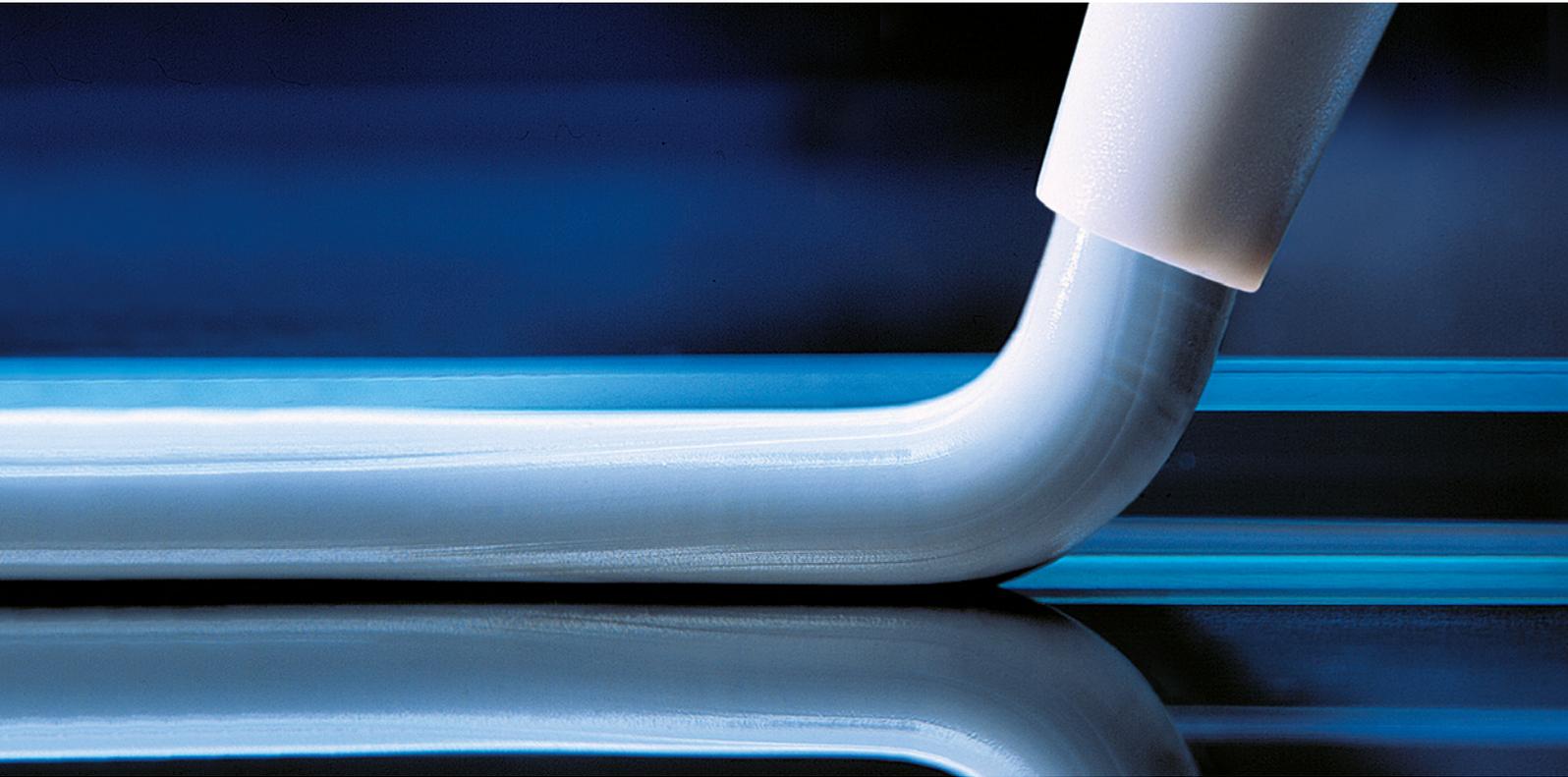


Dynasylan[®] for Adhesives and Sealants




Dynasylan[®]

 **EVONIK**
Leading Beyond Chemistry



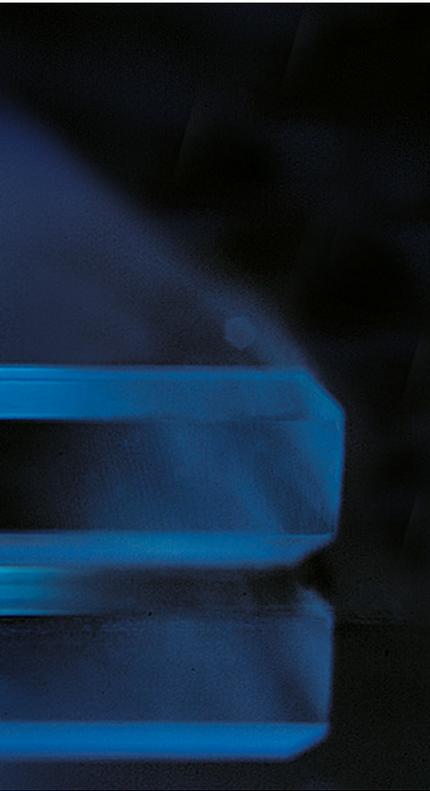
Dynasytan® . The “Glue within Glue”

Many areas of the adhesives and sealants industry have been unimaginable without Dynasytan® for decades. And with good reason: organofunctional Dynasytan® products improve adhesion, cohesion and drying. In addition, they can be used for reinforcement and endcapping.

