

Product Information

Organofunctional Silanes

DOW CORNING

Dow Corning® Z-6040 Silane

FEATURES

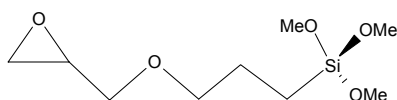
- Epoxy reactivity
- Methoxysilyl inorganic reactivity

BENEFITS

- Improves adhesion
- Increases composite strength properties
- Increased composite wet and dry tensile strength and modulus
- Increased composite wet and dry flexural strength and modulus
- Increased wet and dry compressive strength
- Better appearance
- Better filler wet-out and dispersion
- Lower viscosity of filled liquid resins
- Improved processability

COMPOSITION

- γ -Glycidoxypropyltrimethoxysilane



Coupling agent to improve adhesion of organic resins to inorganic surfaces

APPLICATIONS

- Used in a wide variety of surface treatment and coupling agent applications
- Used as an adhesion promoter for many types of resins
- Compatible with a broad range of resins and fillers

TYPICAL PROPERTIES

Specification Writers: These values are not intended for use in preparing specifications. Please contact your local Dow Corning sales office or your Global Dow Corning Connection before writing specifications on this product.

CTM*	Test	Unit	Result
0176	Appearance		Clear liquid
0005	Color	APHA	50
0004	Viscosity	cst	3
0001A	Specific gravity at 25°C (77°F)		1.07
0002	Refractive index		1.428
0021A	Flash point-closed cup	°C (°F)	>101 (>213)
0625B	Purity by GC	%	>98.5
0018	Chloride	ppm	<10
	Molecular weight	g/mol	236.34
	CAS #		2530-83-8

CTM*: Corporate Test Method, copies of CTM's are available on request.

DESCRIPTION

Dow Corning® Z-6040 Silane is a bifunctional silane containing a glycidoxy reactive organic group and a trimethoxysilyl inorganic group. It is designated γ -glycidoxypropyltrimethoxysilane. This glycidoxy functional silane is reactive with many different types of organic polymers. It is one of a series of organofunctional silanes from Dow Corning Corporation. Other reactive silanes include amines (Dow Corning® Z-6020 and Dow Corning® Z-6026 Silanes), vinyl-benzylamine (Dow Corning® Z-6032 Silane and Dow Corning® Z-6224 Silane), methacrylate (Dow Corning® Z-6030 Silane), vinyl (Dow Corning® Z-6300 Silane, Dow Corning® Z-6518 Silane) and chloropropyl (Dow Corning® Z-6076 Silane).

USES

Dow Corning® Z-6040 Silane possesses both organic and inorganic reactivity that allows it to react with or "couple" organic polymers and inorganic surface. This dual reactivity should be considered when using Dow Corning® Z-6040 Silane in specific applications.

Dow Corning® Z-6040 Silane is particularly recommended as:

- A treatment on glass fiber for use in reinforced plastics
- A treatment on mineral surfaces for use in mineral filled plastics
- An adhesion promoter to enhance the bonding of a polymer coating, paint or adhesive to glass, metals or other polymer surfaces.

For example, *Dow Corning*[®] Z-6040 Silane is used in the finish on fiberglass rovings. Uses include fiberglass reinforced epoxy resin composites with benefits such as improved physical properties, especially the wet strength, of the composite (see Table 1.).

Dow Corning[®] Z-6040 Silane is effective in improving the physical properties of a mineral-filled polymer such as silica-filled epoxy resins (see Table 2.).

Table 3 shows the effectiveness of *Dow Corning*[®] Z-6040 Silane in glass bead-reinforced polybutylene terephthalate.

Dow Corning[®] Z-6040 Silane is also recommended as an additive to improve the adhesion of acrylic latex caulks.

Other polymers that are receptive to *Dow Corning*[®] Z-6040 Silane are urethanes, acrylics, polysulfides and nylon.

