



**AEROSIL<sup>®</sup> for  
Silicone Rubber**

**AEROSIL** Invented to improve<sup>®</sup>

AEROSIL® fumed silica improves the dielectric properties of high-voltage insulators



# AEROSIL® – More than just a powder



Dr. Harry Kloepfer,  
Evonik chemist  
and inventor of  
AEROSIL® fumed silica

Evonik Industries developed AEROSIL® fumed silica more than 60 years ago, and has dominated the world's development and production of fumed silica ever since. The silicone industry as we know it would be inconceivable without fumed silica. AEROSIL® products allow optimal adjustment of the rheological properties for every individual application and improve mechanical properties; moreover, AEROSIL® fumed silica also acts as an anti-sedimentation agent and improves the storage stability, processability and application of silicone materials. Special AEROSIL® grades allow systems to be realized that are highly transparent or particularly stable to heat. It is not just AEROSIL® fumed silica that has become indispensable; the highly specialized and environmentally friendly technologies that it has spawned have also become firmly established in the silicone industry. In addition to the actual AEROSIL® products, we offer in many cases a complete technological solution with

unbeatable advantages. Our specialized teams in Research and Development work towards continued development of the products and their applications.

Dedicated laboratories work out applications and handling solutions in conjunction with customers. Highly efficient logistics guarantee on-time delivery. Well-designed packaging solves technical handling problems before they can occur. Technical support and customer care are available worldwide. A policy of long-term availability means that AEROSIL® fumed silica offers planning security and avoids unexpected investment costs for alternative solutions.

Our worldwide presence allows us to pool our expertise in an international network. We work hand in hand with our customers to develop individual system solutions that meet their highest standards and make their silicone products even more successful.

For us, the highest degree of customer satisfaction is not an elastic concept



AEROSIL® fumed silica imparts high mechanical strength and anti-slip properties to silicone-coated textiles

#### **Years of expertise in solutions**

Silicone Rubber is used in the most varied industries, and is becoming increasingly important particularly in the automotive and textile industries. The development of special hydrophobic AEROSIL® grades has allowed production of modern adhesives and sealants that are helping shape the technologies of the future in automotive production. With these modern Silicone Sealants, it is possible to use structural glazing for light-transparent

roof and facade structures. Silicone-coated fabrics, in contrast, are used not only in technical fields, such as textile structural applications, but also find interesting application in other products. In silicone-coated textiles such as baby socks, for example, Silicone Rubber is used that, thanks to the AEROSIL® reinforcing component, provide a coating of high mechanical strength with anti-slip properties. Coatings of this type also repel dirt and water.

## AEROSIL® milestones for the silicone industry

Market Introduction	AEROSIL® grades / new products	Applications
<b>1940s</b>	Development of the world's first hydrophilic fumed silicas, e.g. AEROSIL® 150, 200, 300	Acetoxy crosslinking RTV one-component Silicone Sealants and high-temperature vulcanizing Silicone Rubber (HTV)
<b>1960s</b>	AEROSIL® R 972: Development of the world's first hydrophobic fumed silica modified with dichlorodimethyl silane (DDS)	Neutrally crosslinking RTV one-component Silicone Sealants (alcoxy and oxime systems)
<b>1970s</b>	AEROXIDE® TiO2 P 25: Development of a fumed titanium dioxide	Heat stabilizer for all Silicone Rubber systems
<b>1980s</b>	AEROSIL® R 812 S: Development of a highly hydrophobic fumed silica modified with hexamethyldisilazane (HMDS)	Highly transparent, high-temperature vulcanizing liquid Silicone Rubber (LSR/LIMS)
<b>1990s</b>	AEROSIL® R 104, R 106: Development of hydrophobic fumed silicas modified with octamethyl cyclotetrasiloxane (D4)	Highly transparent, high-temperature vulcanizing Silicone Rubber (HTV)
<b>Today</b>	AEROSIL® R 8200: Development of a structure modified, highly hydrophobic fumed silica modified with hexamethyldisilazane (HMDS)	Self-leveling RTV one-component Silicone Sealants  RTV two-component casting compounds and molding compounds
	AEROSIL® 200 SP, AEROSIL® 300 SP – Development of a structure modified hydrophilic fumed silica	Highly transparent, easy processing Silicone Rubber (HTV and LSR/LIMS)

### Extremely wide product range, novel and innovative experimental products

With a number of AEROSIL® grades developed specially for the silicone industry, Evonik can offer a product range providing technical advantages and improvements for a large number of silicone systems. And it already has a broad base of novel and innovative experimental products for development of the next generation of AEROSIL® products.

