIVITY: 8 reacts rapidly with water/moisture, protic solvents</td>
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<tr>
<td>Name</td>
<td>MW</td>
<td>bp/°C (mp)</td>
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<td>HEXYLTRICHLOROSILANE</td>
<td>219.61</td>
<td>191-2°</td>
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<td>HEXYLTRIETHOXYSIANE</td>
<td>248.44</td>
<td>115°/18</td>
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<td>HEXYLTRIMETHOXYSIANE</td>
<td>206.35</td>
<td>202-3°</td>
<td>0.911²</td>
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<td>ISOBUTYLDIMETHYLCHLOROSILANE</td>
<td>150.72</td>
<td>131-3°</td>
<td>1.4187²</td>
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<td>ISOBUTYLTRICHLOROSILANE</td>
<td>191.56</td>
<td>140°</td>
<td>1.912</td>
<td>1.4335</td>
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<td>ISOBUTYLTRIMETHOXYSIANE</td>
<td>220.38</td>
<td>190-1°</td>
<td>0.9104</td>
<td>1.3962</td>
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<tr>
<td>ISOOCTYLDIMETHYLCHLOROSILANE</td>
<td>206.83</td>
<td>83-5°/10</td>
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<tr>
<td>ISOOCTYLTRICHLOROSILANE</td>
<td>247.67</td>
<td>117°/50</td>
<td>1.0684</td>
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<td>ISOOCTYLTRIMETHOXYSIANE</td>
<td>234.41</td>
<td>90°/10</td>
<td>0.887</td>
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**SIH6167.0**  
**SIH6167.5**  
**SIH6168.5**  
**SIH6165.0**  
**SIH6165.5**  
**SIH6165.8**  
**SIH6425.5**  
**SIH6428.8**  
**SIH653.0**  
**SIH653.5**  
**SIH653.7**  
**SIH656.6**  
**SIH657.0**  
**SIH6458.0**
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<td>263.24</td>
<td>115-6°/0.3</td>
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<td>flashpoint: &gt;110°C (&gt;230°F)</td>
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<td>SIME6492.5</td>
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<td>flashpoint: &gt;110°C (&gt;230°F)</td>
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<td>SIME6492.8</td>
<td>162.30</td>
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<td>(1-METHOXY-2-PROPOXY)TRIMETHYLSILANE</td>
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<td>(40°)mp</td>
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<td>viscosity: 2 cSt</td>
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<td>233.21</td>
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<td>1.1</td>
<td>1.5100&lt;sup&gt;23&lt;/sup&gt;</td>
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<td>C₁₀H₁₄Cl₂Si</td>
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<td>flashpoint: 95°C (203°F)</td>
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<td>(2-METHYL-2-PHENYLETHYL)METHYLDICHLOROSILANE</td>
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<td>METHYLTRIAETOXYSilANE, 95%</td>
<td>C₇H₁₂O₃Si</td>
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<td>(40°)mp</td>
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<td>flashpoint: 85°C (185°F)</td>
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<td>most common crosslinker for condensation cure silicone RTV's</td>
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<tr>
<td>SIME6520.0</td>
<td>149.48</td>
<td>66.4°</td>
<td>1.275</td>
<td>1.4110</td>
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<td>TOXICITY - ihl rat LDLo: 450ppm/4H</td>
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<td>surface tension: 20.3 dynes/cm</td>
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<td>66.4°</td>
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<td>1.4110</td>
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<td>in combination w/H₂ forms SiC by CVD&lt;sup&gt;1&lt;/sup&gt;.</td>
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<td>HYDROLYTIC SENSITIVITY: 8 reacts rapidly with water/moisture</td>
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<th>Name</th>
<th>MW</th>
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<th>$\Delta H_{\text{comb}}$</th>
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<td>SIM6555.0 METHYLTRETETHYLSILANE</td>
<td>178.30</td>
<td>142$^\circ$</td>
<td>1831 kcal/mol</td>
<td>1.3832</td>
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<td>vapor pressure, 25$^\circ$: 6mm</td>
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<td>dipole moment: 1.72 debye</td>
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<td>viscosity: 0.6 cSt</td>
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<td>2.0kg/$100.00</td>
<td>15kg/$360.00</td>
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<tr>
<td>SIM6560.0 METHYLTRIMETHYLSILANE</td>
<td>136.22</td>
<td>102-3$^\circ$</td>
<td>1142 kcal/mol</td>
<td>1.3696</td>
<td>0.955</td>
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<td>viscosity: 0.50 cSt</td>
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<td>[1185-55-3] TSCA HMIS: 3-4-1-X</td>
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<td>2.0kg/$68.00</td>
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<td>136.22</td>
<td>102-3$^\circ$</td>
<td>1142 kcal/mol</td>
<td>1.3696</td>
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<td>[1185-55-3] TSCA HMIS: 3-4-1-X</td>
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<td>SIM6570.0 METHYLTRI-n-PROPOXYLSILANE</td>
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<td>83-4$^\circ$</td>
<td>14085</td>
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<td>SIM6590.0 METHYLTRI(METHYLETHYLKETOXIME)-SILENE, 95% METHYLTRI(2-BUTANONEOXIME)SILANE</td>
<td>301.46</td>
<td>110-1$^\circ$</td>
<td>1.4548$^{a}$</td>
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<td>C$<em>{13}$H$</em>{27}$N$_3$O$_3$Si</td>
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<td>SIN6596.0 (1-NAPHTYLETHYL)TRICHLOROSILANE</td>
<td>275.64</td>
<td>150-1$^\circ$</td>
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<td>C$<em>{11}$H$</em>{28}$Cl$_3$Si</td>
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<td>employed in high refractive index surface modification</td>
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<td>SIN6597.6 NONAFLUOROHEXYLTRICHLOROSILANE</td>
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Hydrotic Sensitivity: 8 reacts rapidly with moisture, water, protic solvents.
name | MW | bp/mm (mp) | D₄ | n₀
---|---|---|---|---
SIO6629.0 | 358.68 | 190°/3 (17-18)°mp | 0.85 | 1.4427
SIO6640.0 | 387.93 | 160-2°/3 (22)°mp | 0.95 | 1.4602
SIO6642.0 | 416.76 | 165-9°/0.2 (10-12)°mp | 0.87 | 1.4386
SIO6645.0 | 374.68 | 170°/1 (13-17)°mp | 0.885 | 1.439
SIO6698.0 | 292.68 | 225° (97)°mp | 0.95 | 1.4581
SIO6710.5 | 262.94 | 95-9°/0.5 (9-12)°mp | 0.875 | 1.4550
SIO6710.7 | 271.57 | 105°/0.7 (9-12)°mp | 0.833 | 1.4560

**HYDROPHOBIC COMMERCIAL**

**SIO6629.0**

n-octadeclmethyldimethoxysilane

C₂₁H₄₄O₂Si  contains 5-10% C₁₈ isomers

flashpoint: >110°C (>230°F)

autoignition temp: 225°

HYDROLYTIC SENSITIVITY: 7  Si-OR reacts slowly with water/moisture

[70851-50-2]  TSCA HMIS: 3-1-0-X  25g/$52.00  1kg/$119.00  15kg/$962.00

**SIO6640.0**

n-octadecltrichlorosilane, 95%

C₁₈H₃₇Cl₃Si  contains 5-10% C₁₈ isomers

flashpoint: >110°C (>230°F)

provides lipidophilic surface coatings

employed in patterning and printing of electroactive molecular films

see also SIO6624.0


HYDROLYTIC SENSITIVITY: 8  reacts rapidly with moisture, water, protic solvents

[112-04-9]  TSCA HMIS: 3-1-1-X  25g/$11.00  1kg/$119.00  15kg/$962.00

**SIO6642.0**

n-octadecltrioethoxysilane, 95%

C₂₆H₅₂O₃Si  contains 5-10% C₁₈ isomers

forms hydrophobic, oleophilic coatings

flashpoint: >150°C (>302°F)

HYDROLYTIC SENSITIVITY: 7  Si-OR reacts slowly with water/moisture

[7399-00-0]  HMIS: 2-1-0-X  25g/$30.00  1kg/$96.00

**SIO6645.0**

n-octadecltrimethoxysilane, 95%

C₂₁H₄₆O₃Si  contains 5-10% C₁₈ isomers

see also SIH5925.0

TOXICITY- oral rat, LD₅₀: >5000mg/kg

forms clear, ordered, films w/ tetramethoxysilane

flashpoint: 140°C (284°F)


HYDROLYTIC SENSITIVITY: 7  reacts slowly with water/moisture

[1020-84-4]  TSCA HMIS: 2-2-1-X  25g/$27.00  1kg/$88.00

**SIO6698.0**

Octamethylcyclotetrasilazane

C₈H₂₈N₄Si₄  forms α-Si₃N₄ by ammonia thermal synthesis

forms clear, ordered, films w/ tetramethoxysilane

flashpoint: 66°C (150°F)


HYDROLYTIC SENSITIVITY: 7  reacts slowly with water/moisture

[1020-84-4]  TSCA HMIS: 2-2-1-X  25g/$27.00  1kg/$88.00

**SIO6710.5**

n-octyldiisopropylchlorosilane

C₁₄H₃₅ClSi  reaction: >110°C (>230°F)

reagent for preparation of HPLC stationary phases w/high stability and efficiency


HYDROLYTIC SENSITIVITY: 7  reacts slowly with water/moisture

[117559-32-7]  TSCA HMIS: 3-1-1-X  10g/$58.00

**SIO6710.7**

n-octyldiisopropyl(dimethylamino)-silane

C₁₆H₃₃N₃Si  reaction: >110°C (>230°F)

HYDROLYTIC SENSITIVITY: 7  reacts slowly with water/moisture

[151613-25-1]  TSCA HMIS: 3-2-1-X  25g/$250.00
<table>
<thead>
<tr>
<th>Name</th>
<th>MW</th>
<th>bp/mm (mp)</th>
<th>D&lt;sub&gt;20&lt;/sub&gt;</th>
<th>n&lt;sub&gt;0&lt;/sub&gt; &lt;sub&gt;20&lt;/sub&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>n-Octyltrimethylchlorosilane</td>
<td>206.83</td>
<td>222.5°C</td>
<td>0.794</td>
<td>14328&lt;sup&gt;15&lt;/sup&gt;</td>
</tr>
<tr>
<td>OCTYLDIMETHYLCHLOROSILANE</td>
<td>202.42</td>
<td>221-223°C</td>
<td>0.813</td>
<td>1.4230</td>
</tr>
<tr>
<td>n-Octyltrimethyl(dimethylamino)silane</td>
<td>215.45</td>
<td>94-6°C/10</td>
<td>0.80&lt;sup&gt;25&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td>n-Octylmethyl dichlorosilane</td>
<td>227.25</td>
<td>94°/6</td>
<td>0.9761</td>
<td>1.4440</td>
</tr>
<tr>
<td>n-Octylmethyl diethylene silane</td>
<td>246.47</td>
<td>80-2°C/2</td>
<td>0.8478</td>
<td>1.4190</td>
</tr>
<tr>
<td>n-Octylmethyl dimethoxy silane</td>
<td>218.42</td>
<td>87-9°C/5</td>
<td>0.858</td>
<td>1.4190</td>
</tr>
<tr>
<td>n-Octyltrichlorosilane</td>
<td>247.67</td>
<td>224-6°</td>
<td>1.0744</td>
<td>1.4490</td>
</tr>
<tr>
<td>n-Octyltrimethoxysilane</td>
<td>234.41</td>
<td>191-2°</td>
<td>0.907</td>
<td>1.417</td>
</tr>
<tr>
<td>1,1,1,3,3-Pentamethylyl-3-acetoxy-disiloxane</td>
<td>206.39</td>
<td>149-50°C</td>
<td>0.90</td>
<td>1.3887&lt;sup&gt;25&lt;/sup&gt;</td>
</tr>
<tr>
<td>Pentyltrichlorosilane</td>
<td>234.41</td>
<td>191-2°</td>
<td>0.907</td>
<td>1.417</td>
</tr>
</tbody>
</table>

*Please inquire about bulk quantities*
SIP6720.2
PENTYLTRIETHOXYSILANE
AMYTRIPTIETHOXYSILANE mixed isomers
C11H26O3Si

HYDROLYTIC SENSITIVITY: 7  Si-OR reacts slowly with water/moisture

[2761-24-2]  TSCA: 2-2-1-X

SIP6720.5
PERFLUORODODECYL-1H,1H,2H,2H-TRIETHOXYSILANE MIXTURE, 80% (contains ~ 5% SIH5841.2, balance higher homologs)
for the preparation of low surface energy substrates

