Epoxy, Grease, and Varnish

Specifications

	Conductive epoxy	Stycast® epoxy	Apiezon grease		Varnish
			Type N	Type H	
Maximum temperature	573 K	403 K	303 K	513 K	423 K
Glass transition temperature	≥353 K	359 K	—	—	—
Thermal conductivity					
1 K	—	0.0065 W/(m · K)	0.001 W/(m · K)	—	0.034 W/(m · K)
4.2 K	—	0.064 W/(m · K)	0.005 W/(m · K)	—	0.062 W/(m · K)
77 K	—	—	—	—	0.22 W/(m · K)
100 K	—	—	0.11 W/(m · K)	—	0.24 W/(m · K)
300 K	2.5 W/(m · K)	1.3 W/(m · K)	0.19 W/(m · K)	0.22 W/(m · K)	0.44 W/(m · K)
Thermal expansion (1/K)	>360 K: 150×10^{-6} <360 K: 43×10^{-6}	29×10^{-6}	0.00072	0.00072	—
Volume resistivity	At 298 K: 0.0001 to 0.0004 (Ω·cm)	298 K: 5×10^{14} (Ω·m) 394 K: 1×10^{10} (Ω·m)	2×10^{16} (Ω·m)	4.6×10^{13} (Ω·m)	$>1 \times 10^{15}$ (Ω·m)
Shelf-life (298 K max)	12 months from date of manufacture	12 months from date of manufacture	—	—	12 months from date on the can when stored at room temperature
Pot life	4 days, ~1 day working time	45 min, ~20 min working time	—	—	—
Cure schedule	323 K: 12 h 353 K: 90 min 393 K: 15 min 423 K: 5 min 448 K: 45 s	298 K: 16 to 24 h 318 K: 4 to 6 h 338 K: 1 to 2 h	NA	NA	5 min to 10 min drying time
Dielectric strength	NA (conductive)	14.4 kV/mm	—	—	(Dry) 118 kV/mm
Dielectric constant	NA (conductive)	(1 mHz): 5.01	—	—	—
Vapor pressure	—	<13.3 Pa (0.1 Torr) at 298 K	2.27×10^{-7} Pa (1.7×10^{-9} Torr) at 293 K	2.27×10^{-7} Pa (1.7×10^{-9} Torr) at 293 K	Partial
Outgassing	—	TML: 0.25% CVCM: 0.1%	TML: <1% CVCM: <0.1%	TML: <1% CVCM: <0.1%	—

Epoxy

Low temperature conductive epoxy

- Excellent low temperature thermal and electrical conductivity
- Low viscosity
- Thixotropic
- No resin bleed during curing
- Low weight loss
- Low volatility

This epoxy is used to permanently attach test samples or temperature sensors to sample holders. It is a 100% solid, two component, low temperature curing, silver-filled epoxy which features very high electrical and thermal conductivity combined with excellent strength and adhesive properties.

Note: Epoxy must be cured at a minimum of 50 °C for 12 h to achieve proper electrical and physical properties. Curing at 175 °C for 45 s will achieve optimum properties.

ESF-2-5 and ESF-2-10 can be used to 300 mK and below. Results may vary based on application and materials used.

Specifications

Maximum operating temperature: 573 K (300 °C)
Thermal conductivity: 300 K (27 °C)—2.5 W/(m · K)
Thermal expansion coefficient (K^{-1}): Above 360 K (85 °C)—150 × 10^{-6}; below 360 K (85 °C)—43 × 10^{-6}
Volume resistivity (Ω·cm) at 298 K (25 °C): 0.0001 to 0.0004
Shelf life (25 °C [298 K] max): 12 months from date of manufacture
Pot life: 4 days, about 1 day working time
Cure schedule: 323 K (50 °C)—12 h; 353 K (80 °C)—90 min; 393 K (120 °C)—15 min; 423 K (150 °C)—5 min; 448 K (175 °C)—45 s

Ordering information

Part number	Description
ESF-2-5	Low temperature conductive epoxy, 5 packets, 2 g each
ESF-2-10	Low temperature conductive epoxy, 10 packets, 2 g each

Stycast® epoxy 2850-FT, catalyst 9

- Mixed and applied from two-part flexible packets
- Excellent low temperature properties
- Permanent mounting
- Exceptional electrical grade insulation properties
- Low cure shrinkage
- Low thermal expansion
- Resistance to chemicals and solvents

Stycast® is the most commonly used, highly versatile, nonconductive epoxy resin system for cryogenic use. The primary use for Stycast® is for vacuum feedthroughs or permanent thermal anchors. Lake Shore uses this product in vacuum tight lead-throughs with excellent thermal cycle reliability. Stycast® is an alternative to Apiezon® N grease when permanent sensor mounting is desired. (Can place stress on sensor—see Appendix C.)

Note: Can be chemically removed with methylene-chloride (several hour soak). A commercial stripper is available from Miller-Stephenson Co. (http://www.miller-stephenson.com/) part number MS-111.

Shipped as a Dangerous Good.

