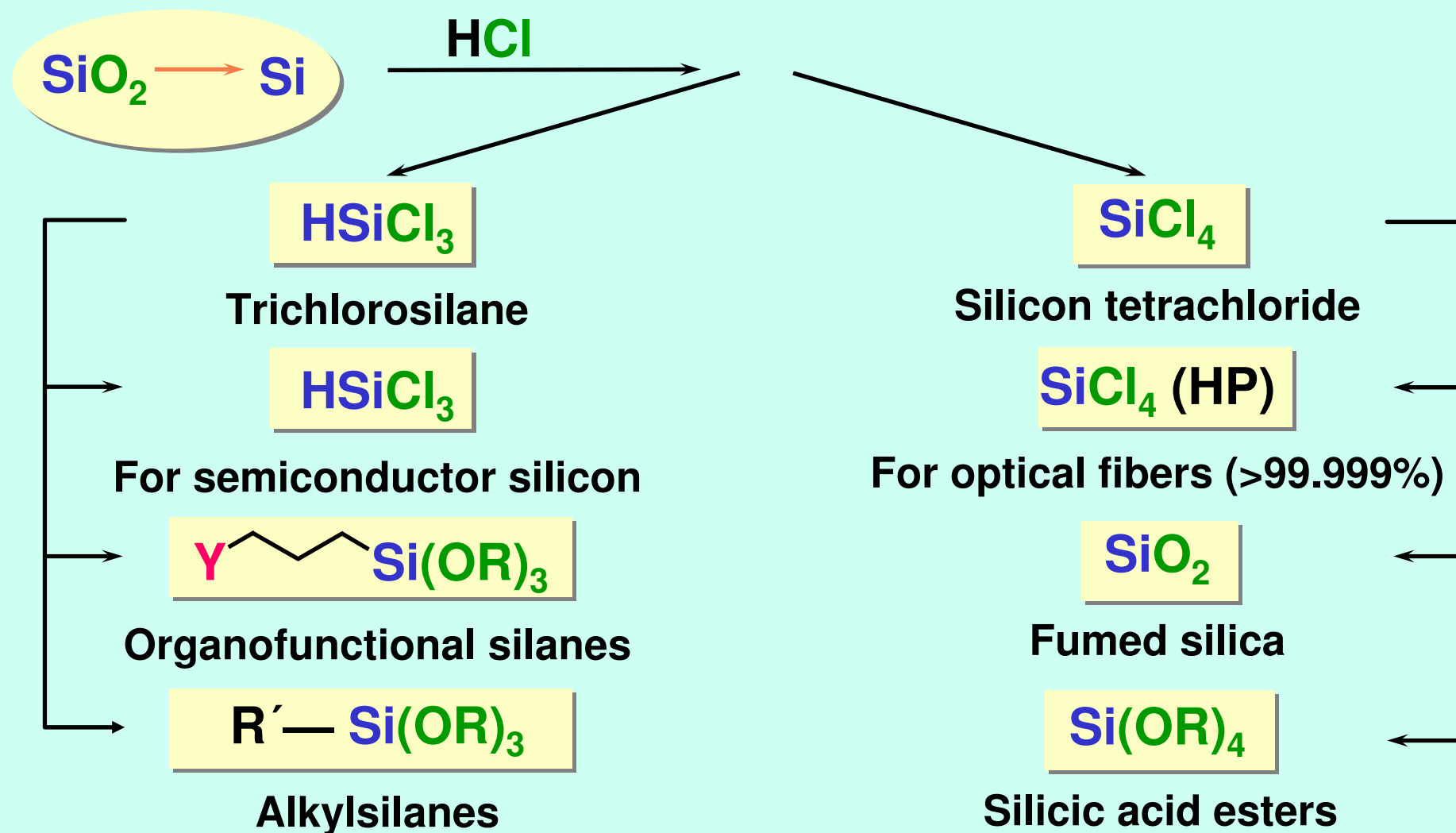


Introduction of Silane

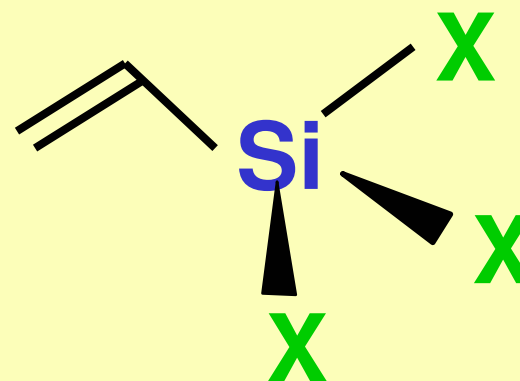
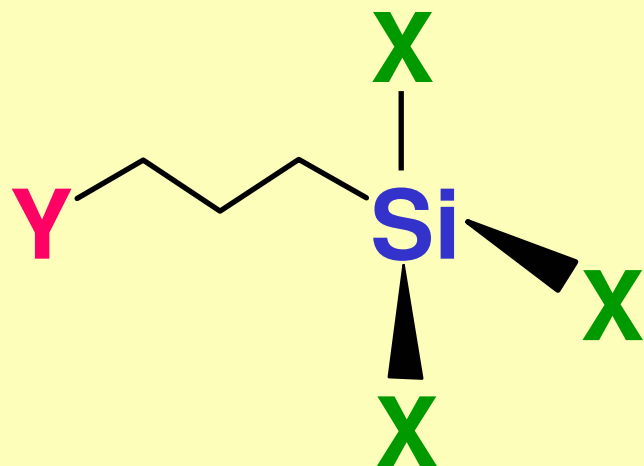
Silane is a chemical compound with chemical formula SiH_4 . It is the silicon analogue of methane. At room temperature, silane is a gas, and is pyrophoric — it undergoes spontaneous combustion in air without the need for external ignition. However, the difficulties in explaining the available (often contradictory) combustion data are ascribed to the fact that silane itself is stable and that the natural formation of larger silanes during production, as well as the sensitivity of combustion to impurities such as moisture and to the catalytic effects of container surfaces causes its pyrophoricity. Above 420°C , silane decomposes into silicon and hydrogen; it can therefore be used in the chemical vapor deposition of silicon.

