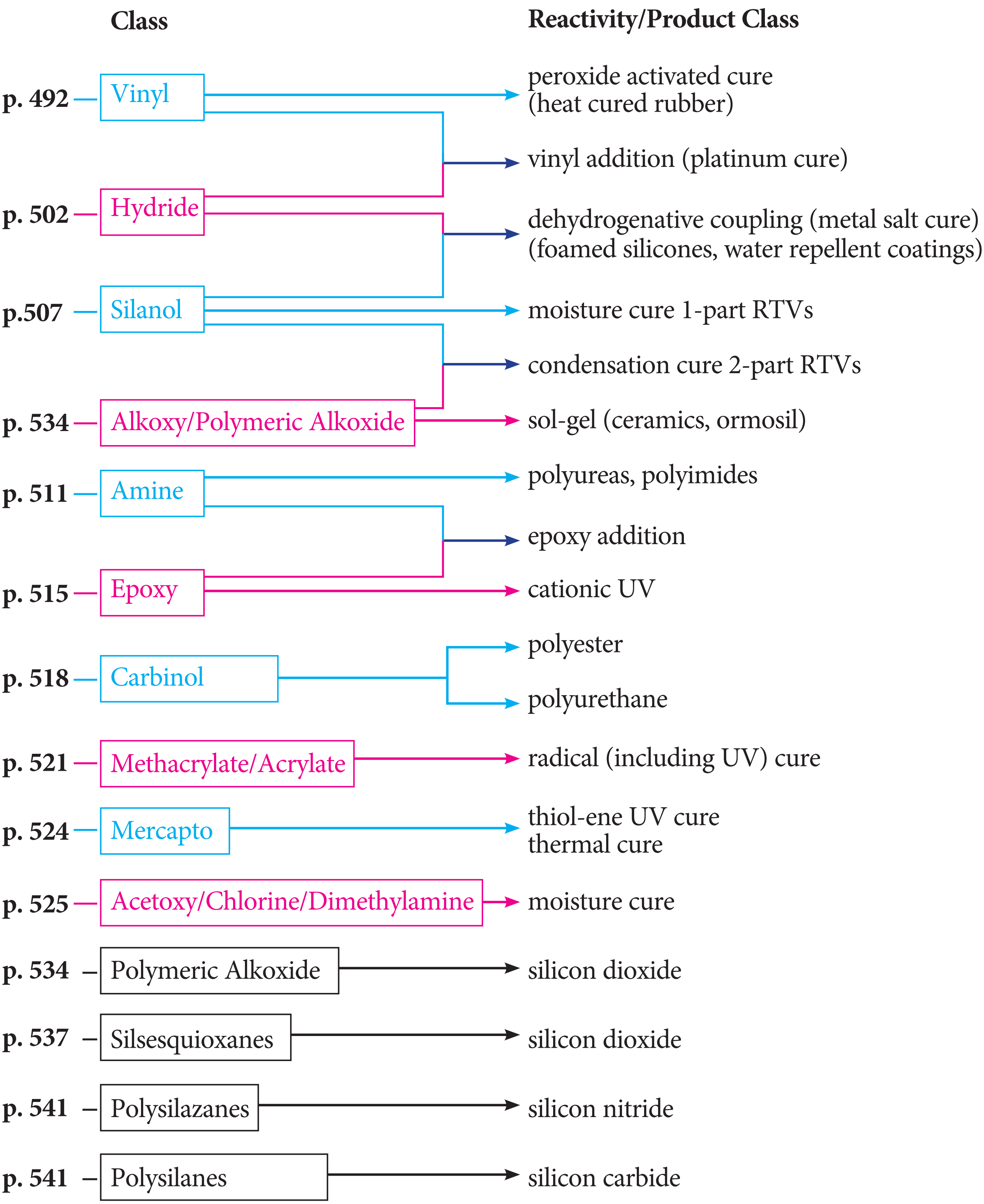
Functional Silicone Reactivity Guide



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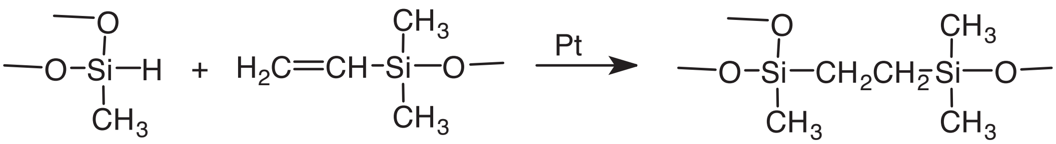
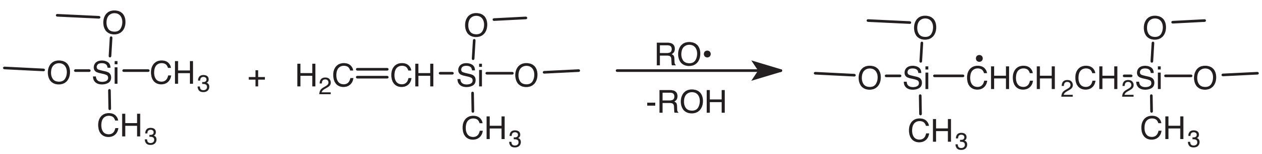
$$Si—CH{=}CH_2$$

Vinyl Functional Polymers

The reactivity of vinyl functional polymers is utilized in two major regimes.[1] Vinyl terminated polymers are employed in addition cure systems. The bond forming chemistry is the platinum catalyzed hydrosilylation reaction which proceeds according to the following equation:



Vinylmethylsiloxane copolymers and vinyl T-structure fluids are mostly employed in peroxide activated cure systems, which involve peroxide-induced free radical coupling between vinyl and methyl groups. Concomitant and subsequent reactions take place among methyl groups and between crosslink sites and methyl groups. The initial crosslinking reaction is depicted in the following equation:



Addition Cure (Platinum Cure)

Addition cure chemistry provides an extremely flexible basis for formulating silicone elastomers. An important feature of the cure system is that no byproducts are formed, allowing fabrication of parts with good dimensional stability. Cures below 50°C, Room Temperature Vulcanizing (RTV), cures between 50° and 130°C, Low Temperature Vulcanizing (LTV), and cures above 130°C, High Temperature Vulcanizing (HTV), are all readily achieved by addition cure. The rheology of the systems can also be varied widely, ranging from dip-cures to liquid injection molding (LIM) and conventional heat-cure rubber (HCR) processing. Vinyl-terminated polydimethylsiloxanes with viscosities greater than 200 cSt generally have less than 2% volatiles and form the base polymers for these systems. More typically, base polymers range from 1000 to 60,000 cSt. The crosslinking polymer is generally a methylhydrosiloxane-dimethylsiloxane copolymer with 15-50 mole % methylhydrosiloxane. The catalyst is usually a complex of platinum in alcohol, xylene, divinylsiloxanes or cyclic vinylsiloxanes. The system is usually prepared in two parts. By convention, the A part typically contains the vinyl-containing silicone and the platinum catalyst at a level of 5-10ppm, and the B part usually contains the hydride functional siloxane.

Formulation of addition cure silicones must address the following issues:

Strength- Unfilled silicones have extremely poor mechanical properties and will literally crumble under pressure from a fingernail. The most effective reinforcing filler is hexamethyldisilazane treated fumed silica. Alternatively, if clarity must be maintained, vinyl "Q" reinforcing resins are employed.

[1] Arkles, B., CHEMTECH, **1983**, *13*, 542.

Platinum Catalysts- see p. 545

Addition Cure Modifiers- see p. 546

Hardness- Higher crosslink density provides higher durometer elastomers. Gels are weakly crosslinked systems and even contain substantial quantities of "free" fluids. In principal, molar equivalents of hydrides react with vinyls. See the section on hydride functional fluids for further information. Also, polymers with vinyl pendant on the chain rather than at chain ends are utilized to modify hardness and compression set.

Consistency- The viscosity of the base polymer and a variety of low surface area fillers ranging from calcium carbonate to precipitated silica are used to control the flow characteristics of silicone elastomers.

Temperature of Cure- Selection of platinum catalysts generally controls the preferred temperature of cure.[1] Platinum in vinyldisiloxanes is usually used in room temperature cures. Platinum in cyclic vinylsiloxanes is usually used in high temperature cures. See the Platinum listings in the catalyst section.(p. 493)

Work Time (Speed of Cure)- Apart from temperature, moderators (sometimes called retarders) and inhibitors are used to control work time. Moderators slow, but do not stop platinum catalysts. A typical moderator is tetravinyltetramethylcyclotetrasiloxane. Inhibitors stop or "shut-down" platinum catalysts and therefore are fugitive, i.e volatile or decomposed by heat or light (UV). Acetylenic alcohols such as methylisobutynol are volatile inhibitors. Patent literature shows that t-butylhydroperoxide is an effective inhibitor that breaks down at temperatures above 130°.

Low Temperature Properties, Optical Properties- The introduction of vinyl polymers with phenyl groups alters physical properties of elastomers. At levels of 3-4 mole %, phenyl groups improve low temperature properties. At higher levels, they are used to alter refractive index of elastomers, ranging from matching fillers for transparency to optical fiber applications. Unfortunately, increased phenyl substitution lowers mechanical properties of elastomers.

Shelf Life- A fully compounded elastomer is a complex system. Shelf-life can be affected by moisture, differential adsorption of reactive components by fillers and inhibitory effects of trace impurities. Empirical adjustments of catalyst and hydride levels are made to compensate for these effects.

Compounding- All but the lowest consistency elastomers are typically compounded in sigma-blade mixers, planetary mixers, two-roll mills or, for large scale production, twin-screw extruders.

Quick Start Formulation Transfer and Impression Molding Elastomer

This low strength formulation is useful as a reproductive molding compound. It is presented here because it can be prepared without special equipment and is an instructive starting point for addition cure silicone elastomers.

DMS-V31	1000 cSt vinyl-terminated polydimethylsiloxane	100 parts
SIS6962.0	hexamethyldisilazane treated silica	50 parts
HMS-301	methylhydrosiloxane-dimethylsiloxane copolymer	3-4 parts
SIP6830.3	platinum complex solution	150-200ppm

In small portions, work the DMS-V31 into the silica with a spatula. After a uniform dispersion is produced, work in the HMS-301. The blend may be stored in this form. Just prior to use add the platinum solution with an eyedropper and work it in rapidly. Working time is 5-10 minutes. The rate of cure can be retarded by adding tetravinyltetramethylcyclotetrasiloxane (SIT7900.0).

[1] Lewis, L. et al. *J. Mol. Cat. A: Chem.* **1996**, *104*, 293.; Lewis, L. et al. *J. Inorg. Organomet. Polym.* **1996**, *6*, 123.

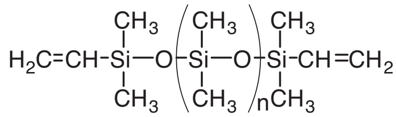
Peroxide Activated Cure

Activated cure silicone elastomers are processed by methods consistent with conventional rubbers. These silicone products are referred to as HCRs (heat cured rubbers). The base stocks are high molecular weight linear polydiorganosiloxanes that can be converted from a highly viscous plastic state into a predominantly elastic state by crosslinking. Vinylmethylsiloxane-dimethylsiloxane copolymers of extremely high molecular weights are the typical base stocks for activated cure silicone elastomers. The base stocks are commonly referred to as gums. Gums typically have molecular weights from 500,000 to 900,000 with viscosities exceeding 2,000,000 cSt. Free radical coupling (cure) of vinyl and methyl groups is usually initiated by peroxides at process temperatures of 140°-160°. Generally, peroxide loading is 0.2-1.0%. Following the cure, a post-cure at 25-30° higher temperature removes volatile peroxide decomposition products and stabilizes polymer properties. The most widely used peroxides include dibenzoylperoxide (often as a 50% concentrate in silicone oil), dicumylperoxide (often 40% on calcium carbonate), 2,5-dimethyl-2,5-di-t-butylperoxyhexane and bis(dichlorobenzoyl)peroxide[1]. The last peroxide is particularly recommended for aromatic-containing siloxanes. Terpolymer gums containing low levels of phenyl are used in low temperature applications. At increased phenyl concentrations, they are used in high temperature and radiation resistant applications and are typically compounded with stabilizing fillers such as iron oxide. Phenyl groups reduce cross-linking efficiency of peroxide systems and result in rubbers with lower elasticity. Fluorosilicone materials offer solvent resistance. Lower molecular weight vinylsiloxanes are frequently added to modify processability of base stocks.

While the use of peroxide activated cure chemistry for vinylmethylsiloxanes is well established for gum rubber stocks, its to use is growing in new applications that are comparable to some peroxide cure acrylic systems. Relatively low viscosity vinylmethylsiloxanes and vinyl T-fluids are employed as grafting additives to EPDM elastomers in the wire and cable industry to improve electrical properties. They also form reactive internal lubricants for vulcanizeable rubber formulations. At low levels they are copolymerized with vinyl monomers to form surfactants for organosols.

[1] Lynch, W., “Handbook of Silicone Rubber Fabrication”, Van Nostrand Reichold, 1978.

Peroxide Catalysts- see p. 549



Vinyl Terminated PolyDimethylsiloxanes (7)-483

CAS: [68083-19-2] TSCA

Code	Viscosity	Molecular Weight	Wgt % Vinyl	Vinyl - Eq/kg	Density	Price/100g	Price/3kg	Price/16kg
DMS-V00	0.7	186	29	10.9	0.81	¥16,300	¥160,100	-
DMS-V03	2-3	500	10-12	3.6-4.3	0.92	¥24,400	¥210,900	-
DMS-V05	4-8	800	7-9	2.4-2.9	0.93	¥25,000	¥216,100	-
DMS-V21	100	6000	0.8-1.2	0.33-0.37	0.97	¥10,400	¥55,400	¥138,000
DMS-V22	200	9400	0.4-0.6	0.21-0.24	0.97	¥8,100	¥48,000	¥122,000
DMS-V25	500	17,200	0.37-0.43	0.11-0.13	0.97	¥9,000	¥50,700	¥128,000
DMS-V31	1000	28,000	0.18-0.26	0.07-0.10	0.97	¥7,800	¥44,300	¥114,000
DMS-V33	3500	43,000	0.12-0.15	0.05-0.06	0.97	¥9,000	¥50,700	¥128,000
DMS-V35	5000	49,500	0.10-0.13	0.04-0.05	0.97	¥7,800	¥44,300	¥114,000
DMS-V41	10,000	62,700	0.08-0.12	0.03-0.04	0.97	¥9,000	¥50,700	¥128,000
DMS-V42	20,000	72,000	0.07-0.09	0.025-0.030	0.98	¥10,400	¥55,400	¥138,000
DMS-V46	60,000	117,000	0.04-0.06	0.018-0.020	0.98	¥10,400	¥55,400	¥138,000
DMS-V51	100,000	140,000	0.03-0.05	0.016-0.018	0.98	¥11,900	¥64,500	¥174,000
DMS-V52	165,000	155,000	0.03-0.04	0.013-0.016	0.98	¥11,900	¥64,500	¥174,000

COMMERCIAL

These materials are most often employed in 2-part addition cure silicone elastomers.

Monodisperse Vinyl Terminated PolyDimethylsiloxane

DMS-Vm31	1000	28,000	0.18-0.26	0.07-0.10	0.97	¥24,700	¥158,200
DMS-Vm35	5000	49,500	0.10-0.13	0.04-0.05	0.97	¥24,700	¥158,200

Monodisperse telechelic silicone fluids offer advantages over traditional telechelic fluids. These materials contain little or no low molecular weight non-functional components which can plasticize and migrate out of cured elastomers, reducing or eliminating migratory contamination issues.

Reduced Volatility Grades*

DMS-V25R	500	17,200	0.37-0.43	0.11-0.13	0.97	¥22,400	¥148,800
DMS-V35R	5000	49,500	0.10-0.13	0.04-0.05	0.97	¥28,200	¥181,000

*total volatiles, 4 hours @ 150°C: 0.2% maximum

Fumed Silica Reinforced Vinyl Terminated PolyDimethylsiloxane

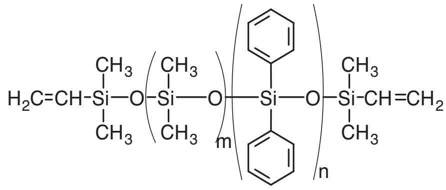
Code	Viscosity	Base Fluid Viscosity	wt% Silica	Vinyl - Eq/Kg	Density	Price/100g	Price/3kg	Price/16kg
DMS-V31S15	3000	1000	15-18	0.06	1.1	¥13,400	¥81,400	¥195,000

Precompounded base materials provide access to low durometer formulations without the need for special compounding equipment required to mix fumed silica. The following is a starting-point formulation.

Part A			Part B		
DMS-V31S15	Base	99.85%	DMS-V31	Vinyl Silicone	90.0%
SIP6831.2	Catalyst	0.15%	HMS-301	Crosslinker	10.0%

Prepare Part A and Part B separately. When ready to cure mix 3 parts A to 1 part B. The mix will cure over 4 hours at room temperature to give the following properties.

