Gelest

Enabling Your Technology

SIVATE™ E610

Enhanced Amine Functional Silane

The benefits of enhanced silanes are:

- Performance extended to non-siliceous surfaces
- Improved corrosion resistance of metal substrates
- Superior film-forming properties in primer applications
- Higher bond strength in aggressive aqueous conditions
- Impart composites and primers with long-term durability in a wide range of environments

Applications Include:

- Adhesive primers for metallic and siliceous substrates
- Coupling agent for thermoset and thermoplastic composites
- Functional Micro-Particles for use in adhesives and sealants
- Corrosion inhibiting primer for paints and coatings on ferrous and non-ferrous substrates

SIVATE™ E610 can be used in coatings and composite applications where conventional silanes are unable to withstand environments in which water and moisture initiate and propagate failure. Enhanced silanes use a conventional silane as a base silane for organic reactivity and combine it with a compatible dipodal silane which stabilizes interfacial bonding. In many instances time to failure is extended 100x beyond controls. After as short a period of 24 hours at exposure to ambient moisture, composites formulated with enhanced silanes demonstrate tensile and flexural strengths superior to composites formulated with conventional silanes. The general mechanism for higher performance is the ability of enhanced silanes to form tightly cross-linked networks adjacent to substrates that are more hydrophobic than conventional silanes. In general, enhanced silanes replace conventional silanes on a 1:1 basis. Preferred deposition is 100% or as a solution in dry solvents such as ethanol or toluene. The cure is dependent on moisture adsorbed on the treated substrate or adsorption from the atmosphere.

Product Code: SIA0610.E1

Density: 0.948 g/mL
pH value: pH (1:1): ~ 11
Viscosity: 2.0 cSt.
Flashpoint: >91°C (>196°F)

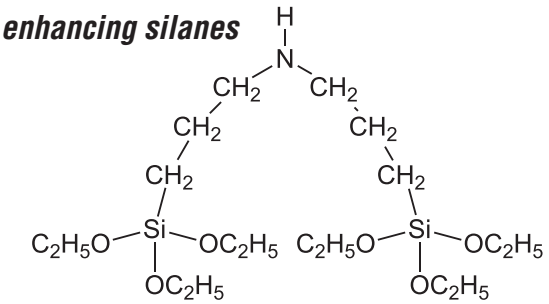
Availability:
2 kg bottles, 16 kg pails, 180 kg drums

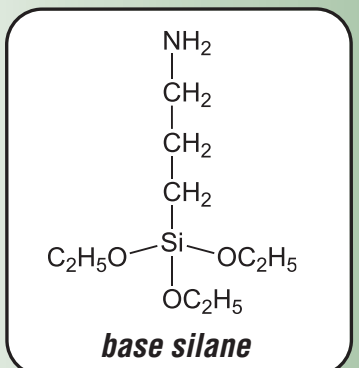
Compared to conventional silanes, SIVATE™ enhanced silanes:

- Improve mechanical properties
- Form coatings on a greater range of substrates
- Increase durability of coatings, primers and composites to long-term environmental exposure

Enhancement of silanes is effected by incorporation of functional and non-functional dipodal silanes. The dipodal silane combines with the functional silane to form a tight conformal network of siloxane bonds, reduces water adsorption at the interface and, most importantly, forms multiple oxane bonds with the substrate. In comparison with conventional silanes, which potentially bond form 3 oxane bonds to the substrate, dipodal silanes can form up to 6 oxane bonds with the substrate. Theoretical studies suggest that the dipodal silanes could have up to 10^6x greater stability in aqueous environments than conventional silanes.