HYDROLYTIC SENSITIVITY: 7  Si-OR reacts slowly with water/moisture

HMIS: 2-1-1-X

SIP6720.7
PERFLUOROOCTYLPHENYLTRICHLOROSILANE
C14H4Cl3F17Si

HYDROLYTIC SENSITIVITY: 8  reacts rapidly with moisture, water, protic solvents

[753025-21-7]  TSCA-L: 3-2-1-X

SIP6721.0
PHENETHYLDIMETHYLCHLOROSILANE
C10H15ClSi
contains \( \alpha,\beta \)-isomers

HYDROLYTIC SENSITIVITY: 8  reacts rapidly with moisture, water, protic solvents

[17146-08-6]  TSCA: 3-2-1-X

SIP6722.0
PHENETHYLTRICHLOROSILANE
C8H9Cl3Si
contains \( \alpha,\beta \)-isomers

HYDROLYTIC SENSITIVITY: 8  reacts rapidly with moisture, water, protic solvents

[940-41-0]  TSCA: 3-1-1-X
<table>
<thead>
<tr>
<th>Name</th>
<th>MW</th>
<th>bp/mm (mp)</th>
<th>D$_{4}^{20}$</th>
<th>n$_{0}^{20}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>3-PHENOXYPROPYL METHYLDICHLOROSILANE</td>
<td>249.21</td>
<td>110$^\circ$/1</td>
<td>1.5190</td>
<td>1.5082</td>
</tr>
<tr>
<td>5-PHENOXYPROPYL TRICHLOROSILANE</td>
<td>269.63</td>
<td>40$^\circ$/0.02</td>
<td>1.2574</td>
<td>1.5190</td>
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<tr>
<td>3-PHENOXYPHENYL UNDECYL TRICHLOROSILANE</td>
<td>381.85</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>4-PHENOXYBUTYL DIMETHYLCHLOROSILANE</td>
<td>226.83</td>
<td>85-7$^\circ$/0.6</td>
<td>0.964</td>
<td>1.4979$^{a}$</td>
</tr>
<tr>
<td>4-PHENOXYBUTYL METHYLDICHLOROSILANE</td>
<td>247.24</td>
<td>105-9$^\circ$/1.5</td>
<td>1.09</td>
<td>1.5190</td>
</tr>
<tr>
<td>11-PHENYLHEXYL TRICHLOROSILANE</td>
<td>339.80</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PHENYL DIMETHYLACETOXY SILANE</td>
<td>194.30</td>
<td>127-9$^\circ$/44</td>
<td>1.006</td>
<td>1.4907</td>
</tr>
<tr>
<td>PHENYL DIMETHYLCHLOROSILANE</td>
<td>170.71</td>
<td>192-3$^\circ$</td>
<td>1.032</td>
<td>1.5082</td>
</tr>
<tr>
<td>PHENYL DIMETHYLOXYSILANE</td>
<td>180.32</td>
<td>93$^\circ$/25</td>
<td>0.926</td>
<td>1.4799</td>
</tr>
<tr>
<td>PHENYL HEXYL TRICHLOROSILANE</td>
<td>295.71</td>
<td>95$^\circ$/0.1</td>
<td>1.5052$^{a}$</td>
<td></td>
</tr>
</tbody>
</table>

$^{a}$flashpoint: >110°C (>230°F)
<table>
<thead>
<tr>
<th>Name</th>
<th>MW</th>
<th>bp/mm (mp)</th>
<th>$D_4$°</th>
<th>$N_0$°</th>
</tr>
</thead>
<tbody>
<tr>
<td>SIP6736.8 Phenylmethylbis(dimethylamino)silane</td>
<td>208.38</td>
<td>108-9°/11</td>
<td>1.4982</td>
<td></td>
</tr>
<tr>
<td>SIP6738.0 Phenylmethyldichlorosilane</td>
<td>191.13</td>
<td>205-6°</td>
<td>1.187</td>
<td>1.5180</td>
</tr>
<tr>
<td>SIP6738.5 1-Pheny1-1-(methyldichlorosilyl)butane</td>
<td>247.24</td>
<td>87-9°/1</td>
<td>1.10</td>
<td>1.5120</td>
</tr>
<tr>
<td>SIP6739.0 Phenylmethyldiethoxysilane</td>
<td>210.35</td>
<td>117-8°/3</td>
<td>0.963</td>
<td>1.4690</td>
</tr>
<tr>
<td>SIP6740.0 Phenylmethyldimethoxysilane</td>
<td>182.29</td>
<td>199-200°</td>
<td>0.9934</td>
<td>1.4694</td>
</tr>
<tr>
<td>SIP6743.0 (3-Phenylpropyl)dimethylchlorosilane</td>
<td>212.78</td>
<td>75°/0.5</td>
<td>0.963</td>
<td></td>
</tr>
<tr>
<td>SIP6744.0 (3-Phenylpropyl)methylidichlorosilane</td>
<td>233.21</td>
<td>96-8°/4</td>
<td>1.086°</td>
<td>1.509°</td>
</tr>
<tr>
<td>SIP6790.0 Phenyltrimethoxysilane</td>
<td>282.32</td>
<td>158°/30</td>
<td>1.194</td>
<td>1.4708</td>
</tr>
<tr>
<td>SIP6810.0 Phenyltrichlorosilane</td>
<td>211.55</td>
<td>201°</td>
<td>1.324</td>
<td>1.5247</td>
</tr>
<tr>
<td>SIP6813.0 1-Pheny1-1-trichlorosilylbutane</td>
<td>267.65</td>
<td>78-80°/0.8</td>
<td>1.201</td>
<td>1.5180</td>
</tr>
<tr>
<td>name</td>
<td>MW</td>
<td>bp/mm (mp)</td>
<td>D&lt;sub&gt;4&lt;/sub&gt;&lt;sup&gt;20&lt;/sup&gt;</td>
<td>n&lt;sub&gt;0&lt;/sub&gt;&lt;sup&gt;20&lt;/sup&gt;</td>
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<tr>
<td>-----------------------------------------------------------</td>
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<td>-----------------------------</td>
</tr>
<tr>
<td><strong>SIP6821.0 PHENYLTRIETHOXYSILANE</strong></td>
<td>240.37</td>
<td>112-3°/10</td>
<td>0.996</td>
<td>1.4718</td>
</tr>
<tr>
<td>C&lt;sub&gt;12&lt;/sub&gt;H&lt;sub&gt;20&lt;/sub&gt;O&lt;sub&gt;5&lt;/sub&gt;Si</td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>vapor pressure, 75°: 1mm</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>coefficient of thermal expansion: 0.9 x 10&lt;sup&gt;-3&lt;/sup&gt;</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>dipole moment: 1.85 debye</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>viscosity, 25°: 1.7 cSt</td>
<td></td>
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<tr>
<td>improves photoresist adhesion to silicon nitride effective treatment for organic-grafted clays&lt;sup&gt;1&lt;/sup&gt;</td>
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<tr>
<td>HYDROLYTIC SENSITIVITY: 7 Si-OR reacts slowly with water/moisture</td>
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<tr>
<td>[780-69-8] TSCA HMIS: 2-1-1-X</td>
<td>100g/$11.00</td>
<td>2kg/$112.00</td>
<td>17kg/$510.00</td>
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<tr>
<td><strong>SIP6822.0 PHENYLTRIMETHOXYSILANE</strong></td>
<td>198.29</td>
<td>211°</td>
<td>1.064</td>
<td>1.4734</td>
</tr>
<tr>
<td>C&lt;sub&gt;9&lt;/sub&gt;H&lt;sub&gt;14&lt;/sub&gt;O&lt;sub&gt;3&lt;/sub&gt;Si</td>
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<tr>
<td>viscosity, 25°: 2.1 cSt</td>
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<tr>
<td>vapor pressure, 108°: 20mm</td>
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</tr>
<tr>
<td>dipole moment: 1.77</td>
<td></td>
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<tr>
<td>intermediate for silicone resin coatings</td>
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<tr>
<td>HYDROLYTIC SENSITIVITY: 7 Si-OR reacts slowly with water/moisture</td>
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<tr>
<td>[2996-92-1] TSCA HMIS: 3-2-1-X</td>
<td>100g/$11.00</td>
<td>2kg/$98.00</td>
<td>18kg/$562.00</td>
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</tr>
<tr>
<td><strong>SIP6826.5 PHENYLTRIS(METHYLETHYLKETOXIMINO)-SILANE</strong></td>
<td>363.53</td>
<td>60-5°/3</td>
<td>0.995</td>
<td></td>
</tr>
<tr>
<td>C&lt;sub&gt;18&lt;/sub&gt;H&lt;sub&gt;29&lt;/sub&gt;N&lt;sub&gt;3&lt;/sub&gt;O&lt;sub&gt;3&lt;/sub&gt;Si</td>
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<tr>
<td>vapor pressure, 81°C (&gt;142°F)</td>
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<tr>
<td>flashpoint: &gt;61°C (142°F)</td>
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<tr>
<td>dipole moment: 1.85 debye</td>
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</tr>
<tr>
<td>dielectric constant: 4.12</td>
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</tr>
<tr>
<td>utilized in architectural hydrophobic coatings</td>
<td></td>
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<tr>
<td>HYDROLYTIC SENSITIVITY: 7 Si-OR reacts slowly with water/moisture</td>
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<tr>
<td>[34036-80-1] TSCA HMIS: 3-3-1-X</td>
<td>50g/$17.00</td>
<td>250g/$68.00</td>
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<tr>
<td><strong>SIP6910.0 n-PROPYLDIMETHYLSILANOL</strong></td>
<td>136.70</td>
<td>113-4°</td>
<td>0.8726</td>
<td>1.4138</td>
</tr>
<tr>
<td>C&lt;sub&gt;6&lt;/sub&gt;H&lt;sub&gt;13&lt;/sub&gt;O&lt;sub&gt;3&lt;/sub&gt;Si</td>
<td></td>
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<tr>
<td>flashpoint: 10°C (50°F)</td>
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<tr>
<td>HYDROLYTIC SENSITIVITY: 8 Si-Cl reacts rapidly with water/moisture</td>
<td></td>
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<tr>
<td>[17477-29-1] TSCA HMIS: 3-4-1-X</td>
<td>25g/$49.00</td>
<td>100g/$159.00</td>
<td></td>
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</tr>
<tr>
<td><strong>SIP6911.0 n-PROPYLDIMETHOXYDIMETHYSILANOL</strong></td>
<td>132.28</td>
<td>94-6°</td>
<td>0.787</td>
<td>1.3927&lt;sup&gt;25&lt;/sup&gt;</td>
</tr>
<tr>
<td>C&lt;sub&gt;6&lt;/sub&gt;H&lt;sub&gt;13&lt;/sub&gt;O&lt;sub&gt;2&lt;/sub&gt;Si</td>
<td></td>
<td></td>
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<tr>
<td>HYDROLYTIC SENSITIVITY: 8 Si-Cl reacts rapidly with water/moisture</td>
<td></td>
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<tr>
<td>[18182-14-4] HMIS: 3-3-1-X</td>
<td>10g/$82.00</td>
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<tr>
<td><strong>SIP6912.0 n-PROPYLMETHYLDICHLOROSILANE</strong></td>
<td>157.11</td>
<td>125°</td>
<td>1.027</td>
<td>1.425</td>
</tr>
<tr>
<td>C&lt;sub&gt;4&lt;/sub&gt;H&lt;sub&gt;10&lt;/sub&gt;Cl&lt;sub&gt;2&lt;/sub&gt;Si</td>
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<tr>
<td>flashpoint: 27°C (81°F)</td>
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<tr>
<td>HYDROLYTIC SENSITIVITY: 8 Si-Cl reacts rapidly with water/moisture</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>[4518-94-9] TSCA HMIS: 3-3-1-X</td>
<td>25g/$38.00</td>
<td>100g/$124.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>SIP6914.0 n-PROPYLMETHYLCHLOROSILANE</strong></td>
<td>148.28</td>
<td>126°</td>
<td>0.8689</td>
<td>1.3931</td>
</tr>
<tr>
<td>C&lt;sub&gt;6&lt;/sub&gt;H&lt;sub&gt;13&lt;/sub&gt;Cl&lt;sub&gt;2&lt;/sub&gt;Si</td>
<td></td>
<td></td>
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<tr>
<td>HYDROLYTIC SENSITIVITY: 8 Si-Cl reacts rapidly with water/moisture</td>
<td></td>
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<tr>
<td>[18173-73-4] HMIS: 3-3-1-X</td>
<td>25g/$86.00</td>
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<tr>
<td><strong>SIP6915.0 n-PROPYLTRICHLOROSILANE</strong></td>
<td>177.53</td>
<td>123-4°</td>
<td>1.185</td>
<td>1.4290</td>
</tr>
<tr>
<td>C&lt;sub&gt;3&lt;/sub&gt;H&lt;sub&gt;7&lt;/sub&gt;Cl&lt;sub&gt;3&lt;/sub&gt;Si</td>
<td></td>
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</tr>
<tr>
<td>flashpoint: 35°C (95°F)</td>
<td></td>
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</tr>
<tr>
<td>ΔHvap: 8.7 kcal/mole</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>HYDROLYTIC SENSITIVITY: 8 Si-Cl reacts rapidly with water/moisture</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>[141-57-1] TSCA HMIS: 3-3-1-X</td>
<td>25g/$13.00</td>
<td>2.5kg/$225.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>SIP6917.0 n-PROPYLTRIETHOXYSILANE</strong></td>
<td>206.36</td>
<td>179-80°</td>
<td>0.8916</td>
<td>1.3956</td>
</tr>
<tr>
<td>C&lt;sub&gt;9&lt;/sub&gt;H&lt;sub&gt;16&lt;/sub&gt;O&lt;sub&gt;3&lt;/sub&gt;Si</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>flashpoint: 57°C (135°F)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HYDROLYTIC SENSITIVITY: 7 Si-OR reacts slowly with water/moisture</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>[2550-02-8] TSCA HMIS: 3-3-1-X</td>
<td>25g/$12.00</td>
<td>2.0kg/$160.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>SIP6918.0 n-PROPYLTRIMETHOXYDIMETHYLSILANE</strong></td>
<td>164.27</td>
<td>142°</td>
<td>0.932&lt;sup&gt;25&lt;/sup&gt;</td>
<td>1.3880</td>
</tr>
<tr>
<td>C&lt;sub&gt;6&lt;/sub&gt;H&lt;sub&gt;13&lt;/sub&gt;O&lt;sub&gt;2&lt;/sub&gt;Si</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>TOXICITY- oral rat, LD50: 7420mg/kg</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>flashpoint: 34°C (93°F)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HYDROLYTIC SENSITIVITY: 7 Si-OR reacts slowly with water/moisture</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>[1067-25-0] TSCA HMIS: 3-3-1-X</td>
<td>25g/$11.00</td>
<td>2kg/$102.00</td>
<td>16kg/$368.00</td>
<td></td>
</tr>
</tbody>
</table>