These novel products will allow continued improvement of various highly interesting properties in Silicone Rubber such as flowability, tear resistance, and transparency.

## AEROSIL® – Advantageous for thermal properties

Food molds made from Silicone Rubber retain their great flexibility not only at temperatures down to -40 °C (ice-cube trays) but also above 200 °C (cake molds)



### **AEROSIL® in flexible and temperature-stable food molds**

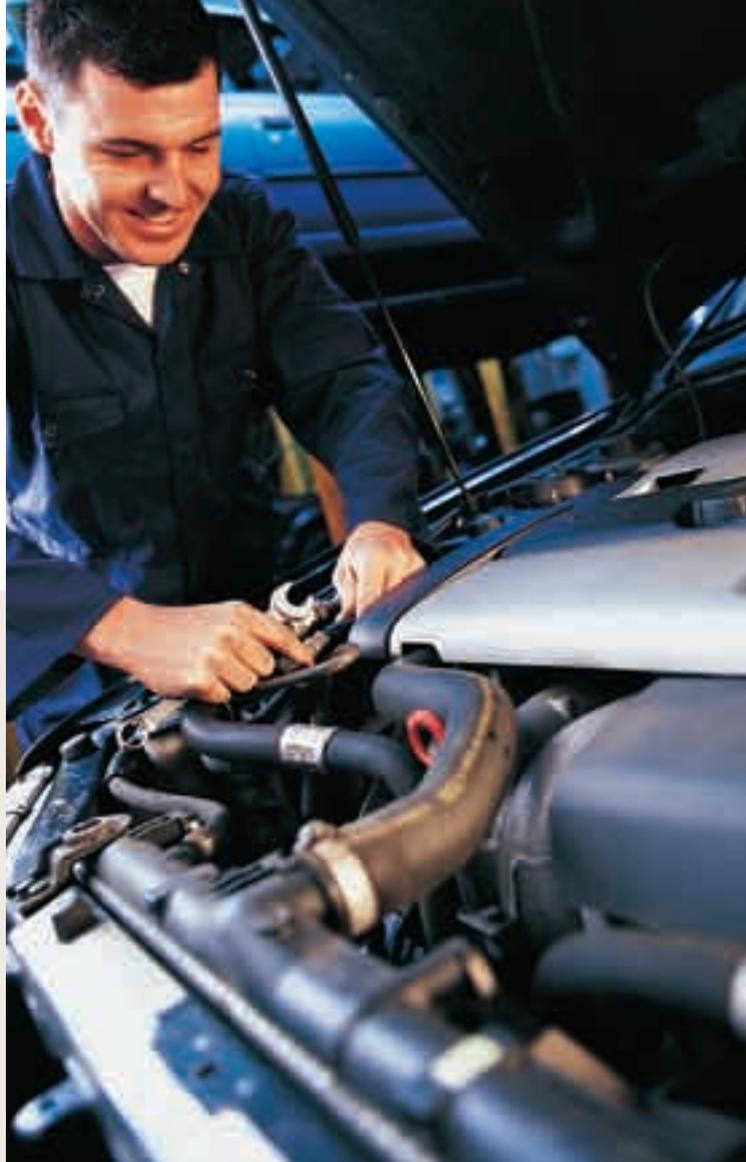
AEROSIL® fumed silica plays an important role as an active reinforcing component in food molds made of Silicone Rubber, such as ice-cube trays or cake molds. Excellent thermal properties such as low-temperature flexibility and heat resistance are obtained by the use of AEROSIL® products or special heat stabilizers.

