Information About High Technology Silicone Materials

DOW CORNING

SYLGARD® 184 SILICONE ELASTOMER, BASE & CURING AGENT

Type	Two-part silicone elastomer
Color	Transparent
Physical Form	
as supplied	Medium-viscosity liquid
as cured	Flexible elastomer
Cure	25 to 150 C (77 to 302 F)
Special Properties	Transparent; reversion resistant; stable dielectric; high physical properties
Primary Uses	Potting and encapsulating
Benefits	Low toxicity; repairability

DESCRIPTION

SYLGARD® 184 silicone elastomer, base & curing agent, is supplied as a two-part kit comprised of liquid components. When the base and the curing agent are thoroughly mixed in a 10:1 weight ratio, the medium-viscosity liquid mixture has a consistency resembling SAE No. 40 motor oil. The liquid mixture will cure in thick or thin sections to a flexible, transparent elastomer ideally suited for electrical/electronic potting and encapsulating applications.

SYLGARD 184 silicone elastomer offers a flexible cure schedule from 25 to 150 C (77 to 302 F), without an exotherm. SYLGARD 184 silicone elastomer requires no post cure and can be placed in service immediately following the completion of the cure schedule at any operating temperature from -55 to 200 C (-67 to 392 F). See Table I for special features and benefits of this product.

USES

Because of its many special features, SYLGARD 184 silicone elastomer is ideal for a wide variety of electrical/electronic potting and encapsulating applications and provides environmental protection for:

- Equipment modules
- Relays, power supplies and magnetic amplifiers
- Transformers, coils and ferrite cores
- Connectors
- Fiber optic waveguide coatings
- Encapsulation of circuit boards

SYLGARD 184 silicone elastomer is especially useful in applications where clarity is desirable, including:

- Encapsulation of solar cells
- Encapsulation of opto-electronic displays

HOW TO USE

Mixing

SYLGARD 184 silicone elastomer is supplied in two parts, a lot-matched base and curing agent, mixed in a ratio of 10 parts base to one part curing agent, by weight.

For best curing results, glassware or tinned cans and glass or metal stirring implements should be used. Mix with a smooth action that will minimize the introduction of excess air.

Pot Life – Working Time

Cure reaction of SYLGARD 184 silicone elastomer, base & curing agent, begins with the mixing process. Initially, cure is evidenced by a gradual increase in viscosity, followed by gelation and conversion to a solid elastomer. Pot life is defined as the time required for viscosity to double following addition of curing agent to base. At 25 C (77 F), the pot life of SYLGARD 184 silicone elastomer is 2 hours. Pot life of this product can be extended by refrigeration at 4 C (40 F); however, do not allow moisture from condensation to collect in the silicone elastomer.

SYLGARD 184 silicone elastomer will cure at 25 C (77 F), will become solid in 24 hours, and will reach full cure in 7 days. See "Curing."

Processing

Thoroughly mix SYLGARD 184 silicone elastomer, base & curing agent, in a ratio of 10 parts base to 1 part curing agent, by weight. Agitate gently to reduce the amount of air introduced. Allow mixture to set 30 minutes before pouring.

Since air bubbles are usually present following mixing, vacuum de-airing is recommended. De-air in a container with at least four times the liquid volume to allow for expansion of material. Air entrapped in the mixture can be removed by using a vacuum of 25 to 29 inches of mercury. Continue the vacuum until the liquid expands and settles to its original volume and bubbling subsides. This may take 15 minutes to 2 hours, depending on the

TYPICAL PROPERTIES

These values are not intended for use in preparing specifications.