Hardness:	20-30 Shore A	Tensile Strength	3.5MPa (500psi)
Elongation	400-450%	Tear Strength	16N/mm (91ppi)



Vinyl Terminated Diphenylsiloxane-Dimethylsiloxane Copolymers CAS: [68951-96-2] TSCA (7)-481

Code	Mole % Diphenylsiloxane	Viscosity	Molecular Weight	Vinyl – Eq/Kg	Refractive Index	Price/100g	Price/3kg
PDV-0325	3.0-3.5	500	15,500	0.10-0.16	1.420	¥14,100	¥96,600
PDV-0331	3.0-3.5	1000	27,000	0.065-0.11	1.420	¥15,400	¥106,900
PDV-0341	3.0-3.5	10,000	62,000	0.027-0.037	1.420	¥16,200	¥113,300
PDV-0346	3.0-3.5	60,000	78,000	0.017-0.021	1.420	¥18,300	¥130,800
PDV-0525	4-6	500	14,000	0.12-0.16	1.430	¥17,200	¥96,600
PDV-0535	4-6	5000	47,500	0.03-0.06	1.430	¥16,200	¥113,300
PDV-0541	4-6	10,000	60,000	0.027-0.038	1.430	¥20,200	¥145,000
PDV-1625	15-17	500	9,500	0.19-0.23	1.465	¥17,400	¥104,500
PDV-1631	15-17	1000	19,000	0.09-0.12	1.465	¥23,300	¥170,800
PDV-1635	15-17	5,000	35,300	0.052-0.060	1.465	¥31,300	¥196,000
PDV-1641	15-17	10,000	55,000	0.033-0.040	1.465	¥43,200	¥255,000
PDV-2331	22-25	1000-1500	12,500	0.13-0.19	1.493	¥65,800	¥342,000
PDV-2335	22-25	4000-5000	23,000	0.07-0.10	1.493	¥76,400	¥403,000

COMMERCIAL

Vinyl Terminated polyPhenylMethylsiloxane CAS: [225927-21-9] TSCA-L

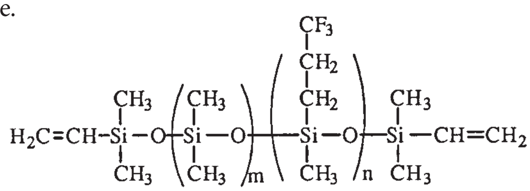
Code	Mole % PhenylMethylsiloxane	Viscosity	Molecular Weight	Vinyl– Eq/Kg	Refractive Index	Density	Price/100g
PMV-9925	99-100	300-600	2000-3000	0.5-1.2	1.537	1.11	¥40,600

These materials are most often employed in 2-part addition cure silicone elastomers where special thermal or optical properties are required.

VinylPhenylMethyl Terminated VinylPhenylsiloxane - PhenylMethylsiloxane Copolymer CAS: [68037-82-1]TSCA

Code	Mole % PhenylMethylsiloxane	Viscosity	Molecular Weight	Vinyl– Eq/Kg	Refractive Index	Density	Price/100g
PVV-3522	30-40	80-150	800-1500	6.0-7.5	1.530	1.10	¥45,900

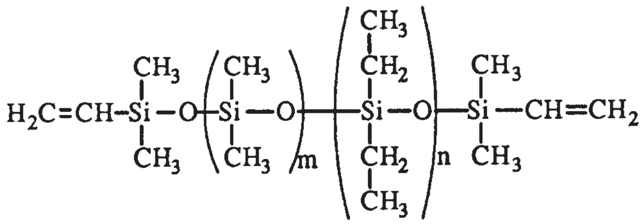
Crosslinks with dicumyl peroxide.



Vinyl Terminated TrifluoropropylMethylsiloxane - Dimethylsiloxane Copolymer CAS: [68951-98-4] TSCA

Code	Mole % $CF_3CH_2CH_2MeSiO$	Viscosity	Molecular Weight	Refractive Index	Specific Gravity	Price/100g	Price/1kg
FMV-4035	35-45	4,000-6,000	6,000-9,000	1.388	1.13	¥32,600	¥186,500
FMV-4042	35-45	14,000-18,000	25,000-35,000	1.388	1.13	¥49,900	¥254,400

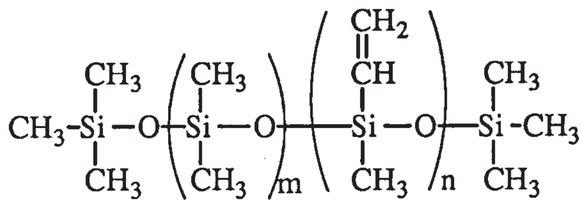
Trifluoropropylmethylsiloxane copolymers offer greater solvent resistance (lower hydrocarbon solubility) and lower refractive index than analogous dimethylsiloxane homopolymers.



Vinyl Terminated Diethylsiloxane - Dimethylsiloxane Copolymers

Code	Mole % Diethylsiloxane	Viscosity	Molecular Weight	Refractive Index	Specific Gravity	Price/100 g
EDV-2022	18-22	150-300	8000-12,000	1.413	0.953	¥51,200

Diethylsiloxane copolymers offer better hydrocarbon compatibility (greater solubility) and higher refractive index than analogous dimethylsiloxane homopolymers.



Vinylmethylsiloxane - Dimethylsiloxane Copolymers, trimethylsiloxy terminated

CAS: [67762-94-1] TSCA

Code	Mole % Vinylmethylsiloxane	Viscosity, cSt.	Molecular Weight	Vinyl - Eq/kg	Specific Gravity	Price/100 g	Price/1kg
VDT-123	0.8-1.2	250-350	12,000	0.11-0.15	0.97	¥10,100	¥50,000
VDT-127	0.8-1.2	700-800	23,000	0.11-0.15	0.97	¥13,400	¥73,000
VDT-131	0.8-1.2	800-1200	28,000	0.11-0.15	0.97	¥10,100	¥50,000
VDT-163	0.3-0.7	2,000,000-4,000,000	425,000	0.04-0.08	0.98	¥20,000	¥118,000
VDT-431	4.0-5.0	800-1200	28,000	0.5-0.7	0.97	¥10,600	¥55,000
VDT-731	7.0-8.0	800-1200	28,000	0.9-1.1	0.96	¥10,100	¥50,000
VDT-954	11.0-13.0	300,000-500,000	225,000	1.1-1.4	0.98	¥36,600	¥202,000
VDT-5035	48-52	4500-5500	50,000	6.0-6.5	0.98	¥15,900	¥90,000

Vinyl containing copolymers are used as crosslinkers in Pt and peroxide cure elastomer. High vinyl content copolymers form elastomers used in high accuracy soft lithography[1,2,3].

[1]Choi, D. et al. *Mat. Sci. Eng. C.* **2004**, *24*, 213.
[2]Infuehr, R. et al. *Appl. Surf. Sci.* **2003**, *254*, 836.
[3]Schmid, H.; Michel. B. *Macromolecules* **2000**, *33*, 3042.

Vinylmethylsiloxane - Dimethylsiloxane Copolymers, silanol terminated, 4-6% OH

CAS: [67923-19-7] TSCA

VDS-1013	10-15	25-40	550-650	0.9-1.4	0.99	¥17,800	¥107,000

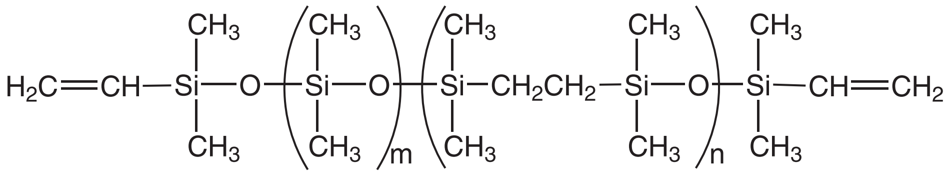
Vinylmethylsiloxane - Dimethylsiloxane Copolymers, vinyl terminated

CAS: [68083-18-1] TSCA

VDV-0131	0.3-0.4	800-1200	28,000	0.04-0.055	0.97	¥24,700	-

These materials are modifiers for addition cure and activated cure elastomers.

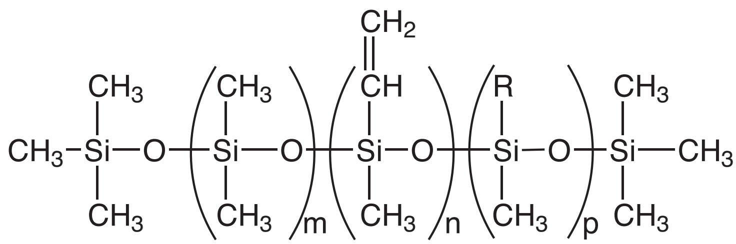
See also MCS-V212, p. 500



Vinyl Terminated Ethylene-Siloxane Copolymer Fluids [26710-23-6]

Code	Viscosity	Mole % Siloxane	Specific Gravity	Refractive Index	Molecular Weight	Price/100g	Price/1kg
DCE-V7512	150-250	70-80	0.907	1.429	>2000	¥35,300	¥214,000

Ethylene-siloxane copolymer polymers exhibit reversion resistant behavior.

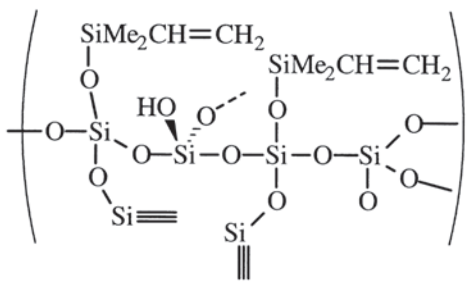


Vinyl Gums (balance dimethylsiloxane unless otherwise specified) TSCA

Code	Mole % Vinylmethylsiloxane	Comonomer %	Specific Gravity	Price/100 g	Price/1kg
VGM-021	0.2-0.3		0.98	¥13,000	¥38,000
VGP-061	0.1-0.2	6-7% Diphenylsiloxane	0.99	¥13,000	¥54,000
VGF-991	1.0-2.0%	98-9% Trifluoropropylmethylsiloxane	1.35	¥20,400	¥108,000
DGM-000*	0.0	100% dimethylsiloxane	0.98	¥13,000	¥38,000

* This gum is listed here for convenience. It contains no vinyl functionality.

These materials are base polymers for activated cure specialty silicone rubbers.



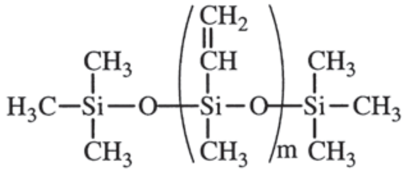
Vinyl Q Resins Dispersions CAS: [68584-83-8] TSCA

Code	Base	Viscosity	Vinyl Eq/kg	Refractive Index	Density	Price/100g	Price/3kg
VQM-135*	DMS-V41	4,500-7000	0.2-0.3	1.405	1.02	¥8,500	¥87,000
VQM-146*	DMS-V46	50,000-60,000	0.18-0.23	1.406	1.02	¥10,100	¥110,000
VQX-221	50% in xylene	-	0.4-0.6	-	1.05	¥11,400	¥131,000

*20-25% Q-resin

Vinyl Q resins are clear reinforcing additives for addition cure elastomers.

See also Hydride Q resins.

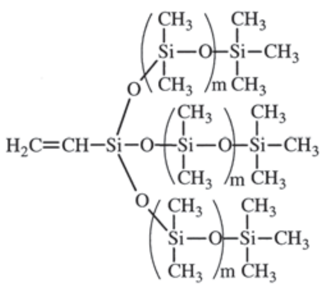


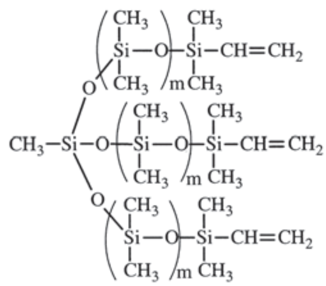
Vinylmethylsiloxane Homopolymers TSCA

Code	Description	Molecular Weight	Viscosity	Density	Price/100g	Price/3kg
VMS-005	cyclics	258-431	3-7	0.99	¥15,400	¥76,000
VMS-T11*	linear	1000-1500	7-15	0.96	¥32,600	¥363,000

*CAS: [68037-87-6]

Low molecular weight vinylmethylsiloxanes are primarily used as moderators (cure-rate retarders) for vinyl-addition cure silicones. They also are reactive intermediates and monomers.





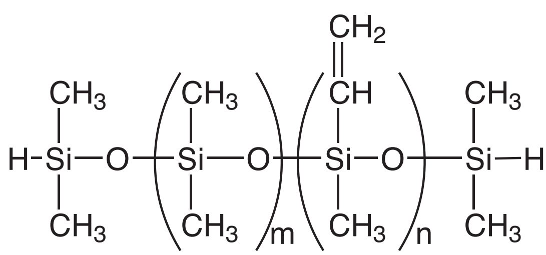
Vinyl T-structure Polymers

Code	Branch Point	Branch Terminus	Vinyl – Eq/Kg	Viscosity	Density	Refractive Index	Price/100g
VTT-106*	Vinyl	Methyl	2-4	5-8	0.90	-	¥16,200
MTV-112	Methyl	Vinyl	3-6	15-30	0.96	1.407	¥32,600

*CAS: [126581-51-9] TSCA

T-structure polymers contain multiple branch points.

These materials are additives and modifiers for addition cure and activated cure elastomers.



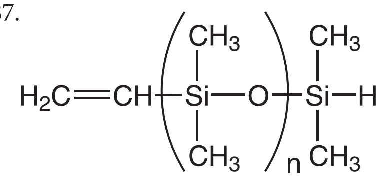
VinylMethylsiloxane – Dimethylsiloxane copolymer, hydride terminated

Code	Viscosity	Molecular Weight	Refractive Index	Specific Gravity	Vinyl- Eq/Kg	Price/100g	Price/1kg
VDH-422	150-250	8000-10,000	-	0.98	0.3-0.5	¥19,400	¥118,000

Vinyl Functional Macromers

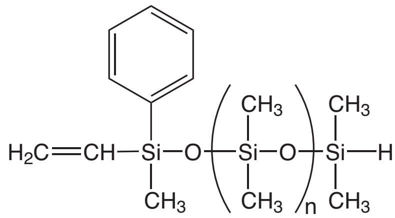
Hetero bi-functional silicone fluids contain little or no low molecular weight components. They can be used as additives into traditional RTV-2 silicone formulations or undergo a stepgrowth process when catalyzed by platinum, resulting in a silicone elastomer.[1]

1. Goff, J. et al, (Polymer Preprints) **2012**, *53(1)*, 487.



α-MonoVinyl-Ω-MonoHydride Terminated PolyDimethylsiloxane

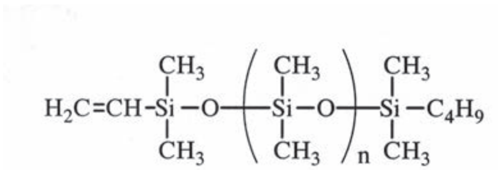
Code	Viscosity	Molecular Weight	Refractive Index	Specific Gravity	Price/100g
DMS-HV15	40-60	2000-3000	1.404	0.96	¥43,200
DMS-HV22	150-250	10,000	1.403	0.97	¥43,200



α-MonoVinyl-MonoPhenyl-Ω-MonoHydride Terminated PolyDimethylsiloxane

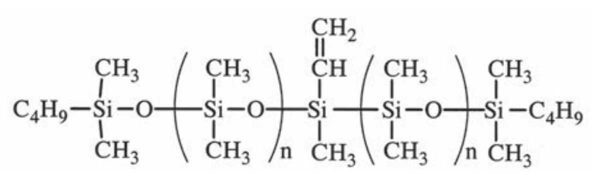
Code	Viscosity	Molecular Weight	Refractive Index	Specific Gravity	Price/100g
PMM-HV12	20	2000	1.4135	0.97	¥41,900

Mono-vinyl functional silicone fluids can be used as components in silicone gels and modifiers in release coatings.



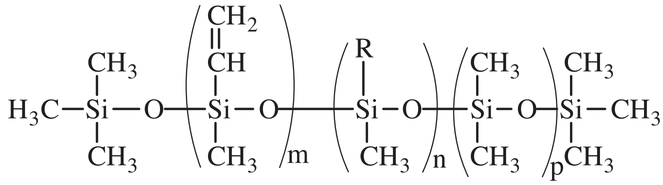
MonoVinyl Terminated PolyDimethylsiloxanes - asymmetric

Code	Viscosity	Molecular Weight	Refractive Index	Specific Gravity	Price/100g
MCR-V21	80-120	5500-6500	1.403	0.97	¥32,600
MCR-V41	8000-12000	55,000-65,000	1.404	0.98	¥59,100



MonoVinyl Functional PolyDimethylsiloxane - symmetric CAS: [689252-00-1]

Code	Viscosity	Molecular Weight	Refractive Index	Density	Price/100g
MCS-V212	16-24	1200-1400	1.419	0.95	¥32,600



VinylMethylsiloxane Terpolymers

(3-5% Vinylmethylsiloxane)-(35-40% Octylmethylsiloxane)-(Dimethylsiloxane) terpolymer CAS: [597543-32-3] TSCA

Code	Viscosity	Molecular Weight	Density	Refractive Index	Vinyl-Eq/Kg	Price/100g	Price/1kg
VAT-4326	500-700	10,000-12,000	0.93	1.437	0.20-0.24	¥18,000	¥92,000

Vinyl-alkyl terpolymers are used in hybrid organic polymer-silicone applications.
Employed as a matrix polymer in vapor sensor films.[1]

[1] Blok, E. et al, US Patent 7,138,090, **2006**.