It is these essential properties that allow adhesives and sealants, when exposed to moisture or applied to particularly difficult surfaces, to be as effective as we know them today. Dynasytan® protects modern adhesives and sealants from high levels

of environmental humidity, and maintains the full adhesive capacity of joined but not yet cured adhesive surfaces, for example during transportation. The development of “high performance” adhesives would have been more or less impossible without Dynasytan® silanes. And it was silanes that made it possible to replace sophisticated and expensive processes such as screwing, welding or riveting.

We would like to thank MAN AG, Munich, for the included pictures of its truck manufacturing plant



But does the use of a product which is so complicated to produce and which requires meticulous testing pay off? Yes, for Dynasytan[®] is manufactured for the sealant industry - where nowadays you will be hard put to find a polysulfide, polyurethane or MS polymer[®] seal without organofunctional silanes - with the highest degree of efficiency and cost-effectiveness. Therefore, by using Dynasytan[®], it is now possible to improve not only high-tech products but all adhesives.

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Only the Best Ideas Make It to Dynasylan® Products

For more than 70 years, Evonik focus has been on the research, production and application of silanes. Numerous discussions with our customers have inspired us to develop new ideas and to put them to the test in reality. This has helped us to differentiate between short-lived trends and real added value.

As with every development process, many good ideas have been rejected along the way. For it is only the perfect ideas that actually manage to become a product. For example Dynasylan® 1189, which is used not only as an adhesion promoter but also and primarily in the functionalization of polymers with aminoreactive groups.

The application of Dynasylan® 1189 has led to environmentally-friendly moisture hardening polymers which produce outstanding properties in sealants and adhesives.

Decades of experience and the specialization in our central business area – silanes – has made us into one of the world's leading suppliers and specialists for organofunctional silanes in the adhesive and sealants industry. A competitive advantage which also gives our customers the edge.



We Trust Only the Real Specialists: You and Us

When it comes to manufacturing Dynasylan® products, Evonik doesn't leave anything to chance. As the world's largest producer in the field of specialty chemicals, we prefer to take care of all the important production steps ourselves. The manufacturing of more than 150 different organofunctional silanes in many different and complex production steps requires considerable know-how and extreme care. Therefore, we process carefully selected silicon in accordance with the strictest criteria in a completely integrated production process. These high standards in quality, in terms of exact specification, extreme purity, process stability with the customer and environmental protection, apply to 'all Dynasylan® products.

But we also place great demands on the future development of new products: customers must be able to use and integrate all Dynasylan® products simply and without difficulty into their own processes. This should lead to measurably better properties in end products and at the same time produce excellent commercial results.

That these objectives can only be achieved through even closer cooperation during product evaluation is confirmed by many of our customers. Therefore, in the years to come, it is our intention to lead a multitude of new development products to the market together with you, within the framework of the brand line Dynasylan® SIVO®. It is creativity, close cooperation and speed that really count here.



Customer Demand		Dynasytan® Concept				Customer Benefits	
Application	Target Effect	Platform	Product Family	Product	Service Function	Benefits	
	Better Adhesion High Durability Long Term Stability Corrosion Resistance Fast Reaction Good Cohesion	Oligomeric System Solvent Based System Water Based System Low Reactivity High Reactivity	Alkylsilanes Aminosilanes Epoxysilanes Hydrosils Mercaptosilanes Methacrylic Silanes		Business Management Applied Technology Technical Service Logistics Global/Local Sales	Competitive Products	
Acrylics							
Butyl Hot Melts	Low Toxicity	Multifunctional Silane Systems™	Oligomers	Dynasytan® 1146	Research and Development	Commercial Success	
Butyl	Chemical Resistance	Short Process Times	Secondary Amino-silanes	Dynasytan® 1124	Customer Service		
Epoxies	Moisture Resistance	Long Process Times	Silazanes	Dynasytan® SIVO® 210	Product Safety	Efficient Production	
Hybrids	Scratch Resistance	Matrix Compatibility	Silicic Acid Esters	Dynasytan® 1151	QM		
MS-Polymers*	Easy Application	Surface Compatibility	Siloxanes	Dynasytan® HYDROSIL 2926	Analytics		
Polysulfides	Primerless Application	Silane Monomers	Vinylsilanes	Dynasytan® 4144	AQURA	True Innovations	
Polyurethanes	Easy Dosing	Silane Oligomers		Dynasytan® 6490	www.dynasytan.com		
Silicones	Improved Handling	Integrated Process		Dynasytan® 6498			
SPUR	Tailormade Solution			Dynasytan® GLYEO			
Waterborne Systems	No Labeling						

The Service Concept of the Brand Dynasytan®

The brand Dynasytan® has become one of the largest and most successful brands for functional silanes, because all the products we supply, be it standard or special silanes, are of top quality. The brand has become synonymous with quality and innovation. However, this is just one part of the full range of services the brand Dynasytan® has to offer. For the successful manufacture of adhesives and sealants in today's world, you need speed, reliability,

a productive customer/supplier relationship and a wide range of products, as well as the essential product quality.

With our range of services we offer more than "simply silanes": we guarantee our customers an individual combination of product properties, advice, product quality, availability and security. The production, storage and transportation of silanes, or their utilization in adhesives, is no easy

business. It is the objective of our service concept to persuade more and more manufacturers and users of adhesives and sealants to choose Dynasytan®.

As technically experienced "silane professionals", our researchers and application

scientists are used to sharing their special knowledge of the handling and correct use of silanes with our customers. We stick to what we know: the use of silanes as adhesion promoter, crosslinker, end-capper, drying agent or rheology modifier in adhesives and sealants.

Minimum Risk. No Compromises. Brand Quality.

The use of silanes in adhesives and sealants can be explained in three words: Little is more.