As Supplied		
CTM 0001A	Specific Gravity at 25 C (77 F)[1]	1.05
CTM 0050	Viscosity[2] at 25 C (77 F), centipoise	5500
As Catalyzed[3]		
CTM 0050	Viscosity at 25 C (77 F), centipoise	3900
CTM 0055	Pot Life[4], minimum, hours	2
As Cured – Physical[5]		
CTM 0176	Appearance	Transparent
CTM 0099	Durometer Hardness, Shore A	40
CTM 0137A	Tensile Strength, MPa (psi)	6.20 (900)
CTM 0137A	Elongation, percent	100
CTM 0159A	Tear Strength, die B, kN/m (ppi)	2.6 (15)
CTM 0022	Specific Gravity at 25 C (77 F)	1.05
CTM 0224	Thermal Conductivity, cal/cm^2-sec-(°C/cm)	3.5×10^4
CTM 0585	Linear Coefficient of Thermal Expansion, cm/cm per °C from -55 to 150 C (-67 to 302 F)	3.0×10^4
CTM 0585	Volume Coefficient of Thermal Expansion, cc/cc per °C from -55 to 150 C (-67 to 302 F)	9.6×10^4
MIL-I-16923G	Thermal Shock Resistance, from -49 to 68 C (-55 to 155 F)	Passes 10 cycles
	Weight Loss, percent	
	after 1,000 hrs at 150 C (302 F)	1.6
	after 1,000 hrs at 200 C (392 F)	3.2
ASTM D 570	Water Absorption, after 7 days immersion at 25 C (77 F), percent	0.10
ASTM D 746	Brittle Point, °C (°F)	-65 (-85)
CTM 0002	Refractive Index at 25 C (77 F)	1.430
	Radiation Resistance, cobalt 60 source	
	at 200 megarads	Still usable
	at 500 megarads	Hard and brittle
UL 94	Flammability[6] Classification	94 V-1
UL	Temperature Rating,	
	Mechanical, °C (°F)	130 (265)
	Electrical, °C (°F)	130 (265)
Electrical[7]		
CTM 0114A	Dielectric Strength, volts/mil[8]	450
CTM 0112	Dielectric Constant, at	
	60 Hz	2.7
	100 Hz	2.66
	100 kHz	2.65
CTM 0112	Dissipation Factor, at	
	60 Hz	0.001
	100 Hz	0.0009
	100 kHz	0.001
CTM 0249A	Volume Resistivity, ohm-cm	2.0×10^{15}
CTM 0171	Arc Resistance, track, seconds	115
Electrical – after heat aging for 1000 hours at 200 C (392 F)		
CTM 0114A	Dielectric Strength, volts/mil[8]	600
CTM 0112	Dielectric Constant, at	
	60 Hz	2.7
	100 Hz	2.7
CTM 0249A	Volume Resistivity, ohm-cm	2.0×10^{14}

[1]In most cases, CTMs (Corporate Test Methods) correspond to ASTM standard tests. Copies of CTM procedures are available upon request.

[2]Brookfield Viscometer Model LVF, spindle #4 at 60 rpm.

[3]Mix ratio 10 parts base to 1 part curing agent, by weight.

[4]Time required to double catalyzed viscosity.

[5]Based on sample thickness of 125 mils and a minimum cure of 4 hours at 65 C (149 F).

[6]Tests, claims, representations and descriptions regarding flammability are based on standard small scale laboratory tests.

[7]Properties obtained on 1.58-mm-thick (0.062-inch) specimens, cured 4 hours at 65 C (149 F).

[8]Measured with 1.4-inch standard ASTM electrode, 500 volts per second rate of rise.

Specification Writers: Please contact Dow Corning Corporation, Midland, Michigan, before writing specifications on this product.

amount of air introduced during stirring.

Clean and degrease all application surfaces using a solvent to remove all mold release agent, processing oils and surface contaminant. Dry and remove all solvent before application.

For best adhesion the application substrate should be primed with SYLGARD® prime coat. Obtain a technical bulletin for proper application instructions. See "Bonding."

CAUTION: SYLGARD primer is flammable. Keep away from heat, sparks and open flame. Use only with adequate ventilation.

