Dynasylan®

FOR MINERAL FILLERS AND PIGMENTS

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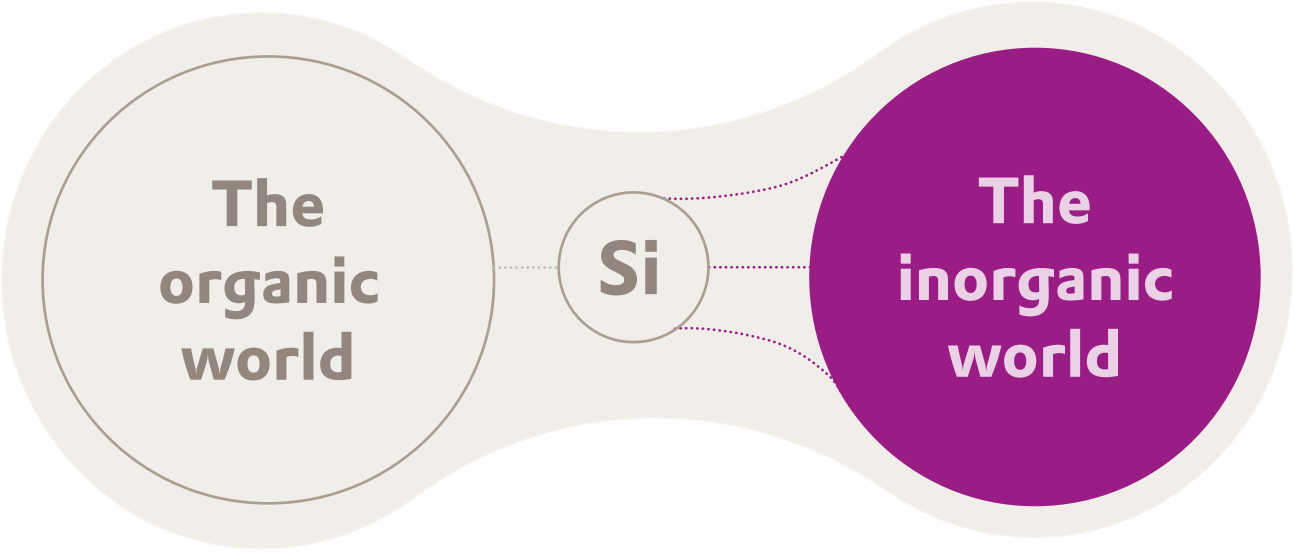
Dynasylan® bridges the inorganic and the organic world



A **hybrid between inorganic and organic constituents, the organosilane,** works as a molecular bridge between inorganic and organic materials. Based on the concept of “bridging the gap”, silanes form permanent chemical bonds which do not only improve, but also create new exceptional functionalities. More than 30 percent of all thermoplastics, thermosets, and elastomers worldwide are compounded and reinforced with fillers and fibers.

Since their development more than 50 years ago, organosilanes have been used to provide a variety of performance and process benefits to mineral-filled compounds.

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Dynasylan® Mastering the Challenge

DYNASYLAN®

Dynasylan® imparts unique, high-end properties to finished products. Reduced water up-take through hydrophobization and an improved melt flow ratio through better dispersion of the mineral in the polymer matrix can be achieved. Chemical coupling between the inorganic and the organic parts of a composite is the key and basis for improved dimensional stability, improved wet-out between the resin and the filler, and reduced viscosity through improved dispersion.

Dynasylan® keeps costs down by maximizing the throughput of high-value products.

Dynasylan® silanes are used in many research and high-tech projects.

For example, the **MAGLEV traction technology employed in the Transrapid** uses cables manufactured with Dynasylan® silanes to meet stringent requirements.

1. Lower viscosity
2. Improved processing
3. Increased output
4. Improved dispersion
5. Higher filler-loading
6. Improved cost-efficiency

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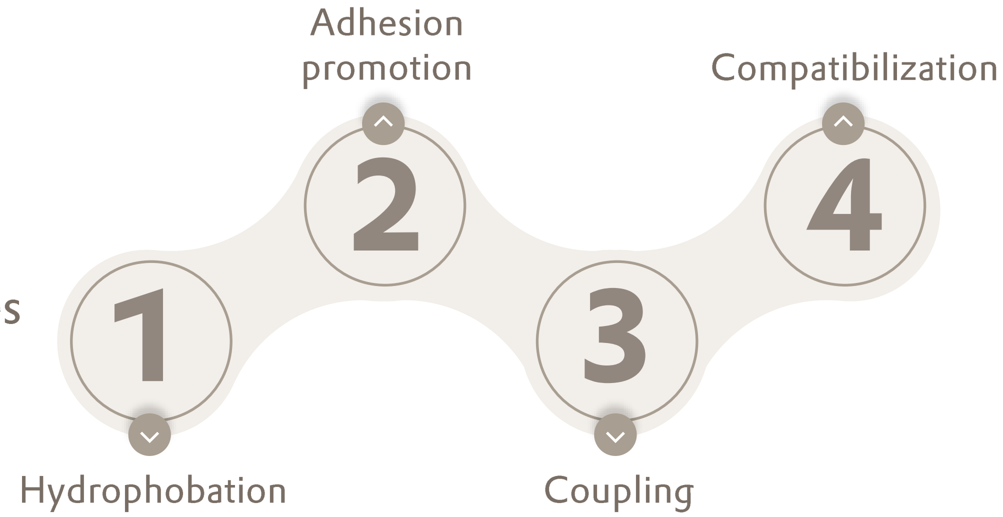
The Compatibilizer: Silanes in Filled Plastics

More than **30 percent** of all thermoplastics, thermosets, and elastomers worldwide are compounded and reinforced with fillers and fibers.

- Since their development **more than 50 years ago, organosilanes** have been used to provide a variety of performance and process **benefits to mineral-filled compounds.**

Organosilanes provide:



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Dynasylan® Content - Vorschlag

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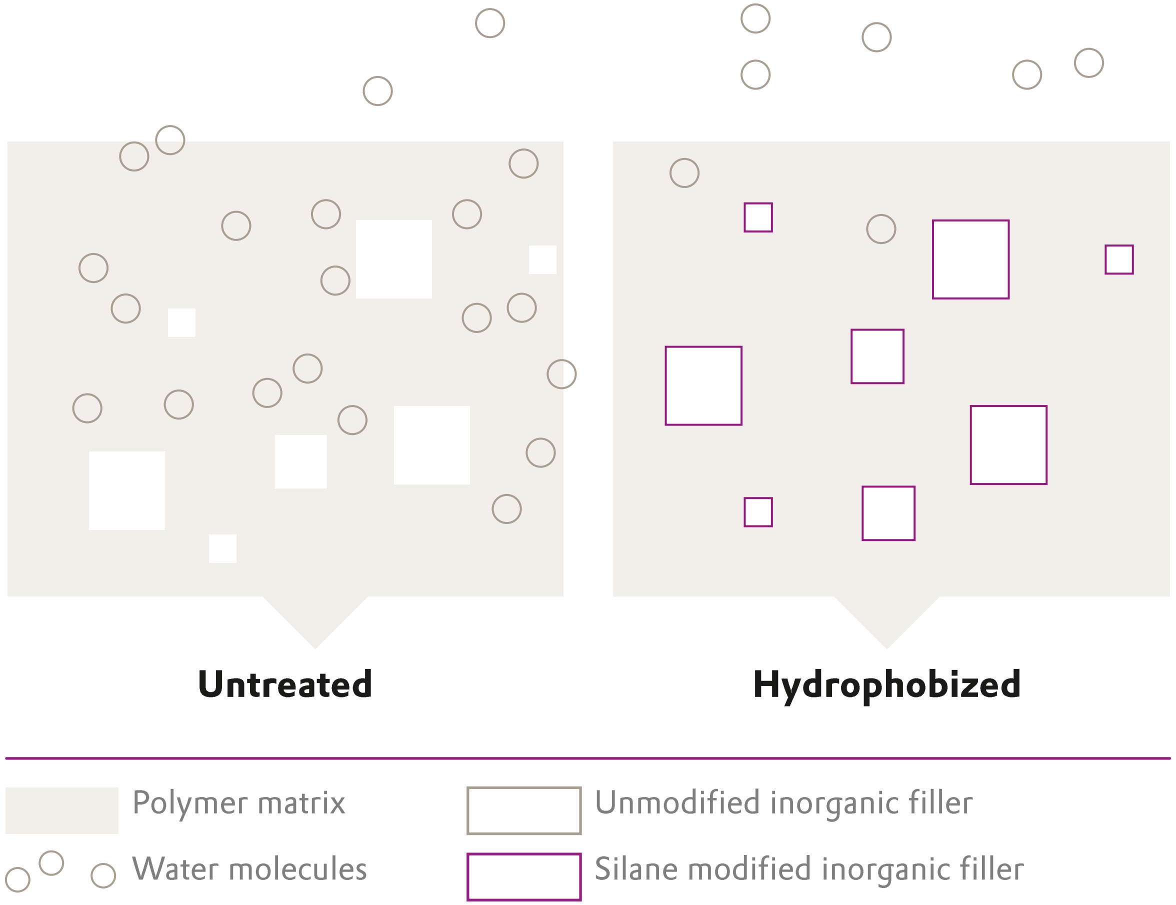
Reduction of water up-take by incorporating silane



Silanes further enhance the hydrophobicity of filled plastics. When silanes are used, the absorption of water by the polymer is significantly reduced.

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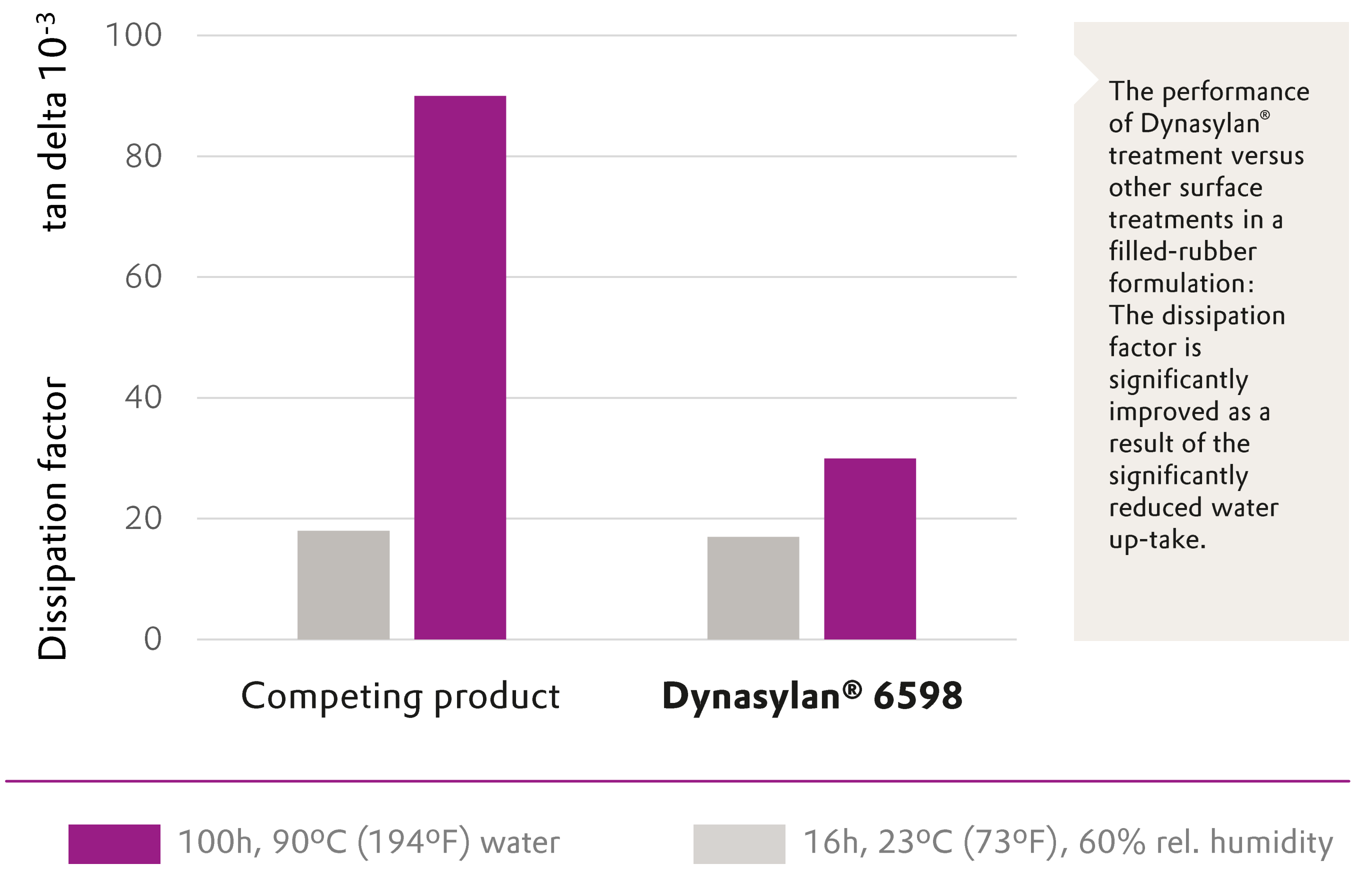
Dynasylan® in – water out

Dynasylan® 6598 significantly improves electrical properties

The diagram to the right illustrates the positive effect of Multifunctional Silane Systems on the dissipation factor of calcined clay-filled EPDM rubber cables after exposure to water. Positive effects include, for example, an improvement of wet-electrical properties in rubber power cables.