Synthesis of Silicon Products



Reactivity of Organofunctional Silanes

Organoalkoxysilanes exhibit
a chemically bifunctional structure



Y = “Organofunctional” group
X = “Silicon-functional” group

STANDARD SILANES

Mercaptosilanes

Aminosilanes

Methacrylsilanes

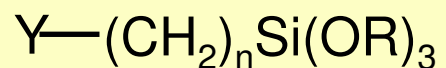
Alkylsilanes

Vinylsilanes

Epoxysilanes

Special Silanes

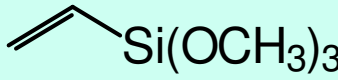
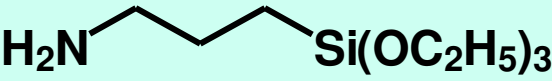
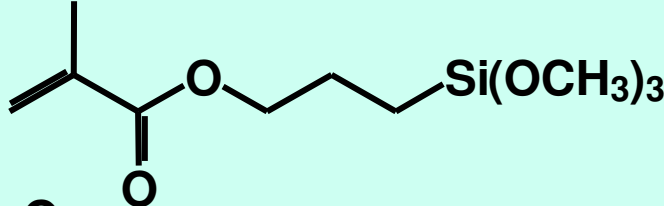
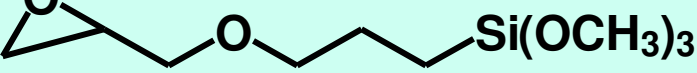
Structures of Organofunctional Silanes



$n = 0, 3$

$R = \text{CH}_3, \text{C}_2\text{H}_5, (\text{CH}_2)_2\text{OCH}_3$

$Y = \text{Organofunctional group}$

SHELAN®		Formula
VTMO	Vinyltrimethoxysilane	
AMEO	3-Aminopropyltriethoxysilane	
MEMO	3-Methacryloxypropyltrimethoxysilane	
GLYMO	3-Glycidyloxypropyltrimethoxysilane	