(3-5% Vinylmethylsiloxane)-(35-40% Phenylmethylsiloxane)-(Dimethylsiloxane) terpolymer

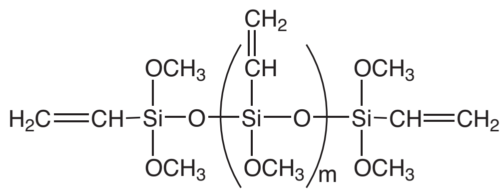
Code	Viscosity	Molecular Weight	Density	Refractive Index	Vinyl-Eq/Kg	Price/100g	Price/1kg
VPT-1323	250-350	2500-3000	1.03	1.467	0.25-0.29	¥16,200	¥95,000

Vinyl-phenyl terpolymers are used in refractive index match applications.

Dimethylsiloxane-vinylmethylsiloxane – (Propylene Oxide – Ethylene Oxide) Block Copolymers

Code	Viscosity	Molecular Weight	Density	Refractive Index	Vinyl-Eq/Kg	Price/100g	Price/1kg
DBP-V102	200	10,000	-	-	0.08-0.10	¥23,300	¥126,000
DBP-V052	200	10,000	-	-	0.03-0.05	¥23,300	¥126,000

Vinyl functional glycol-silicone copolymers are used as hydrophilic additives in silicone RTV-2 formulations.



Vinylmethoxysiloxane Homopolymer CAS: [131298-48-1] TSCA

Code	Description	Viscosity	Density	Price/100g	Price/1kg
VMM-010*	oligomer	8 - 12	1.10	¥10,900	¥58,000

*R.I.: 1.428; 22-3 wgt% vinyl

Vinylethoxysiloxane Homopolymer CAS: [29434-25-1] TSCA

Code	Description	Viscosity	Density	Price/100g	Price/1kg
VEE-005*	oligomer	4 - 7	1.02	¥13,000	¥73,000

*19-22 wgt% vinyl

Vinylethoxysiloxane-Propylethoxysiloxane Copolymer TSCA

Code	Description	Viscosity	Density	Price/100g	Price/1kg
VPE-005*	oligomer	3 - 7	1.02	¥13,000	¥73,000

*9-11 wgt% vinyl

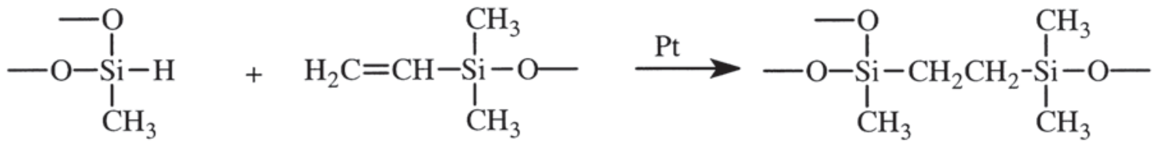
These materials are employed as adhesion promoters for vinyl-addition cure RTVs, as crosslinking agents for neutral cure RTVs, and as coupling agents in polyethylene for wire and cable applications.

≡Si–H

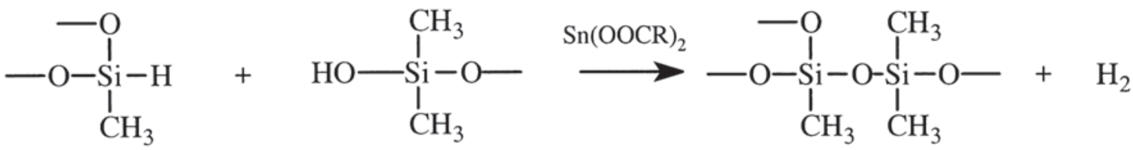
Hydride Functional Polymers

Hydride functional siloxanes undergo three main classes of reactivity: hydrosilylation, dehydrogenative coupling and hydride transfer.

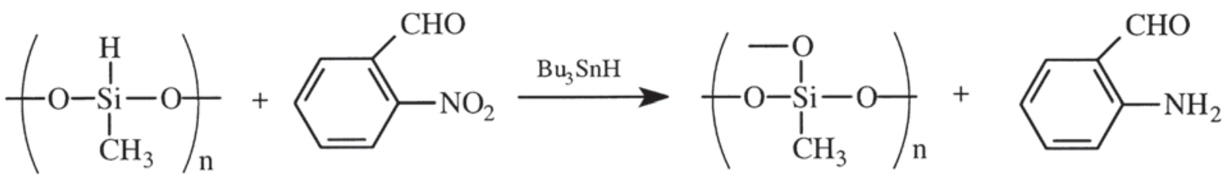
Hydrosilylation



Dehydrogenative Coupling



Reduction



Hydrosilylation - Addition Cure

The hydrosilylation of vinyl functional siloxanes by hydride functional siloxanes is the basis of addition cure chemistry used in 2-part RTVs and LTVs.[1,2] The most widely used materials for these applications are methylhydrosiloxane-dimethylsiloxane copolymers which have more readily controlled reactivity than the homopolymers and result in tougher polymers with lower cross-link density. The preferred catalysts for the reactions are platinum complexes such as SIP6830.3 and SIP6832.2. In principle, the reaction of hydride functional siloxanes with vinyl functional siloxanes takes place at 1:1 stoichiometry. For filled systems, the ratio of hydride to vinyl is much higher, ranging from 1.3:1 to 4.5:1. The optimum cure ratio is usually determined by measuring the hardness of cured elastomers at different ratios. Phenyl substituted hydrosiloxanes are used to crosslink phenylsiloxanes because of their greater solubility and closer refractive index match. The following chart gives some examples of starting ratios for common polymers and crosslinkers calculated at 1.5 Hydride to Vinyl ratio.

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1. Warrick, E. et al. *Rubber Chem. Tech.* **1979**, *52*, 437.
2. Dolgov, O. et al. *Organosilicon Liquid Rubbers, Int'l Poly. Sci. & Tech*. Monograph *#1*, RAPRA, **1975**.

Starting Ratios of Hydride Functional Siloxanes (parts) to 100 parts of Vinylsiloxane*

Hydrosiloxane Vinylsiloxane	HMS-013	HMS-151	HMS-301
DMS-V31	80.8	4.2	2.1
DMS-V41	11.5	1.8	0.9
PDV-0341	11.9	1.9	0.9

* formulation is based on 1.5 Si-H to 1 CH_2=CH-Si; filled formulations may require up to 3x the amount listed

The hydrosilylation of olefins is utilized to generate alkyl- and arylalkyl-substituted siloxanes, which form the basis of organic compatible silicone fluids. The hydrosilylation of functional olefins provides the basis for formation of silicone block polymers.

Dehydrogenative Coupling - Water Repellency, Foamed Silicones

Hydroxyl functional materials react with hydride functional siloxanes in the presence bis(2-ethylhexanoate)tin, dibutyldilauryltin, zinc octoate, iron octoate or a variety of other metal salt catalysts. The reaction with hydroxylic surface groups is widely used to impart water-repellency to glass, leather, paper and fabric surfaces and powders. A recent application is in the production of water-resistant gypsum board. Application is generally from dilute (0.5-2.0%) solution in hydrocarbons or as an emulsion. The coatings are generally cured at 110-150°C. Polymethylhydrosiloxane is most commonly employed. Polyethylhydrosiloxane imparts water-repellency, but has greater organic compatibility.

Silanol terminated polydimethylsiloxanes react with hydride functional siloxanes to produce foamed silicone materials. In addition to the formal chemistry described above, the presence of oxygen and moisture also influences cross-link density and foam structure.

Reductions[3]

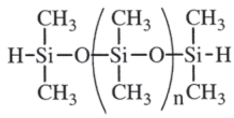
Polymethylhydrosiloxane is a versatile low cost hydride transfer reagent. It has a hydride equivalent weight of 60. Reactions are catalyzed by Pd^0 or dibutyltin oxide. The choice of reaction conditions leads to chemoselective reduction, e.g. allyl reductions in the presence of ketones and aldehydes.[4,5,6] Esters are reduced to primary alcohols in the presence of $Ti(OiPr)_4$[7].

See brochure “Silicon-Based Reducing Agents”.

Physical Properties

Polymethylhydrosiloxanes exhibit the highest compressibility of the silicone fluids, 9.32% at 20,000 psi and the lowest viscosity temperature coefficient, 0.50.

3. Larson, G. L., Fry, J. L., “*Ionic and Organometallic-Catalyzed Organosilane Reductions*”, in *Organic Reactions* S. E. Denmark, Ed. Volume 71, John Wiley and Sons, pp 1-771, **2008**.
4. Lipowitz, J. et al. *J. Org. Chem.* **1973**, *38*, 162.
5. Keinan, E. et al. *Israel J. Chem*. **1984**, *24*, 82. and *J. Org. Chem.* **1983**, *48*, 3545
6. Mukaiyama, T. et al. *Chem. Lett*. **1983**, 1727.
7. Reding, M. et al. *J. Org. Chem*. **1995**, *60*, 7884.



Hydride Terminated PolyDimethylsiloxanes

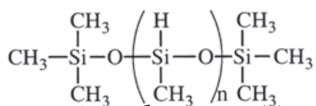
CAS: [70900-21-9] TSCA

Code	Viscosity	Molecular Weight	wt% H	Equivalent Weight	Specific Gravity	Refractive Index	Price/100g	Price/1kg
DMS-H03	2 - 3	400-500	0.5	225	0.90	1.395	¥17,800	¥68,000
DMS-H11	7-10	1000-1100	0.2	550	0.93	1.399	¥17,800	¥68,000
DMS-H21	100	4000-5000	0.04	3,000	0.97	1.403	¥28,600	¥115,000
DMS-H25	500	17,200	0.01	8,600	0.97	1.403	¥20,100	¥78,000
DMS-H31	1000	28,000	0.007	14,000	0.97	1.403	¥20,100	¥78,000
DMS-H41	10,000	62,700	0.003	31,350	0.97	1.403	¥21,900	¥86,000

Hydride terminated silicones are chain extenders for vinyl-addition silicones, enabling low viscosity, high elongation formulations. They are also intermediates for functionally terminated silicones.

Monodisperse Hydride Terminated PolyDimethylsiloxane

Code	Viscosity	Molecular Weight	wt% H	Equivalent Weight	Specific Gravity	Refractive Index	Price/100g	Price/1kg
DMS-Hm15	50	3000-3500	0.07	1,625	0.96	1.403	¥26,000	¥161,000
DMS-Hm25	500	17,200	0.01	8,600	0.97	1.403	¥26,000	¥161,000

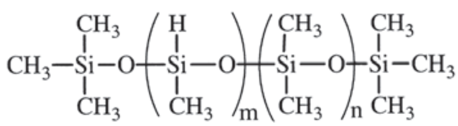


polyMethylHydrosiloxanes, Trimethylsiloxy terminated

Tg: -119° V.T.C: 0.50 CAS: [63148-57-2] TSCA

Code	Viscosity	Molecular Weight	Mole % (MeHSiO)	Equivalent Weight	Specific Gravity	Refractive Index	Price/100g	Price/3kg
HMS-991	15-25	1400-1800	100	67	0.98	1.395	¥7,700	¥40,600
HMS-992	20-35	1800-2100	100	65	0.99	1.396	¥8,500	¥47,000
HMS-993	30-45	2100-2400	100	64	0.99	1.396	¥10,900	¥73,000

MethylHydrosiloxane homopolymers are used as water-proofing agents, reducing agents and as components in some foamed silicone systems.



MethylHydrosiloxane - Dimethylsiloxane Copolymers, Trimethylsiloxy terminated

CAS: [68037-59-2] TSCA

Code	Viscosity	Molecular Weight	Mole % (MeHSiO)	Equivalent Weight	Specific Gravity	Refractive Index	Price/100g	Price/3kg
HMS-013	5000-8000	45,000-60,000	0.5-1.5	10,000	0.97	1.404	¥18,000	¥168,600
HMS-031	25-35	1900-2000	3-4	1600	0.97	1.401	¥15,400	¥95,000
HMS-053	750-1000	20,000-25,000	4-6	1475	0.97	1.403	¥16,700	¥117,500
HMS-064	6000-9000	50,000-60,000	4-8	1240	0.97	1.403	¥20,400	¥194,100
HMS-071	25-35	1900-2000	6-7	1000	0.97	1.401	¥19,400	¥122,800
HMS-082	110-150	5500-6500	7-9	925	0.97	1.403	¥9,800	¥62,300
HMS-151	25-35	1900-2000	15-18	490	0.97	1.400	¥9,800	¥62,300
HMS-301*	25-35	1900-2000	25-35	245	0.98	1.399	¥8,500	¥51,200
HMS-501	10-15	900-1200	45-55	135	0.96	1.394	¥9,800	¥62,300

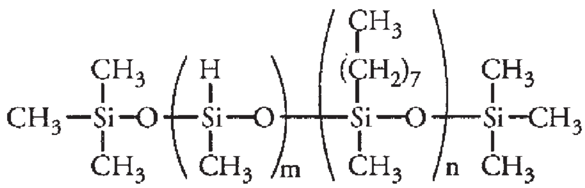
*available in reduced volatility grade

Specialty Hydrosiloxanes

MethylHydrosiloxane - Dimethylsiloxane Copolymers, Hydride terminated CAS: [69013-23-6] TSCA

Code	Viscosity	Molecular Weight	Mole % (MeHSiO)	Equivalent Weight	Specific Gravity	Refractive Index	Price/100g	Price/3kg
HMS-H271	24-60	2000-2600	25-30	200	0.96	1.402	¥11,700	¥84,400
HMS-HM271*	30-70	2000-3000	25-30	200	0.96	1.402	¥10,900	¥71,100

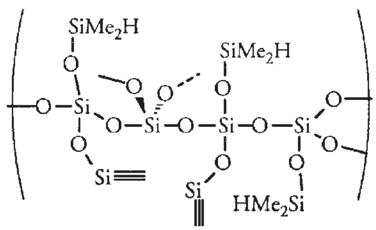
*mixed methyl, hydride terminated.
MethylHydrosiloxane copolymers are the primary crosslinkers for vinyl-addition silicones and intermediates for functional copolymers.



MethylHydrosiloxane - OctylMethylsiloxane copolymers and terpolymers

Code	Viscosity	Mole % (MeHSiO)	Equivalent Weight	Specific Gravity	Refractive Index	Price/25g	Price/100g
HAM-301*	30-80	25-30	440-480	0.91	1.442	¥19,400	¥55,200
HAM-3012**	20-60	25-30	280-320	0.93	1.425	¥16,700	¥46,400

*CAS: [68554-69-8] TSCA ** contains, 30-35% $C_8H_{17}MeSiO$, 35-40% Me_2SiO

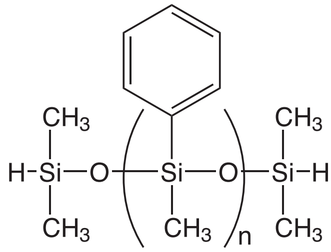


Hydride Q Resin CAS: [68988-57-8] TSCA

Code	Viscosity	Hydride Eq/kg	Equivalent Weight	Specific Gravity	Refractive Index	Price/25g	Price/100g
HQM-105	3-5	7.8-9.2	110-130	0.94	1.410	¥8,500	¥19,900
HQM-107	6-8	7.5-9.0	115-135	0.95	1.410	¥11,100	¥28,400

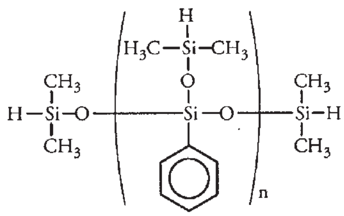
see also SST-3MH1.1 p.538; SST-H8HS8 p540

Phenyl Functional Hydrosiloxanes



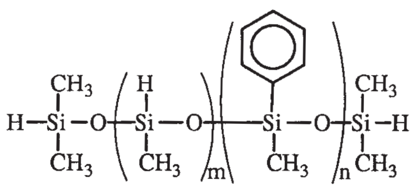
polyPhenylMethylsiloxane, Hydride Terminated*

Code	Viscosity	Mole % [$(HMe_2SiO)(C_6H_5Si)O$]	Equivalent Weight	Specific Gravity	Refractive Index	Price/100g	Price/1 kg
PMS-H03	2 - 5	300-500	200	0.93	1.453	¥35,300	-
PMS-H11	8 - 12	900-1100	500	-	-	¥43,200	-



polyPhenyl - (DiMethylHydrosiloxy)siloxane, hydride terminated

Code	Viscosity	Mole % [$(HMe_2SiO)(C_6H_5Si)O$]	Equivalent Weight	Specific Gravity	Refractive Index	Price/25g	Price/100g
HDP-111	50-80	99-100	150-155	1.01	1.463	¥23,100	¥67,100



MethylHydrosiloxane - PhenylMethylsiloxane copolymer, hydride terminated CAS: [115487-49-5] TSCA

Code	Viscosity	Mole % (MeHSiO)	Equivalent Weight	Specific Gravity	Refractive Index	Price/25g	Price/100g
HPM-502*	75-110	45-50	160-170	1.08	1.500	¥18,000	¥49,900

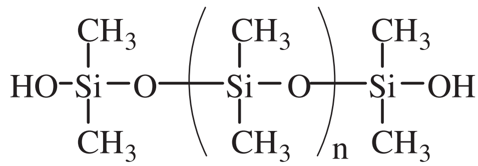
*unit MW: 200

Component in flexible optical waveguides.[1]

[1]Bichler, S. et al, *Optical Materials*, **2012**, 34, 772.

