Medical and Dental Applications

EVONIK
Leading Beyond Chemistry

About Us

Evonik, the creative industrial group from Germany, is one of the world leaders in specialty chemicals. Its activities focus on the key megatrends health, nutrition, resource efficiency and globalization. Evonik benefits specifically from its innovative capability and integrated technology platforms. We apply our creativity daily to new, future-oriented solutions, aligning ourselves to future markets with highly promising growth dynamics, and developing essential and indispensable solutions for our customers.

Our broad range of products reflects the extensive variety of requirements specified by our customers. For more than 30 years we have led the way with trail-blazing research while constantly monitoring the latest trends in various industrial sectors. Always a step ahead of market developments, we offer you solutions to tomorrow's application requirements – today.

Evonik offers a wide range of base materials which can be used in formulations for dental impression materials, Silicone adhesive, gels composite fillers and other medical applications.

POLYMER VS

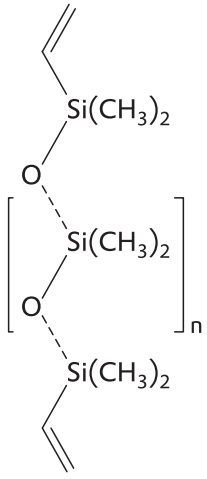
The products of the Polymer VS series are vinyl-terminated polydimethyl siloxanes with different viscosity levels and molecular weights, and a very low content of volatile constituents. They serve as a base polymer in addition-crosslinking silicone formulations.

APPLICATION

Polymer VS cures by a platinum-catalyzed addition reaction with silicone crosslinkers containing SiH groups. Due to the low content of volatile constituents and the crosslinking mechanism, the curing shrinkage remains low and no volatile or corrosive substances are formed while curing. Polymer VS can be used for a wide range of applications by selecting the suitable crosslinkers (Crosslinker 100 series, Crosslinker 200 series), catalysts (Catalyst 500 series), additives and fillers (VQM, Compound VS).

Technical data

PRODUCT NAME	VISCOSITY AT 25°C [mPa·s]	VINYL CONTENT [mmol/g]
Polymer VS 50	50	0.60
Polymer VS 100	100	0.40
Polymer VS 200	200	0.25
Polymer VS 500	500	0.14
Polymer VS 1000	1,000	0.11
Polymer VS 2000	2,000	0.08
Polymer VS 5000	5,000	0.06
Polymer VS 10000	10,000	0.05
Polymer VS 20000	20,000	0.04
Polymer VS 65000	65,000	0.03
Polymer VS 100000	100,000	0.02
Polymer VS 165000	165,000	0.015



POLYMER RV

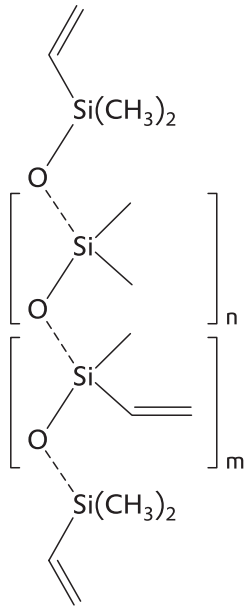
Products of the Polymer RV range are vinyl-functional polydimethyl siloxanes of different molecular weights carrying additional lateral vinyl groups in the polysiloxane chain besides terminal vinyl groups. On account of this structure, they produce higher crosslinking densities than Polymer VS at similar viscosity levels.

APPLICATION

Polymer RV can be used as a base polymer or as an additive with Polymer VS. It cures by a platinum-catalyzed addition reaction with silicone crosslinkers containing SiH- groups. The formulator can adjust the formulation properties over a wide range by selecting the suitable crosslinkers (Crosslinker 100 series, Crosslinker 200 series), catalysts (Catalyst 500 series), additives and fillers (VQM, Compound VS).

Technical data

PRODUCT NAME	VISCOSITY AT 25°C [mPa·s]	VINYL CONTENT [mmol/g]
Polymer RV 100	120	0.5
Polymer RV 200	360	2.3
Polymer RV 5000	3,000	0.4



CROSSLINKER 100 AND 200 SERIES

The crosslinkers of the Crosslinker 100 and 200 series are polydimethyl siloxanes comprising SiH groups in the polymer chain. The crosslinkers of the Crosslinker 200 series include terminal SiH groups. Both crosslinker types are used in polyaddition silicones.