NEW DEVELOPMENTS

**Water-borne silanes
(DS HS 26xx, 27xx, 29xx)**

**Rheology modifier
(DS 4140)**

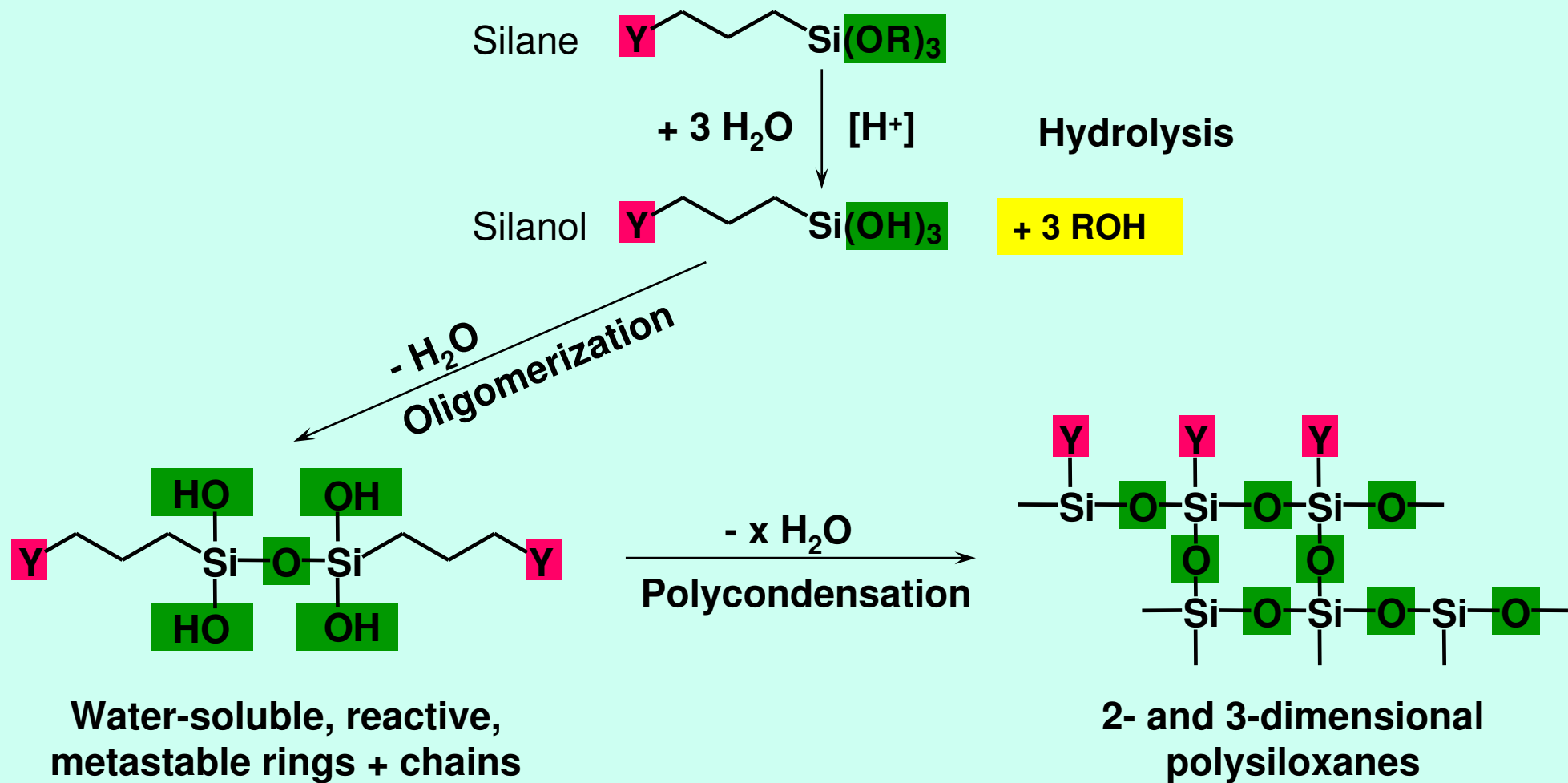
**Cationic aminosilane
(DS 1172)**

**Fluoroalkylsilanes
(DS F 8261, DS F 8800)**

Oligomeric Silanes

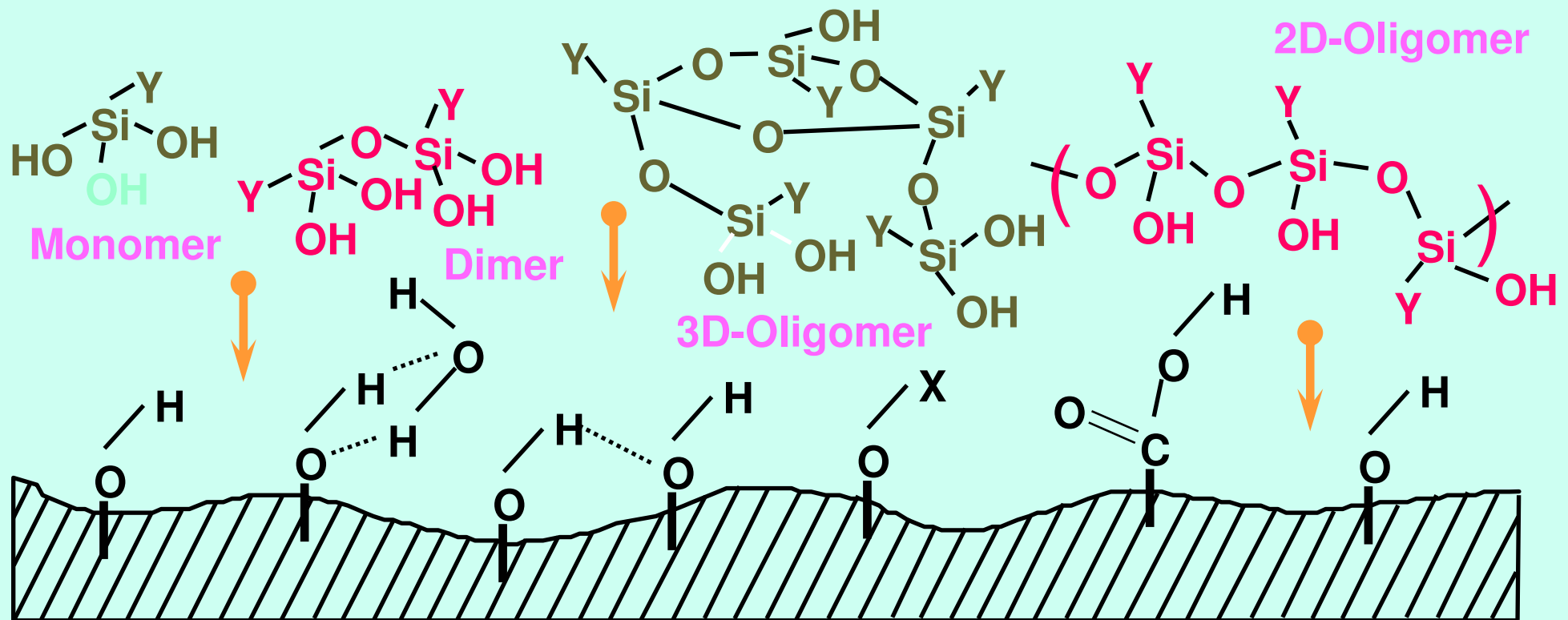
**Sec. aminosilanes
(DS 1189)**

Organosilane Condensation Process



The “Real World”

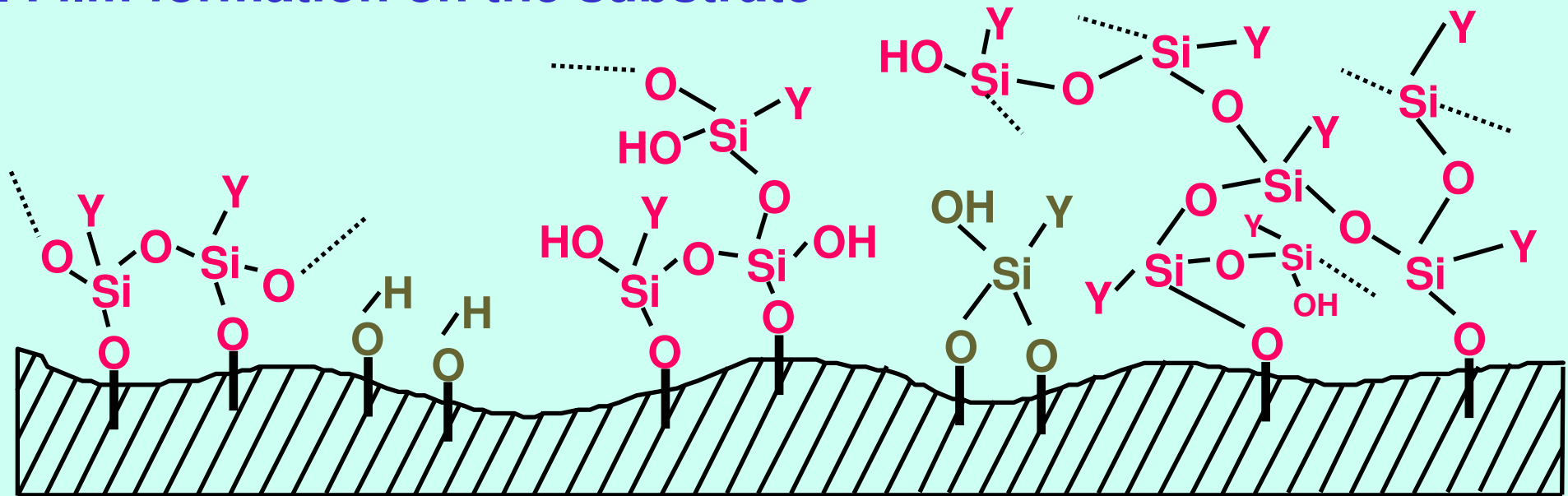
1. Hydrolysis / condensation
2. Diffusion: Solvent to surface



● Reactivity of Organofunctional Silanes

The “Real World”