When pouring SYLGARD 184 silicone elastomer into the curing container, care should be taken to minimize air entrapment. When practical, pouring should be done under vacuum, particularly if the component being potted or encapsulated has many fine voids. If this technique cannot be used, the unit should be evacuated after SYLGARD 184 silicone elastomer has been poured.

After allowing time for the material mass to reach temperature, cure according to the cure time-temperatures listed in "Curing."

Repairability

In the manufacture of electrical/electronic devices it is often desirable to salvage or reclaim damaged or defective units. With most rigid types of potting and encapsulating materials, removal or entry is difficult or impossible without causing excessive damage to internal circuitry. SYLGARD 184 silicone elastomer can be selectively removed with relative ease, allowing repairs or changes to be completed and the area to be repotted with additional product. SYLGARD 184 silicone elastomer, base & curing agent, can be removed by cutting with a sharp blade or knife and tearing material away from the area to be repaired. Thin sections of the adhesive elastomer are best removed from substrates and circuitry by mechanical action such as scraping or rubbing; removal can be assisted by the application of isopropyl alcohol.

Before repotting a repaired device, if possible, roughen the exposed surface of the SYLGARD 184 silicone elastomer, base & curing agent, with an abrasive paper. This will enhance

adhesion and permit the repair material to become an integral matrix with the existing elastomer. Silicone prime coats are not recommended for adhering SYLGARD 184 silicone elastomer, base & curing agent, to itself in repotting applications.

Reversion Resistance

SYLGARD 184 silicone elastomer, base & curing agent, provides excellent reversion resistance even when exposed to temperatures in excess of 200 C (392 F) while under confinement or in deep section.

Temperature Stability

SYLGARD 184 silicone elastomer, base & curing agent, cures to a thermoset material that will not melt or appreciably soften even at elevated temperatures of 250 C (482 F). The material may harden or become brittle after prolonged exposure to these elevated temperatures. SYLGARD 184 silicone elastomer, base & curing agent, has a 130 C (265 F) UL yellow-card temperature index classification for both electrical and mechanical functional use.

Upon exposure to lower temperatures, SYLGARD 184 silicone elastomer, base & curing agent, does not approach a stiffening point until -55 C (-67 F). Overall, the cured elastomer will maintain its basic elastomeric flexibility over an extremely wide range of -55 to 200 C (-67 to 392 F), making it the ideal selection for applications that may experience high or low temperature cycling.

PROCESSING TECHNIQUES

Curing

SYLGARD 184 silicone elastomer, base & curing agent, can be satisfactorily cured either with exposure to air or completely sealed, and at temperatures ranging from 25 to 150 C (77 to 302 F). Curing time can be appreciably decreased by elevating the cure temperature. One of the following cure cycles is suggested:

- 25 C (77 F) for 24 hours
- 65 C (149 F) for 4 hours
- 100 C (212 F) for 1 hour
- 150 C (302 F) for 15 minutes

Large parts will require additional time in the oven to heat to the selected cure temperature. Satisfactory sources of heat include circulating and non-circulating ovens, infrared heating lamps and heat guns.

Full mechanical strength will not be achieved for 7 days when SYLGARD 184 silicone elastomer, base & curing agent, is cured at 25 C (77 F). The majority of its physical strength, however, is present after 24 hours, although surface cure may not yet be complete.

Bonding

SYLGARD 184 silicone elastomer, base & curing agent, will not normally bond to clean, nonporous surfaces such as metal or glass. A primer coat is required to ensure adhesion to these surfaces. SYLGARD prime coat is recommended to obtain the best adhesion. The prime coat should be applied in a thin layer to clean, dry surfaces where adhesion is desired. It should be air dried 1 to 2 hours before the silicone elastomer is applied.