The performance of Dynasylan® treatment versus other surface treatments in a filled-rubber formulation: The dissipation factor is significantly improved as a result of the significantly reduced water up-take.

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Dynasylan®

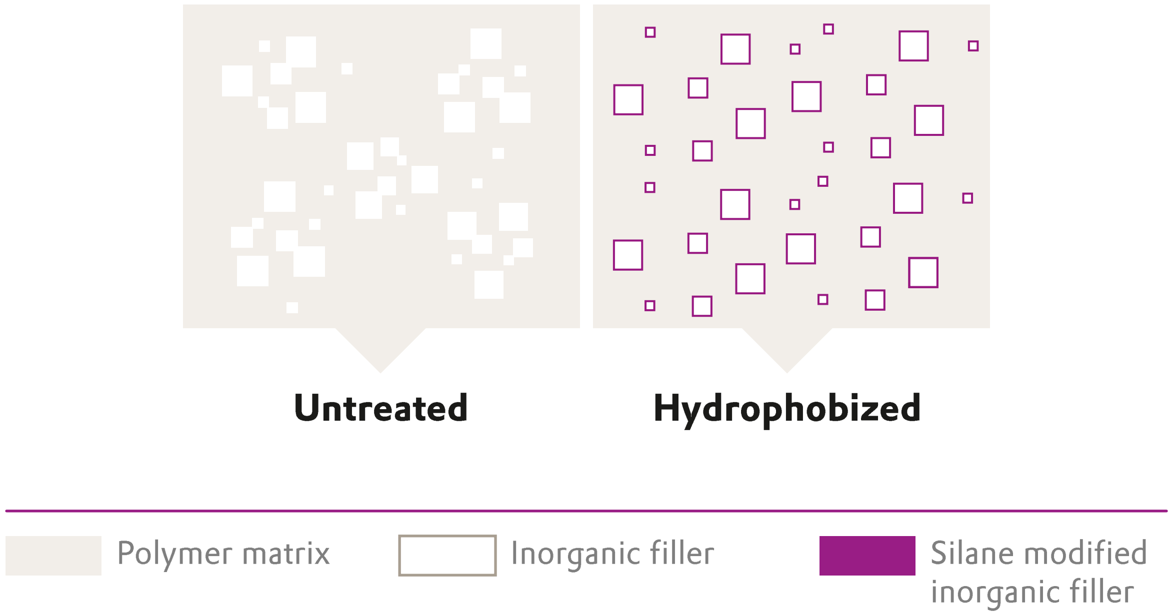
Easier processing with Dynasylan®

The dispersion of fillers in polymers is a demanding technological challenge, as inorganic fillers and the organic polymer matrices have different polarities.

Properly chosen silanes can serve as excellent compatibilizers because of their **dual role:**

combining organic and inorganic groups within one molecule.

Silanes improve dispersion of fillers in polymer matrices



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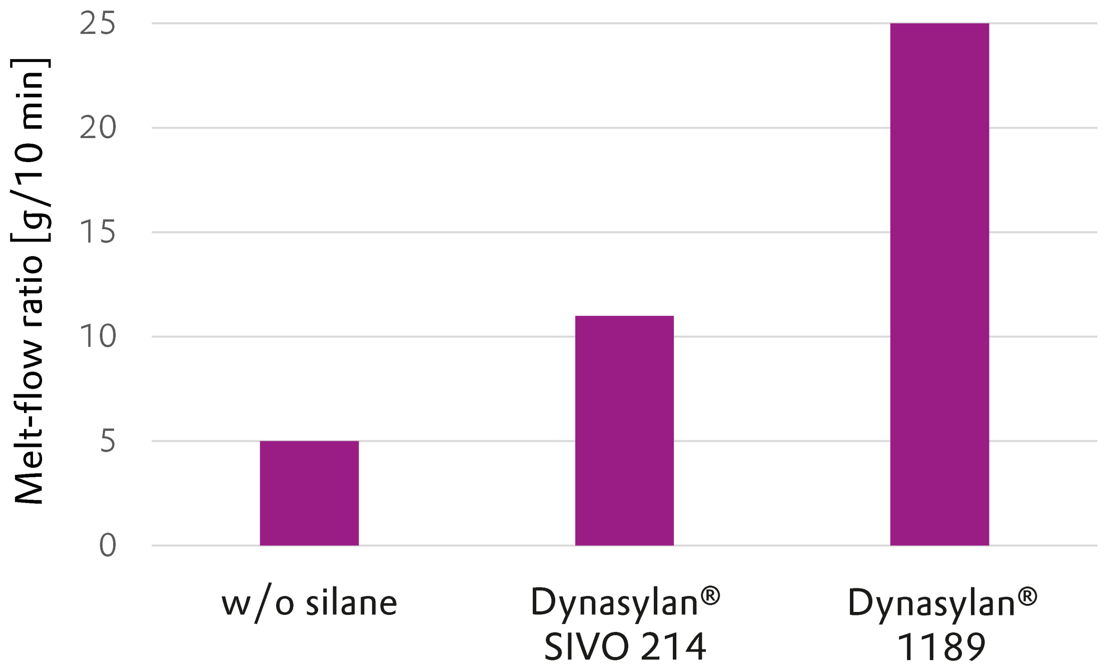
Easier processing with Dynasylan®

Significantly improved processing viscosity of highly filled compounds

Reduced agglomeration is a consequence of improved dispersion of the inorganic in the organic matrix. Also, the melt flow ratio of the compound is significantly increased. The better the choice of silane, the better the compatibilizing effect in the final compound.

Melt flow ratio of a MDH/PP/PP-MAH compound with different silanes



Dynasylan® couples fillers and polymers

What makes silanes so important is that **they can couple inorganic and mineral fillers with organic polymers through a chemical bond.** As a consequence of the coupling, the mechanical properties of the filled compounds are significantly improved. Examples are the use of silane-treated glass fibers in polypropylene, quartz in unsaturated polyester, and aluminium hydroxide in ethylene vinyl acetate.

DYNASYLAN®
BINDS THE RESIN TO THE FILLER

Treater with 1% Dynasylan® MEMO

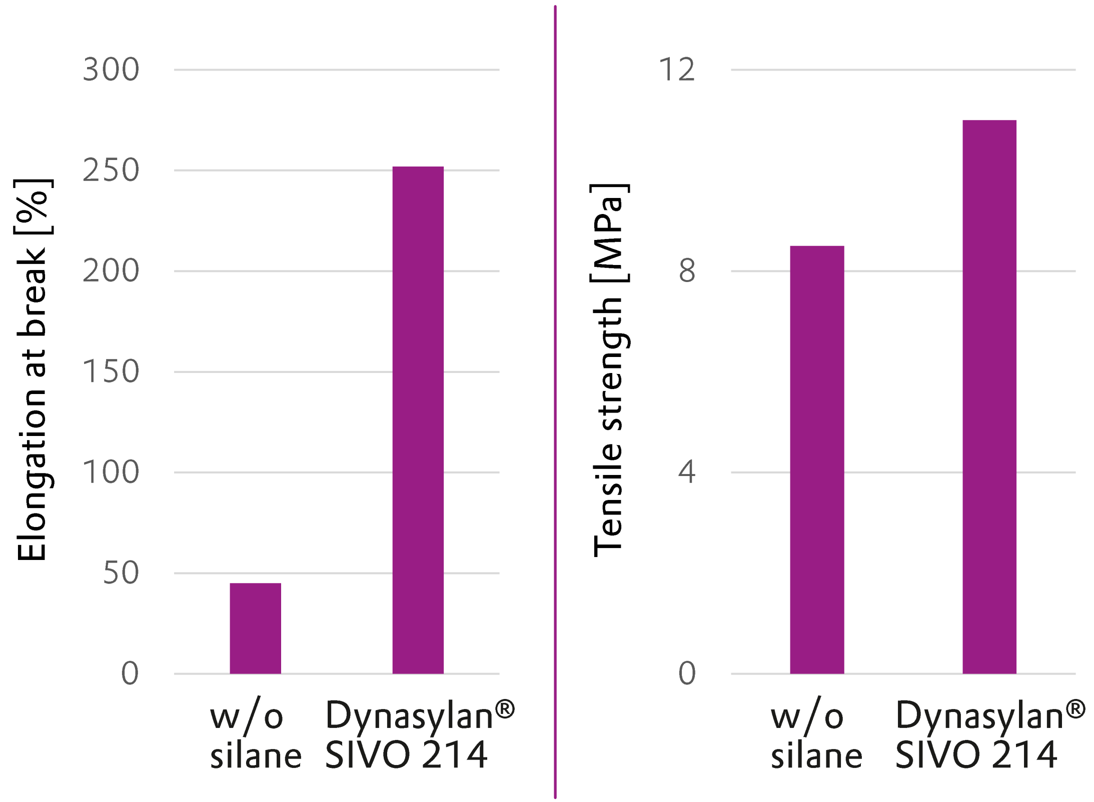
Untreated

Dynasylan® couples fillers and polymers

Mechanical properties are significantly improved by optimized polymer–particle–interaction

The chemical bond between the inorganic and the organic part of the compound is crucial to achieve improved mechanical properties. The elongation at break of magnesium hydroxide-filled PP based cable compound, for instance, improves significantly, without any adverse effects onto the tensile strength.

Dynasylan® binds the resin to the filler



The elongation at break of a magnesium hydroxide-filled polypropylene (PP) compound with additional maleic anhydride as coupling agent.