Silicone Rubber ice-cube trays retain their flexibility even at temperatures as low as -40 °C, making it very easy to remove the ice cubes from the tray without damaging it. Cake molds of Silicone Rubber, on the other hand, are heat-resistant up to 280 °C, non-slip and completely dishwasher safe. No non-stick coating or greasing of the mold is necessary because the batter does not adhere to the elastic silicone mold. And the silicone material results in energy savings of 10–20%. Food molds can be made from solid or liquid silicones, which

may be ready-to-use HTV or LSR Silicone Rubber. These are one-component or two-component systems of a highly viscous or free-flowing consistency, which are fully cured to an elastic Silicone Rubber under the action of specially tailored crosslinker-catalyst systems at processing temperatures above 100 °C.

AEROSIL® fumed silica imparts the necessary rheological, mechanical and optical properties to the Silicone Rubber. Evonik offers a special oxide for Silicone Rubber, AEROXIDE® TiO<sub>2</sub>P 25 as a heat stabilizer for high-temperature application.

**AEROSIL® in and around the automobile**  
Silicone systems such as silicone sealants with AEROSIL® fumed silica as active component are now indispensable also in automotive construction. Whether in the engine, the drive system, the cooling system, the electronics or the body, silicones,



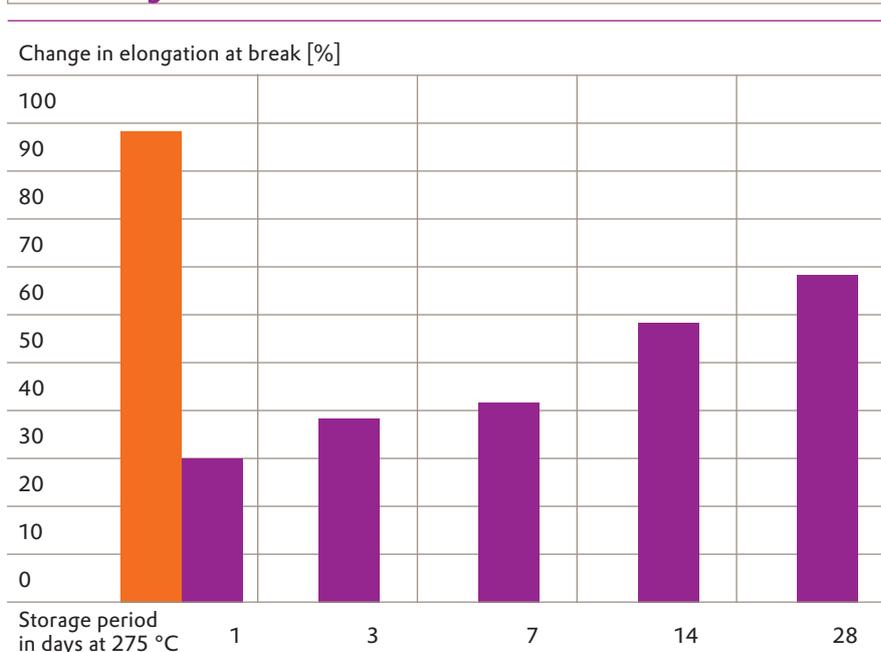
## AEROSIL® does not leave you out in the cold

- High flexibility at low temperatures
- Improvement of heat stability through metal oxides
- Flame-resistance
- UV stabilization
- Ozone stabilization

Silicone Gaskets play an important role in automotive construction. These systems are particularly well suited for sealing of, for example, engine segments: Thanks to AEROSIL® fumed silica they retain their elasticity even during long-term exposure to temperatures of up to 250°C

with their exceptional and highly specific properties, have already overtaken more conventional materials. For sealing engine segments, for example, RTV one-component Silicone Rubber is particularly suitable because they retain their elasticity even on long-term exposure to temperatures of up to 250 °C. The FIGP (Formed in Place Gasket) process is often used here, in which the Silicone Rubber is applied from a dosing head that traces the computer-programmed contour of the product part to be sealed, in the manner of a template. RTV one-component systems are ready-to-use single-component systems of a free-flowing or soft paste consistency that are fully cured to an elastic Silicone Rubber under the effect of atmospheric humidity at room temperature. AEROSIL® fumed silica lends the Silicone Rubber the necessary rheological and mechanical properties.