Although silanes represent the smallest part, they have a considerable influence on the properties of adhesives and sealants. Without silanes, it is often not possible to achieve the desired adhesive strength or the necessary long-term adhesive stability. Basically, the requirements for organofunctional silanes are similar to those we take for granted in high-quality foodstuffs. Inappropriate storage

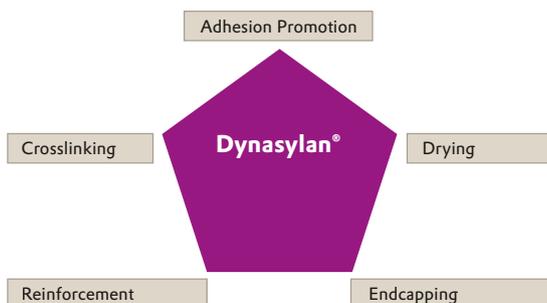
or transport can result in silanes losing not only their positive qualities, but can even lead to considerable difficulties with later products, problems which may not appear until after the adhesive or sealant has been applied - a risk which no manufacturer can afford to take.

These risks can only be eliminated with uncompromising brand quality - the Dynasytan® quality, which we have consistently demonstrated over the years, day after day.

Dynasytan® improves:

- Wet and dry adhesion
- Mechanical properties
- Storage stability
- Resistance to heat, moisture, atmospheric factors and solvents
- Storage, handling and processing

Five Functions. One Brand.



For all of these functions, the use of small amounts of Dynasytan® results in a significant improvement of important properties in adhesives and sealants: better adhesion, increased resistance to solvents, heat, ultraviolet rays and other atmospheric influences. Dynasytan® also creates outstanding mechanical properties.



Turning in Circles and Yet Moving Forwards?

The Dynasylan® brand brings with it high demands: resources protection, sustainable economics, effectiveness, compatibility and the implementation of the initiative of "Responsible Care®" are the most important. In order to guarantee that these demands are met, we produce all standard and special products in low residue material and energy cycles – the so-called "closed loop procedure". These closed production processes are designed in such a way that byproducts or residue from one process can be taken as the base raw material for another process.

As a responsible manufacturer of specialty chemicals, Evonik has concentrated for decades on the constant development of its own standards in terms of environmental protection, sustainability and production technology that protects resources. Therefore, in some cases the standards we set ourselves are often even tougher than those prescribed by the law.

For this reason, seen on a global scale, our production plants can be viewed as leading and unusually innovative. The avoidance of residues and cost-efficient process management pays off in three ways: for the environment, for the manufacturer and for the customer.



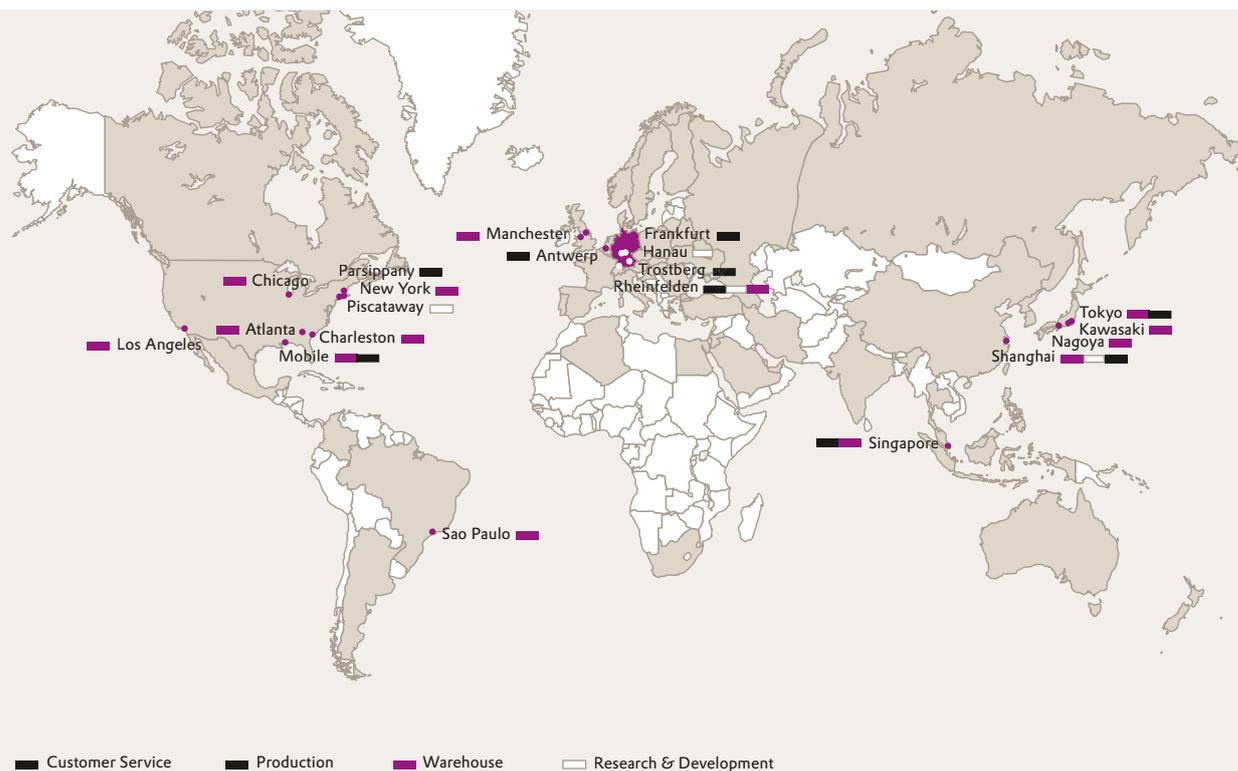
The Question Isn't if Dynasylan[®] Works, but How!

In addition to this resource-saving production method, the brand Dynasylan[®] offers our customers products which, due to their outstanding functionality, can position themselves as real problem solvers.