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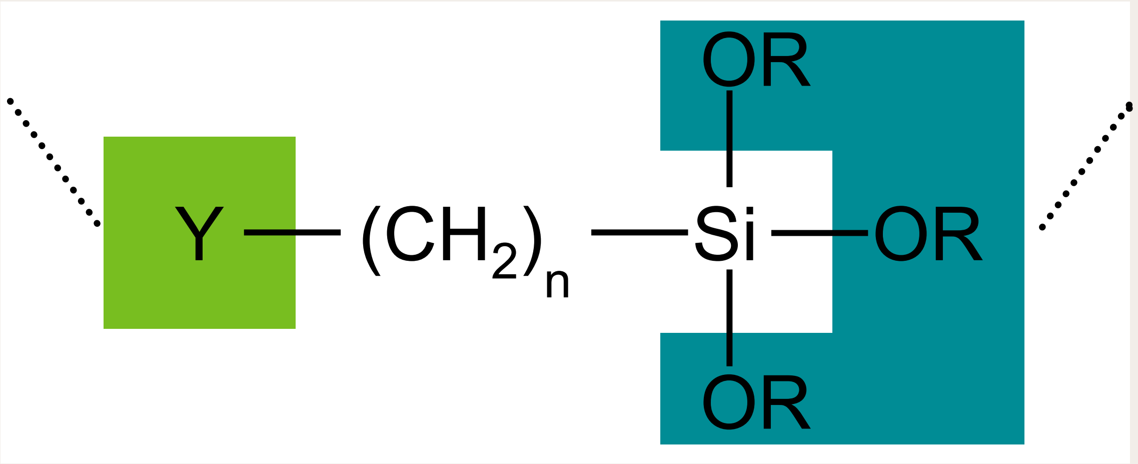
Dynasylan® is the bridge between the inorganic and organic world

TYPICAL STRUCTURE

Most Dynasylan® silanes feature a similar molecular formula

Organofunctional group

can react with polymers, resins, rubber…



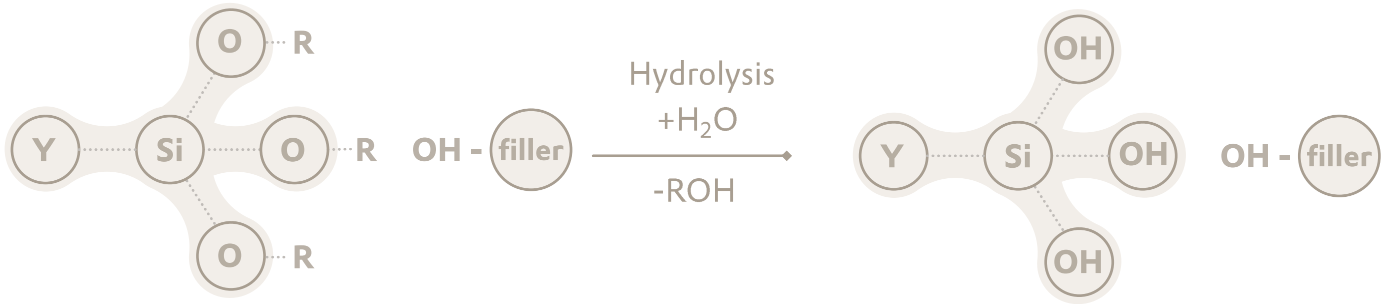
Silicon-functional group

can react with fillers, metals, glass…

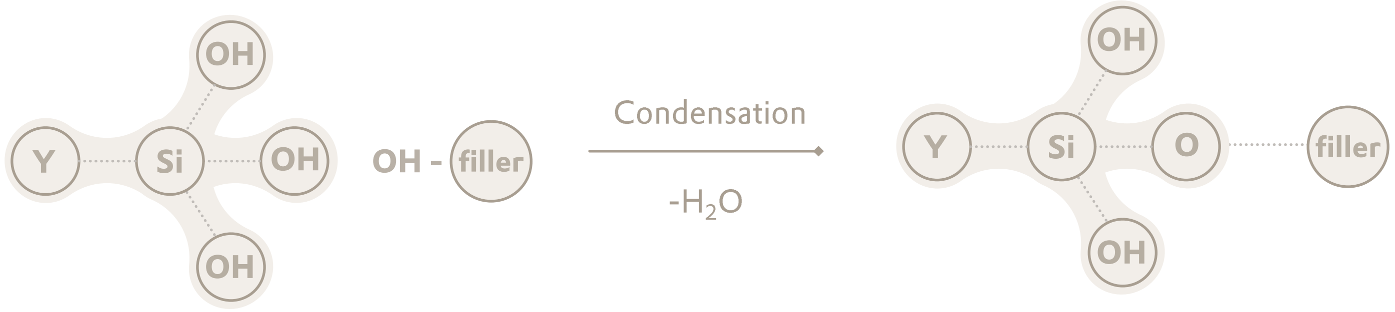
TYPICAL EFFECTS

- **Adhesion/Coupling** (organic ↔ inorganic)
- **Crosslinking** of polymers
- **Surface modification** of inorganic materials
- **Reaction partner/precursor**

Chemical reaction with inorganic substrates



The silicon functional groups are activated



The silane molecules are covalent bonded to the inorganic surface of the particles

The silicon functional group is activated in the presence of humidity and forms silanol groups. During this stage hydrolysis alcohol is generated. In a second step the silanol groups react with the OH-groups of the inorganic substrate during a condensation reaction by generating covalent Si-O bonds and water molecules. The inorganic surface is now permanently modified with the necessary organo-functionality.

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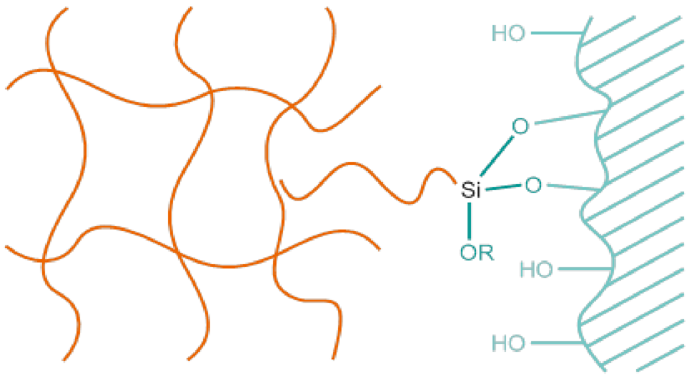
Chemical reaction/interactions with various polymers

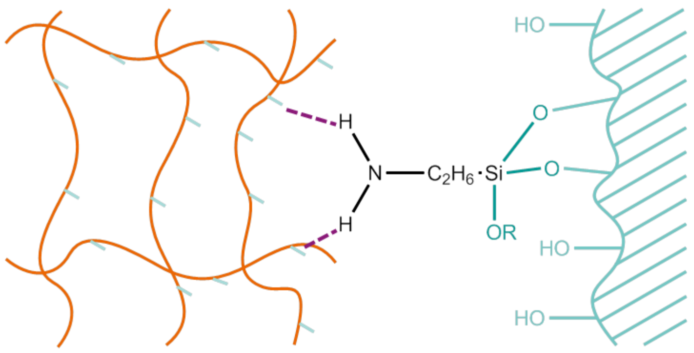


e.g., PP, PE, PS, PDMS

Van der Waals

Alkyl-silanes

- **Strong hydrophobic effect**
- **Excellent dispersion** in non-polar matrices
- Outstanding compatibilization to **non-polar polymers**



e.g., EVA, PA, EBA

Hydrogen bridges

Amino-silanes

- **Strong bonding** via hydrogen bridges
- Outstanding compatibilization to **polar polymers**

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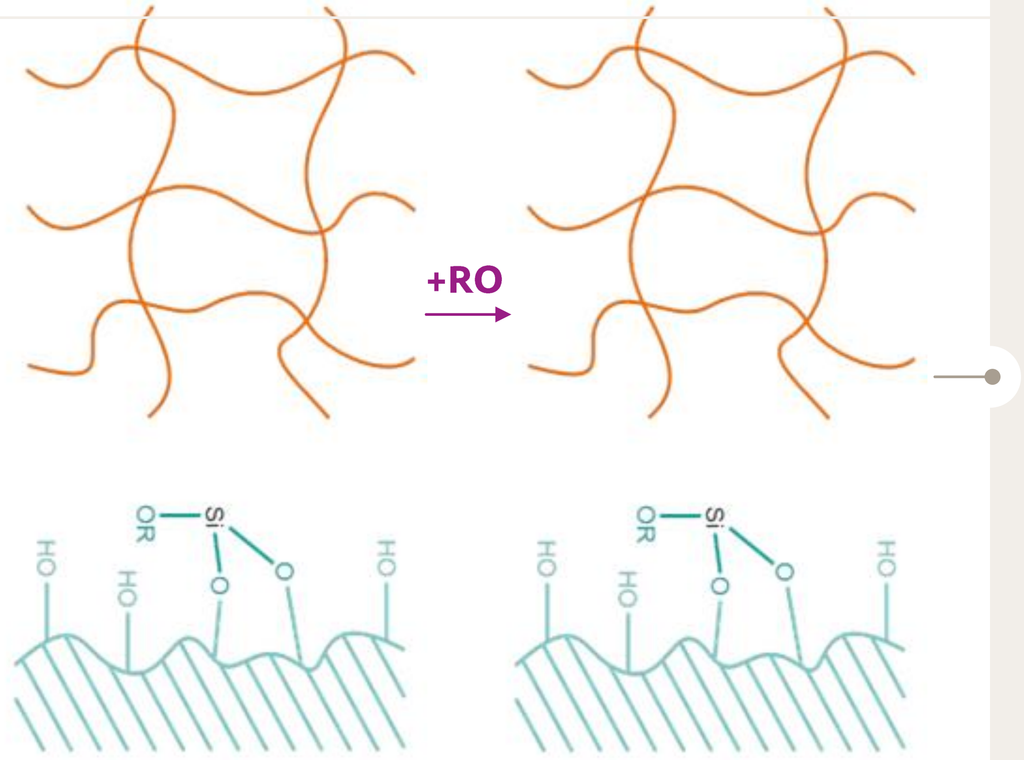
Chemical reaction/interactions with various polymers



PE, EPDM

Radical grafting

Vinyl- or Methacryl-silanes

- **Vinyl-/methacryl group reacts** with free radicals and couples to polymer
- **Significantly improvement** of the mechanical properties
- **Hydrophobic effect**
- **Suitable polymers do not degrade** in contact with free radicals

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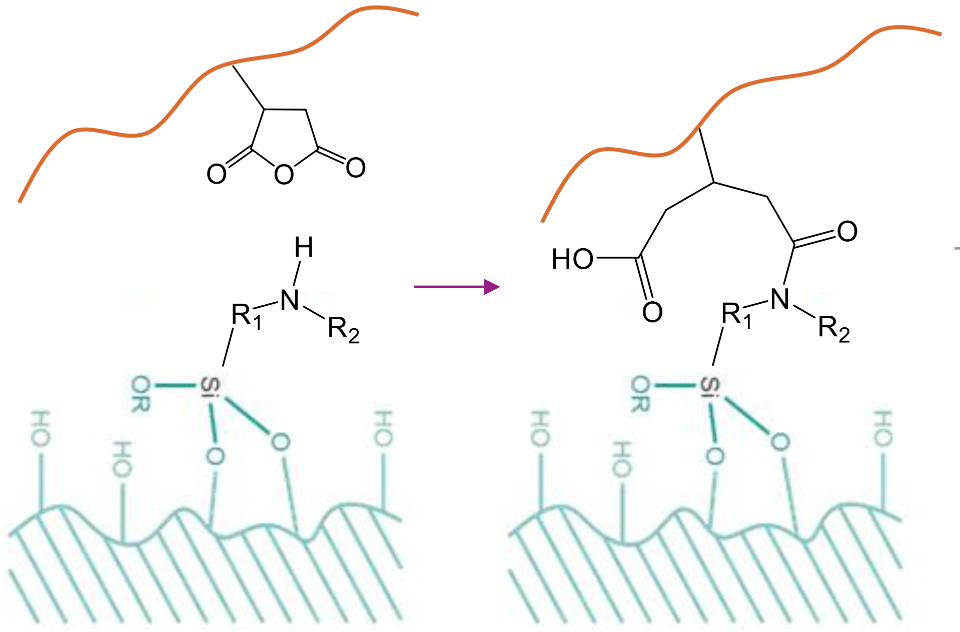
Chemical reaction/interactions with various polymers



MAPE, MAPP

Nucl./electroph. addition

Amino-silanes

- **Ring-opening reaction with maleic anhydride** leads to a covalent bonding
- **Linking of the polmer to the inorganic particle via MAH-silane coupling is hydrolytically more stable** vs. the bond between MAH and OH groups of inorganic particles
- **Excellent mechanical and processing characteristics**
- **Excellent polymer wetting characteristics** of the particle surface