Both series are available with different viscosity levels and SiH contents.

APPLICATION

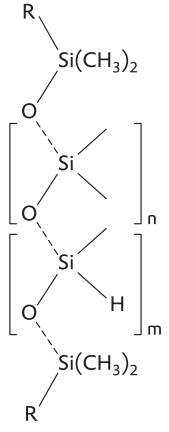
When working with two-component silicone formulations, it must be ensured that Pt-catalyst (e. g. Catalyst 500 series) and SiH crosslinkers are kept strictly separated.

In general, the composition should selected so that the total formulation contains approximately a double molar excess of SiH groups as compared with vinyl groups. Further information about the formulation structure is available upon request.

Particular attention should be paid to the fact that silicones containing SiH may generate hazardous hydrogen gas in connection with certain pollutants. For further information, please consult e. g. **www.silicones-safety.com**.

Technical data

PRODUCT NAME	SIH CONTENT [mmol/g]	VISCOSITY AT 25° [mPa·s]
Crosslinker 100	7.8	45
Crosslinker 101	4.3	45
Crosslinker 110	3.8	100
Crosslinker 120	1.1	500
Crosslinker 180	1.9	50
Crosslinker 190	16	30
Crosslinker 200	3.2	50
Crosslinker 210	4.2	40



R = H, Me

VQM – VINYL-FUNCTIONAL QM RESIN COMPOUNDS

The VQM products are formulations comprising a vinyl-functional QM resin and vinyl-functional silicone polymers. They are used for producing transparent and filler-free formulations with good mechanical properties or for improving the mechanical properties of filled systems.

APPLICATION

The VQM products can be used in transparent silicone formulations, substituting Polymer VS partly or completely. In filled formulations, the filler can also be partly substituted by VQM.

It should be noted that the VQM products have a higher vinyl content than Polymer VS types of similar viscosity. In general, this must be compensated by increasing the SiH content (Crosslinker 100 / 200 series). Further information about designing formulations with VQM is available upon request.

Technical data

PRODUCT NAME	RESIN CONTENT [wt%]	VISCOSITY AT 25°C [mPa·s]	VINYL CONTENT [mmol/g]
VQM 903	20	10,000	0.18
VQM 906	25	50,000	0.19
VQM 907	20	5,000	0.20
VQM 909	20	1,000	0.23
VQM 973	45	30,000	0.34
VQM 985	45	4,000	0.45

COMPOUND VS – FUMED SILICA DISPERSIONS

Compound VS are masterbatches consisting of surface-modified fumed silica and a vinyl-functional silicone polymer. They are used for producing formulations with good mechanical properties or for improving the mechanical properties of filled systems.

APPLICATION

The mechanical strength of a silicone formulation depends directly on its silica content (i. e. tensile strength, elongation at break and tear resistance increase). At the same time, viscosity also rises substantially. This behavior is shown by the below example of a two-component addition-curing silicone. Therein the silica content was increased by a stepwise replacement of Polymer VS 1000 by Compound VS 100.

Due to its production process, Compound VS enables higher mechanical strength at similar viscosity levels when compared with silica used as a powder. Moreover, it avoids the use of powders in the formulation process (dust generation).

In existing formulations, Compound VS can be used as a substitute of Polymer VS and of the filler. Further information about the formulation structure is available upon request.

Technical data

PRODUCT NAME	VISCOSITY AT 25°C [Pa·s]	VINYL CONTENT [mmol/g]	REFRACTIVE INDEX
Compound VS 100	100	0.07	1.412
Compound VS 3000	3,000	0.07	1.412
Compound VS 6000	6,000	0.07	1.413

Composition of formulation

RAW MATERIAL	COMPONENT A [g]	COMPONENT B [g]
Compound VS 100	0 – 100	0 – 100
Polymer VS 1000	100 – 0	100 – 0
Catalyst 510	0.8	– –
Inhibitor MVC	– –	0.2
Crosslinker 210	– –	10