Lowering Viscosity

The viscosity of SYLGARD 184 elastomer, base & curing agent, can be lowered by the addition of 200® fluid, 50 cSt., from Dow Corning. Quantities of 10 percent or less will have little or no effect on the physical or electrical properties. Quantities of 10 percent or greater may decrease the physical strength and hardness but will have no effect on the electrical properties. At concentrations greater than 10 percent the fluid may possibly bleed from cured SYLGARD 184 silicone elastomer. The addition of thinning fluid does not change the mixing ratio of curing agent to base.

Varying the Hardness

Variations of up to 10 percent in concentration of curing agent in SYLGARD 184 silicone elastomer have little effect on cure time or on the physical properties of the final cured elastomer. Lowering the curing agent concentration by more than 10 percent will result in a softer and weaker elastomer; increasing the concentration by more then 10 percent will result in over-hardening of the cured elastomer and will tend to degrade the physical and thermal properties. Changes in the curing agent concentration will have little or no effect on the electrical properties, however.

Release Agents

When SYLGARD 184 silicone elastomer, base & curing agent, is cured in a mold, the mold should first be treated with a release agent to prevent sticking. Suitable release agents include DUPONOL®[1] WAQ at a 5 percent concentration with isopropanol; DOW CORNING® 230 fluid at a 2 percent concentration with CHLOROTHENE®[2] or similar chlorinated solvent; a mild liquid detergent at a 2 to 5 percent concentration with water; or petroleum jelly at a 5 percent solution in a chlorinated solvent.

LIMITATIONS

Inhibition of Cure

In the presence of inhibitors, cure of SYLGARD 184 silicone elastomer is poor. In the inhibited area (usually less than 0.020-inch thick) the silicone elastomer remains in a liquid or tacky state even though the cure schedule has been completed, and despite any subsequent attempts to convert it to a hard, dry, rubbery mass, this material will remain uncured. Extremely minute quantities of inhibitor may be sufficient to produce this effect. The most notable causes of inhibition include:

- Organotin and other organometallic compounds
- Silicone rubbers containing organotin catalyst
- Sulfur, polysulfides, polysulfones and other sulfur-containing materials
- Amines, urethanes, amine-containing materials and other nitrogen-containing materials
- Unsaturated hydrocarbon plasticizers

If a substrate or material is considered questionable in respect to potential cure inhibition, a small-scale compatibility test to ascertain suitability in the particular application is recommended. If inhibition is present it may sometimes be overcome by prebaking the unit at the highest tolerable temperature for approximately 1 to 4 hours to remove volatile chemicals. See bulletin No. 10-022, "How To

[1] "Duponol" is a registered trademark of E. I. du Pont de Nemours & Company.

[2] "Chlorothene" is a registered trademark of The Dow Chemical Company.

Process SYLGARD® Brand Elastomers" for a listing of inhibition-causing materials.

Thermal Expansion

SYLGARD 184 silicone elastomer, base & curing agent, has a notable volume coefficient of thermal expansion (9.6 x 10^{-4} /°C; see Typical Properties chart). The volume of the cured elastomer will increase or decrease approximately 9.6 percent for each 100 C (212 F) of temperature differential. When using SYLGARD 184 silicone elastomer, base & curing agent, at higher temperatures in applications that are highly confined or hermetically sealed, allowance should be made to accommodate volume expansion and prevent pressure build-up. Normal thermal expansion and contraction stresses may be minimized by selecting a cure temperature close to the midway point of the high and low extremes of the thermal cycle.

Temperature limits may be influenced by differences in the thermal expansion values between the silicone elastomer and the encapsulated or potted components, and also by their configurations. Therefore, thermal operating limits should be determined by testing before large scale use.

SAFETY REQUIREMENTS

Handling

SYLGARD 184 silicone elastomer, base & curing agent, does not contain volatile solvents. Special ventilation is not required in the normal use or storage of this product. Base and curing agent liquid components or their cured mixture do not present any significant toxicological hazard incidental to normal industrial handling. Minimal eye protection, such as standard safety glasses, should be adequate for normal industrial use. Direct eye contact can cause temporary eye discomfort; flush thoroughly with copious amounts of water should contact occur. See Material Safety Data Sheet for more detailed handling instructions.