HOW TO USE

Dow Corning[®] Z-6040 Silane can be applied to inorganic surfaces as a dilute aqueous solution (0.1 to 0.5% silane concentration). Aqueous solutions are prepared by adjusting the pH of the water to about 4.5 with acetic acid and then adding the silane and stirring. After adding the silane to the acidified water, it is necessary to stir the mixture for about 15 minutes before it hydrolyses and forms a clear homogeneous solution. Higher concentrations of *Dow Corning*[®] Z-6040 Silane in water are not stable indefinitely and after standing several days may deposit an oily phase of condensed polysiloxane. It is recommended that aqueous solutions of *Dow Corning*[®] Z-6040 Silane be used within 24 hours of preparation. Old solutions will begin to haze—an indication of a significant amount of siloxane condensation.

Dow Corning[®] Z-6040 Silane can also be applied as a solution in many common organic solvents. Solubility and stability of a specific organic solvent should, however, be verified before use in a commercial process.

In the case of mineral fillers, the mineral can be treated by mixing with the silane at very low shear for several minutes without any additional solvent. The silane can be diluted in water or a solvent as described above.

After applying the silane, the glass or mineral surface should be dried for 5 to 15 minutes at 104°C to 121°C (220°F to 250°F) to drive the condensation of silanol groups at the surface and to remove traces of methanol from hydrolysis of the methoxysilane. Optimum application and drying conditions such as time and temperature should be determined for each application prior to use in a commercial process.

For use as a primer, a typical formulation includes 49.5 parts of *Dow Corning*[®] Z-6040 Silane and 0.5 parts of an organic amine, such as benzyldimethylamine, (mixture A) are diluted with about 950 parts methanol, isopropanol or ether glycol. Alternatively, a prehydrolyzed primer may be prepared by adding 5 parts water and 1,000 parts of the above primer solution. In both cases, the primer solution is applied to a solid surface such as glass or metal, and a polymer is heat pressed or cured on the surface.

Dow Corning[®] Z-6040 Silane can be added directly to a resin system at 0.5 to 2.0 pph to promote unprimed adhesion.

Epoxy Reactivity

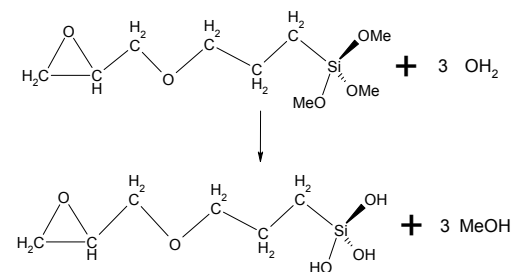
The epoxy group in *Dow Corning*[®] Z-6040 Silane has a reactivity similar to that of organic epoxides. That is, it will undergo ring-opening reactions with acids, amines, alcohols, thiols and other epoxides. The presence of acid or

basic catalysts facilitates this reactivity.

Trimethoxysilyl Reactivity

The trimethoxysilyl portion of *Dow Corning*[®] Z-6040 Silane undergoes the typical chemistry of alkoxy silanes. The methoxysilyl group is subject to hydrolysis in water or water/alcohol solutions.

The initial product of hydrolysis is a silanetriol:



Silanetriols are moderately stable at dilute concentrations in polar solvents such as water and alcohols.

Dispersions of *Dow Corning*[®] Z-6040 Silane are more stable and have more favorable orientation on siliceous surfaces if they are applied from a slightly acid solution. Silanol groups are capable of condensing with hydroxyl groups at the surface of glass and siliceous minerals as shown in Figure 1.

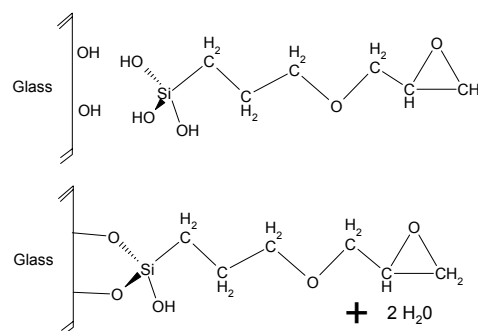


Figure 1

After condensing with the mineral surface, the remaining silanol groups are capable of hydrogen bonding or condensing with adjacent silanol groups. By this combination of covalent and hydrogen bonding, the coupling agent is bonded to the inorganic surface, and modifies it so that it is organoreactive.