3. Film formation on the substrate



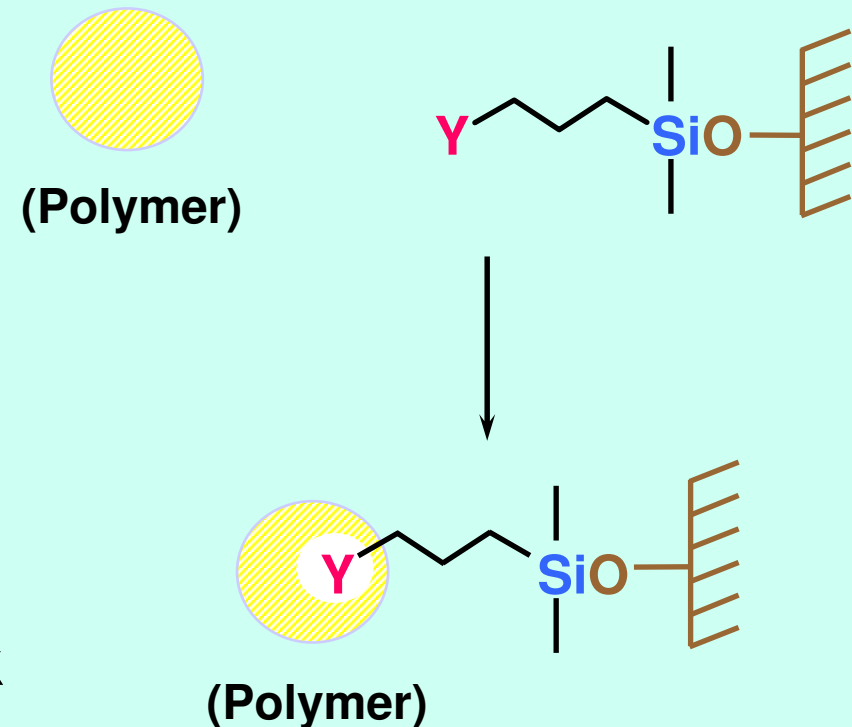
4. Optional: Contact to the polymer matrix

- Compatibility enhancement
- IPN - formation
- Reaction

Silane / Polymer Interaction

Mechanisms involved:

- Chemical bonding
- Hydrogen bonding
- Improved wetting
- Modifying of the crystallinity
- Acid/base interaction
- Interpenetrating polymer network



Alcohol evolved during silane deposition

Silane	Wt %	G/l
Aminopropyltriethoxysilane	62.4	590
Glycidoxypentyltrimethoxysilane	40.6	434
Mercaptopentyltrimethoxysilane	49	517
Vinyltrimethoxysilane	65	629