**COMMERCIAL**

Gelest, Inc.

**PLEASE INQUIRE ABOUT BULK QUANTITIES**
### SIS6952.0
**Name**: SILICLAD®
**MW**: 20 nD
**D4**: 0.88
**bp/mm (mp)**: 20 nD
**Flashpoint**: 25°C (77°F)
**Coefficient of friction of treated glass surface**: 0.2-0.3
**Surface resistivity of treated surface**: 1.2 x 10¹³ ohms
**Reduces blood protein adsorption**: 1
**Hydrophobic, anti-stiction coating for silicon substrates**: 2
2. A. Almanza-Workman et al, J. Electro Chem. Soc. 149, H6, 2002

For application information see Performance Products Brochure

### SIS6984.0
**Name**: SODIUM METHYL SILICONATE, 30% in water
**MW**: 116.12
**D4**: 1.24
**Purity**: 95%
**Flashpoint**: 58°C (136°F)
**pH**: 13.0
**Viscosity**: 10 cSt.

### SIT7093.0
**Name**: TETRADECYLTRICHLOROSILANE
**MW**: 331.83
**D4**: 1.4575
**Flashpoint**: 155°-158°F

### SIT7095.0
**Name**: 1,1,3,3-TETRAETHOXYL-1,3-DIMETHYLDISILOXANE, 95%
**MW**: 282.48
**D4**: 0.953
**Flashpoint**: 205°F

### SIT7534.0
**Name**: 1,1,3,3-TETRAMETHYL-1,3-DIETHOXYDISILOXANE
**MW**: 222.43
**D4**: 0.879
**Flashpoint**: 161°F

### SIT7753.0
**Name**: p-TOLYL DIMETHYL CHLOROSILANE
**MW**: 178.78
**D4**: 0.911
**Flashpoint**: 67°C (153°F)

### SIT7906.0
**Name**: THEXYL METHYL CHLOROSILANE
**MW**: 184.74
**D4**: 1.007
**Flashpoint**: 51°C (125°F)

### SIT8030.0
**Name**: THEXYLDIMETHYLCHLOROSILANE
**MW**: 205.16
**D4**: 1.1609
**Flashpoint**: 80°C (176°F)
<table>
<thead>
<tr>
<th>Name</th>
<th>MW</th>
<th>bp/mm (mp)</th>
<th>D&lt;sub&gt;4&lt;/sub&gt;&lt;sup&gt;20&lt;/sup&gt;</th>
<th>n&lt;sub&gt;0&lt;/sub&gt;&lt;sup&gt;20&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>p-TOLYLTRICHLOROSILANE</td>
<td>225.58</td>
<td>218-20°</td>
<td>1.28</td>
<td>1.5224&lt;sup&gt;25&lt;/sup&gt;</td>
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<tr>
<td>C&lt;sub&gt;9&lt;/sub&gt;H&lt;sub&gt;7&lt;/sub&gt;Cl&lt;sub&gt;3&lt;/sub&gt;Si</td>
<td>flashpoint: 92°C (197°F)</td>
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<tr>
<td>HYDROLYTIC SENSITIVITY: 8 reacts rapidly with moisture, water, protic solvents, protic solvents</td>
<td></td>
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<tr>
<td></td>
<td>[701-35-9]</td>
<td>TSCA</td>
<td>HMIS: 3-2-1-X</td>
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<tr>
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<tbody>
<tr>
<td>p-TOLYLTRIMETHOXYSILANE</td>
<td>212.32</td>
<td>75-8°/8</td>
<td>1.033</td>
<td>1.4726&lt;sup&gt;25&lt;/sup&gt;</td>
</tr>
<tr>
<td>C&lt;sub&gt;10&lt;/sub&gt;H&lt;sub&gt;16&lt;/sub&gt;O&lt;sub&gt;3&lt;/sub&gt;Si</td>
<td>flashpoint: 94°C (201°F)</td>
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<tr>
<td>γc of treated surface: 34 dynes/cm</td>
<td>charge control surface treatment for electrostatic copier particles&lt;sup&gt;1&lt;/sup&gt;</td>
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<tr>
<td>HYDROLYTIC SENSITIVITY: 7 reacts slowly with water/moisture</td>
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<tr>
<td></td>
<td>[17873-01-7]</td>
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<th>n&lt;sub&gt;0&lt;/sub&gt;&lt;sup&gt;20&lt;/sup&gt;</th>
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</thead>
<tbody>
<tr>
<td>TRIACONTYLDIMETHYLCHLOROSILANE, blend</td>
<td>515.42</td>
<td>(60-82°)mp</td>
<td>80% C&lt;sub&gt;30&lt;/sub&gt; and higher, 20% C&lt;sub&gt;22&lt;/sub&gt;-C&lt;sub&gt;28&lt;/sub&gt;</td>
<td></td>
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<tr>
<td>C&lt;sub&gt;32&lt;/sub&gt;H&lt;sub&gt;67&lt;/sub&gt;Cl&lt;sub&gt;2&lt;/sub&gt;Si</td>
<td>HYDROLYTIC SENSITIVITY: 8 reacts rapidly with moisture, water, protic solvents, protic solvents</td>
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<tr>
<td></td>
<td>[70851-52-4]</td>
<td>TSCA</td>
<td>HMIS: 3-1-0-X</td>
<td>25g/$52.00</td>
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<table>
<thead>
<tr>
<th>Name</th>
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<th>n&lt;sub&gt;0&lt;/sub&gt;&lt;sup&gt;20&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>13-(TRICHLOROSILYL)HEPTACOSANE, 95%</td>
<td>528.21</td>
<td>215°/01</td>
<td>0.946</td>
<td></td>
</tr>
<tr>
<td>C&lt;sub&gt;28&lt;/sub&gt;H&lt;sub&gt;57&lt;/sub&gt;Cl&lt;sub&gt;3&lt;/sub&gt;Si</td>
<td>contains isomers</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HYDROLYTIC SENSITIVITY: 8 reacts rapidly with moisture, water, protic solvents</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>[194242-99-4]</td>
<td>TSCA</td>
<td>HMIS: 3-1-1-X</td>
<td>10g/$127.00</td>
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<table>
<thead>
<tr>
<th>Name</th>
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<th>D&lt;sub&gt;4&lt;/sub&gt;&lt;sup&gt;20&lt;/sup&gt;</th>
<th>n&lt;sub&gt;0&lt;/sub&gt;&lt;sup&gt;20&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>7-(TRICHLOROSILYL)PENTADECANE</td>
<td>359.88</td>
<td>146-9°/0.2</td>
<td>0.985</td>
<td></td>
</tr>
<tr>
<td>C&lt;sub&gt;16&lt;/sub&gt;H&lt;sub&gt;33&lt;/sub&gt;Cl&lt;sub&gt;3&lt;/sub&gt;Si</td>
<td>2-HEXYLDECYLTRICHLOROSILANE</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>[102488-47-1]</td>
<td>TSCA</td>
<td>HMIS: 3-3-1-X</td>
<td>10g/$174.00</td>
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<table>
<thead>
<tr>
<th>Name</th>
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<th>bp/mm (mp)</th>
<th>D&lt;sub&gt;4&lt;/sub&gt;&lt;sup&gt;20&lt;/sup&gt;</th>
<th>n&lt;sub&gt;0&lt;/sub&gt;&lt;sup&gt;20&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>TRIFLUOROMETHYLHEPTACOSANE</td>
<td>510.12</td>
<td>84°/1.4</td>
<td>1.639</td>
<td>1.3521</td>
</tr>
<tr>
<td>C&lt;sub&gt;8&lt;/sub&gt;H&lt;sub&gt;4&lt;/sub&gt;Cl&lt;sub&gt;3&lt;/sub&gt;F&lt;sub&gt;13&lt;/sub&gt;Si</td>
<td>flashpoint: 54°C (129°F)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>lowers the coefficient of friction of silicon substrates&lt;sup&gt;1&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>[78560-45-9]</td>
<td>TSCA</td>
<td>HMIS: 3-3-1-X</td>
<td>10g/$28.00</td>
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</table>

<table>
<thead>
<tr>
<th>Name</th>
<th>MW</th>
<th>bp/mm (mp)</th>
<th>D&lt;sub&gt;4&lt;/sub&gt;&lt;sup&gt;20&lt;/sup&gt;</th>
<th>n&lt;sub&gt;0&lt;/sub&gt;&lt;sup&gt;20&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>(TRIDECAFLUORO-1,1,2,2-TETRAHYDRO-2,6-DIHEXYL)TRICHLOROSILANE</td>
<td>481.55</td>
<td>84-5°/17</td>
<td>1.639</td>
<td>1.3521</td>
</tr>
<tr>
<td>C&lt;sub&gt;28&lt;/sub&gt;H&lt;sub&gt;42&lt;/sub&gt;Cl&lt;sub&gt;3&lt;/sub&gt;Si</td>
<td>flashpoint: 54°C (129°F)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>[51851-37-7]</td>
<td>TSCA</td>
<td>HMIS: 2-2-1-X</td>
<td>10g/$26.00</td>
</tr>
<tr>
<td>name</td>
<td>MW</td>
<td>bp/mm (mp)</td>
<td>$D_4^{20}$</td>
<td>$n_0^{20}$</td>
</tr>
<tr>
<td>-----------------------------------------------------------</td>
<td>-----</td>
<td>------------</td>
<td>------------</td>
<td>------------</td>
</tr>
<tr>
<td>SIT8176.0 (TRIDECAFLUORO-1,1,2,2-TETRAHYDRO-OCTYL)TRIETHOXYSILANE</td>
<td>468.29</td>
<td>60-2°/0.5</td>
<td>1.44</td>
<td>1.3322</td>
</tr>
<tr>
<td>SIT8369.0 (3,3,3-TRIFLUOROPROPYL)METHYL-DICHLOROSILANE</td>
<td>211.08</td>
<td>121-2°</td>
<td>1.2611</td>
<td>1.3850</td>
</tr>
<tr>
<td>SIT8371.0 (3,3,3-TRIFLUOROPROPYL)TRICHLOROSILANE</td>
<td>231.50</td>
<td>113-4°</td>
<td>1.395</td>
<td>1.385</td>
</tr>
<tr>
<td>SIT8372.0 (3,3,3-TRIFLUOROPROPYL)TRIMETHOXYSILANE</td>
<td>218.25</td>
<td>144°</td>
<td>1.137</td>
<td>1.3546</td>
</tr>
<tr>
<td>SIT8510.0 TRIMETHYLCHLOROSILANE</td>
<td>108.64</td>
<td>57.6°</td>
<td>0.8580</td>
<td>1.3885</td>
</tr>
<tr>
<td>SIT8515.0 ETHOXYTRIMETHYSILANE</td>
<td>118.22</td>
<td>75-6°</td>
<td>0.7560</td>
<td>1.3678</td>
</tr>
<tr>
<td>SIT8566.0 TRIMETHYLMETHOXYSILANE</td>
<td>104.22</td>
<td>57-8°</td>
<td>0.7560</td>
<td>1.3678</td>
</tr>
<tr>
<td>SIT8572.6 TRIMETHYLSILOXYTRICHLOROSILANE</td>
<td>223.63</td>
<td>128°</td>
<td>1.126</td>
<td></td>
</tr>
<tr>
<td>SIT8712.0 TRIS(DIMETHYLAMINOMETHYL)SILANE</td>
<td>175.35</td>
<td>55-6°/17°</td>
<td>0.8502</td>
<td>1.4322</td>
</tr>
<tr>
<td>SIT8719.5 TRIS(TRIMETHYLSILOXY)SILYLETHYL)DIMETHYLCHLOROSILANE</td>
<td>417.32</td>
<td>85°/0.6</td>
<td>0.906</td>
<td>1.43175</td>
</tr>
<tr>
<td>SIU9050.0 UNDECYLCHLOROSILANE</td>
<td>289.75</td>
<td>155-60°/15°</td>
<td>1.02</td>
<td></td>
</tr>
</tbody>
</table>