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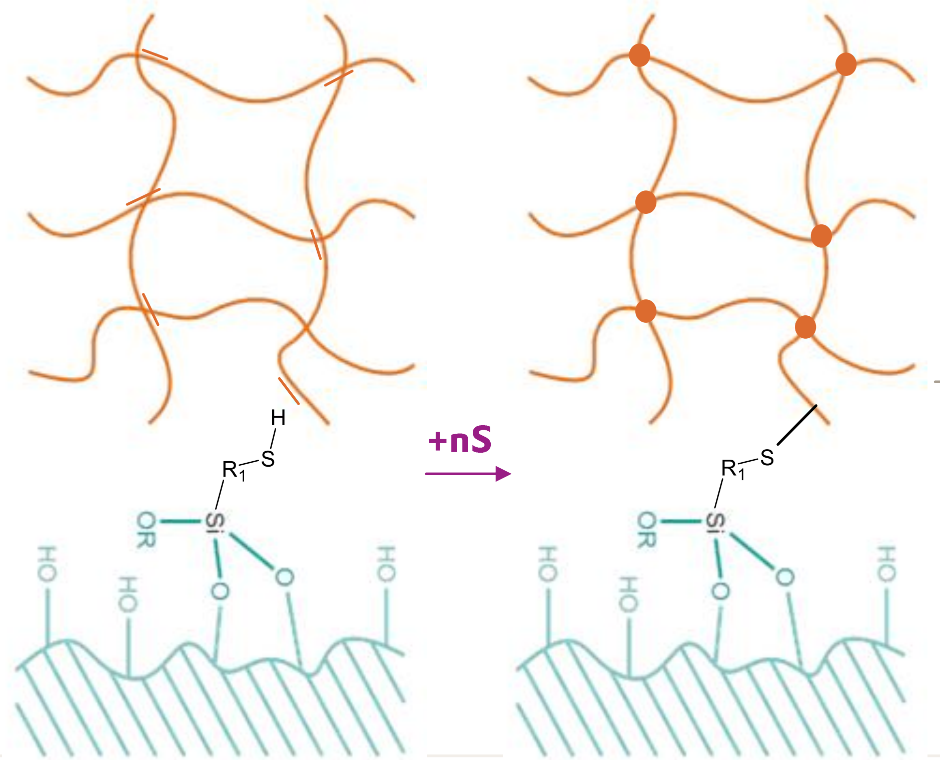
Chemical reaction/interactions with various polymers



EPDM

Reaction with mercapto group

Mercapto-silanes

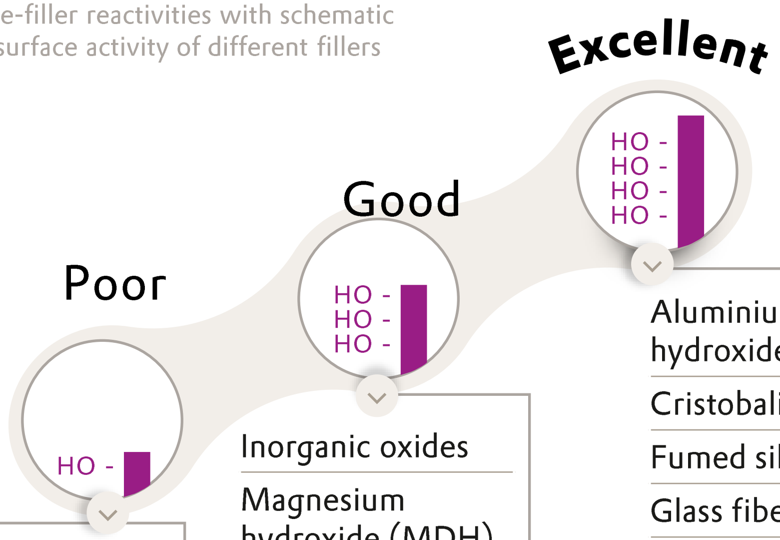
- **Mercapto group reacts with unsaturation on elastomers** in sulphur cured rubber compounds
- **Significantly increased mechanical properties**

The surface determines the successful modification of the particles

Silanes are transformed in the presence of water to silanols.

This step is activating the molecules for the final condensation step in which the silane molecules are covalent bonded to the surface of the inorganic particles.
Thus, the higher the number of OH-groups on the particle surface the more effective the functionalization.
Inorganic particles can be classified as “Excellent”, “Good” and “Poor” concerning the functionalization with silanes.

Comparison of silane-filler reactivities with schematic visualization of the surface activity of different fillers



Poor
- Barium sulfate
- Calcium carbonate
- Carbon black

Good
- Inorganic oxides
- Magnesium hydroxide (MDH)
- Mica
- Other silicate fillers
- Talc
- Titanium dioxide
- Iron oxide

Excellent
- Aluminium hydroxide (ATH)
- Cristobalite
- Fumed silica
- Glass fiber
- Kaolin (clay)
- Precipitated silica
- Quartz
- Wollastonite
- Aluminum pigments
- Glass spheres

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Finding the suitable silane functionality for your polymer

The question which silane is the best suitable for your application is primarily answered by the matrix of the final compound.

In the table of this slide you will find proposed successfully working solutions for polymers like PE, EVA, MAPP, PA, peroxide cured elastomers, UP and EP resins. In case you do not find your polymer base represented here we would be happy to discuss other solutions out of our broad Dynasylan® product portfolio.

POLYMER	RECOMMENDED PRODUCT
Polypropylene (PP) – maleated	Dynasylan® 1189 Dynasylan® SIVO 214 Dynasylan® HYDROSIL 1153*
EVA / PE	Dynasylan® SIVO 214 Dynasylan®1189 Dynasylan® 6498
Polyamide	Dynasylan® SIVO 214 Dynasylan® 1189 Dynasylan® HYDROSIL 1153*
Rubber, peroxide-cured	Dynasylan® 6498 Dynasylan® 6598 Dynasylan® HYDROSIL 2907*
Unsaturated Polyester Resin (UP)	Dynasylan® SIVO 560 Dynasylan® HYDROSIL 2907*
Epoxy Resin (EP)	Dynasylan®GLYEO Dynasylan® HYDROSIL 1153* Dynasylan® HYDROSIL 2926*

* water based

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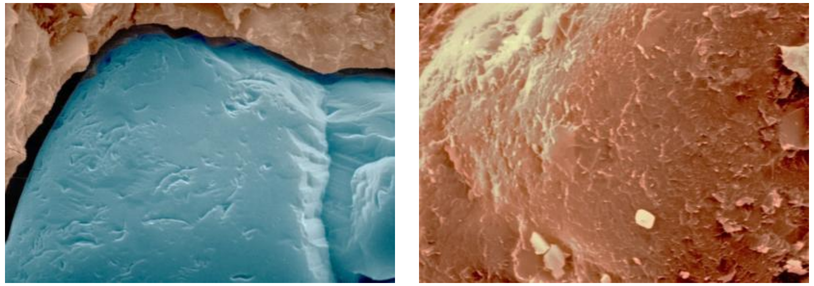
Boosting your product performance with Dynasylan®

DYNASYLAN®

Four major mechanisms how Dynasylan® boosts your products' performance

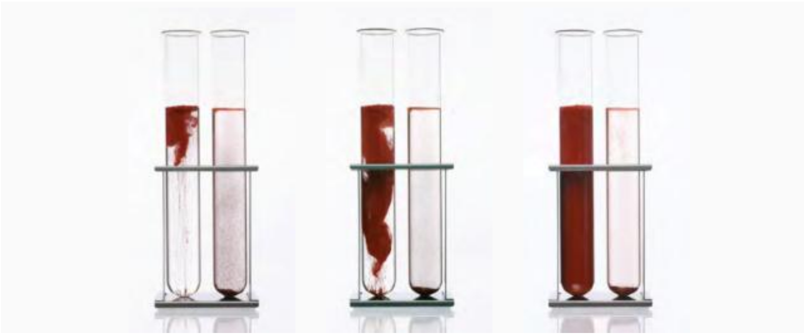
1) Coupling inorganic particles to polymers



2) High filling – low viscosity

3) Oligomers vs. monomers

4) Dispersing in a polar enviroment



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Dynasylan® Coupling inorganic particles to polymers

Inorganic particles and polymers are typically incompatible. The functionalization of these inorganic particles solves this challenge.

Dynasylan® is strongly supportive concerning the optimum interaction between the polymer matrices and the particles.

There is a big variety of applications where this is exercised on a daily base. Examples for that are applications like artificial stone, halogen free flame retardants or elastomer based mechanical rubber goods. Crucial parameter in this applications are the mechanical properties. Besides of the basic compatibilization covalent bonding or physical bonding (vie hydrogen bridges) is essential. In the next slides you will find examples for the high effectivity of Dynasylan® concerning this characteristic.

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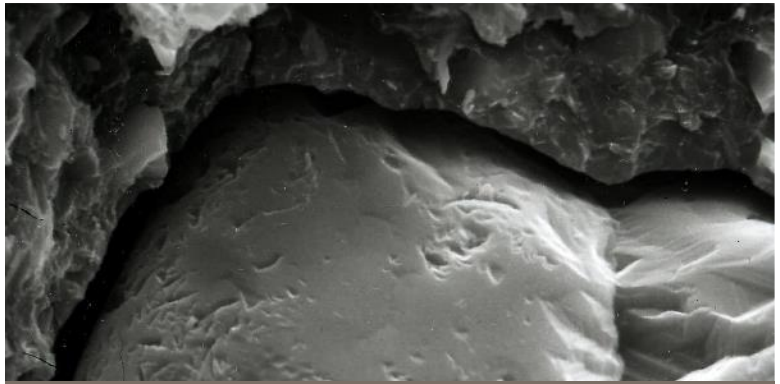
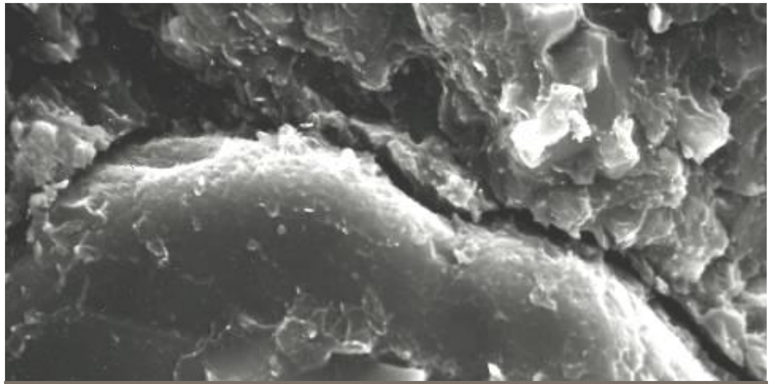
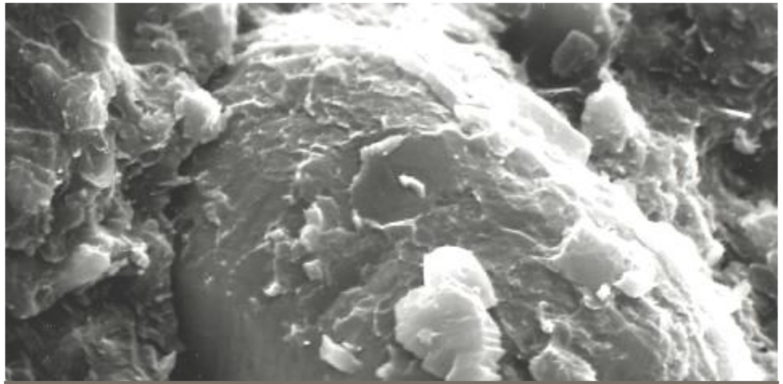
Dynasylan® modified particles in highly filled UP resins



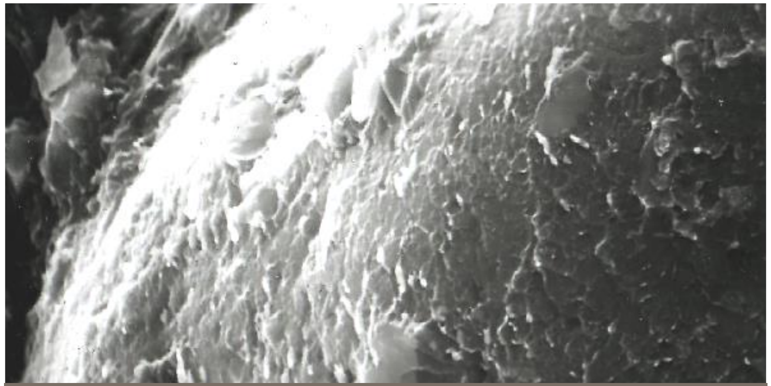
No silane



0,25% Dynasylan®



0.5% Dynasylan®



1.0% Dynasylan®

- Inorganic particles are incompatible to the resin matrix, which leads to poor mechanical properties

- **Adding silane to the system leads to a significantly increasing of compatibility**

- The result is an outstanding cohesion between resin and inorganic particle
- The grade of cohesion depends on the silane amount on the particle surface
- This leads to excellent long-term mechanical properties

