

Silane Coupling Agents

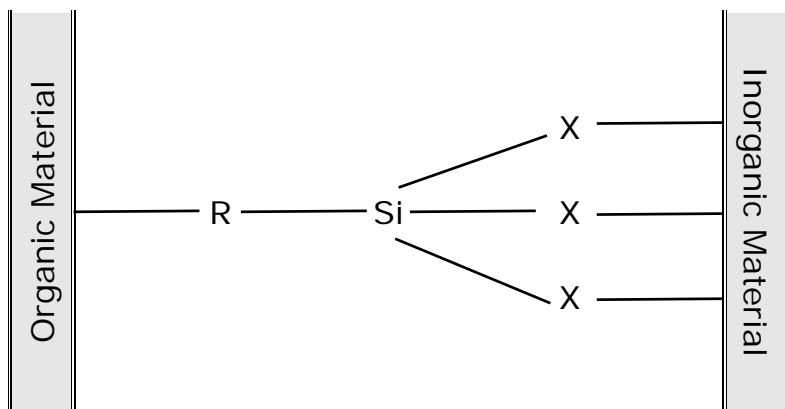


INDEX

<u>Introduction</u>	<u>3</u>
<u>Silane Characteristics</u>	<u>5</u>
<u>Amino Functional Silane Coupling Agents</u>	<u>6</u>
<u>Epoxy Functional Silane Coupling Agents</u>	<u>6</u>
<u>Vinyl Functional Silane Coupling Agents</u>	<u>6</u>
<u>Phenyl Functional Silane Coupling Agents</u>	<u>6</u>
<u>Additional Silane Coupling Agents</u>	<u>6</u>
<u>Contact Us</u>	<u>7</u>

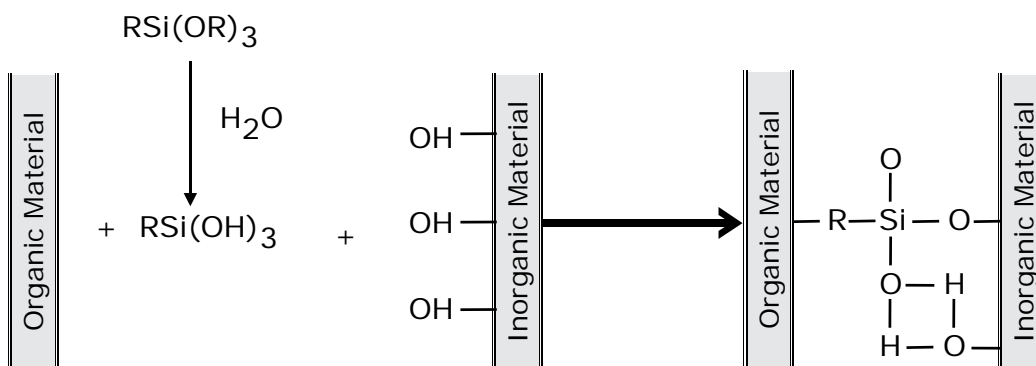
Introduction:

Silane coupling agents are generally illustrated:



Silicone (Si) is the center of the silane molecule which contains an inorganic functional group (R) [ex: vinyl, amino, chloro, epoxy, mercapto, etc.] with a (X) [ex: methoxy, ethoxy, etc.]. The functional group (R) will attach to an organic resin while the functional group (X) attaches to an inorganic material or substrate to achieve a "coupling" effect.

Silane coupling agents are predominantly used as mediators, binding organic materials to inorganic materials. As a result, silanes will improve the electrical and mechanical strength properties of materials in wet or dry conditions.



Silane coupling agents are primarily used in reinforced plastics and electric cables composed of crosslinked polyethylene. Other uses include resins, concrete, sealant primers, paint, adhesives, printing inks and dyeing auxiliaries.

The inorganic group (X) of the silane molecule will react to produce silanol, which forms a metal hydroxide or siloxane bond with the inorganic material. The organic group (R) of the silane molecule will react with the organic material to produce a covalent bond. As a result, the organic material and the inorganic material are tightly bound together after heating.

Treating Process of Aqueous Solutions of Silanes for Glass Fiber:

An aqueous solution of distilled or deionized water (or a mixed solution of water and alcohol) and 0.1% to 0.5% silane coupling agent is prepared. The glass fiber is dipped into the solution and dried at ambient temperature, followed by heating at 110°C to 120°C for 5 to 10 minutes.

Fillers: A filler which contains an excess of hydroxyl groups on the surface is especially effective.