**HYDROPHOBICITY**

CF<sub>3</sub>CF<sub>2</sub>CF<sub>2</sub>CF<sub>2</sub>CF<sub>2</sub>CF<sub>2</sub>CH<sub>2</sub>CH<sub>2</sub>Si(...CH<sub>3</sub>)<sub>3</sub>CH<sub>3</sub> forms hydrophobic monolayers

HYDROLYTIC SENSITIVITY: 8 Si-Cl reacts rapidly with water/moisture, protic solvents

HMIS: 3-2-1-X 10g/$84.00
# Hydrophobic Dipodal Silanes

## Dipodal Surface Bonding

<table>
<thead>
<tr>
<th>name</th>
<th>MW</th>
<th>bp/mm (mp)</th>
<th>(D_4) (^{20})</th>
<th>(n_0) (^{20})</th>
</tr>
</thead>
<tbody>
<tr>
<td>SIB1030.0 [BIS(2-(CHLORODIMETHYLSILYL)-ETHYL)BENZENE mixed isomers]</td>
<td>319.42</td>
<td>116-7°/0.2</td>
<td>1.02</td>
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<tr>
<td>[74129-20-7] TSCA HMIS: 3-1-1-X</td>
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<td></td>
<td></td>
<td>50g/$204.00</td>
</tr>
<tr>
<td>SIB1042.0 [1,2-BIS(2-(CHLORODIMETHYLSILYL)ETHYL)ETHYLENE]</td>
<td>215.27</td>
<td>198-9°</td>
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</tr>
<tr>
<td>[13528-93-3] TSCA HMIS: 3-2-1-X</td>
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<td></td>
<td>25g/$21.00</td>
</tr>
<tr>
<td>SIB1046.0 [1,6-BIS(2-(CHLORODIMETHYLSILYL)HEXANE, 95%]</td>
<td>271.38</td>
<td>113-6°/3</td>
<td>0.961</td>
<td>1.4538</td>
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<tr>
<td>[14799-66-7] HMIS: 3-1-1-X</td>
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<td>100g/$169.00</td>
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<tr>
<td>SIB1048.0 [1,8-BIS(2-(CHLORODIMETHYLSILYL)OCTANE, 95%]</td>
<td>299.43</td>
<td>106-7°/0.4</td>
<td>0.946</td>
<td>1.4540</td>
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<tr>
<td>[5089-28-1] HMIS: 3-1-1-X</td>
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<td>100g/$134.00</td>
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<tr>
<td>SIB1048.2 [1,3-BIS(2-(CHLORODIMETHYLSILYL)PROPANE]</td>
<td>229.30</td>
<td>94°/19</td>
<td>1.0244</td>
<td>1.4647</td>
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<tr>
<td>[2295-06-9] HMIS: 3-2-1-X</td>
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<tr>
<td>SIB1614.0 [BIS(METHYLDICHLOROSILYL)ETHANE]</td>
<td>256.11</td>
<td>208-210°</td>
<td>1.2628</td>
<td>1.4760</td>
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<tr>
<td>[3353-69-3] TSCA HMIS: 3-2-1-X</td>
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<td>100g/$100.00</td>
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<tr>
<td>SIB1615.0 [BIS(METHYLDIETHOXYSILYL)ETHANE]</td>
<td>294.54</td>
<td>80°/1.5</td>
<td>0.92</td>
<td>1.4170</td>
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<td>[18043-74-8] HMIS: 2-2-1-X</td>
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<td>25g/$62.00</td>
</tr>
<tr>
<td>SIB1630.0 [BIS(METHYLDIFLUOROSILYL)ETHANE]</td>
<td>190.29</td>
<td>114°</td>
<td>1.118</td>
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<td>[62987-03-3] HMIS: 3-2-1-X</td>
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<td>10g/$69.00</td>
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<td>SIB1808.0 [1,2-BIS(TRICHLOROSILYL)DECANE]</td>
<td>409.16</td>
<td>114°/1</td>
<td>1.2496</td>
<td>1.4754</td>
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<td>[62987-03-3] HMIS: 3-2-1-X</td>
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<td>25g/$85.00</td>
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</tbody>
</table>

**Cl(Cl(CH₃)₂SiCH₂CH₂Si(CH₃)₂Cl**

- Intermediate for sila-hydrocarbon polymers
- HYDROLYTIC SENSITIVITY: 8 reacts rapidly with moisture, water, protic solvents
- TSCA HMIS: 3-1-1-X
- 50g/$204.00

**Cl(CH₃)₂Si(CH₂)₈Si(CH₃)₂Cl**

- Intermediate for sila-hydrocarbon polymers
- HYDROLYTIC SENSITIVITY: 8 reacts rapidly with moisture, water, protic solvents
- TSCA HMIS: 3-1-1-X
- 100g/$134.00

**CH₂CH₂SiMe₂Cl → ClMe₂SiCH₂CH₂ → Cl(CH₃)₂SiCH₂CH₂Si(CH₃)₂Cl**

- HYDROLYTIC SENSITIVITY: 8 reacts rapidly with moisture, water, protic solvents
- TSCA HMIS: 3-1-1-X
- 100g/$100.00

**Cl(CH₃)₂SiCH₂CH₂Si(CH₃)₂Cl**

- HYDROLYTIC SENSITIVITY: 8 reacts rapidly with moisture, water, protic solvents
- TSCA HMIS: 3-1-1-X
- 100g/$169.00
<table>
<thead>
<tr>
<th>name</th>
<th>MW</th>
<th>bp/mm (mp)</th>
<th>$D_4^{29}$</th>
<th>$n_0^{20}$</th>
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<tbody>
<tr>
<td>SIB1811.5 1,8-BIS(TRICHLOROSILYLETHYL)HEXA- DECAFLUOROOCTANE</td>
<td>725.06</td>
<td>142-4°/0.6 (69-70°)mp</td>
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<tr>
<td>SIB1812.0 BIS(TRICHLOROSILYL)HEXANE</td>
<td>353.05</td>
<td>148-50°/10 1.327 1.4759</td>
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<tr>
<td>SIB1813.0 BIS(TRICHLOROSILYLMETHANE</td>
<td>282.9</td>
<td>183° 1.5567 1.4740</td>
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</tr>
<tr>
<td>SIB1814.0 BIS(TRICHLOROSILYLOCTANE</td>
<td>381.10</td>
<td>140°/1 1.22 1.4757</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SIB1815.0 1,3-BIS(TRICHLOROSILYL)PROPANE</td>
<td>310.97</td>
<td>115-7°/4 1.4394 1.4732</td>
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<td></td>
</tr>
<tr>
<td>SIB1815.4 BIS(TRICHLOROSILYLUDECYL)ETHER</td>
<td>593.48</td>
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<tr>
<td>SIB1816.6 1,4-BIS(TRIETHOXYSILYL)BENZENE</td>
<td>402.64</td>
<td>130-2°/0.4 1.015 1.4549</td>
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<td></td>
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<tr>
<td>SIB1817.0 BIS(TRIETHOXYSILYL)ETHANE</td>
<td>354.59</td>
<td>96°/0.3 0.957 1.4052</td>
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<tr>
<td>SIB1821.0 BIS(TRIETHOXYSILYL)METHANE</td>
<td>340.56</td>
<td>114-5°/3.5 0.9741 1.4098</td>
<td></td>
<td></td>
</tr>
<tr>
<td>name</td>
<td>MW</td>
<td>bp/mm (mp)</td>
<td>D$_4^{20}$</td>
<td>n$_o^{20}$</td>
</tr>
<tr>
<td>--------------------------------------------------</td>
<td>------</td>
<td>--------------</td>
<td>------------</td>
<td>------------</td>
</tr>
<tr>
<td>BIS(TRIETHOXYSYL)OCTANE (C$_2$H$_5$O)$_3$Si(CH$_2$)$_3$Si(OCH$_3$)$_3$</td>
<td>438.76</td>
<td>172-5/0.75</td>
<td>0.926</td>
<td>1.4240</td>
</tr>
<tr>
<td>[52217-60-4] TSCA</td>
<td>HMIS: 2-1-1-X</td>
<td>25g/$30.00</td>
<td>100g/$98.00</td>
<td></td>
</tr>
<tr>
<td>1,2-BIS(TRIETHOXYSYL)DECANE (C$<em>6$H$</em>{12}$O)$_3$Si$_2$</td>
<td>382.65</td>
<td>130-2/0.4</td>
<td>0.984</td>
<td>1.4303</td>
</tr>
<tr>
<td>pendant dipodal silane; employed in high pH HPLC HYDROLYTIC SENSITIVITY: 7 Si-OR reacts slowly with water/moisture</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HMIS: 3-2-1-X</td>
<td>25g/$35.00</td>
<td>100g/$165.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BIS(TRIMETHOXYSYL)ETHANE (C$<em>8$H$</em>{20}$O)$_3$Si$_2$</td>
<td>270.43</td>
<td>103-5/5</td>
<td>1.068</td>
<td>1.4091</td>
</tr>
<tr>
<td>flashpoint: 65° (149°F)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>employed in fabrication of multilayer printed circuit boards see also SIB1817.0 HYDROLYTIC SENSITIVITY: 7 Si-OR reacts slowly with water/moisture</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>[18406-41-2] TSCA</td>
<td>HMIS: 4-2-1-X</td>
<td>25g/$51.00</td>
<td>100g/$208.00</td>
<td></td>
</tr>
<tr>
<td>BIS(TRIMETHOXYSYL)LITHYLMETHYL)BENZENE (C$<em>{16}$H$</em>{34}$O)$_3$Si$_2$</td>
<td>346.53</td>
<td>124-5/0.05</td>
<td>1.097</td>
<td>1.4705</td>
</tr>
<tr>
<td>mixed isomers flashpoint: 193°C (380°F)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HYDROLYTIC SENSITIVITY: 7 Si-OR reacts slowly with water/moisture</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>[193358-40-6] TSCA</td>
<td>HMIS: 3-1-1-X</td>
<td>10g/$180.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BIS-1,3-(TRIMETHOXYSYMETHYL)PROPYL)BENZENE (C$<em>{18}$H$</em>{34}$O)$_3$Si$_2$</td>
<td>402.64</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HYDROLYTIC SENSITIVITY: 7 Si-OR reacts slowly with water/moisture</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>[18418-54-7] TSCA</td>
<td>HMIS: 3-2-1-X</td>
<td>25g/$40.00</td>
<td>100g/$130.00</td>
<td>2kg/$840.00</td>
</tr>
<tr>
<td>1-[TRIETHOXYSYL]-2-[DIETHOXYMETHYL]SILY)ETHANE (C$<em>{10}$H$</em>{26}$O)$_3$Si</td>
<td>324.56</td>
<td>100/0.5</td>
<td>0.946</td>
<td>1.4112</td>
</tr>
<tr>
<td>flashpoint: 102°C (215°F)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>dipodal silane; forms abrasion-resistant sol-gel coatings HYDROLYTIC SENSITIVITY: 7 reacts slowly with water/moisture</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>[18418-54-7] TSCA</td>
<td>HMIS: 3-2-1-X</td>
<td>25g/$40.00</td>
<td>100g/$130.00</td>
<td>2kg/$840.00</td>
</tr>
</tbody>
</table>
Polymeric Hydrophobic Silanes

Polymeric Surface Bonding

<table>
<thead>
<tr>
<th>Molecular Specific Code</th>
<th>Viscosity</th>
<th>Weight</th>
<th>Gravity</th>
<th>Price/100g</th>
<th>Price/1kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>DMS-K05</td>
<td>3 - 6</td>
<td>425-600</td>
<td>1.00</td>
<td>$55.00</td>
<td>$358.00</td>
</tr>
<tr>
<td>DMS-K13</td>
<td>20-50</td>
<td>2000-4000</td>
<td>0.99</td>
<td>$120.00</td>
<td></td>
</tr>
<tr>
<td>DMS-K26</td>
<td>500-800</td>
<td>15,000-20,000</td>
<td>0.99</td>
<td>$94.00</td>
<td></td>
</tr>
</tbody>
</table>