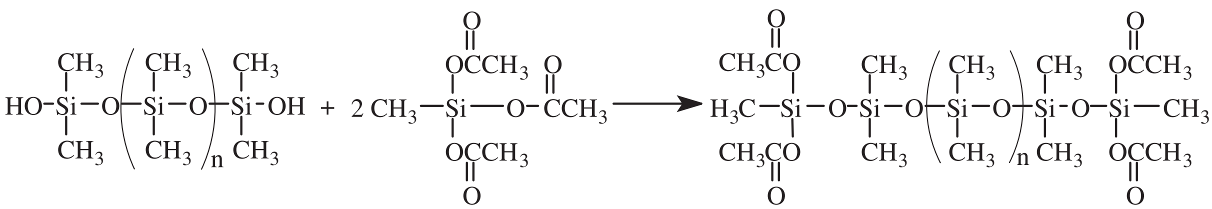
≡Si—OH

Silanol Functional Polymers

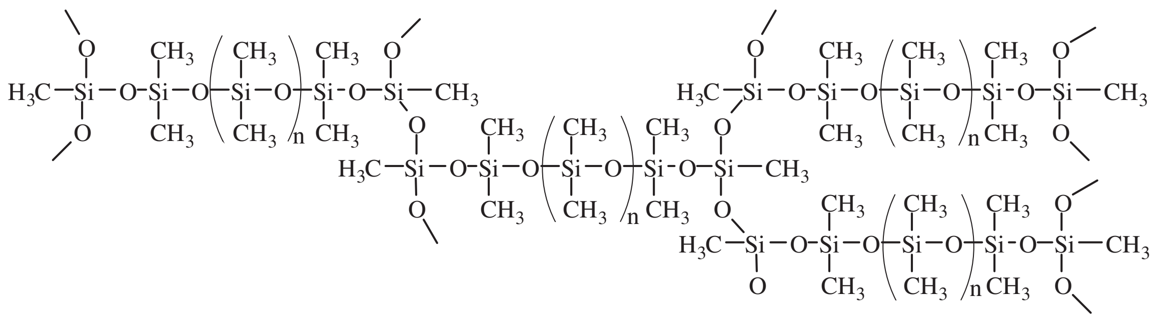


Terminal silanol groups render polydimethylsiloxanes susceptible to condensation under both mild acid and base conditions. They are intermediates for most room temperature vulcanizeable (RTV) silicones. Low molecular weight silanol fluids are generally produced by kinetically controlled hydrolysis of chlorosilanes. Higher molecular weight fluids can be prepared by equilibrating low molecular weight silanol fluids with cyclics, equilibrium polymerization of cyclics with water under pressure or methods of polymerization that involve hydrolyzeable end caps such as methoxy groups. Low molecular weight silanol fluids can be condensed to higher molecular weight silanol fluids by utilization of chlorophosphazene ($PNCl_2$) catalysts.

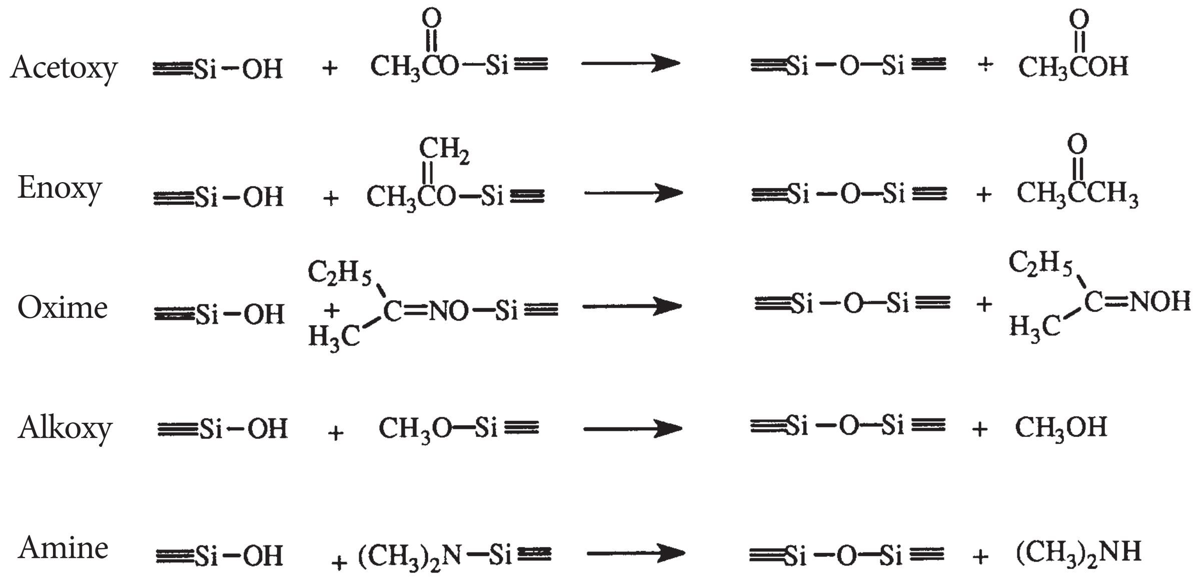
Condensation cure one-part and two-part RTV systems are formulated from silanol terminated polymers with molecular weights ranging from 15,000 to 150,000. One-part systems are the most widely used. One-part systems are crosslinked with moisture-sensitive multi-functional silanes in a two stage reaction. In the first stage, after compounding with fillers, the silanol is reacted with an excess of multi-functional silane. The silanol is in essence displaced by the silane. This is depicted below for an acetoxy system.



The silicone now has two groups at each end that are extremely susceptible to hydrolysis. The silicone is stored in this form and protected from moisture until ready for use. The second stage of the reaction takes place upon use. When the end groups are exposed to moisture, a rapid crosslinking reaction takes place.



The most common moisture cure systems are:



The crosslinking reaction of alkoxy systems are catalyzed by titanates, frequently in combination with tin compounds and other metal-organics. Acetoxy one-part systems usually rely solely on tin catalysts. The tin level in one-part RTV systems is minimally about 50ppm with a ratio of ~2500:1 for Si-OR to Sn, but typical formulations have up to ten times the minimum. Other specialty crosslinking systems include benzamido and mixed alkoxyamino. The organic (non-hydrolyzeable) substituents on the crosslinkers influence the speed of cure. Among the widely used crosslinkers vinyl substituted is the fastest: vinyl > methyl > ethyl >> phenyl.

Two-part condensation cure silanol systems employ ethylsilicates (polydiethoxysiloxanes) such as PSI-021 as crosslinkers and dialkyltincarboxylates as accelerators. Tin levels in these systems are minimally 500ppm, but typical formulations have up to ten times the minimum. Two-part systems are inexpensive, require less sophisticated compounding equipment, and are not subject to inhibition.

The following is a starting point formulation for a two-part RTV.

10:1 ratio of A to B.

Part A			**Part B**		
DMS-S45	silanol fluid	70%	DMS-T21	100 cSt. silicone fluid	50%
SIS6964.0	silica powder	28%	SIS6964.0	silica powder	45%
PSI-021	ethylsilicate	2%	SND3260	DBTL tin catalyst	5%

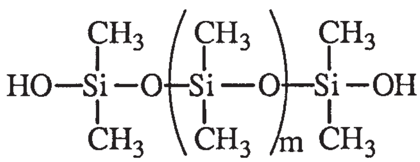
This low tear strength formulation can be improved by substituting fumed silica for silica powder.

Incorporation of hydride functional (Si-H) siloxanes into silanol elastomer formulations results in foamed structures. The blowing agent is hydrogen which forms as a result of silanol condensation with hydrosiloxanes. Foam systems are usually two components which are compounded separately and mixed shortly before use.

Condensation Cure Catalysts- see p. 548
Condensation Cure Crosslinkers- see p. 547

Silanol terminated diphenylsiloxane copolymers are employed to modify low temperature properties or optical properties of silicone RTVs. They are also utilized as flow control agents in polyester coatings. Diphenylsiloxane homopolymers are glassy materials with softening points >120°C that are used to formulate coatings and impregnants for electrical and nuclear applications.

The reactivity of silanol fluids is utilized in applications other than RTVs. Low viscosity silanol fluids are employed as filler treatments and structure control additives in silicone rubber compounding. Intermediate viscosity, 1000-10,000 cSt. fluids can be applied to textiles as durable fabric softeners. High viscosity silanol terminated fluids form the matrix component in tackifiers and pressure sensitive adhesives.



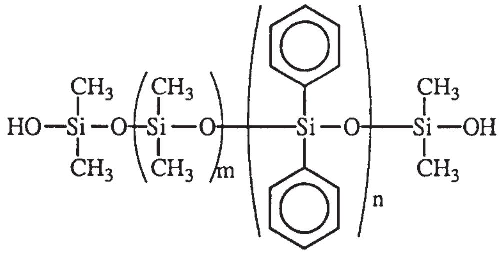
Silanol Terminated PolyDimethylsiloxanes

CAS: [70131-67-8] TSCA

Code	Viscosity	Molecular Weight	wt% (OH)	(OH) - Eq/kg	Specific Gravity	Refractive Index	Price/100g	Price/3kg	Price/16kg
DMS-S12	16-32	400-700	4.5-7.5	2.3-3.5	0.95	1.401	¥10,100	¥55,200	¥197,000
DMS-S14	35-45	700-1500	3.0-4.0	1.7-2.3	0.96	1.402	¥8,800	¥47,200	¥163,000
DMS-S15	45-85	2000-3500	0.9-1.2	0.53-0.70	0.96	1.402	¥8,800	¥47,200	¥163,000
DMS-S21	90-120	4200	0.8-0.9	0.47-0.53	0.97	1.402	¥8,000	¥41,700	¥106,000
DMS-S27	700-800	18,000	0.2	0.11-0.13	0.97	1.403	¥7,400	¥37,700	¥99,000
DMS-S31	1000	26,000	0.1	0.055-0.060	0.98	1.403	¥7,400	¥37,700	¥99,000
DMS-S32	2000	36,000	0.09	0.050-0.055	0.98	1.403	¥7,400	¥37,700	¥99,000
DMS-S33*	3500	43,500	0.08	0.045-0.050	0.98	1.403	¥7,400	¥37,700	¥99,000
DMS-S35	5000	49,000	0.07	0.039-0.043	0.98	1.403	¥8,000	¥41,700	¥104,000
DMS-S42	18,000	77,000	0.04	0.023-0.025	0.98	1.403	¥8,800	¥45,600	¥114,000
DMS-S45	50,000	110,000	0.03	0.015-0.017	0.98	1.403	¥8,800	¥45,600	¥114,000
DMS-S51	90,000-150,000	139,000	0.02	0.010-0.015	0.98	1.403	¥13,300	¥87,000	¥217,000

COMMERCIAL

*also available as an emulsion (see DMS-S33M50 pg 533



Silanol Terminated Diphenylsiloxane - Dimethylsiloxane Copolymers

TSCA

Code	Viscosity	Mole % Diphenylsiloxane	Molecular Weight	Refractive Index	wt% (OH)	Price/100g	Price/3kg
PDS-0338*	6000-8000	2.5-3.5	50,000	1.420	0.4-0.7	¥18,800	¥293,000
PDS-1615**	50-60	14-18	900-1000	1.473	3.4-4.8	¥15,600	¥278,000

*CAS: [68083-14-7] **CAS: [68951-93-9]

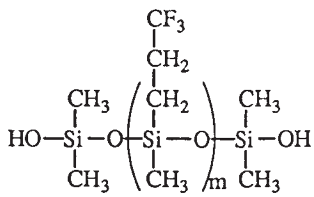
Employed as color stabilizers in sintered PTFE composites.

Silanol Terminated PolyDiphenylsiloxane

Tm: 142-155°; contains cyclics

CAS: [63148-59-4] TSCA

Code	Viscosity	Mole % Diphenylsiloxane	Molecular Weight	Refractive Index	wt% (OH)	Price/100g	Price/1kg
PDS-9931	glassy solid	100	1000-1400	1.610	2.4-3.4	¥25,700	¥168,700



Silanol Terminated PolyTrifluoropropylMethylsiloxane

CAS: [68607-77-2] TSCA

Code	Viscosity	Mole % $CF_3CH_2CH_2MeSiO$	Molecular Weight	Refractive Index	wt% (OH)	Specific Gravity	Price/100g
FMS-9921	50-160	100	550-800	1.379	5-7%	1.28	¥27,300
FMS-9922	150-250	100	800-1200	1.379	3-5%	1.28	¥38,500

Silanol-Trimethylsilyl Modified Q Resins

CAS: [56275-01-5] TSCA

Code	Wgt % Q resin	Molecular Weight	wt%(OH)	Base Resin	solvent	Price/100g	Price/3kg
SQO-299	100	3000-4000	1.7-2.0	-	-	¥30,500	¥280,000
SQD-255	50	3000-4000	-	-	50% D5	¥10,100	¥63,000
SQT-221	60	3000-4000	-	-	40% toluene	¥8,500	¥45,000
SQS-261	35-40	3000-4000	-	DMS-S61*	40% toluene	¥15,400	¥92,000

COMMERCIAL

*300,000-400,000 MW silanol terminated polydimethylsiloxane

Silanol-Trimethylsilyl-modified Q resins are often referred to as MQ resins. They serve as reinforcing resins in silicone elastomers and tackifying components in pressure sensitive adhesives.

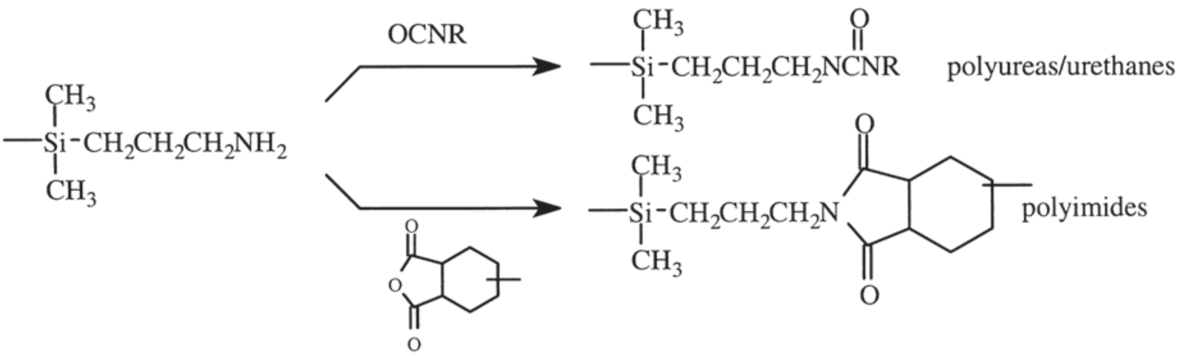
Silanol terminated vinylmethylsiloxane copolymers - see Vinylmethylsiloxane Dimethylsiloxane Copolymers, silanol terminated, p. 494

$$\equiv SiCH_2CH_2CH_2NH_2$$

Amino Functional Silicones

Aminoalkylfunctional silicones have a broad array of applications as a result of their chemical reactivity, their ability to form hydrogen bonds and, particularly in the case of diamines, their chelating ability. Additional reactivity can be built into aminoalkyl groups in the form of alkoxy groups. Aminoalkylsiloxanes are available in the three classes of structures typical for silicone polymers: terminated, pendant group and T-structure.

Aminopropyl terminated polydimethylsiloxanes react to form a variety of polymers including polyimides, polyureas[1] and polyurethanes. Block polymers based on these materials are becoming increasingly important in microelectronic (passivation layer) and electrical (low-smoke generation insulation) applications. They are also employed in specialty lubricant and surfactant applications. Phosphorylcholine derivatives have been utilized as coatings for extended wear contact lens[2].