- **Very Effective:** Silica, Alumina, Glass, Quartz or Aluminum silicate
- **Moderately Effective:** Talc, Hydrated Clay, Alumina or Iron Powder
- **Fairly Effective:** Asbestos, Titanium Dioxide or Zinc Oxide

1. Dry Process - the filler is treated by spraying an aqueous solution of silane followed by forced air or nitrogen to dry.
2. Wet Process - an aqueous solution of silane is added to a filler dispersed in water. Following agitation, the filler is allowed to precipitate by separation and drying.
3. Spray Process - an aqueous solution of silane is sprayed on the filler followed by heating. This process is simple and drying after application is unnecessary.

Silane Treating Process for Metal, Ceramic or Glass Substrates:

The substrate is treated with a mixed solution of 0.2% to 2.0% silane coupling agent and 98.0% to 99.8% diluent (water/alcohol mixture or hydrocarbon). The dilution could be applied by spray or immersion procedures, followed by drying at 120°C to 180°C for 2 to 5 minutes. An aqueous solution of silane is the most effective because the silane hydrolyzes to form silanol.

Calculating the Quantity of Silane Required:

The silicone molecule is preferably attached to the surface of the inorganic material as a primer to form a mono-layer. Applying the silane as a primer will produce optimum coupling results between the substrate and the resin to be applied. When used as a primer the required amount of silane can be calculated by the following:

The actual values may deviate from the calculated value depending on the surface condition of the filler or the silane treating process. The following values may be used as guidelines when the

$$\text{Amount of silane (g)} = \frac{\text{Amount of filler (g)} \times \text{Surface area (m}^2\text{/g)}}{\text{Minimum coating area of silane coupling agent (m}^2\text{/g)}}$$

value is unknown. A dilution of 1% silane to filler may be considered as standard. Generally 0.3% to 0.5% is recommended:

Surface area of filler (m²/g):

E-glass	0.1 - 0.12
Quartz	1 - 2
Kaolin	7
Clay	7
Talc	7
Aluminum polysilicate	1
Calcium carbonate	5
Calcium silicate	2.6

Reactivity:

The alkoxy groups of the coupling agents react with water to form silanol groups which immediately form covalent bonds by dehydration and condensation:



Silane Characteristics:

Product Name	Minimum Coverage Area (m ² /g)	Specific Gravity (@ 25°C)	Refractive Index (@ 25°C)
AP-Silane 21	515	0.97	1.391
AP-Silane 22	410	0.90	1.397
AP-Silane 30	315	0.94	1.398
AP-Silane 31	380	0.97	1.445
AP-Silane 32	351	1.02	1.445
AP-Silane 33	353	0.94	1.420
AP-Silane 33W	ND	1.068	ND
AP-Silane 51	330	1.07	1.427
AP-Silane 71	314	1.04	1.429
AP-Silane 81	398	1.06	1.440
AP-Silane 90			

Amino Functional Silane Coupling Agents:

Product Name	Chemical Name	Chemical Structure	Molecular Weight	Flash Point	Compatible Resins
AP-Silane-31	N-β(aminoethyl)-γ-aminopropyl-methyltrimethoxy silane	$\text{H}_2\text{NC}_2\text{H}_4\text{NHC}_3\text{H}_6\text{Si} \begin{array}{l} \diagup \text{CH}_3 \\ \text{---} \text{OCH}_3 \\ \diagdown \text{OCH}_3 \end{array}$	206.4	230°F	Epoxy Phenolic Melamine Furan
AP-Silane-32	N-β(aminoethyl)-γ-aminopropyl-trimethoxy silane	$\text{H}_2\text{NC}_2\text{H}_4\text{NHC}_3\text{H}_6\text{Si} \begin{array}{l} \diagup \text{OCH}_3 \\ \text{---} \text{OCH}_3 \\ \diagdown \text{OCH}_3 \end{array}$	222.4	262°F	Epoxy Phenolic Melamine
AP-Silane-33	γ-aminopropyl-triethoxy silane	$\text{H}_2\text{NC}_3\text{H}_6\text{Si} \begin{array}{l} \diagup \text{OC}_2\text{H}_5 \\ \text{---} \text{OC}_2\text{H}_5 \\ \diagdown \text{OC}_2\text{H}_5 \end{array}$	221.4	208°F	Nylon Phenolic Epoxy Melamine

Epoxy Functional Silane Coupling Agent:

Product Name	Chemical Name	Chemical Structure	Molecular Weight	Flash Point	Compatible Resins
AP-Silane-51	γ-glycidopropyl-trimethoxy silane	$\text{CH}_2 \begin{array}{l} \diagup \text{O} \\ \diagdown \end{array} \text{CHCH}_2\text{OC}_3\text{H}_6\text{Si} \begin{array}{l} \diagup \text{OCH}_3 \\ \text{---} \text{OCH}_3 \\ \diagdown \text{OCH}_3 \end{array}$	236.3	300°F	Epoxy Phenolic Melamine