Dimethylamino Terminated Polydimethylsiloxanes

<table>
<thead>
<tr>
<th>Molecular Specific Code</th>
<th>Viscosity</th>
<th>Weight</th>
<th>Gravity</th>
<th>Price/100g</th>
<th>Price/1kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>DMS-N05</td>
<td>3 - 8</td>
<td>450-600</td>
<td>0.93</td>
<td>$160.00</td>
<td></td>
</tr>
</tbody>
</table>

Ethoxy Terminated Polydimethylsiloxanes

<table>
<thead>
<tr>
<th>Molecular Specific Code</th>
<th>Viscosity</th>
<th>Weight</th>
<th>Gravity</th>
<th>Price/100g</th>
<th>Price/1kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>DMS-XE11</td>
<td>5-10</td>
<td>800-900</td>
<td>0.94</td>
<td>$32.00</td>
<td>$210.00</td>
</tr>
</tbody>
</table>

Methoxy Terminated Polydimethylsiloxanes

<table>
<thead>
<tr>
<th>Molecular Specific Code</th>
<th>Viscosity</th>
<th>Weight</th>
<th>Gravity</th>
<th>Price/100g</th>
<th>Price/1kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>DMS-XM11</td>
<td>5-12</td>
<td>900-1000</td>
<td>0.94</td>
<td>$29.00</td>
<td>$188.00</td>
</tr>
</tbody>
</table>

Silanol Terminated Polydimethylsiloxanes

<table>
<thead>
<tr>
<th>Molecular Specific Code</th>
<th>Viscosity</th>
<th>% (OH)</th>
<th>(OH) - Eq/kg</th>
<th>Specific Gravity</th>
<th>Refractive Index</th>
<th>Price/100g</th>
<th>Price/3kg</th>
<th>Price/16kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>DMS-S12</td>
<td>16-32</td>
<td>4.5-7.5</td>
<td>2.3-3.5</td>
<td>0.95</td>
<td>1.401</td>
<td>$19.00</td>
<td>$124.00</td>
<td>$496.00</td>
</tr>
<tr>
<td>DMS-S14</td>
<td>35-45</td>
<td>3.0-4.0</td>
<td>1.7-2.3</td>
<td>0.96</td>
<td>1.402</td>
<td>$18.00</td>
<td>$117.00</td>
<td>$460.00</td>
</tr>
<tr>
<td>DMS-S15</td>
<td>45-85</td>
<td>0.9-1.2</td>
<td>0.53-0.70</td>
<td>0.96</td>
<td>1.402</td>
<td>$18.00</td>
<td>$117.00</td>
<td>$460.00</td>
</tr>
</tbody>
</table>
# Hydrophilic Silane Properties

## Polar - Non-hydrogen Bonding

<table>
<thead>
<tr>
<th>Name</th>
<th>MW</th>
<th>bp/mm (mp)</th>
<th>$D_4^{20}$</th>
<th>$n_0^{20}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIS(3-CYANOPROPYL)DIMETHOXYSilane</td>
<td>226.35</td>
<td>180-2°/1</td>
<td>0.985</td>
<td></td>
</tr>
<tr>
<td>BIS[(3-METHYLDIMETHOXYSILYL)PROPYL]-POLYPROPYLENE OXIDE</td>
<td>600-800</td>
<td>-</td>
<td>1.452</td>
<td></td>
</tr>
<tr>
<td>1,3-[BIS(3-TRIETHOXYSILYL)POLYETHYLENOXY]-2-METHYLENEPROPANE</td>
<td>1113.5</td>
<td>-</td>
<td>1.104</td>
<td></td>
</tr>
<tr>
<td>(3-CYANOBUTYL)DIMETHYLCIROSILANE</td>
<td>175.73</td>
<td>80-4°/1</td>
<td>0.993</td>
<td></td>
</tr>
<tr>
<td>(3-CYANOBUTYL)METHYLDICHLOROSILANE</td>
<td>196.17</td>
<td>63°/0.3</td>
<td>1.104</td>
<td></td>
</tr>
<tr>
<td>(3-CYANOBUTYL)TRICHLOROSILANE</td>
<td>216.57</td>
<td>61-3°/0.2</td>
<td>1.220</td>
<td></td>
</tr>
<tr>
<td>2-CYANOETHYLTRICHLOROSILANE</td>
<td>188.52</td>
<td>84-6°/10</td>
<td>1.469</td>
<td></td>
</tr>
</tbody>
</table>

**HydrolYTIC Sensitivity:** 7 Si-OR reacts slowly with water/moisture.
<table>
<thead>
<tr>
<th>Name</th>
<th>MW</th>
<th>BP/MP (°C)</th>
<th>$D_4^{20}$</th>
<th>$n_0^{20}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>2-CYANOETHYLTRIETHOXYSILANE (SIC2445.0)</td>
<td>217.34</td>
<td>224-5°</td>
<td>0.9792</td>
<td>1.4140</td>
</tr>
<tr>
<td>2-CYANOETHYLTRIMETHOXYSILANE (SIC2446.0)</td>
<td>175.26</td>
<td>112°/15</td>
<td>1.079</td>
<td>1.4126</td>
</tr>
<tr>
<td>2-CYANOETHYLTRIMETHOXYSILANE (SIC2450.0)</td>
<td>161.71</td>
<td>108-9°/15</td>
<td>0.986</td>
<td>1.4460</td>
</tr>
<tr>
<td>3-CYANOETHYLTRIMETHOXYSILANE (SIC2454.0)</td>
<td>202.54</td>
<td>93-4°/8</td>
<td>1.302</td>
<td>1.465</td>
</tr>
<tr>
<td>3-CYANOETHYLTRIETHOXYSILANE (SIC2456.0)</td>
<td>189.29</td>
<td>90-2°/7</td>
<td>1.026</td>
<td>1.4167</td>
</tr>
</tbody>
</table>

**Formulae**

- **2-CYANOETHYLTRIETHOXYSILANE**
  - SIC2445.0
  - Name: 2-CYANOETHYLTRIETHOXYSILANE
  - MW: 217.34
  - BP: 112°/15
  - $D_4^{20}$: 0.9792
  - $n_0^{20}$: 1.4140
  - Hydrolytic Sensitivity: 7
  - Reacts slowly with water/moisture
  - Flashpoint: 86°C (186°F)

- **2-CYANOETHYLTRIMETHOXYSILANE**
  - SIC2446.0
  - Name: 2-CYANOETHYLTRIMETHOXYSILANE
  - MW: 175.26
  - BP: 112°/15
  - $D_4^{20}$: 1.079
  - $n_0^{20}$: 1.4126
  - Hydrolytic Sensitivity: 7
  - Reacts slowly with water/moisture
  - Flashpoint: 79°C (174°F)

- **3-CYANOETHYLTRIMETHOXYSILANE**
  - SIC2450.0
  - Name: 3-CYANOETHYLTRIMETHOXYSILANE
  - MW: 161.71
  - BP: 93-4°/8
  - $D_4^{20}$: 1.302
  - $n_0^{20}$: 1.465
  - Hydrolytic Sensitivity: 7
  - Reacts slowly with water/moisture
  - Flashpoint: 75°C (167°F)

- **3-CYANOETHYLTRIETHOXYSILANE**
  - SIC2454.0
  - Name: 3-CYANOETHYLTRIETHOXYSILANE
  - MW: 202.54
  - BP: 93-4°/8
  - $D_4^{20}$: 1.302
  - $n_0^{20}$: 1.465
  - Hydrolytic Sensitivity: 7
  - Reacts slowly with water/moisture
  - Flashpoint: 75°C (167°F)

- **3-CYANOETHYLTRIMETHOXYSILANE**
  - SIC2456.0
  - Name: 3-CYANOETHYLTRIMETHOXYSILANE
  - MW: 189.29
  - BP: 90-2°/7
  - $D_4^{20}$: 1.026
  - $n_0^{20}$: 1.4167
  - Hydrolytic Sensitivity: 7
  - Reacts slowly with water/moisture
  - Flashpoint: 74°C (165°F)

**Flashpoint**

- **Flashpoint**
  - 2-CYANOETHYLTRIETHOXYSILANE: 86°C (186°F)
  - 2-CYANOETHYLTRIMETHOXYSILANE: 79°C (174°F)
  - 3-CYANOETHYLTRIETHOXYSILANE: 75°C (167°F)
  - 3-CYANOETHYLTRIMETHOXYSILANE: 74°C (165°F)

**Toxicity**

- **Toxicity**
  - Oral, Rat, LD50: 5630mg/kg
  - Ventilation: Local exhaust
  - Handling: Avoid contact with skin and eyes
  - Storage: Store in a cool, dry place

**Hydrolytic Sensitivity**

- **Hydrolytic Sensitivity**
  - 7: Reacts slowly with water/moisture
  - 8: Reacts rapidly with water/moisture, protic solvents

**Crosslinker**

- **Crosslinker**
  - Moisture-cure silicone RTVs
## Hydrophilic Silane Properties

### Polar - Hydrogen Bonding

<table>
<thead>
<tr>
<th>name</th>
<th>MW</th>
<th>bp/mm (mp)</th>
<th>D$_{20}^{20}$</th>
<th>n$_{0}^{20}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACETAMIDOPROPYLTRIMETHOXYSILANE</td>
<td>221.33</td>
<td>162-5°/2-3</td>
<td>1.4410</td>
<td></td>
</tr>
<tr>
<td>C$<em>9$H$</em>{12}$NO$_2$Si</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>[57757-66-1] HMIS: 3-2-1-X</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| ACETOXYETHYLDIMETHYLCHLOROSILANE         | 180.71  | 108-9°/50  | 1.031$^{25}$  | 1.4301$^{25}$ |
| C$_8$H$_{13}$ClO$_2$Si                   |         |            |               |             |
| flashpoint: 63°C (145°F)                 |         |            |               |             |
| HYDROLYTIC SENSITIVITY: 8 reacts rapidly with moisture, water, protic solvents |
| [18306-45-1] TSCA HMIS: 3-2-1-X          |         |            |               |             |

| ACETOXYETHYLMETHYLDICHLOROSILANE         | 201.12  | 117°/62    | 1.177$^{25}$  | 1.4390$^{25}$ |
| C$_7$H$_{14}$ClO$_2$Si                   |         |            |               |             |
| flashpoint: 65°C (149°F)                 |         |            |               |             |
| HYDROLYTIC SENSITIVITY: 8 reacts rapidly with moisture, water, protic solvents |
| [18163-34-3] TSCA HMIS: 3-2-1-X          |         |            |               |             |

| ACETOXYETHYLTRICHLOROSILANE              | 221.54  | 143°/70    | 1.272$^{25}$  | 1.4427$^{25}$ |
| C$_7$H$_{14}$ClO$_2$Si                   |         |            |               |             |
| flashpoint: 82°C (180°F)                 |         |            |               |             |
| HYDROLYTIC SENSITIVITY: 8 reacts rapidly with moisture, water, protic solvents |
| [18204-80-3] TSCA HMIS: 3-2-1-X          |         |            |               |             |

| ACETOXYETHYLTRIETHOXYSILANE              | 250.35  | 60°/0.2    | 0.983         | 1.410       |
| C$_7$H$_{14}$O$_2$Si                     |         |            |               |             |
| >280° rearranges to acetoxytriethoxysilane w/ extrusion of ethylene |
| HYDROLYTIC SENSITIVITY: 7 Si-OR reacts slowly with water/moisture |
| [22538-45-0] HMIS: 2-2-1-X               |         |            |               |             |

| ACETOXYETHYLTRIMETHOXYSILANE, 95%        | 208.29  | 108-9°/27  | 1.061         |             |
| C$_7$H$_{15}$O$_2$Si                     |         |            |               |             |
| HYDROLYTIC SENSITIVITY: 7 Si-OR reacts slowly with water/moisture |
| [72878-39-6] HMIS: 3-3-1-X               |         |            |               |             |

| ACETOXYETHYLTRIETHOXYSILANE              | 190.27  | 66°/9°/7   | 1.0420        | 1.4388      |
| C$_7$H$_{15}$O$_2$Si                     |         |            |               |             |
| flashpoint: 63°C (145°F)                 |         |            |               |             |
| HYDROLYTIC SENSITIVITY: 7 Si-OR reacts slowly with water/moisture |
| [5833-57-8] HMIS: 3-2-1-X                |         |            |               |             |

| ACETOXYETHYLTRIMETHOXYSILANE             | 236.34  | 106°/15    | 1.042$^{25}$  | 1.4092      |
| C$_7$H$_{14}$O$_2$Si                     |         |            |               |             |
| HYDROLYTIC SENSITIVITY: 7 Si-OR reacts slowly with water/moisture |
| [5630-83-1] HMIS: 3-2-1-X                |         |            |               |             |

| ACETOXYETHYLTRIETHOXYSILANE, 95%        | 194.26  | 190-1°     | 1.085         |             |
| C$_7$H$_{15}$O$_2$Si                     |         |            |               |             |
| flashpoint: 56°C (133°F)                 |         |            |               |             |
| HYDROLYTIC SENSITIVITY: 7 Si-OR reacts slowly with water/moisture |
| [65625-39-0] TSCA-L HMIS: 3-3-1-X        |         |            |               |             |

| 2-[ACETOXY(POLYETHYLENEOXY)-PROPYL]TRIETHOXYSILANE 95% | 500-700 | 1.04       |             |             |

**Please inquire about bulk quantities**
SIA0090.0
ACETOXYPROPYLMETHYLDICHLOROSILANE
C₆H₁₂Cl₂O₂Si

HYDROLYTIC SENSITIVITY: 8; reacts rapidly with moisture, water, protic solvents

[S290-24-4] TSCA, HMIS: 3-2-1-X
25g/$58.00

SIA0100.0
ACETOXYPROPYLTRIMETHOXYSILANE
C₈H₁₈O₅Si

γ of treated surface: 37.5 dynes/cm

HMIS: 3-1-1-X
25g/$19.00

SIA0114.0
11-ACETOXYUNDECYLTRICHLOROSILANE
C₁₃H₂₅Cl₃O₂Si

flashpoint: >110°C (>230°F)