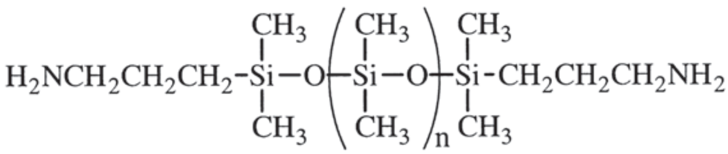
Amino functionality pendant from the siloxane backbone is available in two forms: (aminopropyl)-methylsiloxane-dimethylsiloxane copolymers and (aminoethylaminopropyl)-methylsiloxane-dimethylsiloxane copolymers. They are frequently used in modification of polymers such as epoxies and urethanes, internal mold releases for nylons and as lubricants, release agents and components in coatings for textiles and polishes.

Aminoalkyl T-structure silicones are primarily used as surface treatments for textiles and finished metal polishes (e.g. automotive car polishes). The resistance to wash-off of these silicones is frequently enhanced by the incorporation of alkoxy groups which slowly hydrolyze and form crosslink or reactive sites under the influence of the amine. The same systems can be reacted with perfluorocarboxylic acids to form low surface energy (<7 dynes/cm) films.[3]

[1]Riess, C. *Monatshefte Chem*. **2006**, *137*, 1434.

[2]Willis, S. et al *Biomaterials*, **2001**, *22*, 3261.

[3]Thürman, A. *J. Mater. Chem*. **2001**, *11*, 381.



Aminopropyl Terminated PolyDimethylsiloxanes

Tg: -123° CAS: [106214-84-0] TSCA

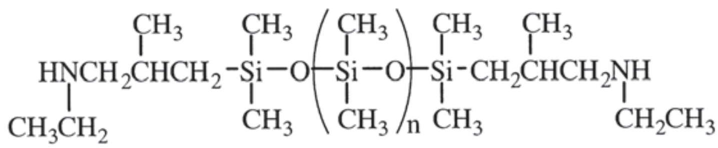
Code	Viscosity	Molecular Weight	wt% Amine (NH_2)	Specific Gravity	Refractive Index	Price/100g	Price/1kg
DMS-A11	10-15	850-900	3.2-3.8	0.98	1.412	¥24,100	¥130,000
DMS-A12	20-30	900-1000	3.0-3.2	0.98	1.411	¥19,400	¥102,000
DMS-A15	50-60	3000	1.0-1.2	0.97	1.408	¥14,900	¥68,000
DMS-A21	100-120	5000	0.6-0.7	0.98	1.407	¥13,800	¥68,000
DMS-A31	900-1100	25,000	0.11-0.12	0.98	1.407	¥13,800	¥68,000
DMS-A32	1800-2200	30,000	0.08-0.09	0.98	1.404	¥11,100	¥53,000
DMS-A35	4000-6000	50,000	0.05-0.06	0.98	1.404	¥13,800	¥71,000

COMMERCIAL

Reduced Volatility Grades

Code	Viscosity	Molecular Weight	wt% Amine (NH_2)	Specific Gravity	Refractive Index	Price/100g	Price/1kg
DMS-A32R*	1900-2300	30,000	0.08-0.09	0.98	1.404	¥23,600	¥117,000

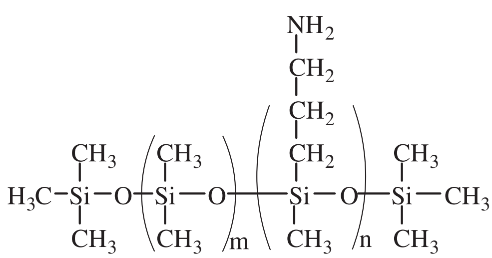
*total volatiles, 4 hours @ 150°C: 2.0 wt% maximum



N-EthylAminoisobutyl Terminated PolyDimethylsiloxane

CAS: [254891-17-3] TSCA

Code	Viscosity	Molecular Weight	% Amine (NH)	Specific Gravity	Refractive Index	Price/100g	Price/1kg
DMS-A211	8-12	800-1000	2.8-3.2	0.93	1.422	¥28,900	¥179,000
DMS-A214	32-40	2500-3000	1.0-1.4	0.96	1.411	¥28,900	¥179,000

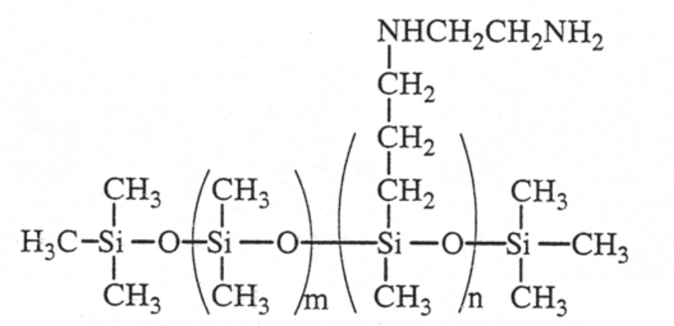


AminopropylMethylsiloxane - Dimethylsiloxane Copolymers

CAS: [99363-37-8] TSCA

Code	Viscosity	Molecular Weight	Mole % (Aminopropyl) MethylSiloxane	Specific Gravity	Refractive Index	Price/100g	Price/3kg
AMS-132	80-120	4500-6000	2-3	0.96	1.404	¥12,500	¥66,000
AMS-152	100-300	7000-9000	4-5	0.97	1.408	¥12,500	¥66,000
AMS-162	64-200	4000-5000	6-7	0.97	1.410	¥12,500	¥66,000
AMS-163	1800-2200	50,000	6-7	0.97	1.411	¥26,000	¥150,000
AMS-191	40-60	2000-3000	9-11	0.97	1.412	¥23,300	¥141,000
AMS-1203	900-1100	20,000	20-25	0.98	1.426	¥23,300	¥141,000

COMMERCIAL



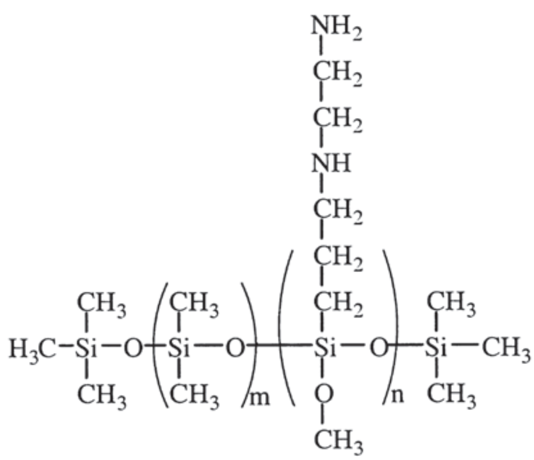
AminoethylaminopropylMethylsiloxane - Dimethylsiloxane Copolymers CAS: [71750-79-3] TSCA

Code	Viscosity	Molecular Weight	Mole % (Diamino-propyl)MethylSiloxane	Specific Gravity	Refractive Index	Price/100g	Price/3kg
AMS-233	900-1200	-	2 - 4	0.98	1.407	¥12,500	¥75,000
AMS-2202	300-500	-	18-24	0.98	1.41	¥24,700	¥139,000

AminoethylaminoisobutylMethylsiloxane - Dimethylsiloxane Copolymers CAS: [106842-44-8] TSCA

Code	Viscosity	Molecular Weight	Mole % (Diamino-isobutyl)MethylSiloxane	Specific Gravity	Refractive Index	Price/100g	Price/3kg
AMS-242	120-150	-	3-5	0.97	1.404	¥16,200	¥101,000

Amine Functional Siloxanes with Alkoxy Groups



AminoethylaminopropylMethoxysiloxane - Dimethylsiloxane Copolymers with branch structure CAS: [67923-07-3] TSCA

Code	Viscosity	Molecular Weight	Mole % (Diamino-propyl)MethoxySiloxane	Specific Gravity	Base Equiv. meq/g	Price/100g	Price/3 kg
ATM-1112	100-200	5000-6500	0.5-1.5	0.97	0.55	¥18,300	¥129,000
ATM-1322*	200-300	-	2 - 4	0.97	-	¥11,100	¥58,000

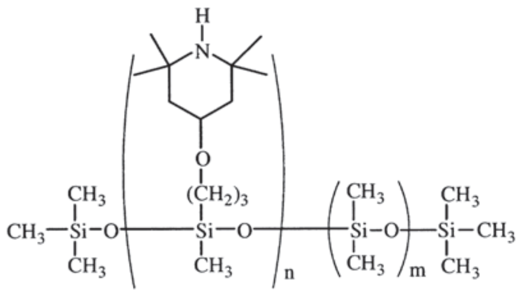
*also available as an emulsion

Diaminoalkoxysiloxanes cure to form durable films on metal substrates.

See ATM-1322M50; p. page 533

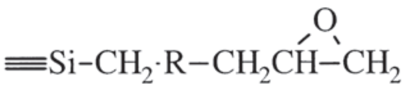
Hindered Amine Functional Siloxanes

Hindered Amine Light Stabilizers (HALS) may be incorporated into polysiloxane structures affording an ultraviolet light stabilizer system that is compatible with other stabilizers such as hindered phenolics and organophosphites and is strongly resistant to water extraction.



(Tetramethylpiperidinyloxy)propylMethylsiloxane-Dimethylsiloxane copolymer CAS: [182635-99-0] TSCA

Code	Viscosity	mole % HALS functional MethylSiloxane	Specific Gravity	Refractive Index	Price/100g	Price/1kg
UBS-0541	10000	4-6	1.00	1.408	¥22,500	¥140,000
UBS-0822	250	7-9	0.98	1.409	¥19,400	¥118,000



Epoxy Functional Silicones

Difunctional and multifunctional epoxy silicones include lower molecular weight siloxanes with discrete structures and higher molecular weight silicones with either pendant or terminal epoxy functionalization. Depending on specific structures and formulations, they selectively impart a wide range of properties, associated with silicones-low-stress, low temperature properties, dielectric properties and release. Properties of cured silicone modified epoxies vary from hydrophilic to hydrophobic depending on the epoxy content, degree of substitution and ring-opening of epoxides to form diols. The ring-strained epoxycyclohexyl group is more reactive than the epoxypropoxy group and undergoes thermally or chemically induced reactions with nucleophiles including protic surfaces such as cellulosics of polyacrylate resins.

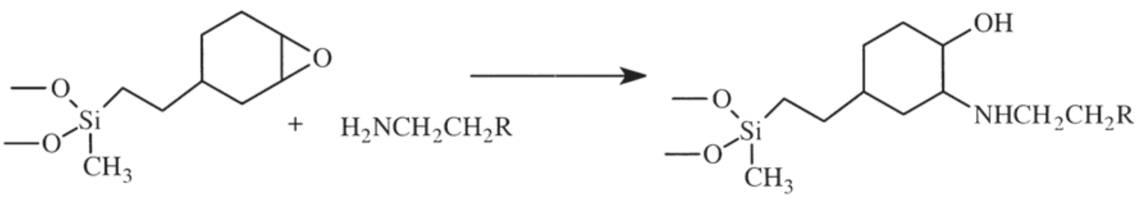
The compatibility of epoxy functional silicones with conventional epoxies varies. In simple unfilled systems, total solubility is required. For filled systems, it is often desireable to consider systems that are miscible but have only limited solubility since microphase separation can allow a mechanism for stress-relief.

Epoxysilicones with methoxy groups can be used to improve adhesion to substrates such as titanium, glass or silicon. They also can improve chemical resistance of coatings by forming siloxane crosslinks upon exposure to moisture.

Silicone - Epoxy Compatibility

	Epoxy Type		
Gelest Product	**Bisphenol**	**Polyglycol**	**Cycloaliphatic**
SIB1092.0	miscible	soluble	soluble
PMS-E11	soluble	soluble	soluble
DMS-E09	soluble	soluble	soluble
DMS-E11	insoluble	miscible	miscible
EMS-622	insoluble	miscible	insoluble

(10% silicone 90% epoxy)



A UV initiator for cycloaliphatic epoxides is OMBO037 described in the Catalyst Section. Epoxy functional siloxane copolymers with polyalkyleneoxide functionality provide hydrophilic textile finishes.

Epoxypropoxypropyl Terminated PolyDimethylsiloxanes

[102782-97-8] TSCA

Code	Viscosity	Molecular Weight	Epoxy-Eq/kg	Specific Gravity	Refractive Index	Price/100g	Price/1 kg
DMS-E09	8-11	363	5.5	0.99	1.446	¥19,400	¥118,000
DMS-E11	12-18	500-600	1.9-2.2	0.98	1.419	¥27,300	¥148,000
DMS-E12	20-35	1000-1400	1.6-1.9	0.98	1.417	¥35,300	¥204,000
DMS-E21	100-140	4500-5500	0.45-0.35	0.98	1.408	¥35,300	¥204,000

Used in preparation of photocurable silicone for soft lithography[1].

[1]Choi, D. et al, *JACS*, **2003**, *125*, 4060.

(Epoxypropoxypropyl Methylsiloxane)-(Dimethylsiloxane) Copolymers

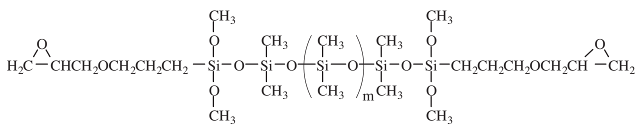
CAS: [68440-71-7] TSCA

EMS-622	200-300	7,000-9,000	5-7	0.99	1.412	¥11,400	¥52,300

Epoxypropoxypropyl Terminated PolyPhenylMethylsiloxanes

[102782-98-9] TSCA

PMS-E11	15-30	500-600	3.0-3.6	1.01	1.475	¥51,200	-
PMS-E15	30-50	1200-1500	1.0-1.7	1.01	1.490	¥59,100	-

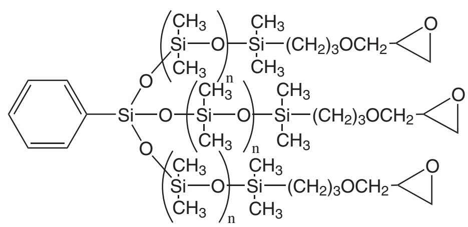


(Epoxypropoxypropyl)dimethoxysilyl Terminated PolyDimethylsiloxanes

[188958-73-8] TSCA

DMS-EX21	80-120	3500-4000	0.48-0.5	0.98	1.408	¥16,400	¥85,000

Multifunctional Siloxanes

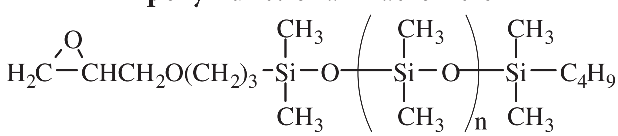


MonoPhenyl functional Tris(Epoxy Terminated PolyDimethylsiloxane)

[90393-83-2] TSCA

Code	Viscosity	Molecular Weight	Epoxy–Eq/Kg	Melting Point	Specific Gravity	Refractive Index	Price/25g
MCT-EP13	30-35	500-750	4-6	-73°	1.05	1.4742	¥18,000

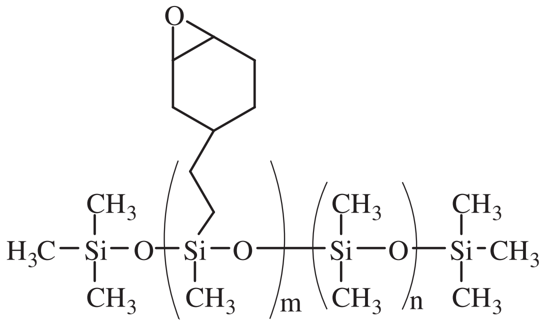
Epoxy Functional Macromers



Mono-(2,3-Epoxy)Propylether Terminated PolyDimethylsiloxane

CAS: [127947-26-6]

Code	Viscosity	Molecular Weight	Epoxy–Eq/Kg	Specific Gravity	Refractive Index	Price/100g	Price/1 kg
MCR-E11	10-15	1000	0.8-1.2	0.96	1.410	¥27,300	¥168,700
MCR-E21	100-120	5000	0.1-0.3	0.97	1.408	¥26,000	¥140,900

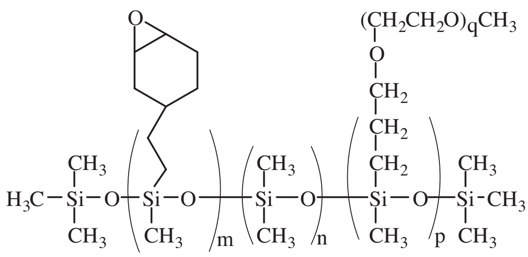


Cycloaliphatic Epoxy Silicones

These materials, characterized by a combination of cycloaliphatic and siloxane structures, have outstanding weathering characteristics, controlled release and coefficient of friction and excellent electrical properties. They can be cured either by cationic UV photoinitiators or conventional epoxy hardeners. In cationic UV-cure systems the cycloaliphatic epoxy silicones combine the properties of reactive diluents with surfactant properties. The release properties can be employed to make parting layers for multilayer films. If high levels of epoxy functional silicones are used in UV-cure formulations, cationic photoinitiators with hydrophobic substitution are preferred.