Figure 1
Product hardness and viscosity

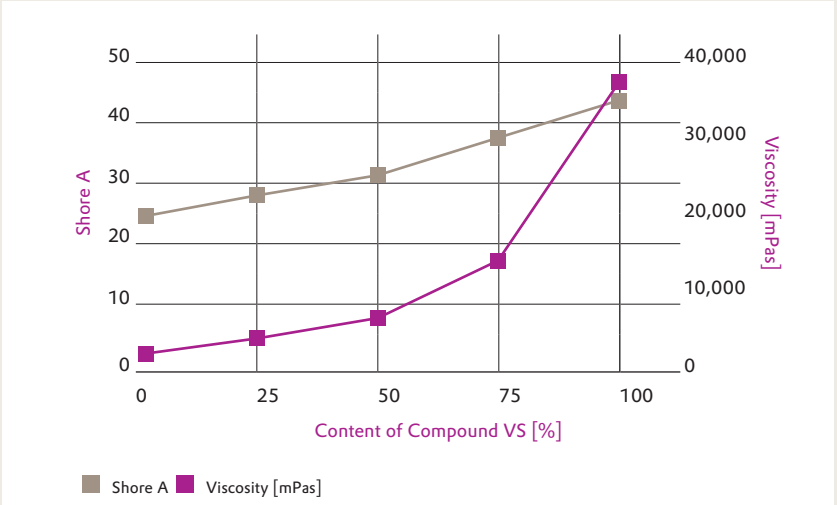
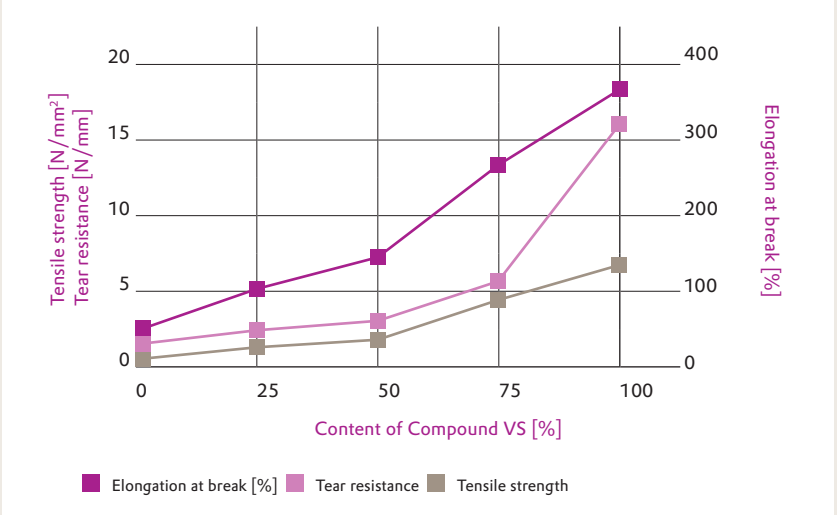


Figure 2
Mechanical properties



CATALYST 500 SERIES – PLATINUM-CATALYSTS

The products of the Catalyst 500 series are diluted solutions of a highly reactive platinum complex in different media. Evonik offers two different complexes: the divinyl tetramethyl disiloxane-platinum(0)-complex and the methyl vinyl cyclosiloxane-platinum(0)- complex. The media offered include Polymer VS, divinyl tetramethyl disiloxane (DVS) and methyl vinyl cyclosiloxane (MVC).

APPLICATION

The platinum complexes are highly efficient even in very small quantities so that typically, only 10 to 20 ppm of platinum are used in formulations. Increasing the concentration leads to higher crosslinking rates, and thus to shorter pot lives.

It should be noted that the complexes react sensitively to a number of substances (e. g. sulphur, heavy metal and amino compounds, some PU and PVC types).

Contact with such substances shall be avoided both while producing the formulation and while the product cures.

If the application imperatively requires for such a contact (e. g. curing in a PU mold), the catalyst loss can be compensated by an increased feedstock concentration of up to approximately 100 ppm. Especially the products Catalyst 517 and 540 are suited for this purpose because they prevent uncontrolled increase of the crosslinking rate due to the inhibiting media DVS and MVC.

Technical data

PRODUCT NAME	COMPLEX	MEDIUM	PLATINUM CONTENT [ppm]	PLATINUM CONTENT [wt%]	VISCOSITY AT 25°C [mPa·s]	TOTAL VINYL CONTENT [mmol/g]
Catalyst 510	DVS	Polymer VS	5,000	0.5	500	0.4
Catalyst 511	DVS	Polymer VS	10,000	1.0	500	0.6
Catalyst 512	DVS	Polymer VS	20,000	2.0	500	1.0
Catalyst 517	DVS	DVS	20,000	2.0	5	11
Catalyst 540	MVC	MVC	20,000	2.0	5	11

INHIBITORS FOR ADDITION-CURING SILICONES

Inhibitors are used for setting the pot life of platinum-catalyzed, addition-cured silicones.

