



Materials Engineering Branch

TIP*



No. 119 Use of Thermally Conductive Potting/Staking Compounds

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Conductive heat transfer from electronic assemblies is particularly important in satellite applications, as heat transfer from air cooling or convection does not occur in the vacuum of space. Thermally conductive materials consisting of epoxies, silicones and polyurethanes are readily available. Typically these polymers are mixed with ceramic or metallic fillers to increase conductivity. The Materials Engineering Branch (MEB) has also fashioned custom materials of its own by adding fillers such as boron nitride, aluminum oxide and powdered metals to increase a polymer's thermal conductivity.

Table 1 is a compilation of thermal conductivity data for some adhesives, potting and staking materials commonly used in spacecraft applications. The table includes the thermal conductivity data reported by manufacturers of the materials and, in most instances, temperature-dependent data measured by the MEB. All MEB measurements were done using the ASTM C-518 "Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Heat Flow Meter." (Note: Thermal conductivity can vary with mix ratio.)

Table 1 also includes the thermal conductivity of materials custom-made in the MEB. Conductivity can be increased by up to a factor of five (compared to the unfilled, cured base material). It should be remembered that fillers will change other material properties such as viscosity, adhesion, tensile strength, and electrical conductivity. The degree of these effects is highly dependent upon the type and quantity of filler added. Any modified material must be evaluated to verify critical performance requirements prior to its use in flight hardware.

Table 1. Thermal Conductivity of Polymeric Thermal Interface Materials

			GSFC Measurements (W/mK)									
Material Class	Specific Material	Mfr.	Mfr's Data (W/mK)	-150 °C (±10%)	-100 °C (±10%)	-50 °C (±10%)	0 °C (±10%)	25 °C (±10%)	50 °C (±10%)	100 °C (±10%)	Other Temperature	Test Date
PVT ¹	BC-408 base	Bicron	None			0.15	0.14	0.15	0.15		0.15@ -65°C	9/26/01
PEI ²	Ultem-7801 ()	GE Plastics	None		0.74	0.85	0.98	1.03	1.08	1.14		9/21/01
PEI	Ultem-7801 (⊥)	GE Plastics	None		0.43	0.47	0.52	0.54	0.57	0.60		9/21/02
Acrylic	142R02	3M	None		0.18	0.20	0.24	0.26	0.27			4/9/01
Epoxy	Scotchweld 2216 B/A Gray	3M	0.39	0.39	0.40	0.40	0.39	0.39	0.38	0.38		4/17/01
Epoxy	Eccobond 281	Emerson & Cumming	1.4									
Epoxy	Eccobond 285/Cat 9	Emerson & Cumming	1.44	0.90	0.94	0.99	1.03	1.05	1.05	1.06		4/12/01
Epoxy	Eccobond 56C/Cat 9	Emerson & Cumming	7.1		1.21	1.44	1.75	1.81	1.85	2.04		8/10/01
Epoxy	Stycast 2850FT/Cat 9	Emerson & Cumming	1.25	0.93	1.02	1.07	1.10	1.11	1.10	1.12		4/13/01
Epoxy	EY 3010 A/B	Fiber-Resin	None			0.11	0.11		0.11		0.13 @ 125°C	12/22/00
Epoxy	Epon 828/Versamid 140 + 35% BN	GSFC/Code 541	None		0.86	0.98	1.03	1.04	1.02	0.99		9/5/01
Epoxy	EA 9309.3 NA	Hysol	.19			0.20	0.21	0.21	0.21	0.21	0.22 @ 150°C	12/15/00
Epoxy	EA 9394	Hysol	0.33			0.43	0.44	0.44	0.45	0.47	0.48 @ 150°C	12/15/00
Epoxy	Epon 815/Versamid 140	Shell/Henkel	None	0.19	0.18	0.18	0.18	0.17	0.17	0.18		5/10/01
Epoxy	Epon 828/Versamid 140	Shell/Henkel	None			0.19	0.21	0.20	0.21	0.21		8/31/01
Polyurethane	Conathane EN-11 A/B	Conap	None	0.20	0.19	0.18	0.18	0.17	0.17	0.17		5/7/01

¹ Polyvinyl toluene

² Polyether imide

Polyurethane	Conathane EN-20 A/B	Conap	0.21									
Polyurethane	Conathane EN-11 A/B + 35% BN	GSFC/Code 541	None	0.53	0.55	0.59	0.57	0.55	0.54	0.53		6/11/01
Polyurethane	Solithane (Mix 7) + 50% BN	GSFC/Code 541	None		0.82	0.79	0.76	0.73	0.71	0.70		3/26/01
Polyurethane	Uralane 5753LV A/B + 40% BN	GSFC/Code 541	None	0.70	0.77	0.88	0.85		0.80	0.79	0.76 @ 125°C	10/23/00
Polyurethane	Uralane 5753LV A/B + 50% BN	GSFC/Code 541	None	0.43	0.54	0.75	0.91	0.90	0.88	0.85		6/20/01
Polyurethane	Uralane 5753LV A/B + 55% BN	GSFC/Code 541	None	0.79	0.98	1.22	1.29	1.36	1.34	1.26		7/10/01
Polyurethane	Uralane 5753LV A/B + 60% BN	GSFC/Code 541	None	0.52	0.65	0.81	1.26	1.36	1.35	1.32		7/9/01
Polyurethane	Solithane 113/C-300 (Formula 7)	Uniroyal Chemical	0.21									
Polyurethane	Uralane 5750LV (A/B)	Vantico	None	0.19	0.19	0.18	0.17	0.17	0.17	0.17		5/8/01
Polyurethane	Uralane5753LV (A/B)	Vantico	0.16					0.18				10/23/00
Silicone	DC 6-1104	Dow Corning	0.12	0.16	0.18	0.22	0.20	0.20	0.19	0.19		4/18/01
Silicone	DC 6-1125	Dow Corning	0.13									
Silicone	DC 93-500	Dow Corning	0.15	0.18	0.18	0.16	0.15	0.14	0.14	0.14		5/9/01
Silicone	Eccosil 4952/Cat 50	Emerson & Cuming	1.0	0.49	0.59	0.90	0.86	0.82	0.77	0.71		4/23/01
Silicone	Eccosil 4954/Cat 50	Emerson & Cuming	1.3	0.63	0.76	1.25	1.19	1.12	1.05	0.94		4/24/01
Silicone	RTV 566 A/B	GE	None	0.38	0.39	0.37	0.34	0.33	0.32	0.31		4/20/01
Silicone	Groendyk 8402	Groendyk	None	0.08	0.12	0.20	0.18	0.17	0.16	0.16		6/18/01
Silicone	CV-2942 A/B	Nusil	1.05	0.66	0.82	1.10	0.99	0.94	0.89	0.80		5/11/01
Silicone	CV-2943 A/B	Nusil	1.26	1.27	1.53	1.56	1.47	1.38	1.29	1.18		5/14/01
Silicone	CV-2946 A/B	Nusil	3.8	1.06	1.51	2.14	1.97	1.88	1.76	1.58	1.45@150°C	10/19/03

Silicone	CV-2948 A/B	Nusil	3.8	1.47	1.94	2.09	1.98	1.88	1.80	1.61	1.27@200°C	10/23/00
Silicone	CV-2960 A/B	Nusil	1.26	0.45	0.60	0.75	0.66	0.64	0.60	0.56		5/15/01