enhancing silanes

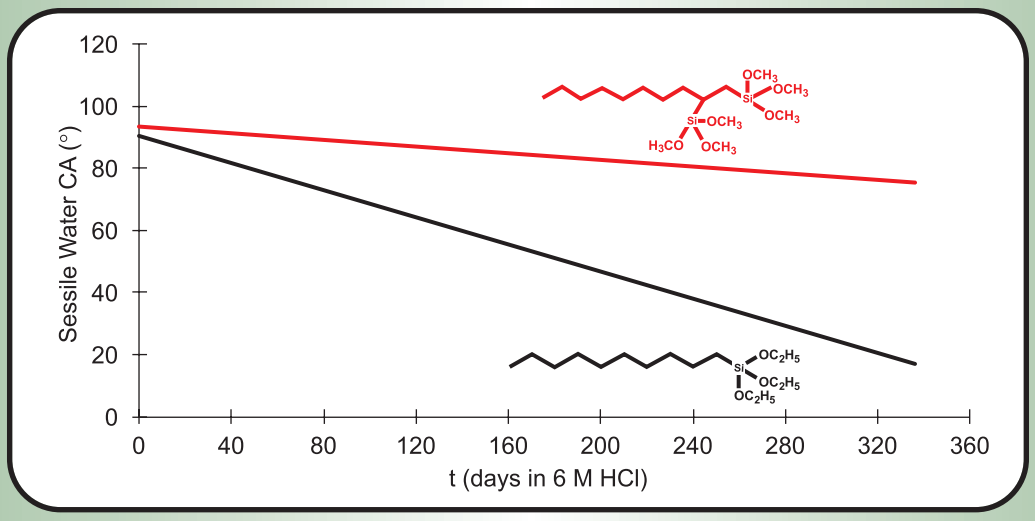




base silane

How do enhanced silanes work? (Mechanism and Chemistry)

The network and film-forming reaction of enhanced silane formulation is clearly demonstrated by observing the hydrolytic stability of films formed from the pure dipodal enhancing silane.



Non-functional dipodal silanes, are resistant to hydrolysis and form high integrity films on a variety of substrates, but by themselves lack the ability to bond with organic polymers in coatings, adhesives and composites. However, they significantly enhance the film integrity of base silanes that are responsible for bonding with organic polymers. The integrity, barrier and bonding properties of silanes are optimized by combining a base silane with both functional and non-functional dipodal silanes.

Barrier Properties (microporosity) of silanes on cold-rolled steel

As measured by Electrochemical Impedance Spectroscopy (EIS)

	R_p (ohm-cm^2)
Control	<1
SIA0610.0	2
SIVATE™ E610	20

Properties for 4-6% aqueous silane solutions applied and then cured at 150° for 4 hours forming coatings 80-120 nm thick. R*p* represents a polarization associated with electrolyte transport through pores.

While initial bond strengths of enhanced silanes are similar to the base silane ageing under high humidity conditions or in aqueous immersion, within 24 hours there is typically a significant increase in retention in properties.

70% Fused Silica Filled Epoxy Molding Compound (85°C/85% RH)

	0 hrs	5 hrs	24 hrs.	100hrs
Control	100%	45%	40%	40%
SIA0610.0	100%	88%	80%	77%
SIVATE™ E610	100%	96%	92%	90%

Flexural Strength – relative values

Thermoplastics in which there is little opportunity for covalent chemical bonding, but rely on polar interactions and/or hydrogen bonding show dramatic increases in mechanical properties.

30% Glass Fiber Reinforced Polysulfone

	As Molded	Conditioned 24h @55% RH
Control	13,700 psi	10,600 psi
SIA0591.0	18,600 psi	12,000 psi
SIVATE™ E591	18,400 psi	17,200 psi

Gelest, Inc.

headquartered in Morrisville, PA, is recognized worldwide as an innovator, manufacturer and supplier of commercial and research quantities of organosilicon, metal-organic compounds and silicones. Gelest serves advanced technology markets through a materials science-driven approach. The company provides focused technical development and application support for: semiconductors, medical materials, pharmaceutical synthesis, diagnostics and separation science, and specialty polymeric materials.

For additional information on Gelest's SIVATE™ Technology or to inquire on how we may assist in *Enabling Your Technology,* please contact:

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11 East Steel Rd.
Morrisville, PA 19067
Phone: 215-547-1015
Fax: 215-547-2484
www.gelest.com