APPLICATION

Inhibitors MVC and DVS are pure silicone-based inhibitors which control the activity of the Pt-catalyst. They are used when exceptionally long working times or very low dosage levels are required. The typical dosage is between 0.01 and 1%.

Inhibitor 600 is a ready-to-use mixture of an alkinol in Polymer VS. Depending on the required pot life, the dosage is typically between 1 and 10%.

Technical data

PRODUCT NAME	BASE	VOLATILITY	VISCOSITY AT 25°C [mPa·s]	VINYL CONTENT [mmol/g]	APPEARANCE
Inhibitor MVC	MVC pure	Low	4	11.6	Clear, colorless liquid
Inhibitor DVS	DVS pure	Medium	4	10.7	Clear, colorless liquid
Inhibitor 600	Alkinol	High	900	0.1	Slightly turbid, colorless liquid

MODIFIER 700 SERIES

CHAIN EXTENDERS FOR VINYL-FUNCTIONAL SILICONE POLYMERS

Modifier 705 and Modifier 715 are SiH-terminated polydimethyl siloxanes which are used as plasticizers in addition-curing silicones. Due to their difunctional structure, these products do not react by crosslinking, but by extending the chains of vinyl-terminated silicone polymers (Polymer VS). Use of the modifiers reduces the crosslinking density and therefore the elastomer hardness.

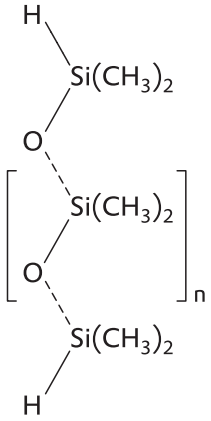
APPLICATION

Use of the modifiers allows obtaining products with a low Shore hardness, even when using low-viscosity vinyl polymers. These modifiers are therefore used in formulations that have a low viscosity prior to crosslinking and should have low Shore hardness after crosslinking. Another important modifier application is the formulation of silicone gels.

When working with two-component silicone formulations, it must be ensured that Pt-catalyst (Catalyst 500 series) and modifier are kept strictly apart. Attention must in particular be paid to the fact that silicones containing SiH may generate hazardous hydrogen gas in connection with certain pollutants.
More information can be found on **www.silicones-safety.com.**

Technical data

PRODUCT NAME	SIH CONTENT [mmol/g]	VISCOSITY AT 25°C [mPa·s]
Modifier 705	0.17	500
Modifier 715	3	3



POLYMER MV 2000

MONO-VINYLFUNCTIONAL POLYDIMETHYL SILOXANE

Polymer MV 2000 is a polydimethyl siloxane that is vinyl-terminated on one side, thus achieving a reduction of modulus and hardness in addition-curing silicone formulations. Due to the monofunctional structure, only one chain end of the silicone polymer reacts with the network. This prevents migration effects.

APPLICATION

The following formulation shows the lower hardness achieved with Polymer MV 2000 as compared with a similar formulation containing the corresponding difunctional vinyl silicone (Polymer VS 2000).

Technical data

Viscosity (25°C)	[mPa·s]	2,000
Vinyl content	[mmol/g]	0.06

Formulation with Polymer MV

COMPONENT	PARTS
Polymer MV 2000	96.5
Catalyst 510	0.4
Inhibitor DVS	0.1
Crosslinker 101	3.0
Hardness of vulcanized formulation	**Shore A 6**

Formulation with Polymer VS

COMPONENT	PARTS
Polymer VS 2000	95.5
Catalyst 510	0.4
Inhibitor DVS	0.1
Crosslinker 101	4.0*
Hardness of vulcanized formulation	**Shore A 24**

*the crosslinker dosage was adapted to maintain a constant stoichiometry

NANOCRYL® D

KEY PROPERTIES:

- **Very high filler level at low viscosity**
- **Reduced shrinkage**
- **Improved flexural strength**
- **High stability under load**
- **Increases lifecycle of composite materials**

Nanocryl® D are composites of spherical silica-nanoparticles with a diameter of 20 nm in (meth)acrylate resins.