A good example for our "green silanes" is Dynasylan[®] 1146, a pre-condensed special silane with only minimal methanol release within the application. As an adhesion promoter for adhesives and sealants, Dynasylan[®] 1146 significantly improves adhesion to the substrate in the case of polyurethane or innovative hybrid systems or silicon rubber even under difficult conditions, such as exposure to moisture. At the same time, this product dramatically reduces the undesired volatile organic compounds (VOC) in later production or application processes, thus increasing safety at work and reducing the impact on the environment.

However, perhaps even more important is the impact on the end product: today, adhesives and sealants produced with Dynasylan[®] 1146 contain almost no VOC and are therefore visibly more compatible and safer when applied by the end customer.





Where Can You Get Dynasylan®?

Quite Simple: All Over the World

Like many of our customers, we are an international player, with more than 50 years' experience in the world's major economic regions.

It takes more than a good product - customized service is essential too. That's why we have continuously adapted our logistics (supply chains) to meet our customers' needs. Over decades our experience and our know-how have repeatedly been proven throughout the world.

Absolute reliability and fast, efficient communication are key - we keep our promises.

Above and beyond punctual delivery, we are working on logistic solutions for the future.

In order to adapt our logistics concept to the exact needs of our customers, we use modern approaches such as the SCOR concept (Supply Chain Operations Reference). With this, we can reliably handle almost any challenge our customers set us.

As the only major manufacturer of organofunctional silanes, Evonik offers trading unit sizes ranging from 25-kg drums to 20-ton bulk containers, available also with customized filling volumes on request. Because of our global presence, we are familiar with local environmental protection and toxicological regulations in numerous countries. This knowledge eases the way for many companies who are starting up local production operations.



At Home Throughout the World: Your Customers, You and Dynasylan®

Let's suppose your production site is located in Brazil. There you produce truck windshield adhesives for an international manufacturer with major exports to NAFTA and Europe. Unexpectedly, you need additional 3.8 tons of a particular silane in 950-kg IBC containers. The delivery has to be at your production site within 12 days so that the just-in-time delivery of your end product to the customer doesn't collapse.

Thanks to the Dynasylan® Service Concept this is not a problem. Being able to guarantee delivery and quality to your customers, even in exceptional circumstances, will give you a big advantage.



The First Step Was Dynasylan® 1146

Every new product should meet the expectations of the developers and customers. But what's even better is when some developments start to reveal, little by little, their true potential. One example is Dynasylan® 1146, whose discovery Evonik can quite rightly claim to be their own.

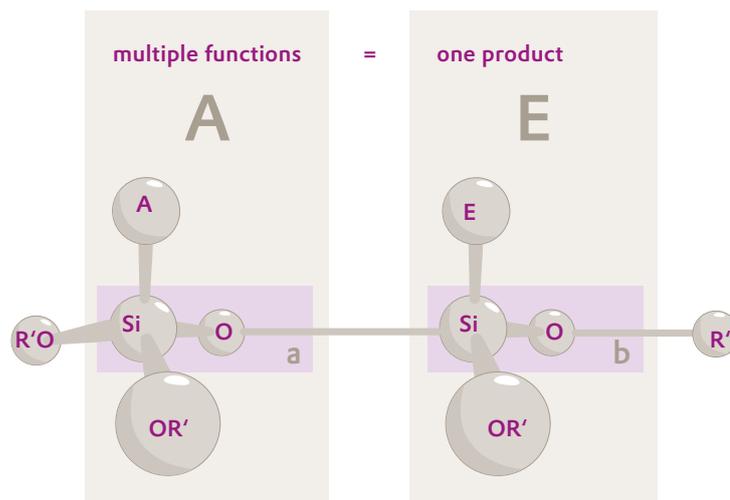
Dynasylan® 1146 was the first Dynasylan® to show true multifunctionality, namely the combination of particularly efficient adhesive promotion and simultaneously strong water repellence.

It was through discussions with our customers that the full potential of the new approach, discovered through Dynasylan® 1146, became clear: the development of Multifunctional Silane Systems™ is specially designed to conform with specific applications.

Some questions show that the possibilities offered by the new class of Multifunctional Silane Systems™ are unlimited:

- Which properties of the adhesive or sealant end products are to be changed at the same time? (e.g. storage stability and better handling)
- Which product or process improvements are to be achieved for the adhesive or sealant? (e.g. VOC freedom and cohesion, reduced toxicity and better cost-effectiveness)
- Which chemical functions should be combined? (e.g. epoxy and amino groups)

Combination of amino and epoxy functionality



A, E = organofunctional groups
OR' = methoxy or ethoxy

The Future of Multifunctional Silane Systems™ Is Called Dynasylan® SIVO®

The development of consistently application-oriented products can only occur through systematic and close cooperation with our customers. In order to guarantee this, Evonik has a highly competent group of researchers and application scientists who have dedicated themselves to the development of new Dynasylan® systems: Dynasylan® SIVO® products.

The product line Dynasylan® SIVO® represents a close collaboration between manufacturer and user, maximum concentration on the problems in practice and highly accelerated development cycles, sometimes of only 6 months.

This means that relevant competitive advantages can be quickly realized:

- Better performance in special application areas for products
- Higher productivity, better handling or increased storage capability of the adhesives and sealants
- Reduced toxicity, better environmental compatibility in their production and in processing at the customers
- Use of less monofunctional silanes to ensure minimal complexity and reduced storage

Dynasylan® SIVO® can generate real added value through innovative, multifunctional silanes such as Dynasylan® 1146 and Dynasylan® SIVO® 210.



Special Questions, Special Answers.