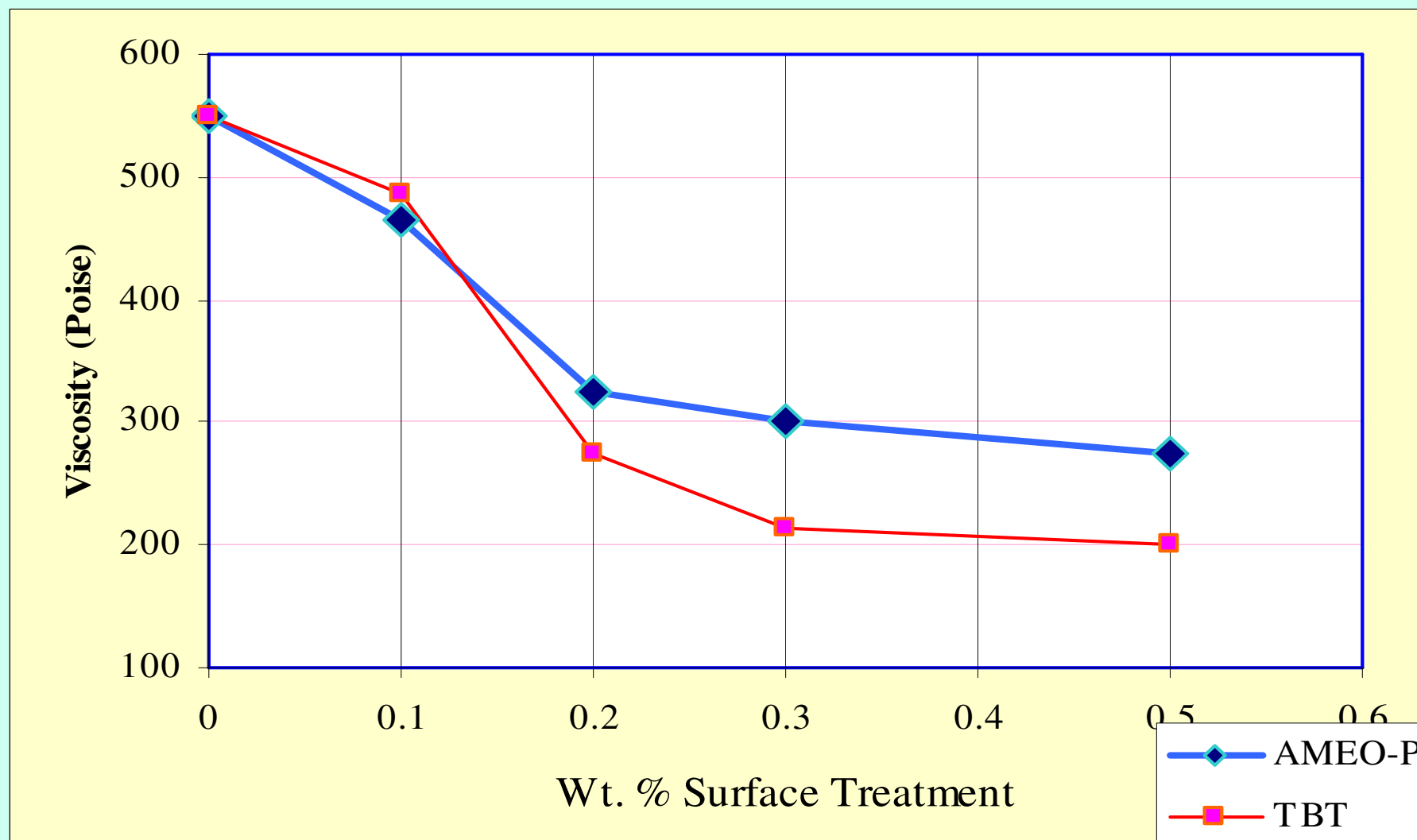
SILANE REACTIVE SUBSTRATE

Filler Reinforcement

Comments

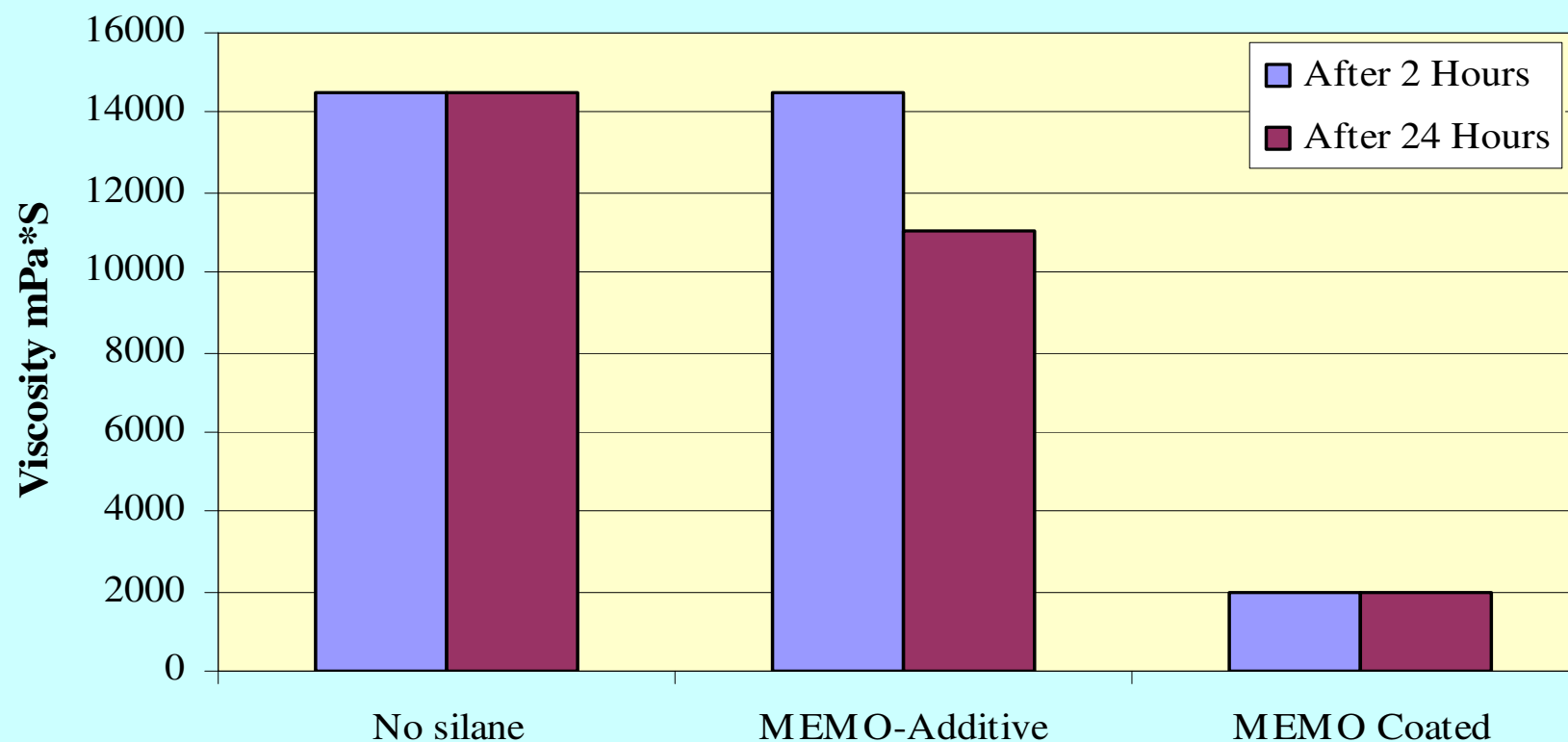
- | | |
|--|---|
| 1. Aluminum Trihydrate | Low Cost, Flame & Smoke Suppressant, 34.6 %
Combine with water |
| 2. Asbestos Fibers | High Strength Reinforcement, Health Hazard |
| 3. Ceramic Fibers | Hi-Tech Applications, Heat Resistance,
Expensive |
| 4. Glass (Fibers, Cloth, Spheres) Most Populer Reinforcement | |
| 5. Kaolin Clay | Wire and Cable, Second largest Volume
Expenders |
| 6. Mica | Reinforcement |
| 7. Silica | 17 Crystalline, Amorphous Phases |
| 8. Talc | Reinforcement, Soft, Inexpensive |
| 9. Wallastonite | Only white needle shaped Minerals |
| 10. Antimony Trioxide, Metal,
Metal Oxide | Flame Retardant |