(EpoxycyclohexylethylMethylsiloxane) - Dimethylsiloxane Copolymers CAS: [67762-95-2] TSCA

Code	Viscosity	Molecular Weight	Mole % (Epoxycyclohexyl)-ethylMethylSiloxane	Specific Gravity	Refractive Index	Price/100g	Price/1 kg
ECMS-127	500-1200	12,000-15,000	1-2	0.98	1.407	¥8,500	¥36,200
ECMS-227	650-800	18,000-20,000	2-3	0.98	1.407	¥8,500	¥36,200
ECMS-327	650-850	18,000-20,000	3-4	0.99	1.409	¥8,500	¥36,200
ECMS-924	300-450	10,000-12,000	8-10	0.97	1.421	¥9,800	¥44,100



(2-3% EpoxycyclohexylethylMethylsiloxane)(10-15% MethoxypolyalkyleneoxyMethylSiloxane)-(Dimethylsiloxane) Terpolymers

Code	Viscosity	Molecular Weight	Epoxy-Eq/Kg	Specific Gravity	Refractive Index	Price/100g	Price/1 kg	Price/10 kg
EBP-234	4000-5000	25,000-36,000	0.75-0.80	1.03	1.445	¥9,300	¥40,900	

CAS: [69669-36-9] TSCA

Epoxycyclohexylethyl Terminated PolyDimethylsiloxanes CAS: [102782-98-9] TSCA

Code	Viscosity	Molecular Weight	Epoxy-Eq/Kg	Specific Gravity	Refractive Index	Price/100g	Price/1 kg
DMS-EC13	25-35	900-1100	1.9-2.0	0.99	1.433	¥51,200	¥231,000
DMS-EC17	60-80	3200-3600	0.5-0.7	0.98	1.412	¥51,200	-

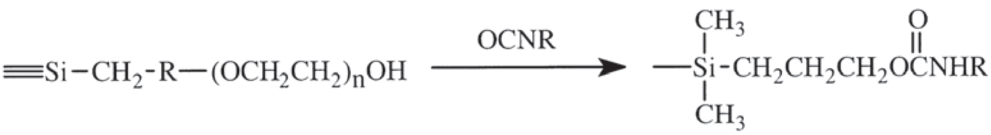
see also SIB1092.0

$$\equiv Si{-}CH_2{-}R{-}(OCH_2CH_2)_nOH$$

Carbinol Functional Silicones

Carbinol (Hydroxy) Functional Siloxanes

The term carbinol refers to a hydroxyl group bound to carbon (C-OH) and is frequently used in silicone chemistry to differentiate them from hydroxyl groups bound to silicon (Si-OH) which are referred to as silanols. Carbinol terminated siloxanes contain primary hydroxyl groups which are linked to the siloxane backbone by non-hydrolyzeable transition groups. Frequently a transition block of ethylene oxide or propylene oxide is used. Carbinol functional polydimethylsiloxanes may be reacted into polyurethanes, epoxies, polyesters and phenolics.

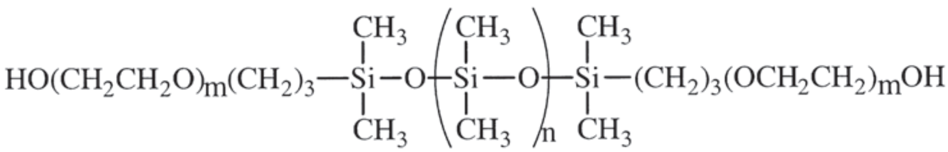


Applications include additives for urethane leather finishes and as reactive internal lubricants for polyester fiber melt spinning. They are also utilized as surfactants and processing aids for dispersion of particles in silicone formulations.

Polyethyleneoxide transition blocks are more polar than polypropyleneoxide blocks and maintain a broad range of liquid behavior. Carbinol terminated siloxanes with caprolactone transition blocks offer a highly polar component which enables compatibility in a variety of thermoplastic resins.

Mono(dicarbinol) terminated polydimethylsiloxanes are macromers with diol termination on one end of a polydimethylsiloxane chain. In contrast with telechelic carbinol terminated polydimethylsiloxanes, they have the unique ability to react with isocyanates to form urethanes with pendant silicone groups. In this configuration the mechanical strength of the polyurethane is maintained while properties such as hydrophobicity, release and low dynamic coefficient of friction are achieved. For example, a 2 wgt % incorporation of MCR-C61 or MCR-C62 into an aromatic urethane formulation increases water contact angle from 78° to 98°. The reduction of coefficient of friction and increased release of urethanes formulated with diol terminated macromers has led to their acceptance as additives in synthetic leather.

Carbinol functional Macromers - see Macromers p. 530



Carbinol (Hydroxyl) Terminated PolyDimethylsiloxanes

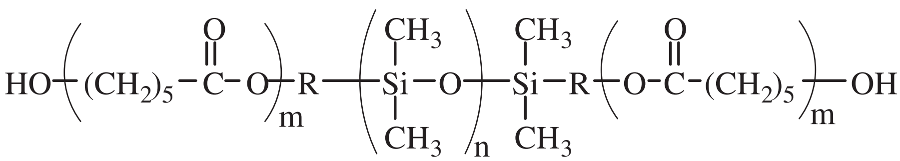
Code	Viscosity	Molecular Weight	Weight % Non-Siloxane	Specific Gravity	Refractive Index	Price/100g	Price/1kg
DMS-C15	30-50	1000	20	0.98	1.417	¥22,500	¥121,000
DMS-C16	50-65	600-850	-	0.97	1.416	¥20,700	¥110,000
DMS-C21	110-140	4500-5500	4	0.98	1.407	¥14,600	¥73,000
DMS-C23	300-350	10,000	-	0.98	1.406	¥16,200	¥83,000
DBE-C25*	400-450	3500-4500	60	1.07	1.450	¥11,100	¥53,000
DBP-C22**	200-300	2500-3200	45-55	0.99	1.434	¥15,600	¥80,000

note: for DMS-C15, DMS-C21, DMS-C23 m=1 CAS: [156327-07-0]; for DMS-C16 m=0 CAS: [104780-66-7] TSCA

*A-B-A ethylene oxide - dimethylsiloxane - ethylene oxide block polymer CAS: [68937-54-2]

**A-B-A propylene oxide - dimethylsiloxane - propylene oxide block copolymer m=12-16 CAS: [161755-53-9]

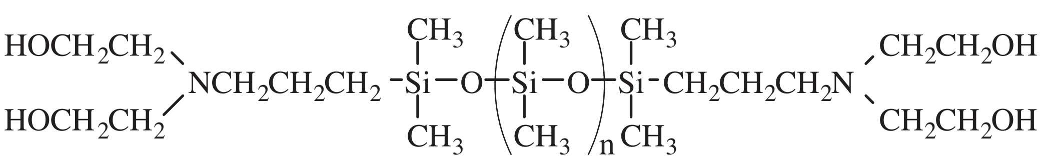
COMMERCIAL



Carbinol (Hydroxyl) Terminated PolyDimethylsiloxanes

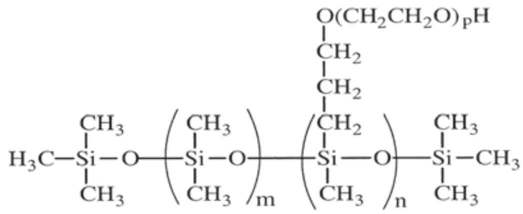
Code	Melting Point	Molecular Weight	Weight % Non-Siloxane	Specific Gravity	Refractive Index	Price/100g	Price/1kg
DBL-C31*	52-6°	5700-6900	50	1.05	-	¥20,400	¥111,000
DBL-C32**	80-85°	7000-8000	25-30	1.05	-	¥23,300	¥130,000

A-B-A caprolactone - dimethylsiloxane - caprolactone block polymer, *m=15-20; **m=7-10 CAS: [120359-07-1]



[Bis(Hydroxyethyl)Amine] Terminated PolyDimethylsiloxanes

Code	Viscosity	Molecular Weight	Weight % Non-Siloxane	Specific Gravity	Refractive Index	Price/100g	Price/1kg
DMS-CA21	120-160	3000	10	0.97	1.414	¥31,600	¥206,000

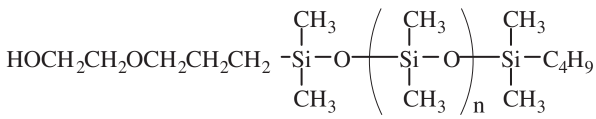


(Carbinol functional)Methylsiloxane-Dimethylsiloxane Copolymers

Code	wt% Non-Siloxane	OH Content (meq/g)	Glycol chains/mol	Viscosity	Molecular Weight	Specific Gravity	Refractive Index	CAS	Price 100g	Price 1kg
CMS-221	20-25	0.7-0.9	3-4	125-150	4000	1.00	1.419	68937-54-2	¥8,800	¥8,800
CMS-222	20	0.4-0.6	2-3	150-200	5500-6500	0.98	1.411	68957-00-6	¥14,100	¥69,000
CMS-832*	50-60	0.2-0.3	-	1000-2000	2000-5000	1.09	1.505	200443-93-2	¥16,200	¥95,000
CMS-626	65	0.3-0.5	1-3	550-650	4500-5500	1.09	1.458	68937-54-2	¥13,800	¥68,000

*(Hydroxypolyethyleneoxypropyl)methylsiloxane-(3,4-Dimethoxyphenylpropyl)methylsiloxane-Dimethylsiloxane terpolymer

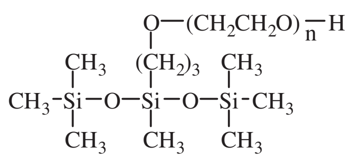
Carbinol Functional Macromers



MonoCarbinol Terminated PolyDimethylsiloxane

CAS: [207308-30-3] TSCA

Code	Viscosity	Molecular Weight	Refractive Index	Specific Gravity	Price/100g	Price/1kg
MCR-C12	15-20	1000	1.409	0.96	¥36,600	¥144,500
MCR-C18	60-140	5000	1.405	0.97	¥24,900	¥134,500
MCR-C22	250	10,000	1.404	0.98	¥23,300	¥116,000

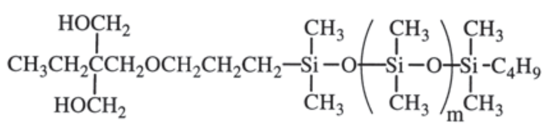


MonoCarbinol Terminated Functional PolyDimethylsiloxanes - symmetric

CAS: [67674-67-3] TSCA

Code	Viscosity	Molecular Weight	Refractive Index	Specific Gravity	Price/100g	Price/1kg
MCS-C11*	5-15	280-380	1.413	0.905	¥14,100	-
MCS-C13**	35-40	550-650	1.446	1.02	¥16,200	¥82,300

* n=0, CAS [17962-67-3]   **n=6-9, CAS[67674-67-3]

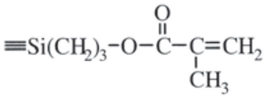


MonoDiCarbinol Terminated PolyDimethylsiloxane

CAS: [218131-11-4]

Code	Viscosity	Molecular Weight	Refractive Index	Specific Gravity	Price/100g	Price/1kg
MCR-C61	50-60	1000	1.417	0.97	¥19,400	¥133,200
MCR-C62	100-125	5000	1.409	0.97	¥19,400	¥133,200

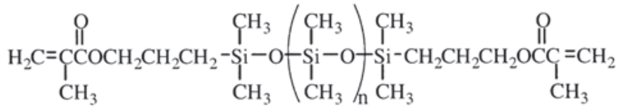
Diol terminated silicones improve electrical and release properties of polyurethanes.



Methacrylate and Acrylate Functional Siloxanes

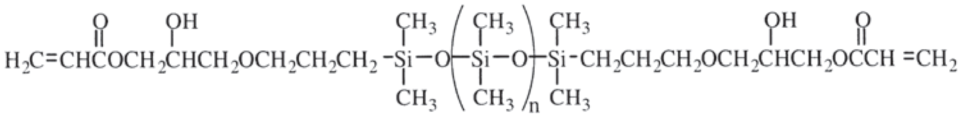
Methacrylate and Acrylate functional siloxanes undergo the same reactions generally associated with methacrylates and acrylates, the most conspicuous being radical induced polymerization. Unlike vinylsiloxanes which are sluggish compared to their organic counterparts, methacrylate and acrylate siloxanes have similar reactivity to their organic counterparts. The principal applications of methacrylate functional siloxanes are as modifiers to organic systems. Upon radical induced polymerization, methacryloxypropyl terminated siloxanes by themselves only increase in viscosity. Copolymers with greater than 5 mole % methacrylate substitution crosslink to give non-flowable resins. Acrylate functional siloxanes cure at greater than ten times as fast as methacrylate functional siloxanes on exposure to UV in the presence of a photoinitiator such as ethylbenzoin. They form permeable membranes for fiber-optic oxygen and glucose sensors.[1]

Oxygen is an inhibitor for methacrylate polymerization in general. The high oxygen permeability of siloxanes usually makes it necessary to blanket these materials with nitrogen or argon in order to obtain reasonable cures.



Methacryloxypropyl Terminated PolyDimethylsiloxanes CAS: [58130-03-3]

Code	Viscosity	Molecular Weight	Refractive Index	Specific Gravity	Price/25g	Price/100g
DMS-R05	4 - 6	380-550	1.448	0.97	¥19,900	¥57,000
DMS-R11	8-14	900-1200	1.422	0.98	¥24,100	¥70,800
DMS-R18	50-90	4500-5500	1.409	0.98	¥24,100	¥70,800
DMS-R22	125-250	10,000	1.405	0.98	¥24,100	¥70,800
DMS-R31	1000	25,000	1.404	0.98	¥20,700	¥59,700



(3-Acryloxy-2-hydroxypropoxypropyl) Terminated PolyDimethylsiloxanes CAS: [128754-61-0]

Code	Viscosity	Molecular Weight	Refractive Index	Specific Gravity	Price/25g	Price/100g
DMS-U21	60-140	600-900	1.426	0.99	¥12,700	¥32,900

Acryloxy Terminated Ethyleneoxide - Dimethylsiloxane-Ethyleneoxide ABA Block Copolymers CAS: [117440-21-8] TSCA

Code	Viscosity	Molecular Weight	MW PDMSO block	Refractive Index	Specific Gravity	Price/100g	Price/1kg
DBE-U12*	80-120	1500-1600	700-800	1.450	1.03	¥19,400	¥118,000
DBE-U22**	110-150	1700-1800	1000-1200	1.445	1.03	¥14,100	¥81,000

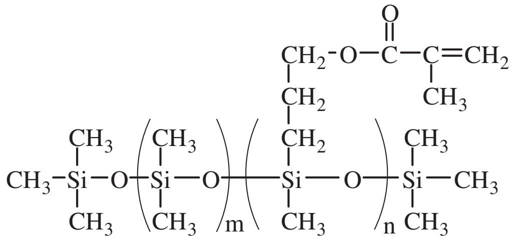
* 45-55 wgt% CH_2CH_2O **30-35 wgt% CH_2CH_2O

Methacryloxypropyl Terminated Branched PolyDimethylsiloxanes CAS: [80722-63-0]

Code	Viscosity	Molecular Weight	Refractive Index	Specific Gravity	Price/25g	Price/100g
SIB1400.0	14-18	683	1.432	0.99	¥16,400	¥44,800

see also- methacrylate functional macromers

[1]Li, L. et al. *Analyt. Chem.* **1995**, *67*, 3746.