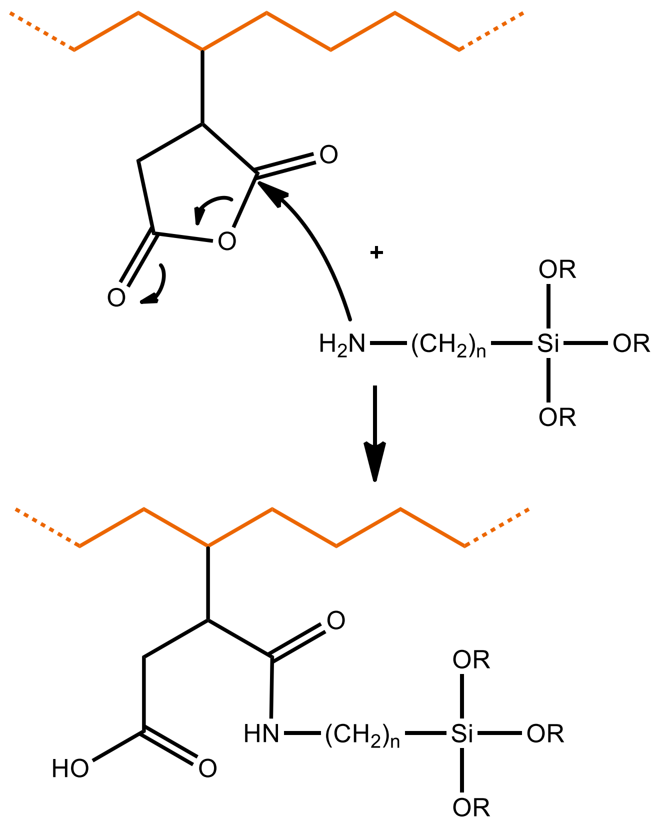
Enhanced design-opportunities with Dynasylan® aminosilane-range

Technical Challenge
Thermoplastic compounds for T3-automotive-cables for high service temperature

Idea
Using of PP based compounds in combination with MAPP and aminosilane modified MDH

State-of-the-art
Glass-fiber-reinforced PP-compounds

Benefits
Very fast reaction
Strong, very stable chemical bonding



Dynasylan® Enhanced design-opportunities with Dynasylan® aminosilane-range

Study
Silane-modified MDH-PP-MAPP-compounds vs. unmodified MDH-PP-MAPP-compound

Analysis
- Melt-flow-rate in [g/10min] – 21.6kg@230°C
- Tensile strength [MPa], elongation at break [%]
- Water up-take [mg/cm²] – 14@70°C, waterbath

100 pts	**Polymer-mix** 97% PP based thermoplastic polyolefin 3% Maleic anhydride grafted PP
185 pts	**Silane-treated-filler** 99% Fine precipitated magnesium hydroxide 1% Dynasylan® amino-silanes

PROCESSING
- MDH pre-treated in plough-share-mixer
- 1% aminosilane based on the filler amount
- Twin-screw-extruder (25mm; l/d=33)
- 3 kg/h and 120 rpm
- Temp.-profile: -/200/200/200/240/240/240/250°C
- Tapes

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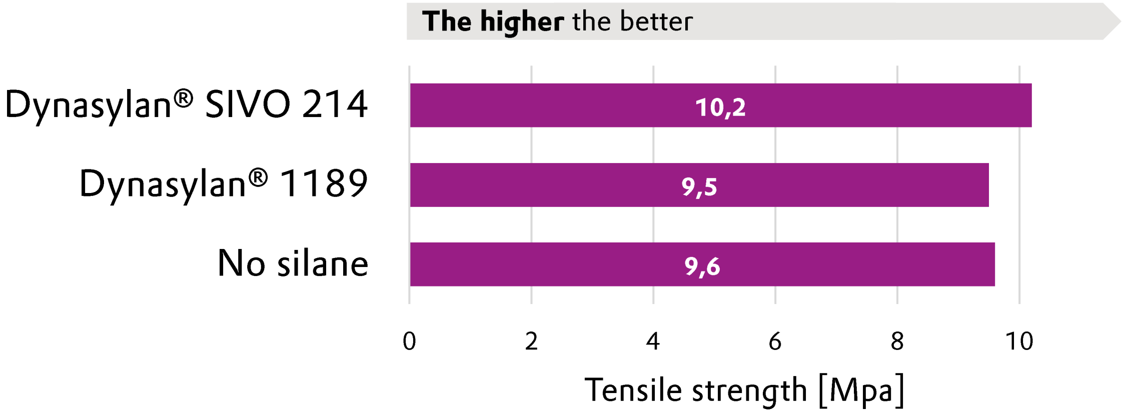
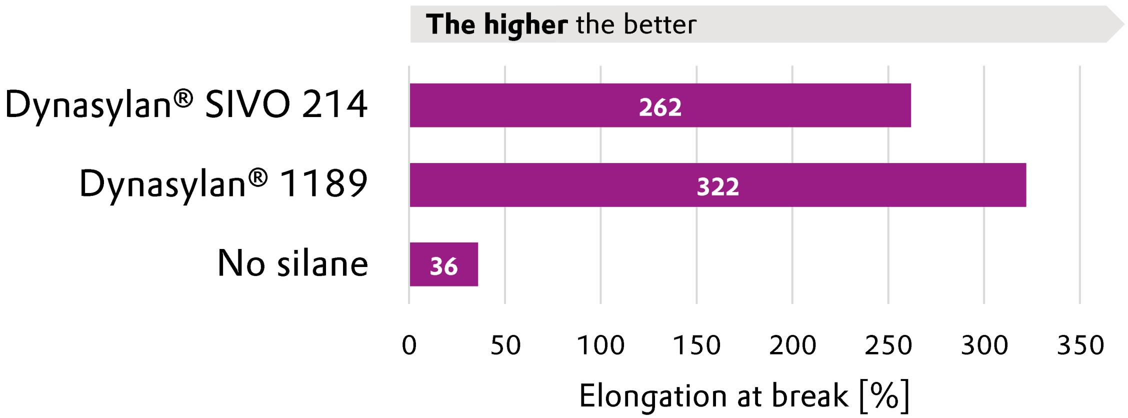
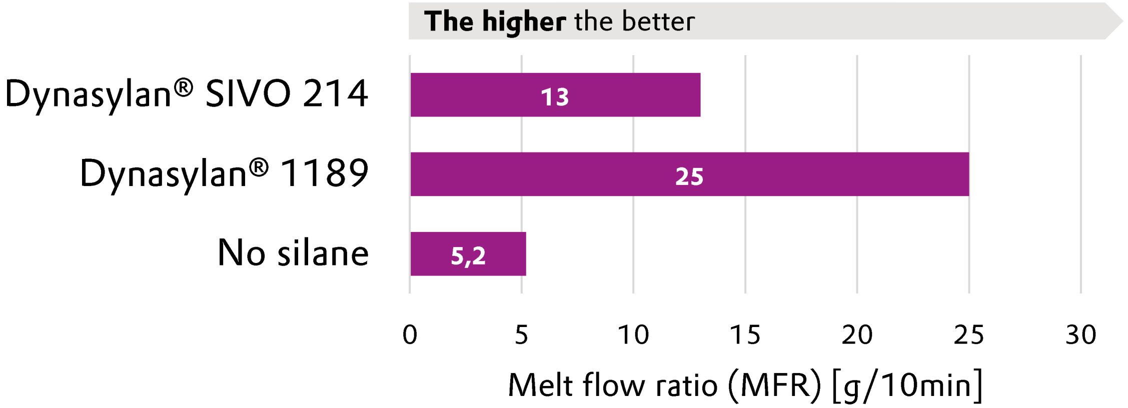
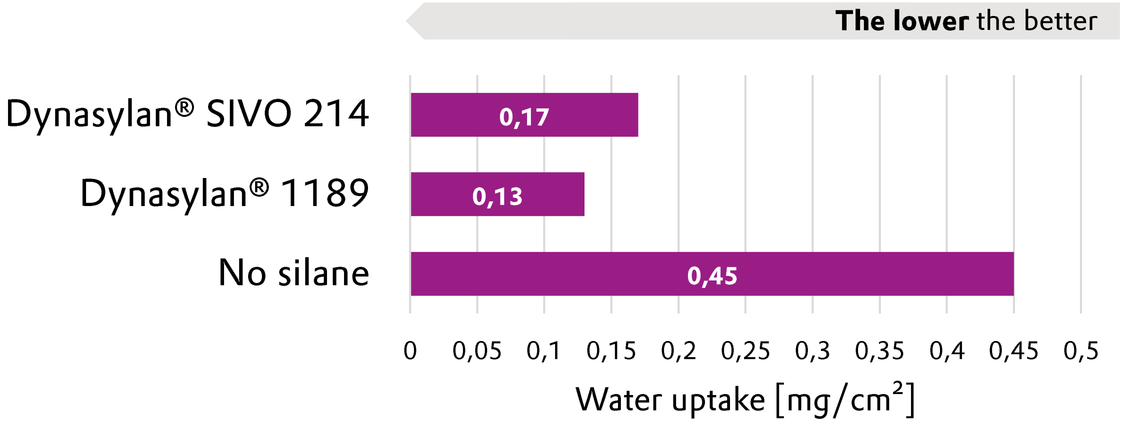
Enhanced design-opportunities with Dynasylan® aminosilane-range









Enhanced design-opportunities with Dynasylan® aminosilane-range

The combination of MAPP and Dynasylan® aminosilanes works great!

SUMMARY OF RESULTS:

- Water up-take is significantly decreased
- MFR is significantly increased
- Elongation at break is significantly increased

Dynasylan® product recommendation:

Dynasylan® 1189:

- Best results concerning water up-take and elongation at break
- By far the lowest viscosity -> highest production speed is possible

Dynasylan® SIVO 214:

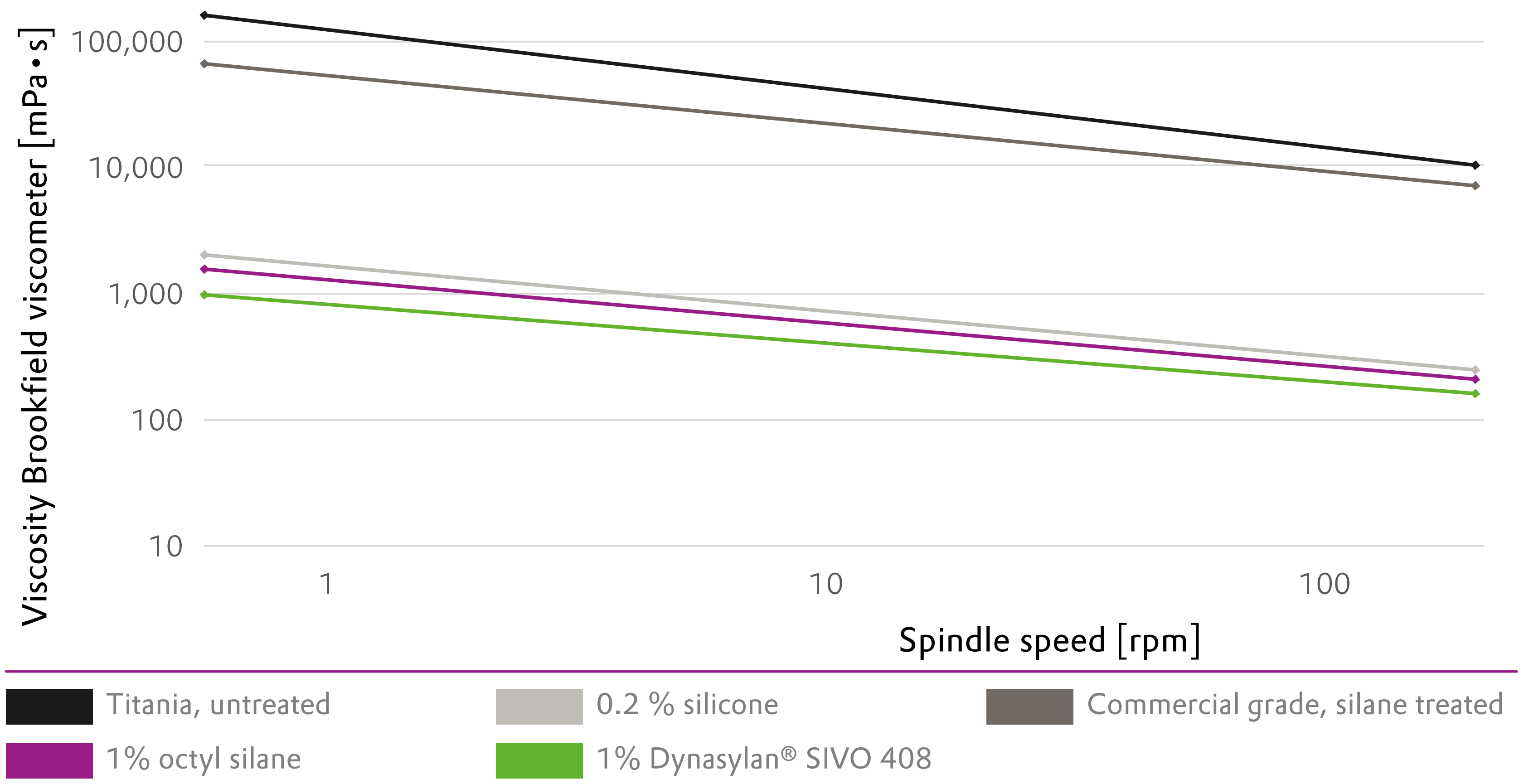
- Best out-balanced option for PP based compounds in combination with maleic anhydride