Viscosity Versus % Surface Treatment of a 45 % Mixture of Xolox in Mineral Oil



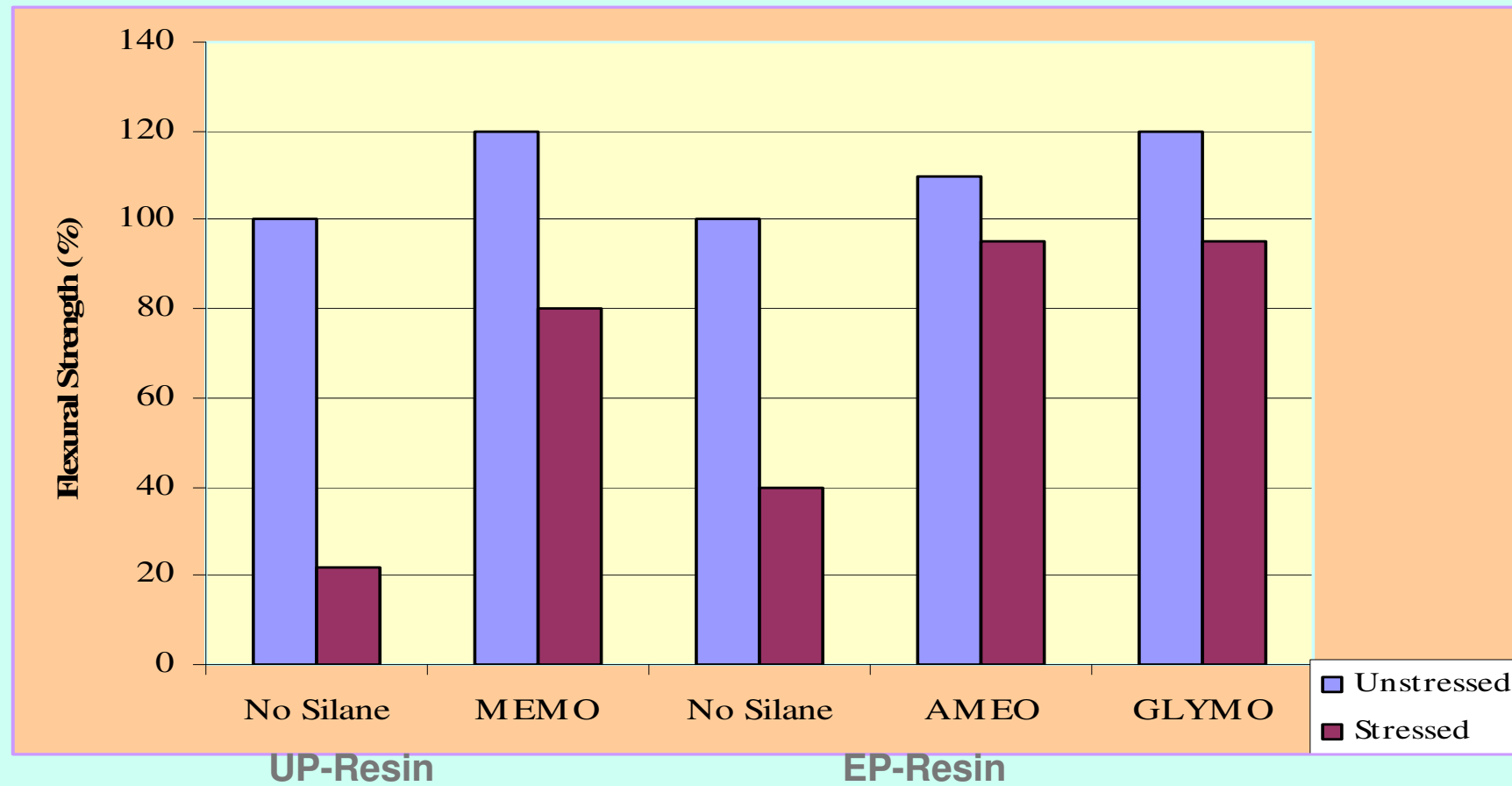
Pretreatment Influence on the Viscosity of a Filler/Resin System

Filler: 60 % pbw Chistobalite Flour, Resin: 0.5 % Shelan MEMO



Glass Fiber/Plastic Adhesion Influence of Shelan Organofunctional Silanes

Stressed: 72 Hours Boiling Water



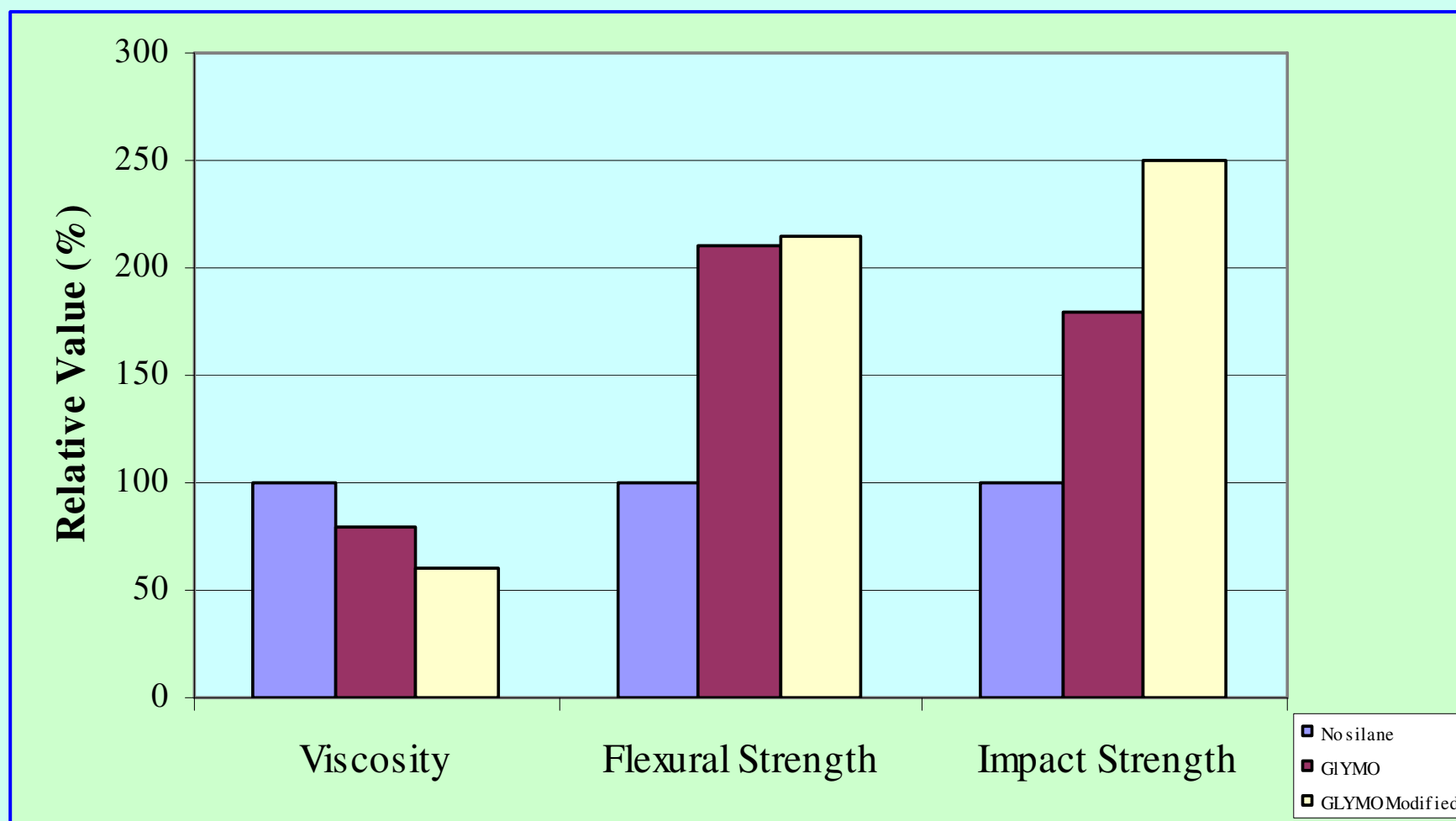
Enhancement of Moisture Resistance in a “Cold Box” Foundry Resin By Silane