HANDLING PRECAUTIONS

Product safety information required for safe use is not included. Before handling, read product and safety data sheets and container labels for safe use, physical and health hazard information. The material safety data sheet is available on the Dow Corning website at www.dowcorning.com. You can also obtain a copy from your local Dow Corning sales representative or Distributor or by calling your local Dow Corning Global Connection.

USABLE LIFE AND STORAGE

When stored at or below 25°C (77°F) in the original unopened containers, this product has a usable life of 36 months from the date of production.

After opening, *Dow Corning*[®] Z-6040 Silane should be protected from atmospheric moisture to prevent gelation.

PACKAGING

This product is available in pails, drums, and 500ml samples.

LIMITATIONS

This product is neither tested nor represented as suitable for medical or pharmaceutical uses.

HEALTH AND ENVIRONMENTAL INFORMATION

To support Customers in their product safety needs, Dow Corning has an extensive Product Stewardship organization and a team of Product Safety and Regulatory Compliance (PS&RC) specialists available in each area.

For further information, please see our website, www.dowcorning.com or consult your local Dow Corning representative.

LIMITED WARRANTY INFORMATION - PLEASE READ CAREFULLY

The information contained herein is offered in good faith and is believed to be accurate. However, because conditions and methods of use of our products are beyond our control, this information should not be used in substitution for customer's tests to ensure that Dow Corning's products are safe, effective, and fully satisfactory for the intended end use. Suggestions of use shall not be taken as inducements to infringe any patent.

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Your exclusive remedy for breach of such warranty is limited to refund of purchase price or replacement of any product shown to be other than as warranted.

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Table 1: Fiberglass reinforced epoxy laminates(1).

Fiberglass finish ²	Flexural Strength (psi)		Compressive Strength (psi)	
	Dry	Wet ³	Dry	Wet ³
None	88,000	65,000	55,000	23,000
0.2% <i>Dow Corning</i> [®] Z-6040 Silane	94,400	85,400	62,000	61,000

¹14 ply 7781 fabric, 1/8 inch laminate using DER 330 and m-phenylenediamine.

²Aqueous solution concentration on an active silane basis, applied as a fiberglass finish.

³Specimen strength retention after 2 hours in boiling water.

Table 2: Silica reinforced epoxy resin(4).

1% Silane treatment	Flexural Strength (psi)		Volume Resistivity (ohm-cm)		Dissipation Factor x10 ²	
	Dry	Wet ⁵	Dry	Wet ⁵	Dry	Wet ⁵
None	18,800	14,900	2.2 x 10 ¹⁵	1.9 x 10 ¹²	0.0051	0.053
<i>Dow Corning</i> [®] Z-6040 Silane	22,400	18,500	1.1 x 10 ¹⁵	6.4 x 10 ¹⁴	0.0046	0.014

⁴100 parts DER 331 epoxy resin, 18 parts curing agent Z, 50 parts Malvern Minerals Novacite[®] 1250 (naturally occurring silica).

⁵After 4 hours immersion in boiling water.

Table 1: Glass bead(6) reinforced polybutylene terephthalate

35% (w/w) glass bead content	Flexural Strength (psi)		Flexural Modulus (psi)		Tensile Strength (psi)	
	Dry	Wet ⁷	Dry	Wet ⁷	Dry	Wet ⁷
Unfilled resin	12,900	13,000	3.14x10 ⁵	3.00x10 ⁵	7,300	7,300
Filled with untreated glass beads	10,800	10,100	5.83x10 ⁵	4.04x10 ⁵	5,600	4,800
0.25% <i>Dow Corning</i> [®] Z-6040 Silane	14,900	14,400	6.07x10 ⁵	5.38x10 ⁵	8,000	7,900

⁶Potters 3000 glass beads from Potters Industries, Inc.

⁷After 16 hours in 50°C (122°F) water.