HMIS: 3-1-1-X
10g/$85.00

SIA0120.0
(N-ACETYLGlycyl)-3-AMINOPROPYLTRIMETHOXYSILANE
C₁₀H₂₁N₂O₆Si

amino acid-tipped silane

HMIS: 3-2-1-X
5.0g/$152.00

SIA0599.4
N-3-[(AMINO(POLYPROPYLENOXY)]AMINOPROPYLTRIMETHOXYSILANE
C₁₀H₂₂O₅Si

contains 30-35% amine terminated polypropylene oxide coupling agent with film-forming capability

HMIS: 2-2-1-X
25g/$76.00

SIB0959.0
BENZOXYPROPYLTRIMETHOXYSILANE
C₁₃H₂₀O₅Si

HYDROLYTIC SENSITIVITY: 7; Si-OR reacts slowly with water/moisture

HMIS: 3-2-1-X
25g/$62.00

SIB1815.1
1,3-BIS(3-TRICHLOROSILYLPROPoxy)-2-DECYLOXYPROPANE
C₁₉H₃₈O₂Cl₆Si₂

dipodal C₁₈ analog w/buried hydrophilicity

HMIS: 3-1-1-X
10g/$124.00

SIB1815.3
3,3-BIS(TRICHLOROSILYLPROPOXYMETHYL)-5-OKA-TRIDECANE
C₂₀H₄₀O₂Cl₆Si₂

dipodal hydrophobic surface treatment with buried hydrophilicity for chromatography

HMIS: 3-1-1-X
10g/$84.00

SIB1824.82
BIS[N,N’-(TRIETHOXYSILYLPROPyl)AMINO-CARBONYL]POLYETHYLENE OXIDE (10-15 EO)

dipodal hydrophilic silane

HMIS: 3-1-1-X
25g/$60.00

SIB1824.84
BIS(TRIETHOXYSILYLPROPyl)POLYETHYLENE OXIDE (25-30 EO)

HMIS: 2-1-1-X
25g/$104.00
<table>
<thead>
<tr>
<th>Name</th>
<th>MW</th>
<th>bp/mm (mp)</th>
<th>D&lt;sub&gt;4&lt;/sub&gt;</th>
<th>n&lt;sub&gt;0&lt;/sub&gt;</th>
<th>Comments</th>
</tr>
</thead>
</table>
| SIB1827.0                   | 484.40 |           |              |            | forms films on electrodes for determination of mercury.  
<table>
<thead>
<tr>
<th>Name</th>
<th>MW</th>
<th>bp/mm (mp)</th>
<th>$D_4^{20}$</th>
<th>$n_0^{20}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>SIM6491.5 Methoxyethoxyundecyltrichlorosilane</td>
<td>363.83</td>
<td>145-9°C/1.25</td>
<td>1.07</td>
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</tr>
<tr>
<td>CH$_3$OCH$_2$CH$_2$(CH$<em>2$)$</em>{11}$SiCl$_3$</td>
<td>forms self-assembled monolayers with “hydrophilic tips”</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hydrolytic Sensitivity: 8 reacts rapidly with moisture, water, protic solvents</td>
<td>HIMS: 3-2-1-X</td>
<td>5.0g/$76.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SIM6492.66 2-[Methoxy(polyethylenoxy)propyl]-trichlorosilane, 90%</td>
<td>472-604</td>
<td>(-8)°mp</td>
<td>1.076</td>
<td>1.403</td>
</tr>
<tr>
<td>CH$_3$O(CH$_2$)$_6$-9(CH$_2$)$_3$SiCl$_3$</td>
<td>forms hydrophilic surfaces provides protein antifouling surface$^1$</td>
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<tr>
<td>Hydrolytic Sensitivity: 7 Si-OR reacts slowly with water/moisture</td>
<td>[36493-41-1] HIMS: 2-1-1-X</td>
<td>10g/$76.00</td>
<td>100g/$247.00</td>
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<tr>
<td>SIM6492.7 2-[Methoxy(polyethylenoxy)propyl]-trimethoxysilane, 90%</td>
<td>460-590</td>
<td>flashpoint: 88°C (190°F)</td>
<td>1.09</td>
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</tr>
<tr>
<td>CH$_3$O(CH$_2$)$_6$-9(CH$_2$)$_3$Si(OCH$_3$)$_3$</td>
<td>viscosity: 29 cSt</td>
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<tr>
<td>Hydrolytic Sensitivity: 7 Si-OR reacts slowly with water/moisture</td>
<td>[65994-07-2] TSCA HIMS: 2-1-1-X</td>
<td>25g/$76.00</td>
<td>100g/$247.00</td>
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<tr>
<td>SIM6492.72 2-[Methoxy(polyethylenoxy)propyl]-trimethoxysilane, 90%</td>
<td>596-725</td>
<td>flashpoint: 88°C (190°F)</td>
<td>1.09</td>
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</tr>
<tr>
<td>CH$_3$O(CH$_2$)$_6$-12(CH$_2$)$_3$Si(OCH$_3$)$_3$</td>
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<tr>
<td>[65994-07-2] TSCA HIMS: 2-2-1-X</td>
<td>25g/$76.00</td>
<td>100g/$247.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CH$_3$OCH$_2$CH$_2$Si(OCH$_3$)$_3$</td>
<td>3-Methoxypropyltrimethoxysilane</td>
<td>194.30</td>
<td>98-9°C/40</td>
<td>0.995</td>
</tr>
<tr>
<td>[33580-59-5] HIMS: 3-2-1-X</td>
<td>25g/$34.00</td>
<td>100g/$110.00</td>
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<td></td>
</tr>
<tr>
<td>CH$_3$O(CH$_2$)$_3$-CH$_2$SiCl$_3$</td>
<td>Methoxytriethyleneoxypolyltrichlorosilane</td>
<td>339.71</td>
<td>140°C/0.2</td>
<td>1.163</td>
</tr>
<tr>
<td>C$<em>{10}$H$</em>{18}$O$_4$Si</td>
<td>flashpoint: 53°C (127°F)</td>
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<tr>
<td>[22870-00-7] HIMS: 3-2-1-X</td>
<td>10g/$122.00</td>
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<tr>
<td>CH$_3$O(CH$_2$)$_3$-CH$_2$SiCl$_3$</td>
<td>Methoxytriethyleneoxypolyltrimethoxysilane</td>
<td>326.46</td>
<td>148°C/0.3</td>
<td>1.034</td>
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<tr>
<td>C$<em>{13}$H$</em>{30}$O$_4$Si</td>
<td>forms polymeric proton-conducting electrolytes$^1$:</td>
<td></td>
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<tr>
<td>[132388-45-5] HIMS: 3-2-1-X</td>
<td>10g/$128.00</td>
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<td></td>
</tr>
<tr>
<td>CH$_3$OCH$_2$CH$_2$Si(OCH$_3$)$_3$</td>
<td>(2-Triethoxysilylpropoxy)ethoxy-sulfolane, 95%</td>
<td>384.56</td>
<td>190-4°C/0.4</td>
<td>1.122</td>
</tr>
<tr>
<td>C$<em>{15}$H$</em>{30}$O$_4$SSi</td>
<td>flashpoint: 102°C (216°F) viscosity: 325-350 cSt.</td>
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<tr>
<td>[50295-40-8] HIMS: 2-2-1-X</td>
<td>10g/$64.00</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>CH$_3$OCH$_2$CH$_2$Si(OCH$_3$)$_3$</td>
<td>(2-Tris(trimethoxysilylpropyl)isocyanurate, 95%</td>
<td>615.86</td>
<td>102°C (216°F)</td>
<td>1.170</td>
</tr>
<tr>
<td>C$<em>{21}$H$</em>{45}$N$<em>3$O$</em>{12}$Si$_3$</td>
<td>flashpoint: 104°C (220°F) viscosity: 350-550 cSt.</td>
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<tr>
<td>[26115-70-8] TSCA HIMS: 2-1-1-X</td>
<td>25g/$12.00</td>
<td>100g/$39.00</td>
<td>2.0kg/$380.00</td>
<td></td>
</tr>
</tbody>
</table>

$^1$ F. Cecchet et al., Langmuir, 22, 1173, 2006

$^1$ J. Ritchie et al., Chem. Mater., 18, 504, 2006

$^1$ J. Ritchie et al., Chem. Mater., 18, 504, 2006
## Hydrophilic Silane Properties

### Hydroxylic

<table>
<thead>
<tr>
<th>name</th>
<th>MW</th>
<th>bp/mm (mp)</th>
<th>D&lt;sub&gt;4&lt;/sub&gt;</th>
<th>n&lt;sub&gt;20&lt;/sub&gt;</th>
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<tbody>
<tr>
<td>SIB1140.0</td>
<td>309.48</td>
<td>0.92</td>
<td>1.409&lt;sup&gt;20&lt;/sup&gt;</td>
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<tr>
<td>BIS(2-HYDROXYETHYL)-3-AMINOPROPYL-</td>
<td></td>
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</tr>
<tr>
<td>TRIETHYOXYLSILANE, 62% in ethanol</td>
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<td></td>
<td></td>
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<tr>
<td>C&lt;sub&gt;13&lt;/sub&gt;H&lt;sub&gt;23&lt;/sub&gt;N&lt;sub&gt;2&lt;/sub&gt;O&lt;sub&gt;4&lt;/sub&gt;Si</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>contains 2-3% hydroxyethylaminopropyltriethoxyisilane</td>
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<tr>
<td>urethane polymer coupling agent</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>employed in surface modification for</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>preparation of oligonucleotide arrays&lt;sup&gt;1&lt;/sup&gt;</td>
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<tr>
<td>HYDROLYTIC SENSITIVITY: 7</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Si-OR reacts slowly with water/moisture</td>
<td></td>
<td></td>
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<tr>
<td>[7538-44-5] TSCA HMIS: 3-4-0-X 25g/$30.00 100g/$98.00</td>
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<tr>
<td>SIB1142.0</td>
<td>472.73</td>
<td>0.985</td>
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<tr>
<td>N,N'-BIS(HYDROXYETHYL)-N,N'-BIS-</td>
<td></td>
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</tr>
<tr>
<td>(TRIMETHOXYSIYLPROPYL)ETHYLENEDIAMINE</td>
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</tr>
<tr>
<td>C&lt;sub&gt;18&lt;/sub&gt;H&lt;sub&gt;40&lt;/sub&gt;N&lt;sub&gt;2&lt;/sub&gt;O&lt;sub&gt;8&lt;/sub&gt;Si&lt;sub&gt;2&lt;/sub&gt;</td>
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<tr>
<td>for solid state synthesis of oligonucleotides</td>
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<tr>
<td>for solid state synthesis of oligonucleotides</td>
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<tr>
<td>HYDROLYTIC SENSITIVITY: 7</td>
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<tr>
<td>Si-OR reacts slowly with water/moisture</td>
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<tr>
<td>[214362-07-9] HMIS: 2-4-1-X 25g/$66.00</td>
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<tr>
<td>SIB1824.2</td>
<td>542.86</td>
<td>0.899</td>
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<tr>
<td>2,2-BIS(3-TRIETHOXYSIYLPROPYL)</td>
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<tr>
<td>METHYL)BUTANOL, 50% in ethanol</td>
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<td></td>
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<tr>
<td>C&lt;sub&gt;24&lt;/sub&gt;H&lt;sub&gt;54&lt;/sub&gt;O&lt;sub&gt;9&lt;/sub&gt;Si&lt;sub&gt;2&lt;/sub&gt;</td>
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<tr>
<td>for solid state synthesis of oligonucleotides</td>
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<tr>
<td>HYDROLYTIC SENSITIVITY: 7</td>
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<tr>
<td>Si-OR reacts slowly with water/moisture</td>
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<tr>
<td>[186543-03-3] HMIS: 2-4-1-X 25g/$136.00</td>
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<tr>
<td>SIB1824.4</td>
<td>500-550</td>
<td>0.889</td>
<td>1.401</td>
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<tr>
<td>N-[HYDROXY(POLYETHYLENEOXY)PROPYL]-</td>
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<tr>
<td>TRIETHYOXYLSILANE, (6-12 EO) 50% in ethanol</td>
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<tr>
<td>C&lt;sub&gt;10&lt;/sub&gt;H&lt;sub&gt;22&lt;/sub&gt;N&lt;sub&gt;2&lt;/sub&gt;O&lt;sub&gt;4&lt;/sub&gt;SiO(CH&lt;sub&gt;2&lt;/sub&gt;CH&lt;sub&gt;2&lt;/sub&gt;O)&lt;sub&gt;6-9&lt;/sub&gt;-6H</td>
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</tr>
<tr>
<td>contains some bis(urethane) analog</td>
<td></td>
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<tr>
<td>hydrophilic surface modifier</td>
<td></td>
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<tr>
<td>stabilizes Si&lt;sub&gt;3&lt;/sub&gt;N&lt;sub&gt;4&lt;/sub&gt; aqueous colloids&lt;sup&gt;1&lt;/sup&gt;</td>
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<tr>
<td>HYDROLYTIC SENSITIVITY: 7</td>
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<td></td>
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<tr>
<td>Si-OR reacts slowly with water/moisture</td>
<td></td>
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<td></td>
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<tr>
<td>[74695-91-3] HMIS: 2-1-1-X 25g/$16.00 100g/$52.00 2kg/$728.00</td>
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</table>