(Methacryloxypropyl)methylsiloxane - Dimethylsiloxane Copolymers CAS: [104780-61-2] TSCA

Code	Viscosity	Specific Gravity	Mole % (Methacryloxy-propyl)Methylsiloxane	Price/100g
RMS-044	8000-10,000	0.98	4 - 6	¥69,700
RMS-033	1000-2000	0.98	2 - 4	¥43,200
RMS-083	2000-3000	0.99	7 - 9	¥52,500

(Acryloxypropyl)methylsiloxane - Dimethylsiloxane Copolymers

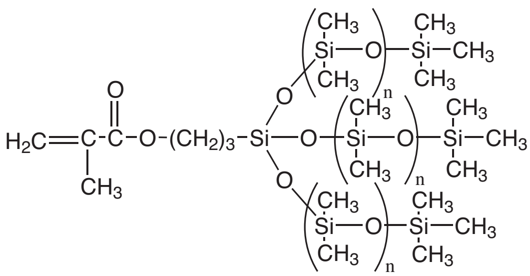
Code	Viscosity	Specific Gravity	Mole % (Acryloxy-propyl)Methylsiloxane	Price/100g
UMS-182	80-120	1.01	15-20	¥40,600
UMS-992*	50-125	1.10	99-100	¥32,600

*homopolymer Refractive Index: UMS-182 = 1.426; UMS-992 = 1.464 UMS-182-CAS: 158061-40-6

(3-Acryloxy-2-Hydroxypropoxypropyl)Methylsiloxane-Dimethylsiloxane Copolymer

Code	Viscosity	Molecular Weight	Mole % (Acryloxy-functional)Methylsiloxane	Price/100g
UCS-052	500-1,500	7500-8500	4-6	¥24,100

amber liquid



Methacryloxypropyl T-structure Siloxanes CAS: [67923-18-6] TSCA

Code	Viscosity	Molecular Weight	Specific Gravity	Price/100g
RTT-1011	10 - 20	570-620	0.95	¥26,300

contains multiple branch points (>2 methacrylate groups)

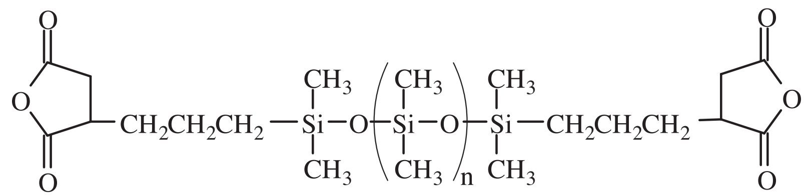
Acryloxypropyl T-structure Siloxanes

Code	Viscosity	Molecular Weight	Specific Gravity	Refractive Index	Price/100g
UTT-1012	10 - 30	500-900	0.96	1.421	¥32,600

contains multiple branch points (>2 acrylate groups)

Methacrylate functional macromers- see p. 530, 531

Anhydride, Bicycloheptenyl, and Carboxylate functional Silicones

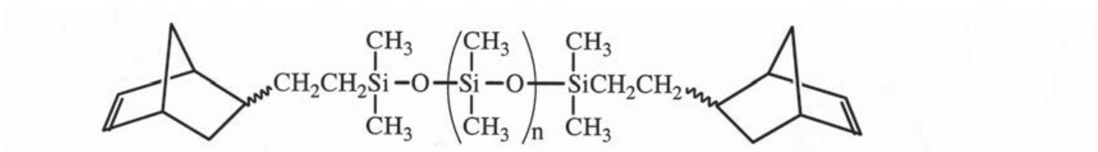


Anhydride functional Silicones

Anhydride functional siloxanes can be reacted directly with amines and epoxides or hydrolyzed to give dicarboxylic acid terminated siloxanes.

Succinic Anhydride Terminated PolyDimethylsiloxane

Code	Viscosity	Molecular Weight	Specific Gravity	Refractive Index	Price/25g	Price/100g
DMS-Z21	75-100	600-800	1.06	1.436	¥24,700	¥72,100



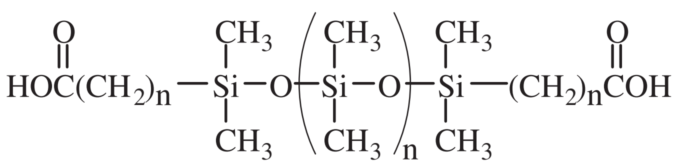
Bicycloheptenyl functional Silicones

Bicycloheptenyl terminated silicones undergo ring-opening metathesis polymerization (ROMP) reactions.[1,2]

[1] Finkelstein, E. 10th Int'l Organosilicone Symp. Proc, **1993**, P-120.
[2] Angeletakis, C. et al, US Pat. 6,455,029, **2002.**

(Bicycloheptenyl)ethyl Terminated PolyDimethylsiloxane CAS: [945244-93-9]

Code	Viscosity	Molecular Weight	Specific Gravity	Refractive Index	Price/25g	Price/100g
DMS-NB25	400-600	12,000-16,000	0.98	1.406	¥24,700	¥70,000
DMS-NB32	1300-1800	16,000-20,000	0.96	1.406	¥24,700	¥70,000



Carboxylate functional Silicones

Carboxylic acid functional siloxanes are excellent rheology and wetting modifiers for polyesters. When reacted with inorganic bases or amines, they perform as anti-static surfactants and lubricants.

(Carboxyalkyl) Terminated PolyDimethylsiloxane

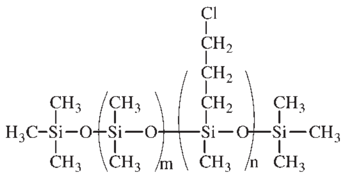
Code	Viscosity	Molecular Weight	Termination	Specific Gravity	Refractive Index	Price/25g	Price/100g
DMS-B12*	15-30	1000	Carboxydecyl	0.96	1.421	¥18,800	¥54,000
DMS-B25*	450-550	10,000	Carboxydecyl	0.97	1.403	¥17,200	¥49,000
DMS-B31**	800-1200	28,000	Carboxypropyl	0.98	-	¥17,200	¥49,000

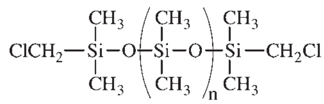
*CAS: [58130-04-4] ** [158465-59-9]

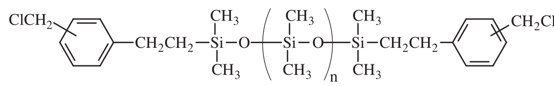
Chloroalkyl and Mercapto Functional Silicones

Chloroalkyl-functional Silicones

Chlororopropyl-functional silicones are moderately stable fluids which are reactive with polysulfides and durable press fabrics. They behave as internal lubricants and plasticizers for a variety of resins where low volatility and flammability resistance is a factor. Chloromethyl and chloromethylphenethyl terminated polydimethylsiloxanes offer access to block copolymers through various polymerization chemistries such as ATRP & RAFT.







(Chloropropyl)Methylsiloxane - Dimethylsiloxane Copolymers CAS: [70900-20-8] TSCA

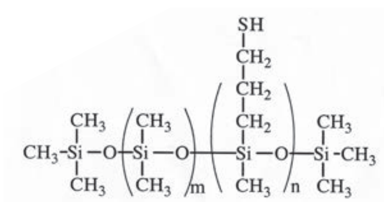
Code	Viscosity	Molecular Weight	Mole % (Chloro-propyl)MethylSiloxane	Specific Gravity	Refractive Index	Price/100g	Price/1kg
LMS-152	300-450	7500-10,000	14 - 16	1.01	1.420	¥28,900	¥156,400

Chloromethyl terminated PolyDimethylsiloxane CAS: [158465-60-2]

Code	Viscosity	Molecular Weight		Specific Gravity	Refractive Index	Price/100g	Price/1kg
DMS-L21	100-150	6000-8000	-	0.98	1.406	¥24,700	¥153,000

Chloromethylphenethyl terminated PolyDimethylsiloxane

Code	Viscosity	Molecular Weight		Specific Gravity	Refractive Index	Price/100g	Price/1kg
DMS-LP21	100-150	5000	-	0.98	1.420	¥32,600	-



Mercapto-functional Silicones

Mercapto-functional siloxanes strongly adsorb onto fibers and metal surfaces. High performance toner fluids for reprographic applications are formulated from mercapto-fluids. As components in automotive polishes they are effective rust inhibitors. They act as internal mold release agents for rubber and semi-permanent lubricants for automotive weather stripping. Mercapto-fluids are valuable additives in cosmetic and hair care products. They also undergo radical initiated (including UV) addition to unsaturated resins. Homopolymers are used as crosslinkers for vinylsiloxanes in rapid UV cure fiber optic coatings[1] and soft lithography stamps.[2]

[1] Mueller, U. et al. *J. Macromol. Sci. Pure Appl. Chem.* **1996**, *A43*, 439.
[2] Campos, L. et al. *Chem. Mater.* **2009**, *21*, 531.

Mercaptopropyl terminated PolyDimethylsiloxane

Code	Viscosity	Molecular Weight		Specific Gravity	Refractive Index	Price/100g	Price/1kg
DMS-SM21	80-120	10000	-	-	-		-

(Mercaptopropyl)Methylsiloxane - Dimethylsiloxane Copolymers CAS: [102783-03-9] TSCA

Code	Viscosity	Molecular Weight	Mole % (Mercapto-propyl) MethylSiloxane	Specific Gravity	Refractive Index	Price/100g	Price/1kg
SMS-022	120-250	6000-8000	2 - 3	0.97	1.406	¥9,300	¥40,900
SMS-042	120-170	6000-8000	4 - 6	0.98	1.408	¥9,300	¥40,900
SMS-142	100-200	3000-4000	13 - 17	0.98	1.410	¥19,400	¥117,300
SMS-992*	75-150	4000-7000	99-100	0.97	1.496	¥35,300	-

*homopolymer, contains cyclics

Polydimethylsiloxanes with Hydrolyzable Functionality

Polydimethylsiloxanes with hydrolyzable functionality react with water to produce silanol terminated fluids of equivalent or higher degrees of polymerization. Polymers with this category of reactivity are almost never directly hydrolyzed. Chlorine and dimethylamine terminated fluids are usually employed in ordered chain extension and block polymer synthesis, particularly urethanes and polycarbonates. Acetoxy and dimethylamine terminated fluids can also be used as unfilled bases for rapid cure RTVs.

Chlorine Terminated PolyDimethylsiloxanes CAS: [67923-13-1] TSCA

Code	Viscosity	Molecular Weight	Specific Gravity	Price/100g	Price/1kg
DMS-K05	3-8	425-650	1.00	¥19,400	¥110,000
DMS-K13	20-50	2000-4000	0.99	¥35,300	¥199,000
DMS-K26	500-800	15,000-20,000	0.99	¥28,400	¥175,000

Chlorine Terminated Nonafluorohexylmethylsiloxane – Dimethylsiloxane Copolymers CAS: [908858-79-7] TSCA-L

Code	Viscosity	Molecular Weight	Specific Gravity	Price/25g	Price/1kg
FMS-K11	5-15	500-1000	1.46	¥25,200	¥74,000

Diacetoxymethyl Terminated PolyDimethylsiloxanes CAS: [158465-54-4] TSCA

Code	Viscosity	Molecular Weight	Specific Gravity	Price/100g	Price/1kg
DMS-D33	2000-4000	36,000	0.99	¥20,400	

Dimethylamino Terminated PolyDimethylsiloxanes CAS: [67762-92-9] TSCA

Code	Viscosity	Molecular Weight	Specific Gravity	Price/100g	Price/1kg
DMS-N05	3 - 8	450-600	0.93	¥45,900	-
DMS-N12	15 - 30	1550-2000	0.95	¥40,600	-

hazy liquids

Ethoxy Terminated PolyDimethylsiloxanes CAS: [70851-25-1] TSCA

Code	Viscosity	Molecular Weight	Specific Gravity	Price/100g	Price/1kg
DMS-XE11	5-10	800-900	0.94	¥11,900	¥61,600

TriEthoxysilylethyl Terminated PolyDimethylsiloxanes CAS: [195158-81-7]

Code	Viscosity	Molecular Weight	Specific Gravity	Price/100g	Price/1kg
DMS-XT11	8-12	600-900	0.96	¥11,900	¥61,600

Methoxy Terminated PolyDimethylsiloxanes CAS: [68951-97-3] TSCA

Code	Viscosity	Molecular Weight	Specific Gravity	Price/100g	Price/1kg
DMS-XM11	5-12	900-1000	0.94	¥11,100	¥55,800

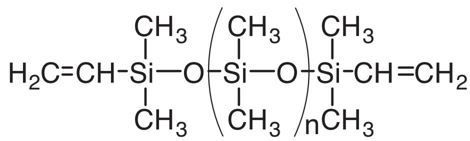
MethoxyMethylsiloxane-Dimethylsiloxane copolymer
methoxy terminated with branch structure CAS: [68440-84-6] TSCA

Code	Viscosity	Mole % MethoxyMethylsiloxane	Specific Gravity	Price/100g	Price/1kg
XMS-5025.2*	2-5	10-20	0.83	¥11,400	¥70,000

*20% in isopropanol

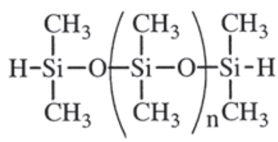
Monodisperse Reactive Silicones via Anionic Living Polymerization

Monodisperse silicones offer certain advantages over standard telechelic silicones. They have a discrete molecular weight and no low molecular weight non-functional cyclic siloxanes that can migrate out of the fluid or materials produced with them. Higher molecular weight vinyl functional materials can be used as base silicones for 2-part RTVs.



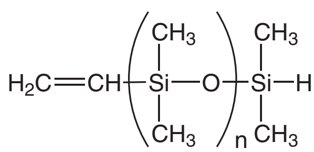
Monodisperse Vinyl Terminated PolydiMethylsiloxane

Code	Viscosity	Molecular Weight	Wt% Vinyl	Vinyl – Eq/kg	Specific Gravity	Price/100g	Price/3kg
DMS-Vm31	1000	28,000	0.18-0.26	0.07-0.10	0.97	¥24,700	¥158,200
DMS-Vm35	5000	49,500	0.10-0.13	0.04-0.05	0.97	¥24,700	¥158,200



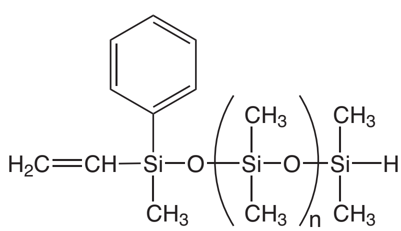
Monodisperse Hydride Terminated PolyDimethylsiloxane

Code	Viscosity	Molecular Weight	Wt% H	Equivalent Weight	Refractive Index	Specific Gravity	Price/100g	Price/1kg
DMS-Hm15	50	3000-3500	0.07	1,625	0.96	1.403	¥26,000	¥161,000
DMS-Hm25	500	17,200	0.01	8,600	0.97	1.403	¥26,000	¥161,000



α-MonoVinyl-Ω-MonoHydride Terminated PolyDimethylsiloxane

Code	Viscosity	Molecular Weight	Refractive Index	Specific Gravity	Price/100g	Price/1kg
DMS-HV15	40-60	2000-3000	1.404	0.96	¥43,200	¥201,000
DMS-HV22	150-250	10,000	1.403	0.97	¥43,200	¥201,000



α-MonoVinyl-MonoPhenyl-Ω-MonoHydride-Terminated PolyDimethylsiloxane

Code	Viscosity	Molecular Weight	Refractive Index	Specific Gravity	Price/100g	Price/1kg
PMM-HV12	20	2000	1.4135	0.97	¥41,900	¥208,000

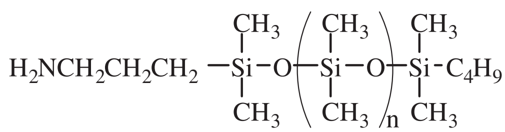
Macromers and Monofunctional Silicones

Macromers are relatively high molecular weight species with a single functional polymerizeable group which, although used as monomers, have high enough molecular weight or internal monomer units to be considered polymers. A macromer has one end-group which enables it to act as a monomer molecule, contributing only a single monomeric unit to a chain of the final macromolecule. The term macromer is a contraction of the word macromonomer. Copolymerization of macromers with traditional monomers offers a route to polymers that are usually associated with grafting. Macromers provide a mechanism for introducing pendant groups onto a polymer backbone with conditions consistent with radical, condensation or step-growth polymerization but result in pendant groups that are usually associated with significantly different polymerization conditions and significantly different physical properties than the main polymer chain. Siloxane macromers afford a mechanism for introducing a variety of desirable properties without disrupting the main chain integrity of an organic polymer.

Two general classes of siloxane macromers are available: asymmetric and symmetric. Asymmetric macromers have been the most widely used, but symmetric monomers, which open a path for hyper-branched polymers, are anticipated to have increased commercial utilization. Macromers are primarily defined by the functional group anticipated to be the reactive functionality in a polymerization. Other modifications usually effect a greater degree of compatibility with the proposed bulk polymer. These include modifying or replacing the most widely used siloxane building block, dimethylsiloxane, with other siloxanes, typically trifluoropropylmethylsiloxane.

MonoAminopropyl Terminated PolyDimethylsiloxanes

MonoAminopropyl Terminated PolyDimethylsiloxanes are most widely used as intermediates for acrylamide functional macromers or as terminating groups for polyamides and polyimides.

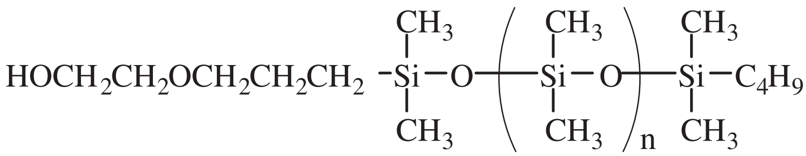


MonoAminopropyl Terminated PolyDimethylsiloxanes - asymmetric

Code	Viscosity	Molecular Weight	Refractive Index	Specific Gravity	Price/100g	Price/1kg
MCR-A11	8-12	800-1000	1.411	0.92	¥49,900	¥240,000
MCR-A12	18-25	2000	1.411	0.97	¥48,500	¥222,000

MonoCarbinol Terminated PolyDimethylsiloxanes

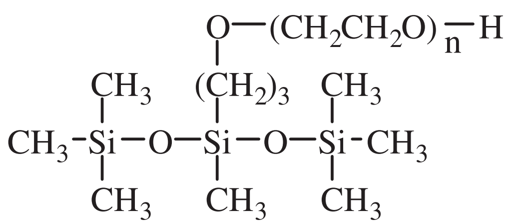
Monocarbinol terminated silicones are pigment dispersants and compatibilizers for a variety of resin systems including epoxies, urethanes and silicones. The action of these materials has been likened to surfactants for non-aqueous systems.