Dynasylan® SIVO 408 – High filling and low viscosity

Significant drop of viscosity of highly filled non-polar matrix

Dynasylan® SIVO 408 leads to superior viscosity characteristics

Remark: 27% of TiO_2 particles (untreated vs. treated)
In non-polar paraffin-oil



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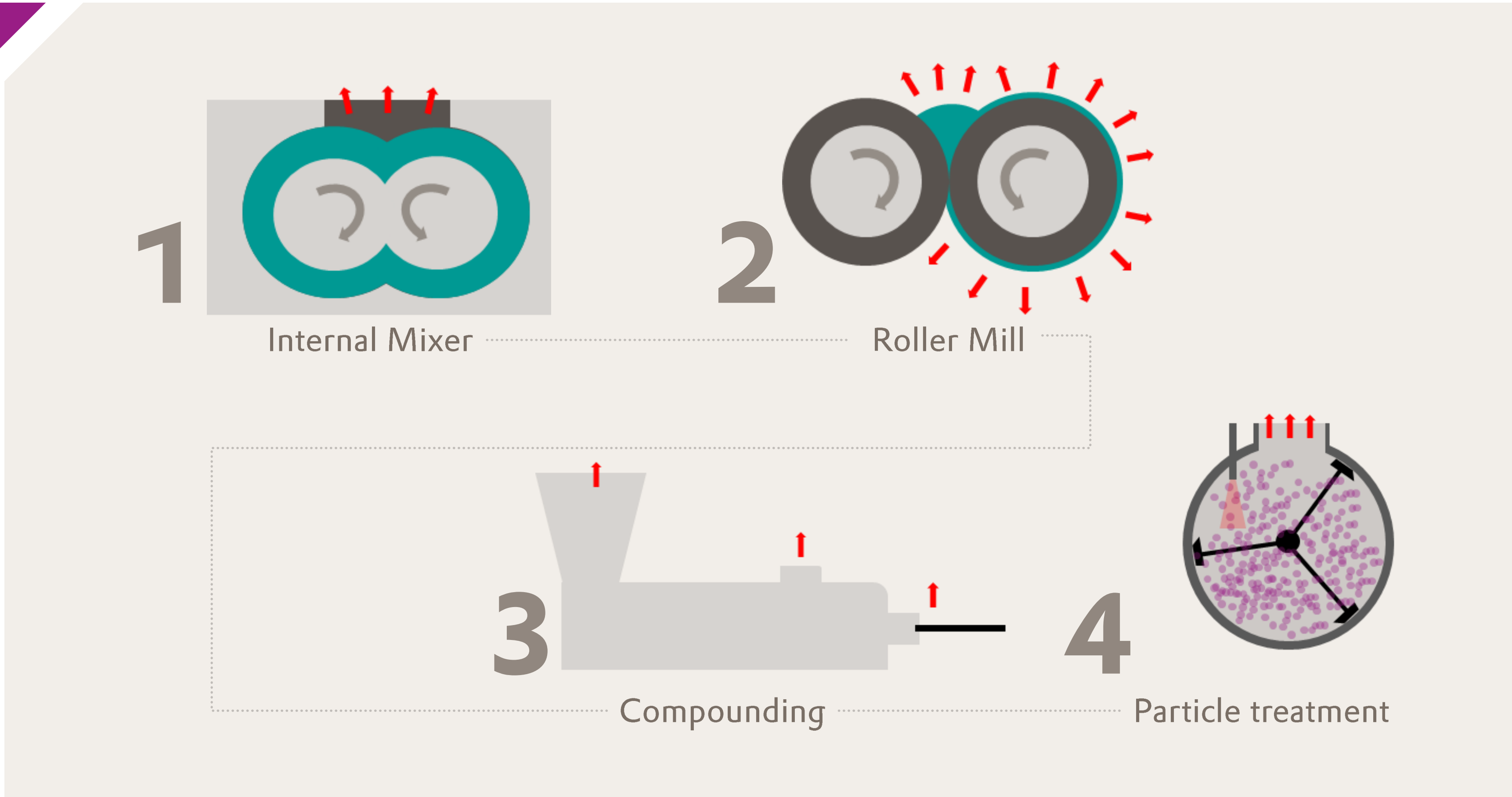
Oligomers solve typical processing challenges

Strong evaporation of monomers during processing leads to problems during the compounding step



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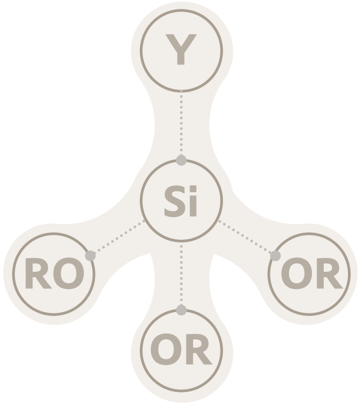
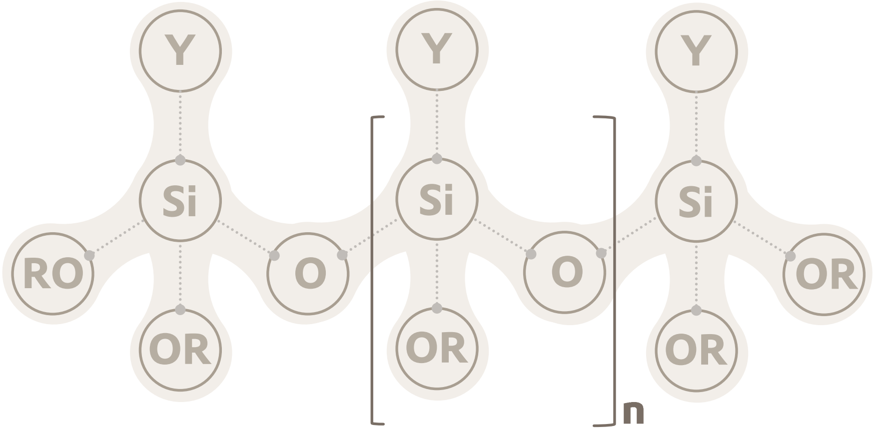
Dynasylan® oligomers outperform monomers

Dynasylan®
Monomer



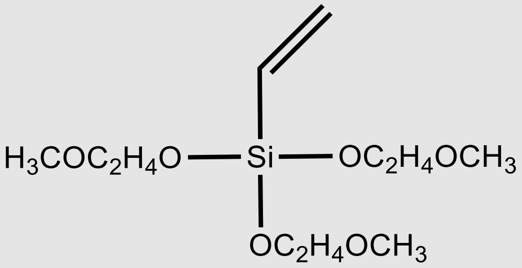
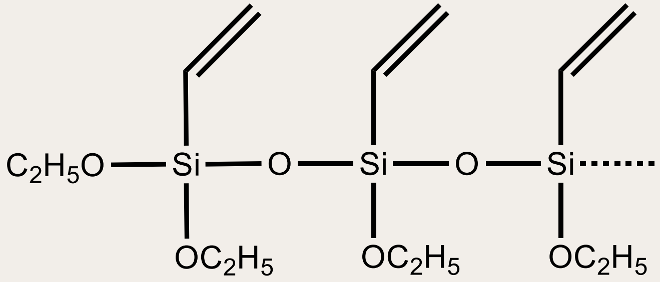
Dynasylan®
Oligomer



Dynasylan® oligomers outperform monomers

- Higher effectivity and reduced dosage amount
- Reduced volatile by-products
- Enhanced processing
- Safer handling
- Higher boiling and flash point

Dynasylan® 6498 vs. Dynasylan® VTMOEO

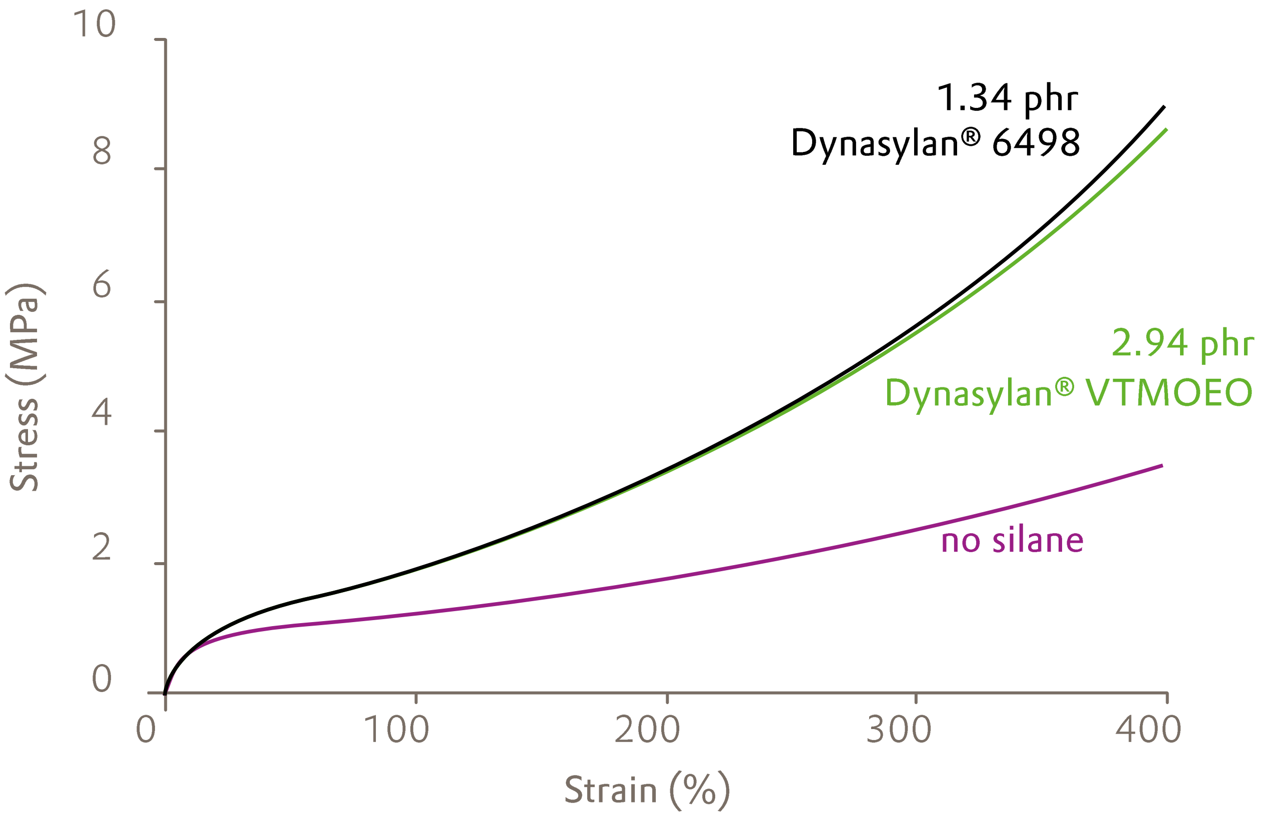
	Monomer	Oligomer
		
	Dynasylan® VTMOEO	Dynasylan® 6498
Viscosity (20°C) [mPa·s]	Ca. 2.8 mPa·s	Ca. 3.6 mPa·s
Vinylgroups [%Mass]	10%	21%
Released hydrolysis alcohol [g hydrolysis alcohol/kg Dynasylan®]	820 g (2-Methoxyethanol)	490 g (Ethanol)
Hydrolysis alcohol	Critical CMR substance	Less critical substance