The Dynasylan® Specialty Silanes

Over the last ten years, adhesives and sealants have developed into a high-tech industry. This stands for future and responsibility.

These innovations have opened up new and unequalled areas of application for adhesives and sealants, creating both new opportunities and challenges, which demand new solutions.

A part of these solutions are the Dynasylan® special silanes, which often represent real “solutions for the customer” due to their special properties.

Thus they can be used both for the formulation of new adhesives and sealants, and for “modernizing” successful adhesives and sealants which have to be changed in order to keep up with constantly increasing demands. For example, through its reaction with free isocyanate groups, the use of Dynasylan® 1189 results in outstanding moisture curable binders which are at the same time environmentally-friendly.



Especially, where high adhesion is required quickly, adhesives formulated on the basis of special silanes have proved to be effective. For example, in heavy goods vehicle production, after only a few minutes, an approx. 40-kg windshield has such a high level of adhesion to the lacquered chassis surface, that the driver’s cab could be swung round without any risk at all. Long curing periods are unnecessary so that the vehicles can be moved without restriction and be delivered just in time.

Dynasylan® 1189

In adhesives and sealants, Dynasylan® 1189 acts as an adhesion promoter, primarily to **functionalize polymers** with aminoreactive groups, for example **isocyanate pre-polymers**. This functionalization with Dynasylan® 1189 leads to new and environmentally-friendly moisture curable binders which can be processed into adhesives and sealants with innovative property profiles. In addition, the trialkoxysilicon function in Dynasylan® 1189 guarantees sufficiently quick curing and high crosslinking density in the resulting end product.

- Accelerates the production of silane-terminated PU binders (basis polymers) and thus their adhesives and sealants
- Reacts quickly and completely with free isocyanate groups to form hydrophobic, thermally stable urea groups
- Produces high yields of very good, reproducible and mostly colorless polymers with low viscosity
- Causes no side reactions and no precuring undesirable for PU chemistry
- Efficient polar adhesion promoter with integrated non-polar alkyl group, results in adhesives and sealants with extremely high elasticity

Dynasylan® 1146

Dynasylan® 1146: adhesion promoter in many adhesives and sealants with extended properties profile: environmentally- and user-friendly through reduced VOC. The unique oligomeric structure of Dynasylan® 1146, achieved through patented Evonik technology, produces not only a good adhesion spectrum but also an important water-repellent effect in the adhesives and sealants from which it is made on the basis of RTV-1 silicone, 2K polyurethane, butyl rubber, silane-terminated hybrid polymers (hybrid systems) or 2K epoxy resin.

With Dynasylan® 1146, the disadvantage of having to provide labeling due to the sensitizing potential, known from other aminosilane adhesion promoters, is now a thing of the past.

- Improves adhesion in adhesives and sealants made with it, also on problematic substrates and when exposed to moisture
- Effectively repels undesirable moisture penetration into the sealant, thereby preventing premature product failure
- Balances important mechanical properties such as tensile and flexural strength to a high level
- Improves handling and processing of adhesives and sealants
- Releases significantly lower alcohol amounts through the reduced VOC
- Is non-sensitizing on contact with skin and therefore does not require special labeling
- Causes less yellowing of white or transparent sealants, compared to traditional aminosilanes



Dynasylan® 1124

Similar to Dynasylan® 1189, Dynasylan® 1124 can be used as a multi-purpose Dynasylan®, as an adhesion promoter and for the retroactive modification of suitable pre-polymers. However, Dynasylan® 1124's main strength lies in its function as an adhesion promoter in polyurethane – either directly as an additive or as a highly efficient primer component. With this secondary aminosilane, excellent adhesion properties can be achieved on problematic polymer substrates, e.g. polycarbonate, which suggests its use in automobile applications. Because of its structure, Dynasylan® 1124 is also suitable for the manufacture of silane-terminated polyurethanes; strongly crosslinked (high modulus area) pre-polymers are thus possible.

- Has been proven as a highly efficient adhesion promoter in many polyurethane systems (formulations)
- In solvent-based primer applications, due to its extraordinarily good adhesive properties in difficult-to-stick synthetic materials, Dynasylan® 1124 is far superior to conventional aminosilanes
- Has a very high crosslinking potential due to a total of 6 alkoxy groups, which is particularly advantageous in high modulus structural adhesives
- As secondary aminosilane, accelerates the production of silane-terminated PU binders (basis polymers) and, where necessary, also their adhesives and sealants
- Reacts quickly and without residue with free isocyanate groups to form hydrophobic, heat stable urea groups

Dynasylan® GLYEO

Ideal adhesion promoter for aqueous adhesive and sealant systems, as well as for many glass applications. Dynasylan® GLYEO hydrolyzes and condenses slower than Dynasylan® GLYMO. This guarantees significantly improved stability in aqueous adhesive systems (acrylate, epoxy, latex). Dynasylan® GLYEO is specially recommended for applications in which controlled adhesion and cohesion is particularly important, or in trendsetting ethoxy systems.