### Percentage change of elongation at break for HTV Silicone Rubber after storage at 275 °C\*



■ HTV without heat stabilizer ■ with 1.5% AEROXIDE® TiO<sub>2</sub> P 25

\* The data are not legally binding. Results may vary according to equipment and formulation.

## AEROSIL® – Advantageous for optical properties

RTV one-component Silicone Sealants are reinforced with AEROSIL® fumed silica; they are usually pigmented but may also be highly transparent, glossy or matt



### AEROSIL® offers far more than an attractive appearance

- Transparency
- Smooth, glossy surfaces
- Matting of surfaces

#### Special effects: matting of silicone surfaces

Matting of Silicone Sealants is of interest in certain application areas for safety reasons (to provide an anti-glare effect) as well as for esthetic purposes. In electronic LED displays, for example, matting suppresses disturbing reflectance of light. Conventional matting agents cannot be used in silicone sealants because their water content is too high. Moreover, the large quantities of these substances necessary to achieve a matting effect would adversely affect the mechanical properties. Evonik's VP AEROPERL® R 806/30 is a novel synthetic silica, developed specifically for RTV one-component Silicone Sealants, achieving significant matting even when used in small quantities.

#### AEROSIL® lets you keep things in view

Thanks to AEROSIL® fumed silica, Silicone Rubber is colorless and highly transparent. This has resulted in the material being used in a wide range of applications on purely esthetic grounds. Silicone Rubber can be pigmented to almost any color, but highly transparent formulations are also commercially available. These are used for medical applications, such as tubes and catheters, but are also preferred in products for daily use such as nipples for baby bottles and diving goggles because they allow visual checking.

The transparency of such formulations is controlled essentially by two factors: the particle size of the silica and the refractive

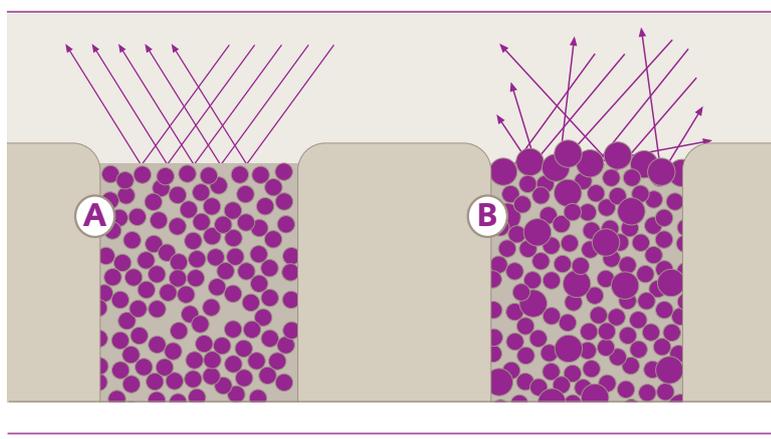


Highly transparent diving goggles and snorkel mouthpieces of HTV Silicone Rubber

index of the polymer or filler. AEROSIL® grades such as AEROSIL® 300 SP having a relatively high active surface area are especially suitable for highly transparent silicone systems. By modifying the fumed silica surface with silanes or silicones, the refractive index can be adjusted so that it is similar to that of Silicone Rubber, improving the transparency of the silicone system.

AEROSIL® R 106 and AEROSIL® R 812 S are examples of extremely hydrophobic materials that allow high-transparency products.