Stressed: 3 Days Storage at 95% Humidity

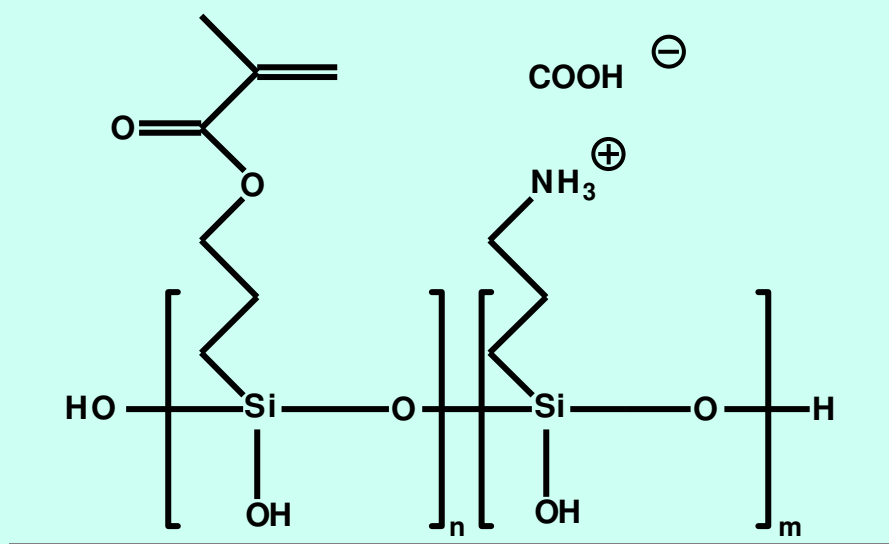


EP-Resin/Filler System Influence of Organofunctional silanes on Viscosity and Mechanical Properties

Filler: 60% Quartz Flour, 1% Silane Coated on Filler



Example: SHELAN® HS 2929
Methacryl-/Aminofunctional Water-Borne
Oligosiloxane



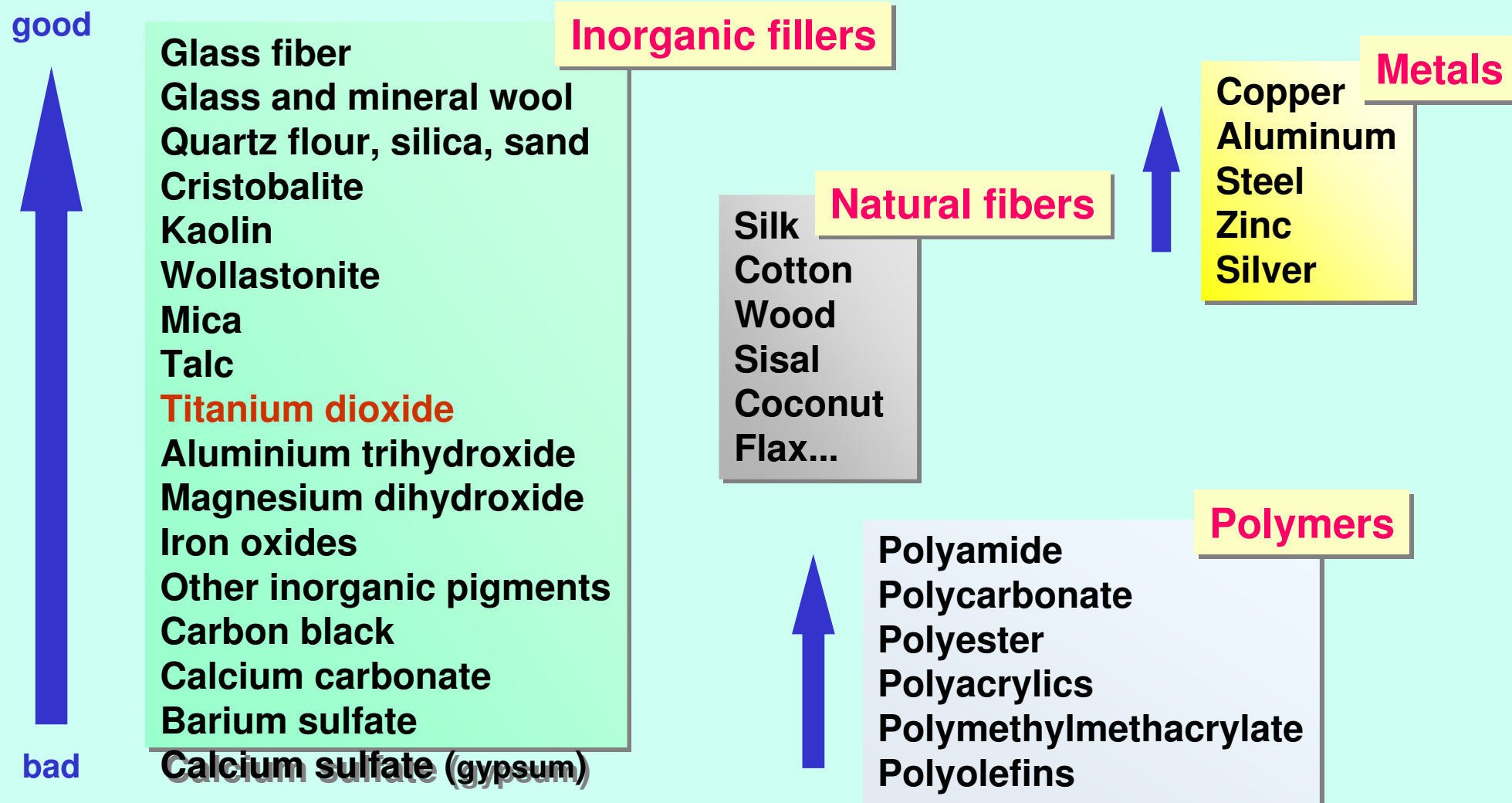
(cationic)