- Epoxy functionalized adhesion promoter with slow hydrolyzing ethoxy groups
- Dramatic increase in stability of water-based adhesives and sealants, without negatively affecting epoxy functionality
- Releases more environmentally-friendly ethanol when applied compared to conventional methano releasing silanes

Dynasylan® SIVO® 210

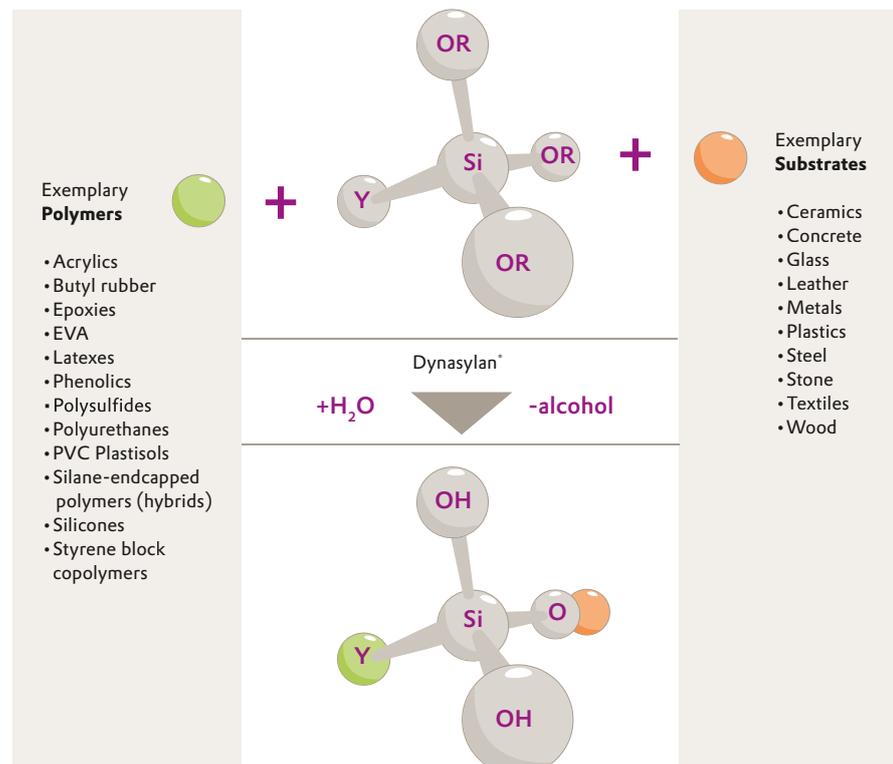
Dynasylan® SIVO® 210 is an amino functional silane system which is used as an adhesion promoter and in the modification of aminoreactive polymers (e.g. with isocyanate or epoxy groups). It contains a customized combination of primary and secondary aminoalkylethoxy silanes, that's why Dynasylan® SIVO® 210 is especially well-suited for the composition of 3-dimensional, crosslinked layers on and between substrates and in organic matrices. Toxic methanol can not be released, only the more environmentally-friendly ethanol instead. In addition, its good crosslinking ability makes Dynasylan® SIVO® 210 a preferred component in the manufacture of chemically-modified foil-clad adhesives, as well as in corrosion-resistant primer systems for diverse metals.

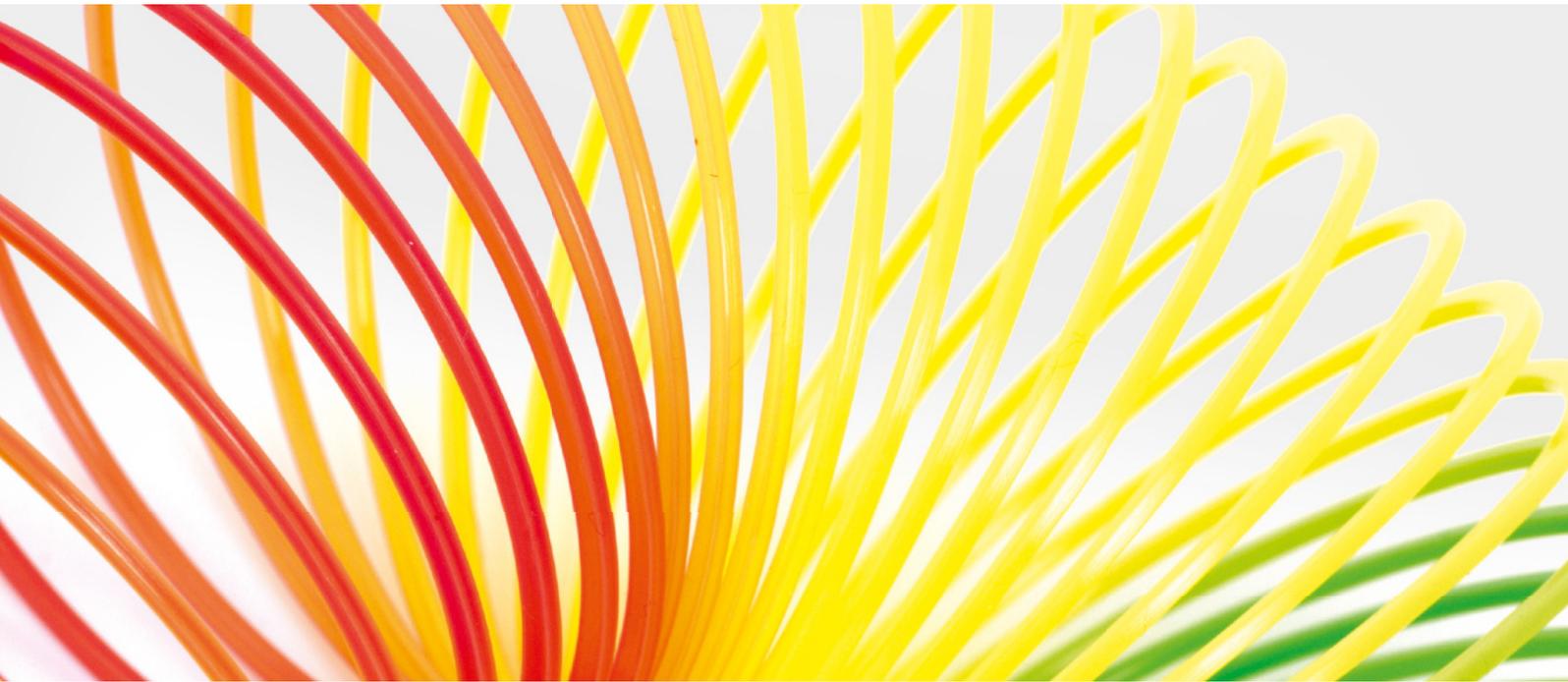
- Can be used as additive or as primer
- Improves product properties such as tensile, modulus and impact strength
- Perfectly combines primary with stronger basic secondary aminosilanes, thereby producing customized reactivity for the functionalization of aminoreactive polymers (with epoxy or isocyanate groups), e.g. for foil-clad adhesives
- On the silicon side of the silanes, too, the combination of 3 with 6 alkoxy groups produces sufficiently dense 3D crosslinking structures with enough flexibility