Specifications

Maximum operating temperature: 403 K (130 °C)
Glass transition temperature: 359 K (86 °C)
Thermal conductivity:
1 K (272 °C)—0.0065 W/(m · K)
4.2 K (269 °C)—0.064 W/(m · K)
300 K (27 °C)—1.3 W/(m · K)
Thermal expansion coefficient (1/K): 29 × 10^{-6}
Volume resistivity [Ω·m]
298 K (25 °C)—5 × 10^{14}
394 K (121 °C)—1 × 10^{10}
Shelf life (25 °C [298 K] max): 12 months from date of manufacture
Pot life: 45 minutes, about 20 minutes working time
Cure schedule: 298 K (25 °C)—16 h to 24 h
318 K (45 °C)—4 h to 6 h
338 K (65 °C)—1 h to 2 h
Dielectric strength: 14.4 kV/mm
Dielectric constant (1 MHz): 5.01
Vapor pressure at 298 K (25 °C): <13.3 Pa (0.1 Torr)
Outgassing **TML:** 0.25% **CVCM:** 0.01%

Ordering information

Part number	Description
ES-2-20	Stycast® epoxy, 20 packets, 2 g each

Grease

Apiezon® grease—Types N and H



- Stable
- Nonpermanent sensor mounting
- Chemically inert
- Nontoxic
- Easily applied and removed
- Excellent lubrication properties

Apiezon® grease is well-suited for cryogenic use because of its low vapor pressure and high thermal conductivity. It is often used for nonpermanent mounting and thermal anchoring of cryogenic temperature sensors as well as for lubricating joints and o-rings.

Apiezon® N: this general purpose grease enhances thermal contact and provides a temporary mounting method for temperature sensors. It is pliable at room temperatures and solidifies at cryogenic temperatures, which makes it easy to apply and remove the sensor (without damage) at room temperature. The grease is not an adhesive and will not necessarily hold a sensor or wires in place without some mechanical aid, such as a spring clip or tape. It is very good for sensors inserted into holes. Contains a high molecular weight polymeric hydrocarbon additive which gives it a tenacious, rubbery consistency allowing the grease to form a cushion between mating surfaces.

Apiezon® H: this grease will withstand temperatures up to 523 K (250 °C) without melting. It is designed for general purposes where operating temperatures necessitate the use of a relatively high melting point grease.

Note: *Can be removed using Xylene with an isopropyl alcohol rinse.*

Specifications

	Type N	Type H
Approximate melting point:	316 K (43 °C)	523 K (250 °C)
Thermal conductivity:		
293 K (20 °C)	0.19 W/(m·K)	0.22 W/(m·K)
1 K (-272 °C)	0.001 W/(m·K)	—
4.2 K (-269 °C)	0.005 W/(m·K)	—
100 K (-173 °C)	0.15 W/(m·K)	—
300 K (27 °C)	0.44 W/(m·K)	—
Volume resistivity:	2×10^{16} Ω·m	4.6×10^{13} Ω·m
Thermal expansion coefficient (K^{-1}):	0.00072	
Vapor pressure at 293 K (20 °C):	2.67×10^{-7} Pa (2×10^{-9} Torr)	3.60×10^{-7} Pa (2.7×10^{-9} Torr)
Solvent system:	Hydrocarbons or chlorinated solvents	

Ordering information

Part number	Description
GAN-25	Apiezon® N grease, 25 g tube
GAH-25	Apiezon® H grease, 25 g tube

Varnish

VGE-7031 varnish

- Clear modified phenolic
- Can be air-dried or baked
- Use up to 470 K for 1 to 2 hour maximum
- Varnish will not outgas after baking
- Can be used in vacuum (1.33×10^{-6} Pa [9.98×10^{-9} Torr])
- Superior electrical properties
- Excellent chemical resistance
- May be applied by dipping, roller coating, brushing, or spraying
- Moderately good, low stress adhesive
- Enhances thermal contact

VGE-7031 insulating varnish and adhesive possesses electrical and bonding properties which, when combined with its chemical resistance and good saturating properties, make it an excellent material for cryogenic temperatures. As an adhesive, VGE-7031 bonds a variety of materials, has fast tack time, and may be air-dried or baked. It is excellent for laminating many types of materials, and may be applied to parts to be bonded and either baked shortly after applying or allowed to air dry and baked after the parts are stored and assembled hours, days, or even **weeks** later. It is also an electrically insulating adhesive at cryogenic temperatures, and is often used as a calorimeter cement. VGE-7031 is compatible when dry with a wide variety of materials, including cotton, Dacron® polyester fiber, nylon glass tapes, laminates, Mylar® polyester film, mica products, polyester products, vinyl products, wire enamels, paints, rayon, plastics, and metals. When soaked into cigarette paper, it makes a good, high thermal conductivity, low electrical conductivity heat sinking layer.

Note: May be thinned to the desired application viscosity with a 50:50 mix of denatured alcohol and toluene.

The solvents in the varnish have a tendency to craze Formvar® wire insulation. The wire cannot be disturbed during curing of the varnish (typically 12 to 24 hours at room temperature).

Classified as hazardous cargo by the U.S. Government. UPS Ground shipment only.

Available in continental U.S. only.

Specifications

Maximum operating temperature: 423 K (150 °C)
Thermal conductivity:
1 K (-272 °C)—0.034 W/(m·K)
4.2 K (-269 °C)—0.062 W/(m·K)
77 K (-196 °C)—0.22 W/(m·K)
100 K (-173 °C)—0.24 W/(m·K)
300 K (27 °C)—0.44 W/(m·K)
Percent solids by weight: 18 to 20%
Viscosity at 298 K (25 °C): 1.3 kg/(m·s) (1300 cP)
Specific gravity at 298 K (25 °C): 0.88
Flash point, closed cup: 269 K (-4 °C)
Shelf life: 12 months from date on the can when stored at room temperature
Drying time (25 µm film, tack free): 5 min to 10 min at 298 K (25 °C); 2 min to 5 min at 398 K (125 °C)
Solvent system: Xylene, alcohol, acetone

Ordering information

Part number	Description
VGE-7031	Insulating varnish and adhesive, 0.47 L (1 pt) can