MonoCarbinol Terminated PolyDimethylsiloxanes - asymmetric CAS: [207308-30-3] TSCA

Code	Viscosity	Molecular Weight	Refractive Index	Specific Gravity	Price/100g	Price/1kg
MCR-C12	15-20	1000	1.409	0.96	¥36,600	¥144,500
MCR-C18	80-90	5000	1.405	0.97	¥24,900	¥134,500
MCR-C22	250	10000	1.404	0.98	¥23,300	¥116,000

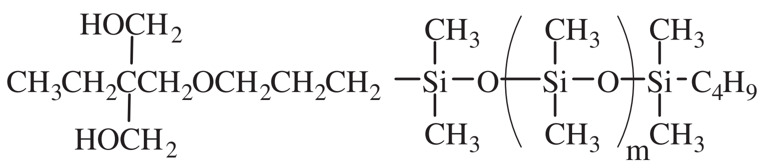
hydroxyethoxypropyl terminated



MonoCarbinol Terminated Functional PolyDimethylsiloxanes - symmetric CAS: [67674-67-3] TSCA

Code	Viscosity	Molecular Weight	Refractive Index	Specific Gravity	Price/100g	Price/1kg
MCS-C11*	5-15	280-380	1.413	0.905	¥14,100	-
MCS-C13**	35-40	550-650	1.446	1.02	¥16,200	¥82,300

* n=0, CAS [17962-67-3] **n=6-9, CAS[67674-67-3]

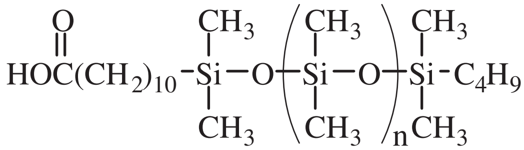


MonoDiCarbinol Terminated PolyDimethylsiloxanes - asymmetric CAS: [218131-11-4] TSCA

Code	Viscosity	Molecular Weight	Refractive Index	Specific Gravity	Price/100g	Price/1kg
MCR-C61	50-60	1000	1.417	0.97	¥19,400	¥133,200
MCR-C62	100-125	5000	1.409	0.97	¥19,400	¥133,200

MonoCarboxy Terminated PolyDimethylsiloxanes

Carboxylic acid terminated silicones form esters. They also behave as surfactants.

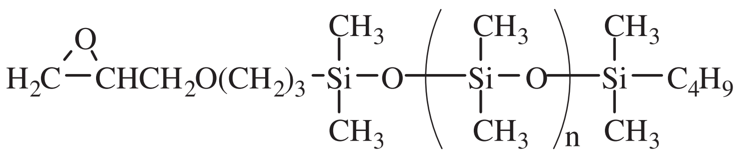


MonoCarboxydecyl Terminated PolyDimethylsiloxanes - asymmetric

Code	Viscosity	Molecular Weight	Refractive Index	Specific Gravity	Price/100g	Price/1kg
MCR-B12	20	1500	1.415	0.94	¥51,200	-

MonoEpoxyTerminated PolyDimethylsiloxanes

Monofunctional epoxy terminated silicones have been utilized as modifiers for aliphatic epoxy systems. They have been used as thermal stress reduction additives to epoxies employed in electronic applications. They have also been acrylated to form UV curable macromers.



Mono (2,3-Epoxy)Propylether Terminated PolyDimethylsiloxanes - asymmetric

CAS:[1108731-31-2]/ [127947-26-6] TSCA

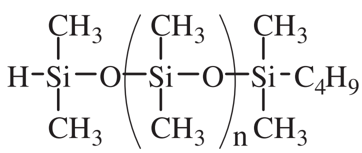
Code	Viscosity	Molecular Weight	Refractive Index	Specific Gravity	Price/100g	Price/1kg
MCR-E11	10-15	1000	1.410	0.96	¥27,300	¥168,700
MCR-E21	120	5000	1.408	0.97	¥26,000	¥140,900

Mono (2,3-Epoxy)Propylether Functional PolyDimethylsiloxanes - symmetric

Code	Viscosity	Molecular Weight	Refractive Index	Specific Gravity	Price/100g	Price/1kg
MCS-E15	45-55	800-900	1.398	1.09	¥40,600	¥215,000

MonoHydrideTerminated PolyDimethylsiloxanes

Hydride functional macromer can be derivatized or reacted with a variety of olefins by hydrosilylation. They are also modifiers for platinum-cure silicone elastomers.



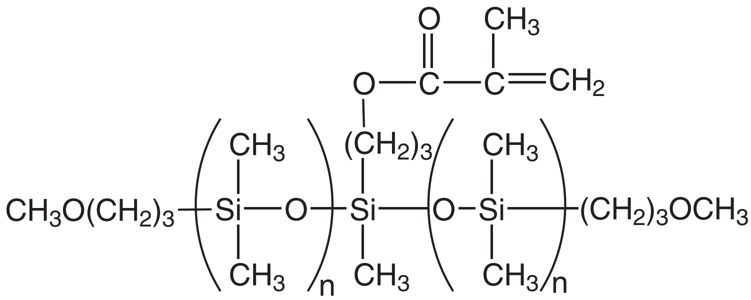
MonoHydride Terminated PolyDimethylsiloxanes - asymmetric

CAS:[1038821-58-7] TSCA

Code	Viscosity	Molecular Weight	Refractive Index	Specific Gravity	Price/100g	Price/1kg
MCR-H07	5-8	800-900	1.404	0.96	¥40,600	¥210,000
MCR-H11	8-12	900-1100	1.407	0.96	¥32,600	¥195,100
MCR-H21	80-120	4500-5000	1.411	0.96	¥32,600	¥195,100

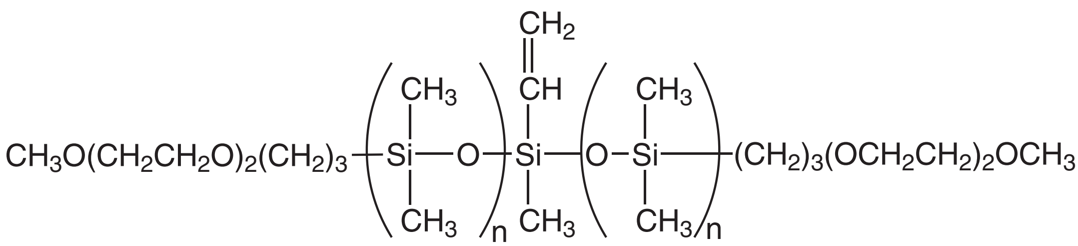
Polar Endcapped Symmetric Macromers

Macromers with polar terminations can be used as additives into more polar organic resins to add silicone characteristics with reduced likelihood of phase separation.



MonoMethacryloxypropyl Functional PolyDimethylsiloxanes, methoxypropyl terminated - symmetric

Code	Viscosity	Molecular Weight	Refractive Index	Specific Gravity	Price/100g	Price/1kg
MCS-MX11	8-12	1000	-	0.96	¥59,100	-



MonoVinyl Functional PolyDimethylsiloxanes, methoxy(diethyleneoxide)propyl terminated - symmetric

Code	Viscosity	Molecular Weight	Refractive Index	Specific Gravity	Price/100g	Price/1kg
MCS-VX15	40-60	5000	-	0.96	¥59,100	-

MonoMethacrylateTerminated PolyDimethylsiloxanes

The most widely employed silicone macromers are methacrylate functional. Applications have been reported for hair spray[1], contact lens[2], pigment dispersion[3] and adhesive release[4]. The materials copolymerize smoothly with other acrylate and styrenic monomers as indicated by their reactivity ratios.

1. US Pats 5166276, 5480634; 2. JP-A-230115/90, US Pat 6,943,203; 3. US Pat 6,991,884; 4. US Pat 4,728,571

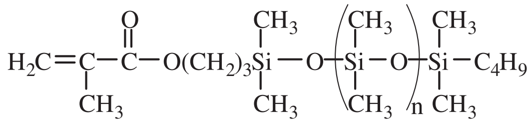
Reactivity Ratios

Monomers	r1:r2*
MCR-M11:methylmethacrylate	nm**:1.60
MCR-M22:methylmethacrylate	nm**:2.10
MCR-M11:styrene	0.26:1.07
MCR-M11:acrylonitrile	5.4:0.89

*M1M1°/M1M2°:M2M2°/M2M1°; **no meaningful results

Solubility of Macromers in Polar Monomers

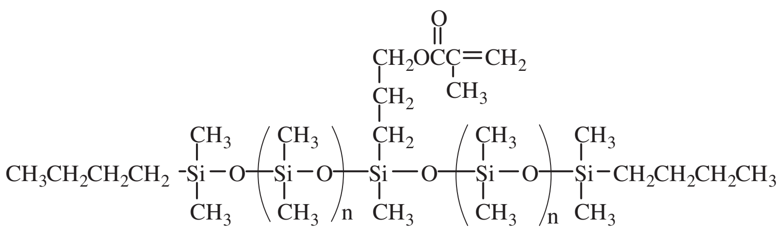
Macromer	Solubility (wt%) in Dimethylacrylamide	Solubility (wt%) in Hydroxyethylmethacrylate
MCR-M11	4	1
MCS-M11	8	2
MFR-M15	100 (miscible)	2



MonoMethacryloxypropyl Terminated PolyDimethylsiloxanes - asymmetric CAS: [146632-07-7] TSCA

Code	Viscosity	Molecular Weight	Refractive Index	Specific Gravity	Price/100g	Price/1kg
MCR-M07	6-9	600-800	1.416	0.96	¥36,600	¥202,000
MCR-M11	10	800-1000	1.411	0.96	¥23,300	¥131,900
MCR-M17	70-80	5000	1.406	0.97	¥27,300	¥160,800
MCR-M22	150-200	10000	1.405	0.97	¥27,300	¥160,800

inhibited with BHT



MonoMethacryloxypropyl Functional PolyDimethylsiloxanes - symmetric TSCA

Code	Viscosity	Molecular Weight	Refractive Index	Specific Gravity	Price/100g	Price/1kg
MCS-M11	7-9	800-1000	1.417	0.93	¥20,700	¥118,600

inhibited with BHT

MonoMethacryloxypropyl Terminated PolyDimethylsiloxanes - asymmetric

Code	Viscosity	Molecular Weight	Refractive Index	Specific Gravity	Price/100g	Price/1kg
MFR-M15	50-70	800-1000	1.398	1.09	¥61,800	-

inhibited with BHT

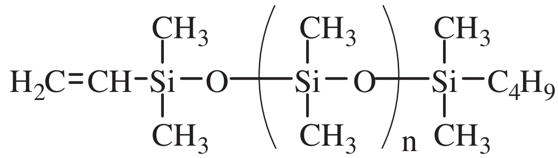
MonoMethacryloxypropyl Terminated PolyTrifluoropropylMethylsiloxanes - symmetric

Code	Viscosity	Molecular Weight	Refractive Index	Specific Gravity	Price/100g	Price/1kg
MFS-M15	40-60	800-1000	1.398	1.09	¥51,200	-

inhibited with BHT

MonoVinylTerminated PolyDimethylsiloxanes

Monovinyl functional siloxanes are utilized to control modulus and tack in silicone gels, elastomers and coatings.



MonoVinyl Terminated PolyDimethylsiloxanes - asymmetric

Code	Viscosity	Molecular Weight	Refractive Index	Specific Gravity	Price/100g	Price/1kg
MCR-V21	80-120	5500-6500	1.403	0.97	¥32,600	¥175,500
MCR-V41	8000-12000	55000-65000	1.404	0.98	¥59,100	¥238,000

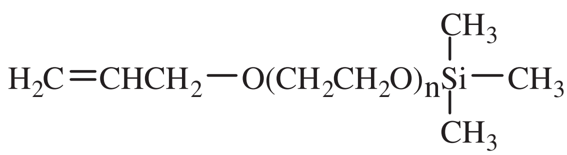
MonoVinyl Functional PolyDimethylsiloxanes - symmetric

TSCA

Code	Viscosity	Molecular Weight	Refractive Index	Specific Gravity	Price/100g	Price/1kg
MCS-V212	16-24	1200-1400	1.419	0.97	¥32,600	¥152,700

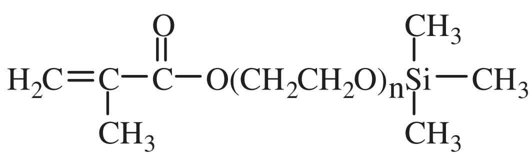
Silylated Organic Macromers

Silylated macromers provide a route to incorporation of polar monomers into mixtures of non-polar monomers. Subsequent to polymerization, the trimethylsilyl group is removed by hydrolysis.



MonoAllyl-Mono Trimethylsiloxy Terminated Polyethylene Oxide - asymmetric

Code	Viscosity	Molecular Weight	Refractive Index	Specific Gravity	Price/25g	Price/100g
SIA0479.0	20-25	500	1.456	1.04	¥13,000	¥34,500



MonoMethacryloxy-Mono Trimethylsiloxy Terminated Polyethylene Oxide - asymmetric

Code	Viscosity	Molecular Weight	Refractive Index	Specific Gravity	Price/25g	Price/100g
SIM6485.9	-	400	-	1.02		¥28,900

Reactive Silicone Emulsions

Emulsions of reactive silicones are playing an increasing role in formulation technology for water-borne systems. Primary applications for silicone emulsions are in textile finishes, release coatings and automotive polishes. Silanol fluids are stable under neutral conditions and have non-ionic emulsifiers. Aminoalkylalkoxysiloxanes are offered with cationic emulsifiers.

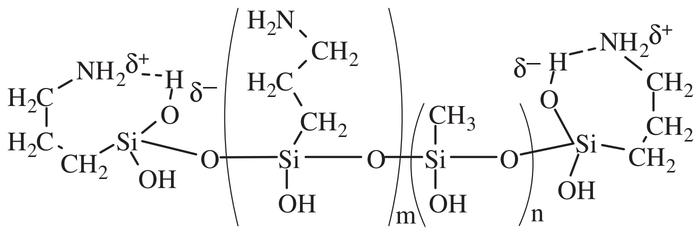
Reactive Silicone Emulsions

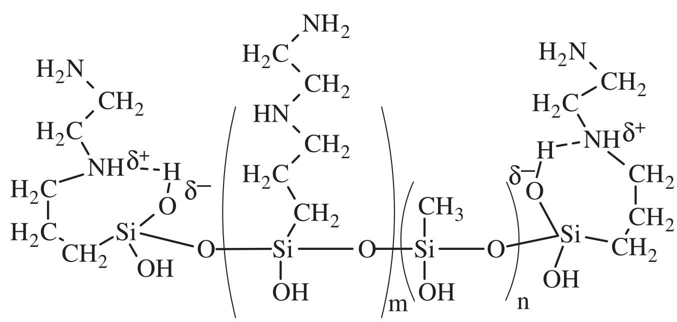
emulsifier content: 3-6% TSCA

Code	silicone class	base fluid viscosity	wt% solids	emulsion type	Price/100 g	Price/3kg	Price/18kg
DMS-S33M50	silanol	3500	50	nonionic	¥6,100	¥36,900	¥99,000
ATM-1322M50*	diamino/alkoxy	200-300	50	cationic	¥6,100	¥37,000	¥104,000

*0.45mEq/g combined primary and secondary amine

Water-borne Silsesquioxane Oligomers





Water-borne silsesquioxane oligomers act as primers for metals, additives for acrylic latex sealants and as coupling agents for siliceous surfaces.[1] They offer both organic group and silanol functionality. These amphoteric materials are stable in water solutions and, unlike conventional coupling agents, have very low VOCs.

Water-borne Silsesquioxane Oligomers

TSCA

Code	Functional Group	Mole %	Molecular Weight	Weight % in solution	Specific Gravity	Viscosity	pH	Price/100g	Price/3kg
WSA-7011*	Aminopropyl	65-75	250-500	19-21	1.10	5-15	10-10.5	¥7,200	¥107,000
WSA-9911**	Aminopropyl	100	270-550	21-26	1.06	5-15	10-10.5	¥8,500	¥87,000
WSA-7021	Aminoethylaminopropyl	65-75	370-650	23-27	1.10	5-10	10-11	¥11,100	¥127,000
WSAV-6511‡	Aminopropyl, vinyl	60-65	250-500	15-20	1.11	3-10	10-11	¥12,700	¥139,000
WSAF-1511	Aminopropyl, fluoroalkyl	15-20	—	15-20	1.06	1-5	3-5	¥15,400	¥172,000

*CAS[1411854-75-5] **[29159-37-3] ‡[207308-27-8]

[1] Arkles, B. in *"Silanes & Other Coupling Agents"*, Mittal, K. L. Ed. **1992**, p91, Utrecht.