Dynasylan® as Adhesion Promoter

When used as an adhesion promoter, Dynasylan® acts as a bifunctional organo-silicon binding agent, which creates a chemical link (bridge) between an adhesive or sealant and either an inorganic or organic substrate. As an adhesion promoter, Dynasylan® can be added as an additive directly during the production of the end product. This has become successful and normal practice in many application areas (TK systems are becoming increasingly important). Where a particularly complicated adhesion problem is concerned (and if the use of Dynasylan® as an additive is impossible in this special case), the Dynasylan® adhesion promoter can also be applied as a primer (e.g. as water- or solvent-containing solution) to the substrate.

The silicon functional group "OR" (mainly methoxy or ethoxy groups) hydrolyzes in water (humidity, surface moisture) to form reactive silanol groups (Si-OH). Depending on the amount of moisture present, alcohol is released in smaller or larger amounts. A further reaction of the silanol groups often occurs through condensation with reactive surface groups of the relevant substrate (e.g. metal or glass). Crucial for the success or failure of an adhesive or sealant is the selection of the right adhesion promoter, and in particular the selection of the organofunctional group "Y". This ensures optimum compatibility with the polymer type being used and is decisive for the quality of the physical properties of the adhesive.

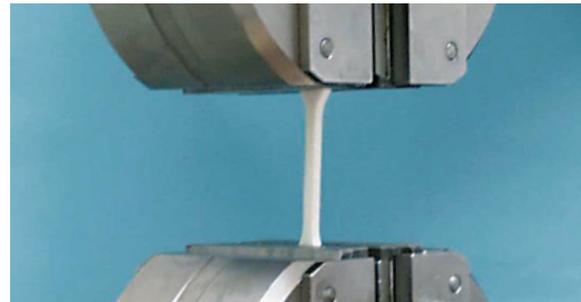




Dynasylan® as Crosslinking Agent

Dynasylan® products have long been in use as a polymer crosslinking agent, for example in silicones, MS polymers® and polyurethanes. In these applications, they positively influence properties such as modulus of elasticity, flexural or tensile strength. In addition, silanes can modify a polymer chain through radical polymerization or by reacting with active groups. Crosslinking is catalyzed by humidity; actual crosslinking speed can be adapted to the respective product requirements through various factors, e.g. type and

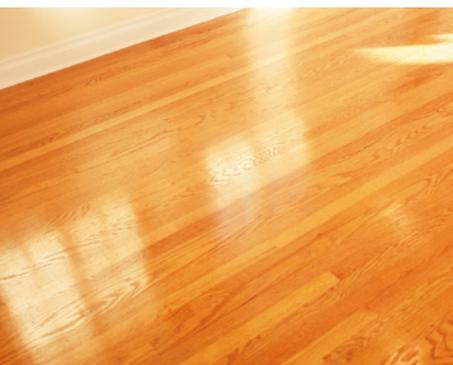
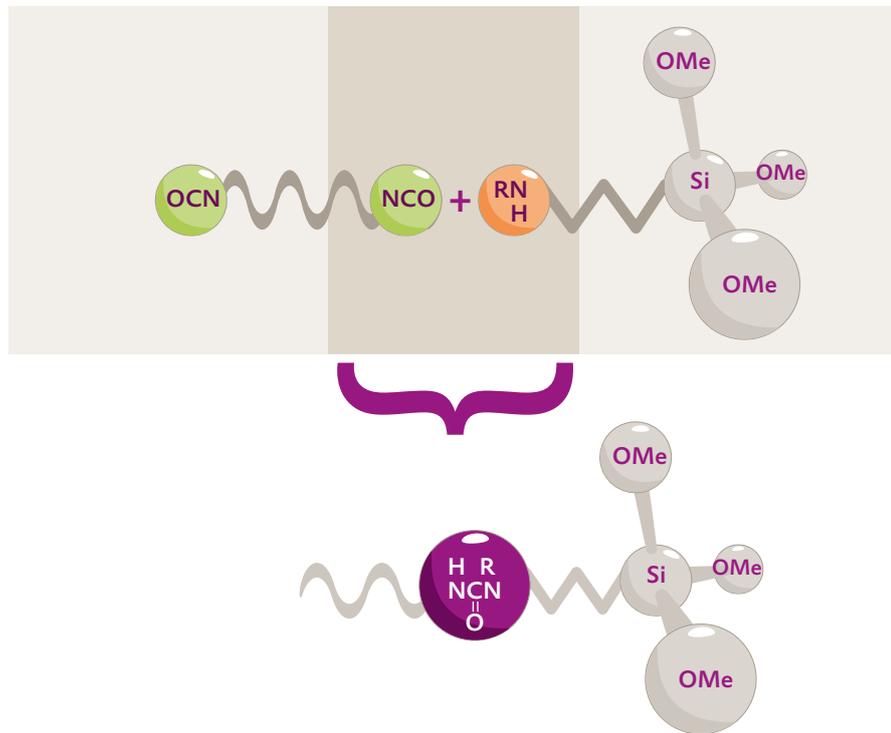
amount of silanes, or changes to catalyst or pH values. The type and amount of alkoxy groups in the basic silicon structure of Dynasylan®, as well as the basicity of the polymer group "Y", can have a significant impact on the nature of the crosslinking. Our most important crosslinkers are: Dynasylan® P, Dynasylan® 40, Dynasylan® A, Dynasylan® VTMO and various aminosilanes (as co-crosslinkers) e.g. Dynasylan® 1146 or Dynasylan® TRIAMO.