EINECS: listed TSCA: neg

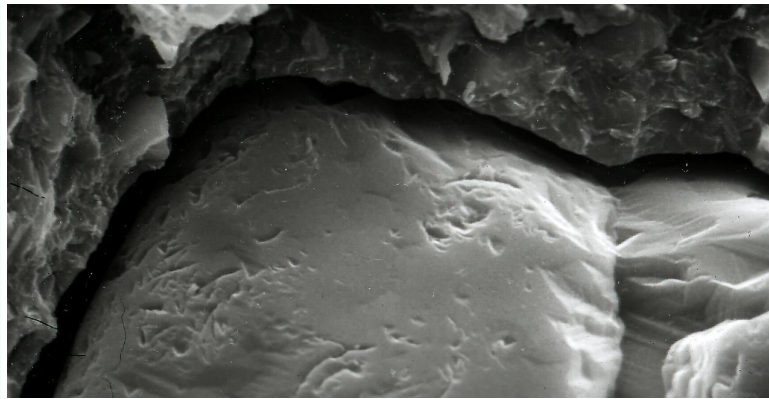
Physical Properties:

Silane content:	50 %	Residual alcohol:	< 3 %
SiO₂-content:	approx. 13 %	Flash point:	> 95 °C
Density (20 °C):	approx. 1.11 g/cm³	pH (20 °C, 1:1 in H₂O):	4
Viscosity (20 °C):	approx. 100 mPa•s	Color:	< 1 G

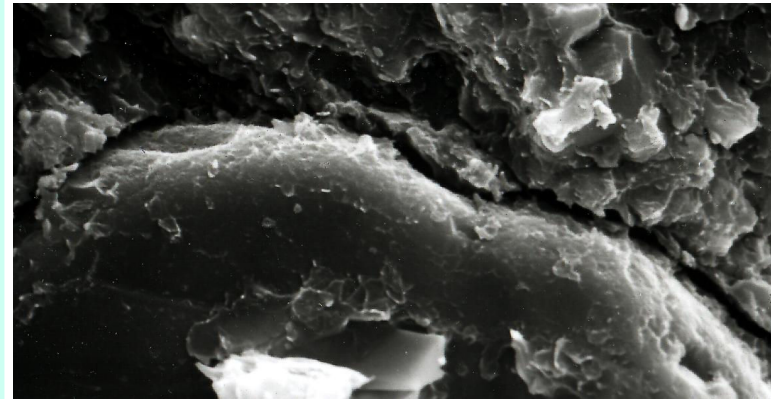
Surface modification by Organofunctional Alkoxysilanes



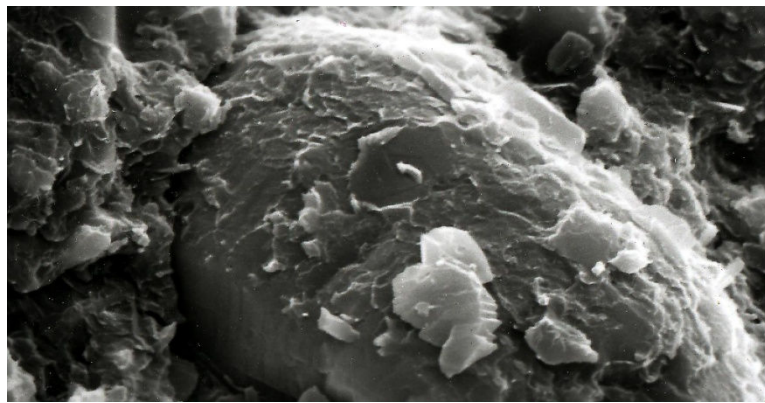
Cristobalite-Filled UP-Resin



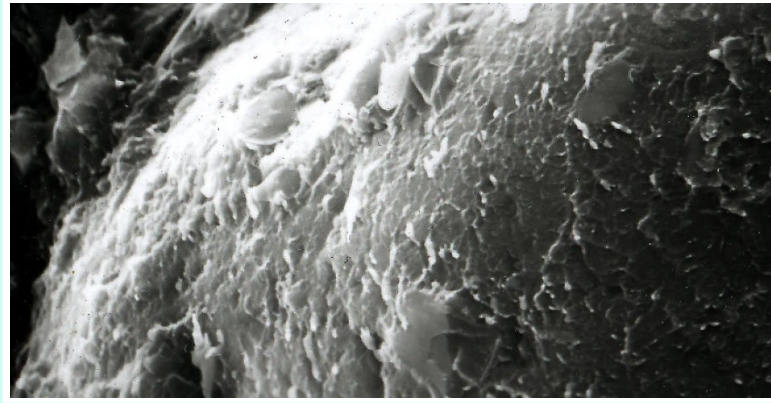
0 % SHELAN® MEMO*



0.25 % SHELAN® MEMO*



0.5 % SHELAN® MEMO*



1 % SHELAN® MEMO*

*** SHELAN® MEMO loading as a percentage relative to the resin**

SILANE TREATMENT METHOD

<u>Method</u>	<u>Advantage</u>	<u>Application</u>
Integral Blend	Simplest method	Sealants, Filled Thermosets
Aqueous Solution	Speed	Glass Fibers, Large Fillers
Organic Solution	Gives Uniform Mono-layer	
Dry Blending	Most Efficient	Filler Pretreatment
Primers	Efficiency	Bonding Metal, Large glass surface