### Matting effect of surfaces



(A) Conventional sealant with AEROSIL® products (glossy surface)  
 (B) Sealant with AEROSIL® fumed silica and VP AEROPERL® R 806/30 (matt surface)

## AEROSIL® – Advantageous for rheological properties

With AEROSIL® it's guaranteed to flow perfectly – or not at all

- Viscosity
- Extrusion rate
- Thixotropic effect
- Flowability
- Storage stability



### Silicone Rubber and AEROSIL® – without thickening?

In addition to their reinforcing effect, fumed silicas such as AEROSIL® fumed silica in particular have thickening and thixotropic properties that are disadvantageous in a number of applications and must therefore be suppressed. This is especially important in very low-viscosity and free-flowing systems such as Liquid Silicone Rubber (LSR) and RTV two-component systems (casting and molding compounds). Low viscosities are essential here, and not only for ease of processing: fairly long storage periods, without significant changes in the rheological properties, must be guaranteed for these sensitive systems. By modification of hydrophilic starting products in special processes, Evonik can offer highly hydrophobic (e.g. AEROSIL® R 812 S) and even highly hydrophobic structurally modified products (e.g. AEROSIL® R 8200) that satisfy these exacting requirements.

### Silicone Rubber deliberately thickened – thanks to AEROSIL®!

Other silicone systems, on the other hand, require certain levels of viscosity, which can be set selectively by the use of a fumed silica. When processing RTV one-component Silicone Sealants, for example, a particular extrusion rate (extrudability) is absolutely essential.

The attainment of a particular viscosity level (yield point) is also essential so that the sealant remains in the desired location in the application (e.g. in a wall joint) and is fully cured at exactly that location. This effect that AEROSIL® fumed silica provides is known as thixotropy.

In general, hydrophilic AEROSIL® products of moderate active surface area such as AEROSIL® 150 are used for RTV one-component Silicone Sealants. Hydrophobic products like AEROSIL® R 106 and AEROSIL® R 812 S with higher active surface areas are excellently suited for highly transparent systems.

(left) Structurally modified, hydrophobic AEROSIL® R 8200 for low-viscosity, free-flowing RTV two-component Silicone Rubber

(middle) RTV two-component Silicone Rubber finds application in monument preservation (molding compounds), in dental technology, and for rapid prototyping of components in, e.g., the automotive industry

(right) RTV one-component Silicone Sealant before hardening in a seal (left) without AEROSIL® products (right) with AEROSIL® fumed silica as thixotropic agent

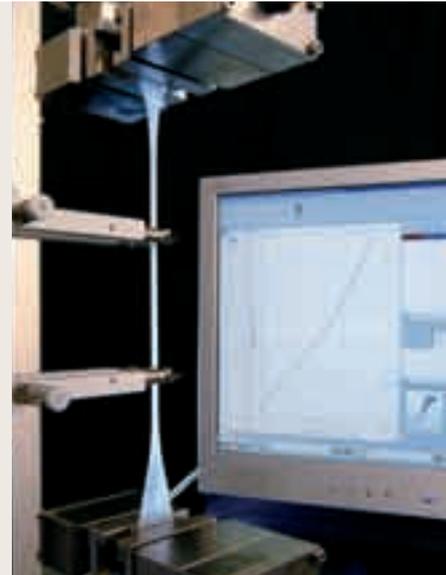


Processing of RTV one-component Silicone Sealants, e.g. for sealing showers

## AEROSIL® – Advantageous for mechanical properties

(left) AEROSIL® fumed silica is used as a reinforcing component in Silicone Rubber products for earthquake-proof building foundations

(right) Tensile testing machine for determination of mechanical properties such as tensile strength, elongation at break, and tear resistance of cured Silicone Rubber



### **AEROSIL® – in earthquake-proof building foundations**

Silicone Rubbers with AEROSIL® fumed silica as the active reinforcing component play an important role in earthquake-proof foundations. The Japanese-developed technology of using Silicone Rubber as an important component of foundations affords buildings in particularly endangered regions additional protection against earthquake damage, even under large mechanical stress.

For this purpose, conventional building materials are combined in a special process with layers of Silicone Rubber for which the parameters have previously

been calculated with high precision. RTV two-component Silicone Rubber is used not only for sealing purposes in this application, but also to provide the foundation with a special elasticity at both high and low temperatures. RTV two-component Silicone Rubber is a ready-to-use two-component systems of a free-flowing or slightly pasty consistency, which, under the action of crosslinker-catalyst systems tailored specifically to these systems, are cured at room temperature to an elastic Silicone Rubber. AEROSIL® fumed silica imparts to the Silicone Rubber the required rheological and mechanical properties.