PROPERTY IMPROVEMENT

Nanocryl® D enables the production of base resins for composite materials which contain up to 60% SiO_2 and yet remain low-viscous and free-flowing. Therefore, the combination of Nanocryl® D with conventional fillers enables much higher filling ratios than using conventional fillers alone, thereby reducing the shrinkage significantly.

The large amount of nanoscale SiO_2 particles decreases the abrasion, making the surface smoother and hence better to polish. Both toughness and hardness of the composite also increase as does, consequently, the lifetime of the filling in the mouth.

Product overview

PRODUCT NAME	MONOMER	MIXTURE	SiO_2-CONTENT [wt%]	VISCOSITY AT 25°C [mPa·s]
Nanocryl® D 302	Hydroxy propyl methacrylate		60	150
Nanocryl® D 303	Hydroxy ethyl methacrylate		60	150
Nanocryl® D 322	Urethane dimethacrylate and Triethylene glycol dimethacrylate	80 : 20	50	10,000
Nanocryl® D 323	Urethane dimethacrylate and Hydroxy ethyl methacrylate	90 : 10	50	15,000

APPLICATION

To ensure optimum compatibility, we recommend premixing all other recipe components and adding the Nanocryl® D to this mixture under stirring.

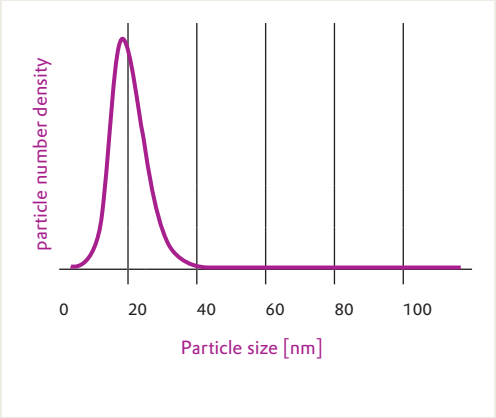
Nanocryl® D products are compatible with most acrylate monomers, oligomers and polymerization initiators. Nevertheless, compatibility with the individual formulation components should be tested separately prior to recipe development.

The required silicon dioxide total content in the ready formulation is dependent on the desired product properties.

In general, the property improvements increase proportionally to the solids content. As a result, as high a SiO_2 content as possible is recommended (≥ 20 wt%, corresponding to e. g. ≥ 40% Nanocryl® D) for first screening tests. The optimum content should then be ascertained through systematic tests.

To achieve the highest possible solids content, the additional use of conventional fillers is recommended. The nanoparticles then fill the space between the larger particles. This enables the formulator to increase the total content of reinforcing fillers, and thus optimize the material properties.

Figure 3
Particle size distribution (Determined by SANS)



How it works

Nanocryl® D products are colloidal dispersions of up to 60 wt% of amorphous silicon dioxide in a range of conventional unsaturated (meth)acrylate monomers and oligomers. The dispersed phase consists of surface-modified, spherically shaped SiO_2 nanoparticles with diameters of 20 nm having an extremely narrow particle size distribution.

In contrast to conventional micro-filler composite materials, the spherical particles are distributed homogenously and agglomerate-free in the resin matrix.

This results in a very low viscosity for the dispersion despite high SiO_2 contents.

The nanoparticles are produced from aqueous sodium silicate solution in a chemical process. In this very mild process the binding agent is not damaged, in contrast to the processes in which filling agents in powdered form are dispersed with dissolvers and the application of very high shear energy.

Europe | Middle East | Africa

Evonik Operations GmbH
Charlottenburger Straße 9
21502 Geesthacht
Germany
Phone +49 4152 8092-0
Fax +49 4152 79156
www.evonik.com

Asia | Pacific

Evonik Specialty Chemicals Co., Ltd.
55, Chundong Road
Xinzhuang Industry Park
Shanghai, 201108
PR China
Phone +86 21 6119-1125
Fax +86 21 6119-1406

The Americas

Evonik Corporation
P.O. Box 34628
Richmond, VA 23234
USA
Phone +1 804 727-0700
Fax +1 804 727-0855

www.evonik.com/solutions-for-adhesives

Inv.-Nr.: 01-2020

EVONIK
Leading Beyond Chemistry