#### References

## Hydrophilic Silane Properties

### Ionic-Charge Inducible

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<tr>
<th>Name</th>
<th>MW</th>
<th>bp/mm (mp)</th>
<th>D&lt;sub&gt;4&lt;/sub&gt;</th>
<th>n&lt;sub&gt;o&lt;/sub&gt;</th>
<th>CAS Number</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>SIB0957.0</td>
<td>348.25</td>
<td>9°C (48°F)</td>
<td>1.4104</td>
<td>0.942</td>
<td>62398-80-9</td>
<td>(2-N-BENZYLAMINOETHYL)-3-AMINOPROPYLTRIMETHoxySILANE, hydrochloride 50% in methanol</td>
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<tr>
<td>SIB1835.0</td>
<td>355.58</td>
<td>106°C (223°F)</td>
<td>1.4300</td>
<td>1.023</td>
<td>31024-70-1</td>
<td>BIS(3-TRIMETHOXYSILYLPROPYL)-N-METHYLAMINE</td>
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<tr>
<td>SIC2263.0</td>
<td>196.14</td>
<td>12-12.5</td>
<td>1.17</td>
<td></td>
<td></td>
<td>CARBOXYETHYLSILANETRIOL, SODIUM 25% in water</td>
</tr>
<tr>
<td>SIC2415.0</td>
<td>338.11</td>
<td>50% in methylene chloride</td>
<td>1.37</td>
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<td></td>
<td>2-(4-CHLOROSULFONYLPHENYL)ETHYLTRICHLOROSILANE, 50% in methylene chloride</td>
</tr>
<tr>
<td>SIC2415.4</td>
<td>338.11</td>
<td>50% in toluene</td>
<td>1.08</td>
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<td>2-(4-CHLOROSULFONYLPHENYL)ETHYLTRICHLOROSILANE, 50% in toluene</td>
</tr>
<tr>
<td>SIC2417.0</td>
<td>324.85</td>
<td>50% in methylene chloride</td>
<td>1.30</td>
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<td>2-(4-CHLOROSULFONYLPHENYL)ETHYLTRIMETHOXYSILANE, 50% in methylene chloride</td>
</tr>
<tr>
<td>SID3392.0</td>
<td>510.32</td>
<td>13°C (55°F)</td>
<td>1.4085</td>
<td>0.863</td>
<td>68959-20-6</td>
<td>N,N-DIDECYL-N-METHYL-N-(3-TRIMETHOXYSILYLPROPYL)AMMONIUM CHLORIDE, 42% in methanol</td>
</tr>
<tr>
<td>SID3395.4</td>
<td>249.43</td>
<td>74-6°/3</td>
<td>1.41425</td>
<td>0.9336</td>
<td></td>
<td>DIETHYLMETHYLTRIETHOXYSILANE</td>
</tr>
</tbody>
</table>

### Solid Phase Extraction (SPE) columns with benzenesulfonic acid functionalized silica are utilized to analyze urine samples for amino acids and drugs of abuse.

**ClSO<sub>2</sub>CH<sub>2</sub>CH<sub>2</sub>Si(OCH<sub>3</sub>)<sub>3</sub>**

- Solid Phase Extraction (SPE) columns with benzenesulfonic acid functionalized silica are utilized to analyze urine samples for amino acids and drugs of abuse.

**ClSO<sub>2</sub>CH<sub>2</sub>CH<sub>2</sub>Si(OCH<sub>3</sub>)<sub>3</sub>**

3. treated silica acts as etherification catalyst;
4. treatment of surface oxidized PMDSO supports electroosmotic flow;
5. N,N-DIDECYL-N-METHYL-N-(3-TRIMETHOXYSILYLPROPYL)AMMONIUM CHLORIDE, 42% in methanol; amber color
6. HYDROLYTIC SENSITIVITY: 7 Si-OR reacts slowly with water/moisture
7. HYDROLYTIC SENSITIVITY: 7 Si-OR reacts slowly with water/moisture
8. HYDROLYTIC SENSITIVITY: 7 Si-OR reacts slowly with water/moisture
9. HYDROLYTIC SENSITIVITY: 7 Si-OR reacts slowly with water/moisture
10. HYDROLYTIC SENSITIVITY: 7 Si-OR reacts slowly with water/moisture
11. HYDROLYTIC SENSITIVITY: 7 Si-OR reacts slowly with water/moisture
12. HYDROLYTIC SENSITIVITY: 7 Si-OR reacts slowly with water/moisture
13. HYDROLYTIC SENSITIVITY: 7 Si-OR reacts slowly with water/moisture
<table>
<thead>
<tr>
<th>name</th>
<th>MW</th>
<th>bp/mm (mp)</th>
<th>$D_4^{20}$</th>
<th>$n_0^{20}$</th>
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</thead>
<tbody>
<tr>
<td>SID3396.0</td>
<td>235.40</td>
<td>120°/20</td>
<td>0.934</td>
<td>1.423</td>
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<td>(N,N-DIETHYL-3-AMINOPROPYL)TRI-METHOXYSILANE</td>
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<td>flashpoint: 100°C (212°F)</td>
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<tr>
<td>HYDROLYTIC SENSITIVITY: 7 Si-OR reacts slowly with water/moisture</td>
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</tr>
<tr>
<td>[41051-80-3] TSCA</td>
<td>HMIS: 2-2-1-X</td>
<td>25g/$62.00</td>
<td>100g/$202.00</td>
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</tr>
<tr>
<td>SIO6620.0</td>
<td>496.29</td>
<td>0.89</td>
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<tr>
<td>OCTADECYLDIMETHYL(3-TRIMETHOXYSILYL-PROPYL)AMMONIUM CHLORIDE, 60% in methanol</td>
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<tr>
<td>C_{36}H_{85}ClNO_3Si</td>
<td>contains 3-5% Cl(CH_2)_{12}Si(OMe)_3</td>
<td>flashpoint: 15°C (59°F)</td>
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<td></td>
</tr>
<tr>
<td>employed as lubricant/anti-static surface treatment</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>orients liquid crystals</td>
<td></td>
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</tr>
<tr>
<td>dispersion/coupling agent for high density magnetic recording media</td>
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</tr>
<tr>
<td>HYDROLYTIC SENSITIVITY: 7 Si-OR reacts slowly with water/moisture</td>
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<tr>
<td>[27668-52-6] TSCA</td>
<td>HMIS: 3-4-0-X</td>
<td>25g/$18.00</td>
<td>2kg/$280.00</td>
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<tr>
<td>SIP6926.2</td>
<td>301.48</td>
<td>156-7°/0.25</td>
<td>1.089</td>
<td>1.498</td>
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<td>2-(2-PYRIDYLETHYL)THIOPROPYLTRI-METHOXYSILANE</td>
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<tr>
<td>C_{13}H_{23}NO_3Si</td>
<td>chelates metal ions</td>
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<td>[29398-72-4] HMIS: 3-2-1-X</td>
<td>10g/$118.00</td>
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<td>SIP6926.4</td>
<td>301.48</td>
<td>160-2°/0.2</td>
<td>1.09</td>
<td>1.5037</td>
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<tr>
<td>2-(4-PYRIDYLETHYL)THIOPROPYLTRI-METHOXYSILANE</td>
<td></td>
<td>pKa: 4.8</td>
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<tr>
<td>C_{13}H_{23}NO_3Si</td>
<td>immobileizable ligand for immunoglobulin IgG separation using hydrophobic charge induction chromatography (HCIC)</td>
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<tr>
<td>[198567-47-4] HMIS: 3-2-1-X</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SIP8939.0</td>
<td>269.43</td>
<td>105°/0.9</td>
<td>1.00</td>
<td>1.4624^{24}</td>
</tr>
<tr>
<td>2-(4-PYRIDYLETHYL)TRIETHOXYSILANE</td>
<td></td>
<td>amber liquid</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C_{13}H_{23}NO_3Si</td>
<td>see also SIT8396.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HYDROLYTIC SENSITIVITY: 7 Si-OR reacts slowly with water/moisture</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>[98299-74-2] HMIS: 3-2-1-X</td>
<td>10g/$119.00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SIT8157.0</td>
<td>240.59</td>
<td>280°-decomposes</td>
<td>0.93</td>
<td></td>
</tr>
<tr>
<td>2-[TRICHLOROSILYL]ETHYL]PYRIDINE</td>
<td></td>
<td>(207°)mp</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C_{7}H_{8}Cl_3NSi</td>
<td>fuming solid, moisture sensitive</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HYDROLYTIC SENSITIVITY: 8 reacts rapidly with moisture, water, protic solvents</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>[17082-69-8] TSCA</td>
<td>HMIS: 3-2-1-X</td>
<td>25g/$45.00</td>
<td>100g/$146.00</td>
<td></td>
</tr>
<tr>
<td>SIT8158.0</td>
<td>240.59</td>
<td>flashpoint: 4°C (39°F)</td>
<td>0.93</td>
<td></td>
</tr>
<tr>
<td>4-[TRICHLOROSILYL]ETHYLPYRIDINE, 15-20% in toluene</td>
<td></td>
<td>hazy liquid; extremely moisture sensitive</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C_{7}H_{8}Cl_3NSi</td>
<td>see also SIT8396.0 2-(TRIMETHOXYSILYLETHYL)PYRIDINE</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>employed in polypyridine self-assembled monolayers^{1}.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HYDROLYTIC SENSITIVITY: 8 reacts rapidly with moisture, water, protic solvents</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>[17082-70-1] TSCA</td>
<td>HMIS: 3-4-1-X</td>
<td>25g/$29.00</td>
<td>100g/$96.00</td>
<td></td>
</tr>
<tr>
<td>Name</td>
<td>MW</td>
<td>bp/mm (mp)</td>
<td>D&lt;sub&gt;4&lt;/sub&gt;</td>
<td>n&lt;sub&gt;0&lt;/sub&gt;</td>
</tr>
<tr>
<td>------</td>
<td>-----</td>
<td>------------</td>
<td>-------------</td>
<td>------------</td>
</tr>
<tr>
<td>SIT8378.3</td>
<td>3-(TRIHYDROXYSILYL)-1-PROPANE-SULFONIC ACID</td>
<td>202.26</td>
<td>(-62°)</td>
<td>1.12</td>
</tr>
<tr>
<td>SIT8378.5</td>
<td>N-TRIMETHOXYSILYLBENZYL-N,N,N-TRIMETHYLAMMONIUM CHLORIDE</td>
<td>265.43</td>
<td>114-8°/2</td>
<td>1.030</td>
</tr>
<tr>
<td>SIT8402.0</td>
<td>N-TRIMETHOXYSILYLPYRIDINE</td>
<td>428.52</td>
<td>0.92</td>
<td></td>
</tr>
<tr>
<td>SIT8405.0</td>
<td>N-TRIMETHOXYSILYLPYRIDINE</td>
<td>227.33</td>
<td>105°/0.3</td>
<td>1.06</td>
</tr>
<tr>
<td>SIT8405.0</td>
<td>N-TRIMETHOXYSILYLPYRIDINE</td>
<td>265.43</td>
<td>114-8°/2</td>
<td>1.030</td>
</tr>
<tr>
<td>SIT8412.0</td>
<td>N-TRIMETHOXYSILYLBENZYL-N,N,N-TRIMETHYLAMMONIUM BROMIDE</td>
<td>428.52</td>
<td>0.92</td>
<td></td>
</tr>
</tbody>
</table>
**Polymeric Hydrophilic Silanes**