Abnormal Exposures

CAUTION: The liquid curing agent component of SYLGARD 184 silicone elastomer may generate hydrogen gas if contaminated with strong acids, bases or catalytic oxidizing materials. If exposure is suspected, use appropriate caution to relieve hydrogen gas pressure. Keep away from sparks and flame, and supply adequate ventilation to reduce localized build-up of hydrogen gas.

TABLE I: SPECIAL FEATURES AND BENEFITS

Special Feature	*Benefit*
• Low toxicity	• No special precautions required for normal industrial handling
• No solvents or cure by-products; no exotherm during cure	• Requires no special venting; will not cause corrosion; low shrinkage during cure
• Cures to a transparent, flexible elastomer	• Provides stability and relief from mechanical shock; low transmission of vibration; visual inspection of components and easy repairability
• Environmental protection	• Low water absorption; good radiation resistance; little out-gassing in hard vacuum
• Excellent dielectric properties	• Maintains and protects existing electrical insulation requirements
• Stability over a wide temperature range; reversion resistant	• Maintains elastomeric flexibility and provides functional stability from -55 to 200 C (-67 to 392 F), even in confinement
• Flame resistant	• UL flammability classification of 94 V-1 and a temperature rating of 130 C (265 F)

Spills

Spills of the liquid base and curing agent components of SYLGARD 184 silicone elastomer can become extremely slippery. Sawdust or other absorbent material should be immediately applied to any liquid spill for temporary relief. The spill should be removed with high flash point mineral spirits or other suitable solvent.

SHIPPING LIMITATIONS

None.

STORAGE AND SHELF LIFE

When stored in original unopened containers at or below 32 C (90 F), SYLGARD 184 silicone elastomer, base & curing agent, has a shelf life of 12 months from date of shipment from Dow Corning.

PACKAGING

SYLGARD 184 silicone elastomer, base & curing agent, is shipped in kits that contain both the base and curing agent, liquid components in separate containers. Each kit contains the appropriate weight of curing agent for the amount of base. Complete kits are available in 1.1-, 8.8-, 44- and 495-lb (0.5-, 4-, 20- and 225-kg) quantities, net weight.

MSDS INFORMATION

ATTENTION: PRODUCT SAFETY INFORMATION REQUIRED FOR SAFE USE IS NOT INCLUDED. BEFORE HANDLING, READ PRODUCT AND MATERIAL SAFETY DATA SHEETS AND CONTAINER LABELS FOR SAFE USE, PHYSICAL AND HEALTH HAZARD INFORMATION. THE MATERIAL SAFETY DATA SHEET IS AVAILABLE FROM YOUR DOW CORNING REPRESENTATIVE, OR DISTRIBUTOR, OR BY WRITING TO DOW CORNING CUSTOMER SERVICE, OR BY CALLING (517) 496-6000.

WARRANTY INFORMATION – PLEASE READ CAREFULLY

Dow Corning believes that the information in this publication is an accurate description of the typical characteristics and/or uses of the product or products, but it is your responsibility to thoroughly test the product in your specific application to determine its performance, efficacy and safety.

Unless Dow Corning provides you with a specific written warranty of fitness for a particular use, Dow Corning's sole warranty is that the product or products will meet Dow Corning's then current sales specifications. **DOW CORNING SPECIFICALLY DISCLAIMS ANY OTHER EXPRESS OR IMPLIED WARRANTY, INCLUDING THE WARRANTIES OF MERCHANTABILITY AND OF FITNESS FOR USE.** Your exclusive remedy and Dow Corning's sole liability for breach of warranty is limited to refund of the purchase price or replacement of any product shown to be other than as warranted, and Dow Corning expressly disclaims any liability for incidental or consequential damages. Suggestions of uses should not be taken as inducements to infringe any particular patent.