Dynasylan® 6498 vs. Dynasylan® VTMOEO

Identical mechanical properties with approx. 54% less Dynasylan® 6498 necessary and approx. 73% less hydrolysis alcohol released

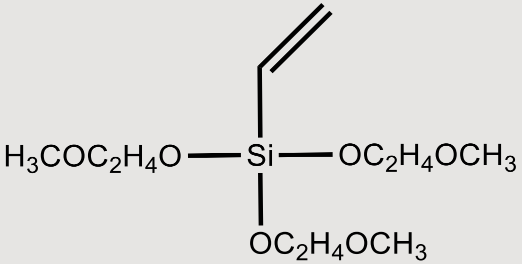
- No differences in processing
- Less Dynasylan® 6498 is neccessary
- No release of CMR hydrolysis alcohol
- Significantly reduced amount of VOC release
- Approx. 73% less hydrolysis alcohol released in this example:

Dynasylan® VTMOEO – Dosage = 2.94 phr – Released alcohol = 2.41 phr
Dynasylan® 6498 – Dosage = 1.34 phr – Released alcohol = 0.66 phr

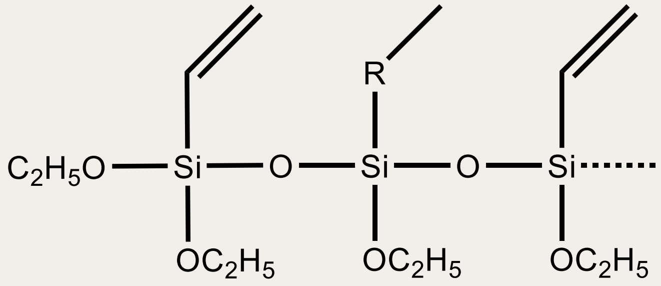


Dynasylan® 6598 vs. Dynasylan® VTMOEO

Monomer



Oligomer



	Monomer	Oligomer
	Dynasylan® VTMOEO	**Dynasylan® 6598**
Viscosity (20°C) [mPa·s]	Ca. 2.8 mPa·s	Ca. 4.6 mPa·s
Vinylgroups [%Mass]	10%	10%
Released hydrolysis alcohol [g hydrolysis alcohol/kg Dynasylan®]	820 g (2-Methoxyethanol)	460 g (Ethanol)
Hydrolysis alcohol	Critical CMR substance	Less critical substance

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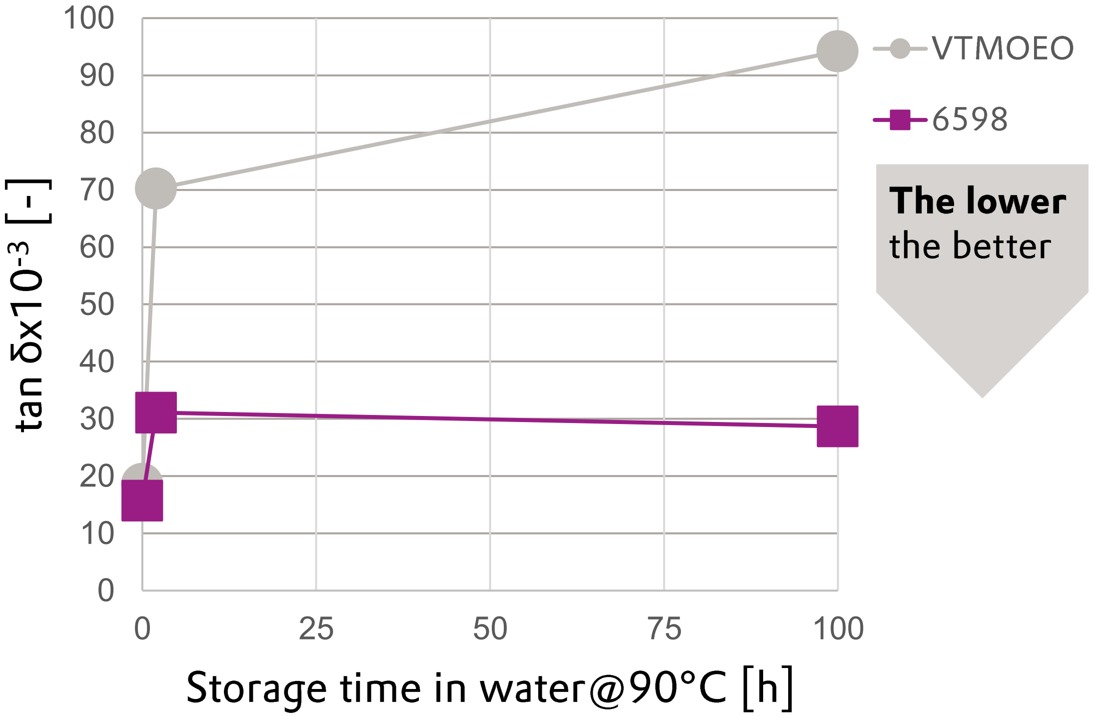
Dynasylan® 6598 vs. Dynasylan® VTMOEO

Superior electrical properties with Dynasylan® 6598, reduced alcohol release and less critical hydrolysis alcohol vs. Dynasylan® VTMOEO

What is special about Dynasylan® 6598

- Multifunctional silane oligomer – vinyl and alkyl
- 1:1 exchangeable Dynasylan® 6598 vs. Dynasylan® VTMOEO with comparable mechanical properties
- Dynasylan® 6598 leads to significantly increased long-term electrical properties (tan δ) vs. Dynasylan® VTMOEO

Dissipation factor tan $\delta x10^{-3}$ of EPDM based rubber compound before and after aging in water at 90°C



Dynasylan® 4148: A Hydrophilic Dispersion Aid Agent

DYNASYLAN® 4148

1

Red iron oxide treated with Dynasylan® 4148 (left) and untreated (right) after 10s in water

2

Self-dispersed red iron oxide treated with Dynasylan® 4148 (left) and untreated (right) after 20s in water

3

Red Iron oxide treated with Dynasylan® 4148 (left) and untreated (right) after 60s in water

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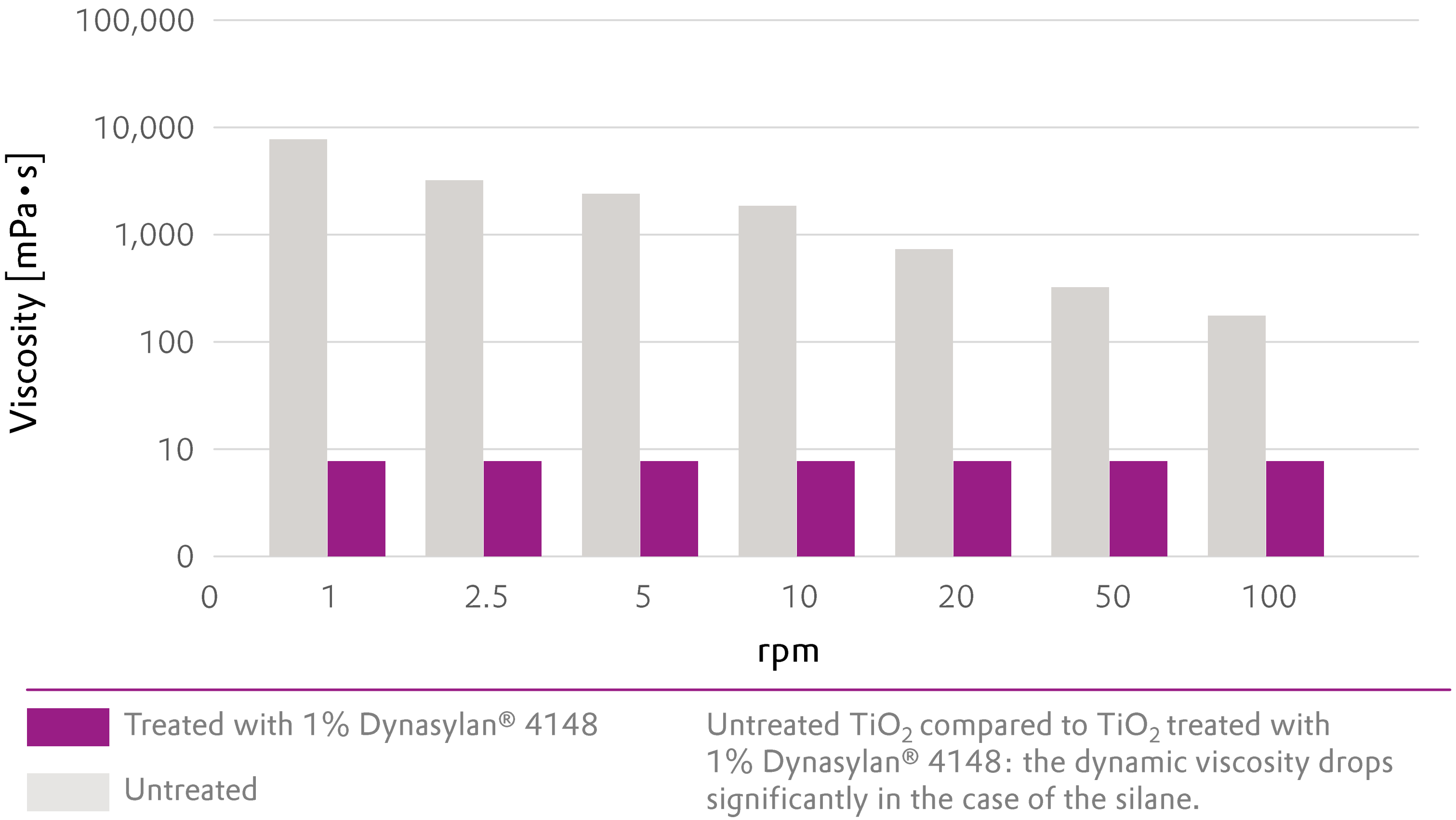
Dynasylan® 4148: A Hydrophilic Dispersion Aid Agent

Dynamic viscosity of 72.2 wt% TiO_2 in water

As Dynasylan® 4148 does not provide chemical reactivity beyond the silicon functional group, this product can be used in combination with all other products of the Dynasylan® product range. Even self-dispersability can be achieved.



Untreated TiO_2 compared to TiO_2 treated with 1% Dynasylan® 4148: the dynamic viscosity drops significantly in the case of the silane.

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There are different ways to introduce **the silane onto the filler or into the final compound.**

1. Pre-treatment method
2. In-situ method
3. Dry silane method

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1 Pre-treatment method

2 In-situ method

3 Dry silane method

Pure silane on filler

In this process, the silane is sprayed onto a well-agitated filler**. For maximum efficiency, uniform silane dispersion is essential.**

Control of silane addition, dwell time, and exact temperature control within the system are essential. An elevated temperature is required for a complete reaction to occur between the silane and the filler surface.

During the silane adding the temperature of the particles needs to be kept at a moderate range (20-40 °C). After everything has been homogenized the temperature needs to be increased (60-80°C) to ensure that finalization of the coupling reaction and to make sure that all the hydrolysis alcohol and moister have been removed out of the system.