**Polymeric Amine**

<table>
<thead>
<tr>
<th>Name</th>
<th>MW</th>
<th>bp/mm (mp)</th>
<th>$D_{20}$</th>
<th>$n_o^{20}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>SIT8414.0</td>
<td>384.08</td>
<td>flashpoint: $11^\circ$C ($52^\circ$F)</td>
<td>0.88</td>
<td></td>
</tr>
<tr>
<td>N-TRIMETHOXYDILYPROPYL-N,N,N-TRI-n-BUTYLAMMONIUM CHLORIDE, 50% in methanol</td>
<td>contains 3-5% chloropropyltrimethoxysilane and Bu$_3$NH+Cl$^-$</td>
<td>HYDROLYTIC SENSITIVITY: 7 reacts slowly with water/moisture</td>
<td>25g/$81.00</td>
<td></td>
</tr>
</tbody>
</table>

| SIT8415.0 | 257.83 | flashpoint: $16^\circ$C ($61^\circ$F) | 0.927 | 1.3966 |
| N-TRIMETHOXYDILYPROPYL-N,N,N-TRIMETHYLMAMMONIUM CHLORIDE, 50% in methanol | employed for bonded chromatographic phases | anti-static agent | used to treat glass substrates employed in electroblotting | see also SIT8395.0 | HYDROLYTIC SENSITIVITY: 7 reacts slowly with water/moisture | 25g/$18.00 | 2.0kg/$390.00 |

---

**Water-borne Aminoalkyl Silsesquioxane Oligomers**

<table>
<thead>
<tr>
<th>Code</th>
<th>Functional Group</th>
<th>Mole %</th>
<th>Molecular Weight</th>
<th>Weight % in solution</th>
<th>Specific Gravity</th>
<th>Viscosity</th>
<th>pH</th>
<th>Price/100g</th>
<th>3kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>WSA-7011</td>
<td>Aminopropyl</td>
<td>65-75</td>
<td>250-500</td>
<td>25-28</td>
<td>1.10</td>
<td>5-15</td>
<td>10-10.5</td>
<td>$29.00</td>
<td>$435.00</td>
</tr>
<tr>
<td>WSA-9911</td>
<td>Aminopropyl</td>
<td>100</td>
<td>270-550</td>
<td>22-25</td>
<td>1.06</td>
<td>5-15</td>
<td>10-10.5</td>
<td>$24.00</td>
<td>$360.00</td>
</tr>
<tr>
<td>WSA-7021</td>
<td>Aminoethylaminopropyl</td>
<td>65-75</td>
<td>370-650</td>
<td>25-28</td>
<td>1.10</td>
<td>5-10</td>
<td>10-11</td>
<td>$29.00</td>
<td>$435.00</td>
</tr>
<tr>
<td>WSAV-651</td>
<td>Aminopropyl, vinyl</td>
<td>60-65</td>
<td>250-500</td>
<td>25-28</td>
<td>1.11</td>
<td>3-10</td>
<td>10-11</td>
<td>$35.00</td>
<td>$480.00</td>
</tr>
</tbody>
</table>

---

### Epoxy Functional Silanes - Trialkoxy

<table>
<thead>
<tr>
<th>Chemical Formula</th>
<th>Molecular Weight</th>
<th>TSCA Code</th>
<th>HMIS</th>
<th>Flashpoint</th>
<th>Boiling Point</th>
<th>Density</th>
<th>Refractive Index</th>
<th>Viscosity</th>
<th>Specific Surface Area</th>
<th>Toxicity - Oral Rat, Lethal Dose (mg/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SIE4668.0</td>
<td>2-(3,4-EPOXYCYCLOHEXYL)ETHYL-TRIETHOXYSILANE</td>
<td>C₁₄H₂₈O₄Si</td>
<td>[10217-34-2]</td>
<td>288.46</td>
<td>114-7°/0.4</td>
<td>1.015</td>
<td>1.4455</td>
<td></td>
<td></td>
<td>flashpoint: 104°C (220°F)</td>
</tr>
<tr>
<td>SIE4670.0</td>
<td>2-(3,4-EPOXYCYCLOHEXYL)ETHYL-TRIMETHOXYSILANE</td>
<td>C₁₁H₂₂O₄Si</td>
<td>viscosity: 5.2 cSt</td>
<td>coefficient of thermal expansion: 0.8 x 10⁻³</td>
<td>vapor pressure, 152°: 10mm</td>
<td>ring epoxide more reactive than glycidoxypropyl systems.</td>
<td></td>
<td></td>
<td></td>
<td>toxicity - oral rat, LD₅₀: 12,300mg/kg</td>
</tr>
<tr>
<td>SIE4675.0</td>
<td>5,6-EPOXYHEXYLTRIETHOXYSILANE</td>
<td>C₁₂H₂₆O₄Si</td>
<td>flashpoint: 99°C (210°F)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Epoxy Functional Silanes - Dialkoxy

<table>
<thead>
<tr>
<th>Chemical Formula</th>
<th>Molecular Weight</th>
<th>TSCA Code</th>
<th>HMIS</th>
<th>Flashpoint</th>
<th>Boiling Point</th>
<th>Density</th>
<th>Refractive Index</th>
<th>Viscosity</th>
<th>Toxicity - Oral Rat, Lethal Dose (mg/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SIG5840.0</td>
<td>(3-GLYCIDOXYPROPYL)TRIMETHOXYSILANE</td>
<td>C₁₁H₂₄O₄Si</td>
<td>[2530-83-8]</td>
<td>236.34</td>
<td>120°/2</td>
<td>1.070</td>
<td>1.4290</td>
<td>viscosity: 3.0 cSt</td>
<td></td>
</tr>
<tr>
<td>SIG5839.0</td>
<td>(3-GLYCIDOXYPROPYL)TRIETHOXYSILANE</td>
<td>C₁₀H₂₂O₄Si</td>
<td>[2602-34-8]</td>
<td>278.4</td>
<td>124°/3</td>
<td>1.00</td>
<td>1.425</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SIG5832.0</td>
<td>(3-GLYCIDOXYPROPYL)METHYLDIETHOXY-SILANE</td>
<td>C₁₁H₂₄O₃Si</td>
<td>[2897-60-1]</td>
<td>248.39</td>
<td>122°/5</td>
<td>0.978</td>
<td>1.431</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SIG5836.0</td>
<td>(3-GLYCIDOXYPROPYL)METHYLDIMETHOXY-SILANE</td>
<td>C₁₀H₂₀O₃Si</td>
<td>[65799-47-5]</td>
<td>220.34</td>
<td>100°/4</td>
<td>1.02</td>
<td>1.431</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Epoxy Functional Silanes - Monoalkoxy

<table>
<thead>
<tr>
<th>Chemical Formula</th>
<th>Molecular Weight</th>
<th>TSCA Code</th>
<th>HMIS</th>
<th>Flashpoint</th>
<th>Boiling Point</th>
<th>Density</th>
<th>Refractive Index</th>
<th>Toxicity - Oral Rat, Lethal Dose (mg/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SIG5825.0</td>
<td>(3-GLYCIDOXYPROPYL)DIMETHYLETHOXY-SILANE</td>
<td>C₁₀H₂₀O₃Si</td>
<td>[17963-04-1]</td>
<td>218.37</td>
<td>100°/3</td>
<td>0.950</td>
<td>1.4337</td>
<td></td>
</tr>
</tbody>
</table>

Aqueous exposure of treated surfaces converts Epoxy-Silanes to Hydrophilic-Diols.
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 with appropriate caution.

<table>
<thead>
<tr>
<th>Name</th>
<th>MW</th>
<th>bp/mm (mp)</th>
<th>D₄²₀</th>
<th>n₀²₀</th>
</tr>
</thead>
<tbody>
<tr>
<td>DODECYLSILANE</td>
<td>200.44</td>
<td>80°/7</td>
<td>0.7753</td>
<td>1.4380²⁰</td>
</tr>
<tr>
<td>C₁₂H₂₈Si</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>forms SAMS on gold surfaces</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>872-19-5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DODECYLSILANE</td>
<td>200.44</td>
<td>80°/7</td>
<td>0.7753</td>
<td>1.4380²⁰</td>
</tr>
<tr>
<td>n-OCTADECYLSILANE</td>
<td>284.60</td>
<td>195°/15</td>
<td>0.794</td>
<td></td>
</tr>
<tr>
<td>C₁₈H₃₆Si</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>forms self-assembled monolayers on titanium¹</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Name</th>
<th>MW</th>
<th>bp/mm (mp)</th>
<th>D₄²₀</th>
<th>n₀²₀</th>
</tr>
</thead>
<tbody>
<tr>
<td>HYDROOCTYL)SILANE</td>
<td>378.22</td>
<td>75°/251.446</td>
<td>1.3184</td>
<td></td>
</tr>
<tr>
<td>C₈H₇F₁₃Si</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>provides vapor-phase hydrophobic surfaces on titanium, gold, silicon</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>[469904-32-3]</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10-UNDECENYL SILANE</td>
<td>184.40</td>
<td>0.78</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C₁₁H₂₄Si</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HMIS: 2-3-1-X</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

MethylHydrosiloxane homopolymers are used as water-proofing agents, reducing agents and as components in some foamed silicone systems.

<table>
<thead>
<tr>
<th>Name</th>
<th>MW</th>
<th>bp/mm (mp)</th>
<th>D₄²₀</th>
<th>n₀²₀</th>
</tr>
</thead>
<tbody>
<tr>
<td>PolyMethylHydrosiloxanes, Trimethylsiloxy terminated</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tg: -119°</td>
<td>V.T.C: 0.50</td>
<td>CAS: 63148-57-2</td>
<td>TSCA</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Code</th>
<th>Viscosity</th>
<th>Molecular Weight</th>
<th>Mole % (MeHSiO)</th>
<th>Equivalent Weight</th>
<th>Specific Gravity</th>
<th>Refractive Index</th>
<th>Price/100g</th>
<th>Price/3 kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>HMS-991</td>
<td>15-25</td>
<td>1400-1800</td>
<td>100</td>
<td>67</td>
<td>0.98</td>
<td>1.395</td>
<td>$14.00</td>
<td>$96.00</td>
</tr>
<tr>
<td>HMS-992</td>
<td>25-35</td>
<td>1800-2100</td>
<td>100</td>
<td>65</td>
<td>0.99</td>
<td>1.396</td>
<td>$19.00</td>
<td>$134.00</td>
</tr>
<tr>
<td>HMS-993</td>
<td>35-45</td>
<td>2100-2400</td>
<td>100</td>
<td>64</td>
<td>0.99</td>
<td>1.396</td>
<td>$24.00</td>
<td>$168.00</td>
</tr>
</tbody>
</table>
Surface Modification with Silanes:  What’s not covered in “Hydrophobicity, Hydrophilicity and Silane Surface Modification”?

Silanes which are expected to form covalent bonds after deposition onto surfaces are discussed in the Gelest brochure entitled “Silane Coupling Agents: Connecting Across Boundaries”.

Aminosilanes which are important in some hydrophilic surface treatments are covered in detail.

Further Reading

Silane Coupling Agents - General References and Proceedings

Substrate Chemistry - General References and Proceedings

Hydrophobicity & Hydrophilicity

Product Information

<table>
<thead>
<tr>
<th>Product Code</th>
<th>Product Name</th>
<th>Molecular Weight</th>
<th>Boiling Point/mm (Melting Point)</th>
<th>Refractive Index</th>
<th>Specific Gravity</th>
<th>Other Physical Properties</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>SIA0588.0 (AMINOETHYLAMINOMETHYL)PHENETHYL-298.46</td>
<td>126-30°/0.2</td>
<td>1.02 1.5083</td>
<td>flashpoint: &gt; 110°C (&gt;230°F)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TRIMETHOXYSILANE, 90% mixed m,p isomers</td>
<td>C₁₄H₉₂N₂O₃Si</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>coupling agent for polyimides</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>photochemically sensitive (194nm) self-assembled monolayers</td>
<td></td>
</tr>
<tr>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

Indicates Product listed in TSCA Inventory (L = Low Volume Exemption; S = Significant New Use Restriction)
Cover background photo:
Fluoroalkylsilane treated multi-color red granite is both hydrophobic and oleophobic.

The Stenocara beetle, an African desert species, harvests water that adsorbs on superhydrophilic bumps on its back, then transfers droplets into superhydrophobic channels that lead to its mouth.