## AEROSIL® makes you a winner in every tensile test

- Tensile strength
- Tear resistance
- Hardness
- Elongation
- Rebound resilience
- Compression set



The use of AEROSIL® fumed silica as a reinforcing filler allows significant improvement of the mechanical properties of, e.g. various sports goods made of HTV Silicone Rubber

### **AEROSIL® – Tough Stuff**

The use of AEROSIL® products as reinforcing components in elastomers allows lasting improvement of such mechanical properties of the cured Silicone Rubber as tensile strength, elongation at break, and tear resistance.

AEROSIL® fumed silica also helps to control the temperature dependence of the mechanical properties. The scope for improvement of the above-mentioned properties depends on the type of silicone polymer used as well the concentration and the chosen AEROSIL® grade.

## Our Technical Handling Service Offers our Concentrated Expertise

(right) AEROSIL® fumed silica in a semi bulk container (FIBC: Flexible Intermediate Bulk Container)

(left) Typical bag packaging of Evonik AEROSIL® fumed silica



### Working with AEROSIL®

At a time when automation, rationalization, industrial hygiene for the protection of employees and environmental regulations are becoming increasingly important, so also is the subject of the handling of AEROSIL® products. For more than 10 years now, AEROSIL® fumed silica has been expanding its activities in this area concurrently with this development.

Basic product knowledge and process-engineering experience in handling fumed oxides are necessary for planning dust-free automated plants for AEROSIL® products. We offer our customers our expertise in this area for the solution of specific problems. In this way we jointly develop concepts that simplify the handling of AEROSIL® fumed silica for our customers.

#### Handling

The term „handling“ describes the techniques required to move AEROSIL® fumed silica within a customer’s plant. The following are the most important considerations here:

- emptying of packaging units
- silo storage
- internal conveying
- dosing
- feeding materials into the manufacturing process

In addition, the term „handling“ also covers the activities necessary to execute the above steps. Your local customer service agent will be happy to provide further details of this service offer.



Dust-free automated conveying system

### **Packaging**

AEROSIL® fumed silica in powder form is available in three different forms of packaging. The standard packaging is the multi-layer paper bag, which is in some cases provided with an polyethylene coating on one layer. The net weights of the bags, of between 10 and 20 kg, depend on the AEROSIL® grade and also on the set tapped density. Evonik offers AEROSIL® fumed silica also in FIBC (Flexible Intermediate Bulk Containers) as a form of semi bulk packaging. Here again, filling quantities vary depending on the product and its densification. Another possibility, for bulk usage, is purchase in silo trucks, which requires the customer to have an appropriate storage silo. The AEROSIL® fumed silica dispersions known as AERODISP® are supplied in 60 kg drums, 220 kg barrels and 1000 kg IBCs (intermediate bulk containers).