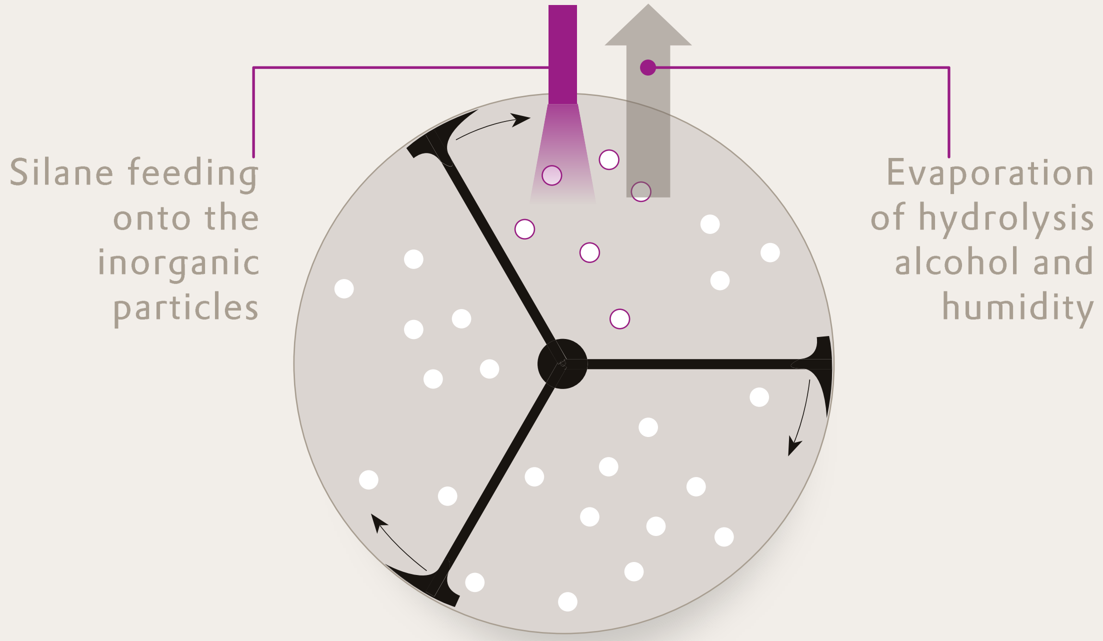
Dynasylan® **Practice**

1 Pre-treatment method

2 In-situ method

3 Dry silane method

Schematic view of a horizontal Pflugshare® mixer



1 Pre-treatment method

2 In-situ method

3 Dry silane method

Slurry process

The filler treatment in a slutty is possible with **water-soluble silanes, waterborne silane systems or silane-based water-oil emulsions**. The slurry process should be considered as a **commercial treatment procedure** when the filler is handled as a slurry during the manufacturing. Treating solutions may be aqueous, mixtures of alcohol and water, or a variety of polar and non-polar solvents. aqueous, mix

Typically, **low concentrations of the silane (up to 5%) are dissolved by hydrolysis**. The silane solution or emulsion is applied by spraying. Removal of water, solvents and reaction by-products requires additional steps such as **dehydration and drying**.

1 Pre-treatment method

2 In-situ method

3 Dry silane method

The neat silane can also be added during compounding and should migrate to the filler surface. The in-situ treatment procedure makes it possible to coat freshly formed filler surfaces, for example, during silica/rubber compounding.

The undiluted silane is added directly to the polymer before or together with the filler. It is essential that the resin or other additives do not react with the silane prematurely, as otherwise the coupling efficiency will be reduced. Typical compounding equipment includes internal mixers, kneaders, Banbury mixers, two-roll mills, co-rotating twin screw extruders, and Buss kneaders.

Dynasylan® **Practice**

1 Pre-treatment method

2 In-situ method

3 Dry silane method

The silane can also be added as a dry concentrate, for example, as a wax dispersion, dry liquid, or masterbatch. Here, the silane is adsorbed at very high levels onto suitable carriers and then blended with the polymer and the filler during compounding. **The use of "solid" silanes leads to highly effective dispersions, even with simple production equipment.** In addition, an easy and safer handling method is assured. Silane loadings are comparable to those in the in-situ method.
In this case the reaction of the silane with the filler happens during the compounding step – see step 2.

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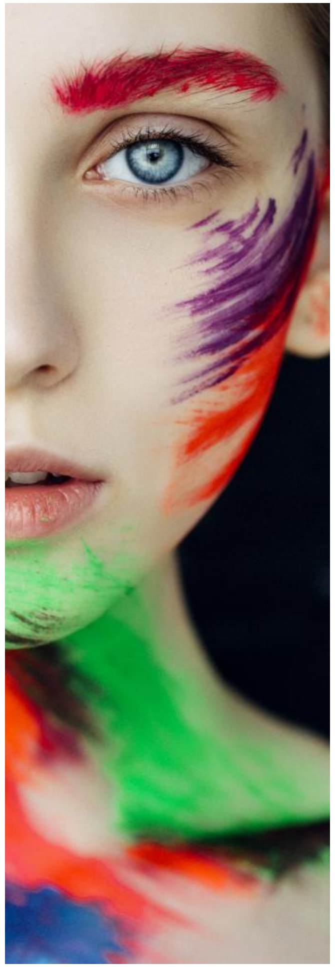
General considerations



1. Take sufficient health and safety precautions (MSDS, exposure limits, explosion limits, toxicity of by-products). Watch off-gases.
2. Check the surface area of your mineral. Minerals with surface areas higher than 70 m^2/g need a dosage higher than 1 % of silane.
3. Check the correct combination of the chosen silane and resin to which the mineral should be applied.
4. Make sure that the mineral surface provides enough moisture.
5. Avoid additional dispersing aids.
6. Use the mixers which are designed for the functionalization of particles.
7. Silane should be distributed evenly on the filler surface; best results through spraying.
8. Allow the mineral filler to blend properly.
9. Heat up to finalize the hydrolysis and condensation reaction and to remove generated alcohol and water.
10. Keep mixing to avoid agglomerates and hard particles.
11. Check for proper treatment level and formed chemical bonds through extraction

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Product overview

Product name	Description and use	Coupling/Compatibilizing/Crosslinking								Properties		
		PE	EVA/PE	PP	Rubber	Acrylics	Epoxy	Unsaturated polyester	Others	Flash point, degrees	% residual moisture required for hydrolysis at 1wt. % silane loading based on filter	Evolved VOC (alcohol) per kg of fully hydrolyzed silane
AMINOSILANES												
Dynasylan® AMEO	Coupling agent for polar compounds		●	●						93°C (199° F)	0.25	624 g ethanol/kg
Dynasylan® SIVO 210	High-performance Multifunctional Silane Systems™ for polar compounds		●	●						> 100°C (>212°F)	0.25	630 g ethanol/kg
Dynasylan® HYDROSIL 1151	Waterborne, VOC-free high-performance Multifunctional Silane System™ for polar compounds		●	●					●	80°C (176°F)	0	No VOC release only water
Dynasylan® HYDROSIL 2775	Waterborne, VOC-free high-performance Multifunctional Silane System™ for polar compounds		●	●					●	>93°C (>199°F)	0	No VOC release only water
Dynasylan® SIVO 214	High-performance Multifunctional Silane Systems™ for polar compounds		●	●						>90°C (194°F)	0.25	630 g ethanol/kg
Dynasylan® 1189	High-performance silane for polar compounds		●	●						110°C (230°F)	0.20	408 g methanol/kg

Dynasylan® Product overview

Product name	Description and use	PE	EVA/PE	PP	Rubber	Acrylics	Epoxy	Unsaturated polyester	Others	Flash point, degrees	% residual moisture required for hydrolysis at 1wt. % silane loading based on filter	Evolved VOC (alcohol) per kg of fully hydrolyzed silane
		Coupling/Compatibilizing/Crosslinking								Properties		
VINYSILANES												
Dynasylan® VTMO	Crosslinking agent	●	●							25°C (77°F)	0.37	649 g methanol/kg
Dynasylan® VTEO	Crosslinking agent	●	●							38°C (100°F)	0.28	726 g ethanol/kg
Dynasylan® HYDROSIL 2907	Waterborne, VOC-free high-performance Multifunctional Silane System™ for polar compounds	●	●		●				●	>80°C (>176°F)	0	No VOC release only water
Dynasylan® VTMOEO	Coupling agent	●	●		●					115°C (239°F)	0.20	814 g 2-methoxy-ethanol/kg
Dynasylan® 6598	High-performance Multifunctional Silane Systems™ for non-polar compounds	●	●		●					≥70°C (≥158°F)	0.18	465 g ethanol/kg
Dynasylan® 6498	High-performance Multifunctional Silane Systems™ for non-polar compounds	●	●		●					≥75°C (≥167°F)	0.16	480 g ethanol/kg
Dynasylan® 6490	High-performance Multifunctional Silane Systems™ for non-polar compounds	●	●		●					87°C (188°F)	0.23	400 g methanol/kg

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Dynasylan®

Product overview

		Coupling/Compatibilizing/Crosslinking								Properties		
Product name	Description and use	PE	EVA/PE	PP	Rubber	Acrylics	Epoxy	Unsaturated polyester	Others	Flash point, degrees	% residual moisture required for hydrolysis at 1wt. % silane loading based on filter	Evolved VOC (alcohol) per kg of fully hydrolyzed silane
ALKYLSILANES												
Dynasylan® 9896	Hydrophobizing agent							●	●	> 63ºC (>145ºF)	0.07	c.a 100 g ethanol/kg
Dynasylan® OCTEO	Hydrophobizing agent								●	> 93ºC (>199ºF)	0.20	500 g ethanol/kg
Dynasylan® IBTEO	Hydrophobizing agent								●	63ºC (145ºF)	0.25	627 g ethanol/kg
ALKYLSILANES												
Dynasylan® HYDROSIL 2776	Waterborne, VOC-free Coupling and compatibilizing agent							●	●	>100ºC (>212ºF)	0	No VOC release only water
Dynasylan® HYDROSIL 2909	Waterborne, VOC-free Coupling and compatibilizing agent							●	●	>95ºC (>203ºF)	0.25	No VOC release only water

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Dynasylan®

Product overview

Product name	Description and use	Coupling/Compatibilizing/Crosslinking								Properties		
		PE	EVA/PE	PP	Rubber	Acrylics	Epoxy	Unsaturated polyester	Others	Flash point, degrees	% residual moisture required for hydrolysis at 1wt. % silane loading based on filter	Evolved VOC (alcohol) per kg of fully hydrolyzed silane
OTHER FUNCTIONAL SILANES												
Dynasylan® MEMO	Coupling agent for unsaturated compounds				●	●	●	●	●	110ºC (230ºF)	0.22	378 g ethanol/kg
Dynasylan® 4148	High-performance silane for hydrophilic applications				●	●		●	●	>95ºC (>203ºF)	0.10	185 g methanol/kg
Dynasylan® HYDROSIL 2926	Waterborne, VOC-free high-performance Multifunctional Silane System for coupling								●	>98ºC (>208ºF)	0	No VOC release only water release
Dynasylan® GLYMO	Coupling agent for polar compounds									122ºC (252ºF)	0.23	407 g methanol/kg

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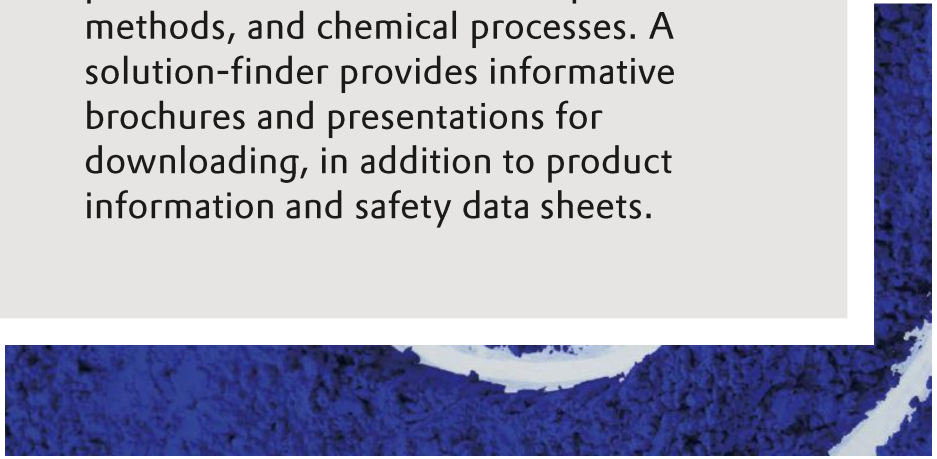
Dynasylan® on the Internet

Information, addresses, and contacts

Our website offers a well-structured platform with information on products, methods, and chemical processes. A solution-finder provides informative brochures and presentations for downloading, in addition to product information and safety data sheets.



The database containing details of Evonik contacts and dealers worldwide gives convenient access to important contact data at any time.

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