Vinyl Functional Silane Coupling Agent:

Product Name	Chemical Name	Chemical Structure	Molecular Weight	Flash Point	Compatible Resins
AP-Silane-21	Vinyltrimethoxy silane	$\text{CH}_2=\text{CHSi} \begin{array}{l} \diagup \text{OCH}_3 \\ \text{---} \text{OCH}_3 \\ \diagdown \text{OCH}_3 \end{array}$	148.2	90°F	Crosslinking Polyethylene
AP-Silane-22	Vinyltriethoxy silane	$\text{CH}_2=\text{CHSi} \begin{array}{l} \diagup \text{OC}_2\text{H}_5 \\ \text{---} \text{OCH}_3 \\ \diagdown \text{OC}_2\text{H}_5 \end{array}$	190.3	138°F	Crosslinking Polyethylene

Additional Silane Coupling Agents:

Product Name	Chemical Name	Chemical Structure	Molecular Weight	Flash Point	Compatible Resins
AP-Silane-30	N-Propyl-trimethoxy silane	$\text{CH}_3\text{CH}_2\text{CH}_2\text{Si} \begin{array}{l} \diagup \text{CH}_3 \\ \text{---} \text{OCH}_3 \\ \diagdown \text{OCH}_3 \end{array}$	164.3	93°F	Fiberglass
AP-Silane-33W	Aminoalkyl silane	High solids aminoalkyl silane and silane oligomer in an aqueous solution.		Non-flammable	Phenolic, Acrylic, Melamine, Epoxy
AP-Silane-71	γ-Methacryloxy-propyl trimethoxy silane	$\text{CH}_2=\text{C} \begin{array}{l} \diagup \text{CH}_3 \\ \text{---} \text{C} \end{array} \begin{array}{l} \text{---} \text{O} \end{array} \text{---} \text{C}_3\text{H}_6\text{Si} \begin{array}{l} \diagup \text{OCH}_3 \\ \text{---} \text{OCH}_3 \\ \diagdown \text{OCH}_3 \end{array}$	248.4	257°F	Unsaturated polyester
AP-Silane-81	γ-Mercaptopropyl trimethoxy silane	$\text{HSC}_3\text{H}_6\text{Si} \begin{array}{l} \diagup \text{OCH}_3 \\ \text{---} \text{OCH}_3 \\ \diagdown \text{OCH}_3 \end{array}$	196.4	210°F	Rubber
AP-Silane-90	Methyltrimethoxy silane	$\text{CH}_3\text{Si} \begin{array}{l} \diagup \text{OCH}_3 \\ \text{---} \text{OCH}_3 \\ \diagdown \text{OCH}_3 \end{array}$	136.2	47°F	



400 Paterson Plank RD | Carlstadt, NJ 07072

Main: 201-933-0600 | FAX:201-964-8442

www.advpolymer.com

Let us put the API advantage to work for you!

Advanced Solutions

Advanced Polymer, Inc. has been a respected provider of a variety of technically innovative specialty chemicals for almost 40 years. We combine a wealth of experience with our R&D resources, and the responsiveness of our technical and customer services, to support our customers. We work closely with our customers to develop environmentally compliant products for a variety of applications across a range of industries .

You may also be interested in products for:

- Architectural Finishes
- Auto & Marine Care
- Lubricants
- Paints, Inks and Specialty Coatings
- Paper and Film
- Textiles and Leather Care

FOLLOW US ON 

[@advpolymer.com](https://twitter.com/advpolymer.com)



Become a Fan of Advanced Polymer, Inc.

All statements, technical information and recommendation contained herein are based on information we believe reliable, but the accuracy or completeness thereof is not guaranteed, and the following is made in lieu of all warranties, express or implied: Seller's and manufacturer's only obligation shall be to replace such quantity of the product proved to be defective. Neither seller nor manufacturer shall be liable for any injury, loss of damage, direct or consequential arising out of the use of or the inability to use the product. Before using, user is responsible to determine the suitability of the product for the user's intended application. The user assumes all risk and liability whatsoever in connection therewith. No statement or recommendation contained herein shall have any force or effect unless in an agreement signed by the officers of seller and manufacturer. Since the manufacturer of the products described in the product catalog has no means of controlling the final use of the product by the consumer for the user, it is the responsibility of the immediate purchaser and any intermediate seller or sellers to inform the user of the purposes for which the product may be fit and suitable and the properties of the product, including the precautionary measures, which must be taken in order to ensure the safety of the user and of other third persons and property. No statement made herein shall be taken as an authorization or inducement to practice any patented invention without appropriate license.