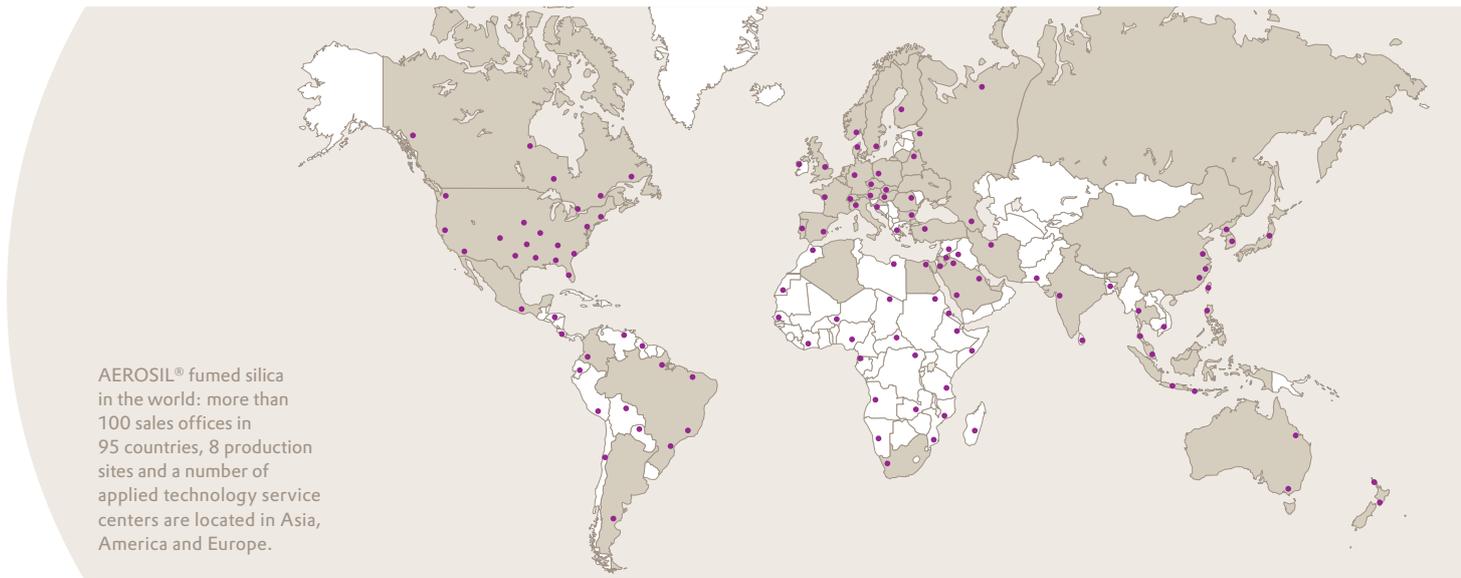
### **Storage stability**

AEROSIL® fumed silica is chemically inert to a large extent, and under suitable storage conditions undergoes no chemical changes even over fairly long storage periods. It must be noted, however, that a few substances react with silicon dioxide.

On account of the high specific surface area, volatile substances may be adsorbed at the surface of AEROSIL® products. In the case of water vapor this adsorption is reversible. Organic modification of hydrophobic AEROSIL® grades significantly reduces the ability of these products to adsorb water vapor.

AEROSIL® products may become slightly compacted over long storage periods. This may lead to a slight increase in the tapped density and affect the associated product properties.

## The Advantage of a Global Enterprise – Local Proximity



Size usually creates distance – but not at Evonik. As a leading specialty chemicals company Evonik relies on the business philosophy: „as decentralized as possible, as centralized as necessary“.

The decentralized organization at all levels and in all divisions of the company is tailored to operative units which can respond to the market quickly, flexibly and on a customer-oriented basis. As a

brand operating worldwide, AEROSIL® uses production facilities, application-related service centers, research centers and commercial and technical service offices in all regions of the world.

The mere fact that we produce on 3 continents represents a decisive advantage for us and our customers when it comes to an effective world-wide delivery



service. With a total of more than 1200 motivated employees and more than 100 service offices in 95 countries, we also offer our customers the biggest service network of all suppliers on the market.

The combination of highest product quality and a marked focus on service and consulting is a major cornerstone of the

AEROSIL® strategy. As a brand that is active worldwide we also want to combine with partners to form a strong, international network in which we concentrate our areas of expertise.

A functioning globality, which our customers experience on a local level.

**Always close by.**

## Technical Literature



### For detailed information

on our technical bulletins and for downloads please visit our Internet Service Center at [www.aerosil.com](http://www.aerosil.com), or write to:

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### Brochure Product Overview

- AEROSIL® Product Overview
- Dynasylan® Product Overview

### Industry Brochure Adhesives and Sealants

- AEROSIL® and Silanes for Adhesives and Sealants

### Industry Information No. 2123

- AEROSIL® in Adhesives and Sealants

### Technical Bulletin Pigments No. 11

- Basic Characteristics of AEROSIL® fumed silica

### Technical Bulletin Pigments No. 12

- Evonik Silicas for HTV Silicone Rubber

### Technical Bulletin Pigments No. 28

- Handling of Synthetic Silicas and Silicates

### Technical Bulletin Pigments No. 63

- Synthetic Silicas for Sealants

### Technical Information No. 1148

- AEROSIL® R 104 and AEROSIL® R 106 for Silicone Rubber Applications

### Technical Information No. 1151

- AEROSIL® VV for Silicone Rubber Applications

### Technical Information No. 1209

- AEROSIL® R 8200 for Silicone Rubber

### Technical Information No. 1253

- AEROSIL® and AEROXIDE® for Liquid Silicone Rubber (LSR/LIMS)