Dynasytan[®] as Endcapper

For many years now, there have been polyurethane-based adhesives and sealants in which curing and crosslinking occurs through the reaction of the isocyanate end groups (NCO groups) with humidity. However, because of their physiological effects, many of today's manufacturers of adhesives and sealants

would like to replace the NCO groups with others that do not represent a health risk but are nevertheless moisture-reactive. In light of this trend, Dynasytan[®] offers the quick application, without side reactions, of NCO-containing prepolymers with highly reactive secondary aminosilanes.



For the production of these new binder systems (use in structural adhesives, parquet adhesives, over-paintable hybrid sealants), Evonik provides the following silanes:

Dynasytan[®] 1189:

- Rapid reaction with NCO groups, also without a catalyst
- Urea structure protected against hydrolysis through the butyl group

Dynasytan[®] 1124:

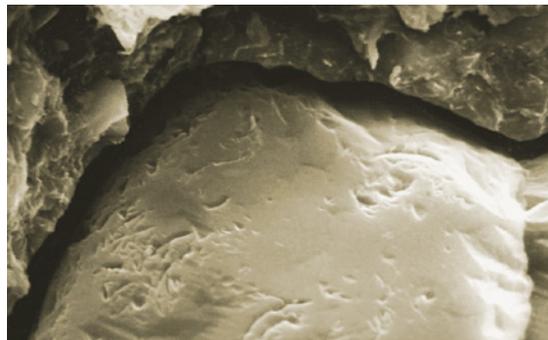
- Rapid reaction with NCO groups, also without a catalyst
- Increased cohesion density through double silicon function

Dynasylan[®] as Drying Agent

Due to their tendency to hydrolyze rapidly, vinyl silanes such as Dynasylan[®] VTMO are used as drying agents in moisture-curing hybrid-sealing compounds. Dynasylan[®] VTMO reacts with unwanted water, even when other silanes are present due to formulation for other purposes (e.g. adhesion promotion).

Thus Dynasylan[®] VTMO gives sealing compounds improved storage stability and prevents the compound from curing prematurely. The main source of unwanted moisture penetration in hybrid systems is, besides insufficient moisture exclusion during production, often left-over residual moisture on the filler material. Where further demands are made on the drying agent due to the end application, e.g. high flash point and low volatility, we recommend Dynasylan[®] 6490 as oligomeric and environmentally-friendly drying agent.





untreated



treated

Dynasylan[®] as Reinforcer

Dynasylan[®] products can be used to strengthen adhesives and sealants internally, using the same mechanism as with adhesion. When using reinforced fillers with reactive surfaces (e.g. with OH groups), carefully selected Dynasylan[®] reinforcer creates a strong covalent link over molecular bridges between the filler and polymer system. This results not only in a visible improvement in internal cohesion, but less filler agglomerate is formed in the polymer mass, which in turn leads to the fixed particles being better mixed. The Dynasylan[®] reinforcement can be

given as an additive, together with the filler, directly to the adhesive and sealant, or, in a previous step, the filler is coated with the Dynasylan[®] best suited to that particular use.

For many years, brands like AEROSIL[®] or AEROXIDE[®] have successfully used pyrogenic silica or pyrogenic special oxides modified with Dynasylan[®] in the market. The desired and highly valued effects are: thickening, thixotropy, processability, transparency and reinforcement.

Dynasylan® on the Internet

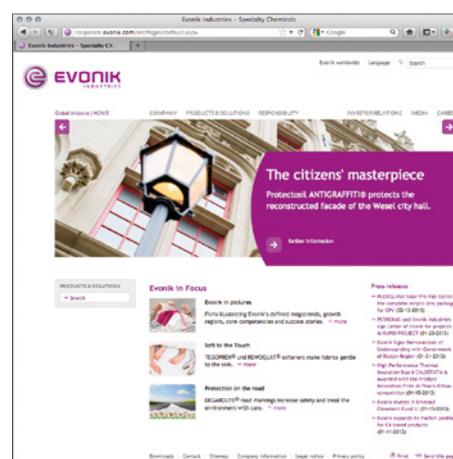
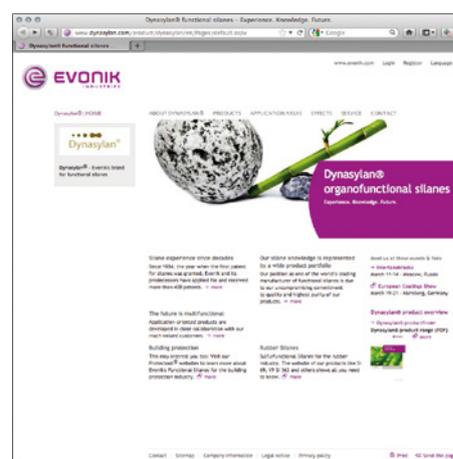
Information, addresses and contacts

The website www.dynasylan.com provides you with a well-structured information platform, where you will find everything you need to know on products, procedures and chemical processes. Via a Solution Finder, you can also download product information and security data sheets, as well as informative brochures or presentations.

The worldwide database with Evonik contact persons and traders allows you comfortable and easy access to important contact data at any time.

www.dynasylan.com

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