### Technical Information No. 1349

- Structure modified AEROSIL® fumed silica for the Silicone Rubber Industry

## Solutions for the Silicone Rubber Industry

	Room Temperature Vulcanisation		Heat Cured System	
Systems	One pack system RTV 1-C Silicone Sealants	Two pack system RTV 2-C Casting and molding compounds	Heat cured rubber HTV Press vulcanization and extrusion articles	Liquid silicone rubber LSR Injection molded articles
<b>Effects</b>				
Control of rheological and mechanical properties <b>Thixotropic effect, flow properties and reinforcing action</b>	AEROSIL® 130 AEROSIL® 150 AEROSIL® R 972 AEROSIL® R 8200	AEROSIL® 200 AEROSIL® 300 AEROSIL® R 812 S AEROSIL® R 8200 SIPERNAT® 120 SIPERNAT® 320 DS SIPERNAT® D 17	AEROSIL® 200/V AEROSIL® 300/V AEROSIL® 380 AEROSIL® R 104 SIPERNAT® 160 SIPERNAT® D 17	AEROSIL® 300 AEROSIL® 380 AEROSIL® R 812 S AEROSIL® R 8200 SIPERNAT® 160 SIPERNAT® 120 SIPERNAT® 320 DS SIPERNAT® D 17
Control of optical properties <b>Transparency/Pigmentation (black)</b>	AEROSIL® R 974 AEROSIL® R 106 AEROSIL® R 812 S	AEROSIL® 200 SP AEROSIL® 300 SP AEROSIL® R 812 S AEROSIL® R 8200 LAMP BLACK 101* PRINTEX® 60	AEROSIL® 200 SP AEROSIL® 300 SP AEROSIL® 380 AEROSIL® R 106 PRINTEX® 300 PRINTEX® P**	AEROSIL® 300 SP AEROSIL® 380 AEROSIL® R 812 S AEROSIL® R 8200 PRINTEX® alpha**
Improvement of heat stability	AEROXIDE® TiO <sub>2</sub> P 25	AEROXIDE® TiO <sub>2</sub> P 25 LAMP BLACK 101*	AEROXIDE® TiO <sub>2</sub> P 25 PRINTEX® 300	AEROXIDE® TiO <sub>2</sub> P 25 PRINTEX® alpha**
Matting	VP AEROPERL® R 806/30			
Electrical conductive/ Antistatic			PRINTEX® P** PRINTEX® L 6 PRINTEX® XE 2/XE 2-B	PRINTEX® alpha**
Improved shelf life	Dynasylan® VTMO*** Dynasylan® 6490			
Improvement Adhesion	Dynasylan® BDAC (acetoxo system)			
Improvement Adhesion	Dynasylan® AMEO Dynasylan® TRIAMO Dynasylan® MEMO Dynasylan® GLYMO Dynasylan® DAMO Dynasylan® 1146 (oxyme and alkoxy system)			
Cross Linker	Dynasylan® VTMO Dynasylan® VTEO Dynasylan® MTMS (alkoxy system)	Dynasylan® P Dynasylan® A Dynasylan® 40 (condensations cured)		
In-situ surface treatment			Dynasylan® HMDS Dynasylan® VTEO	Dynasylan® HMDS Dynasylan® VTEO

\* low adsorption capacity

\*\* low sulfur content

\*\*\* water scavenger

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The customer is not released from the obligation to conduct careful inspection and testing of incoming goods.

Performance of the product described herein should be verified by testing, which should be carried out only by qualified experts in the sole responsibility of a customer. Reference to trade names used by other companies is neither a recommendation, nor does it imply that similar products could not be used.

[www.aerosil.com](http://www.aerosil.com)



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INDUSTRIES

Evonik. Power to create.