Materials Tip

Materials Engineering Branch

Use of Thermally Conductive Potting/Staking Materials			
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Conduction of heat from electronic assemblies is extremely important in satellite applications, since heat transfer from air cooling or convection cannot occur in the vacuum of space. There are many commercially available, thermally conductive materials of various types: epoxies, silicones, and polyurethanes often mixed with appropriate fillers. In addition, the Materials Engineering Branch (MEB) has modified several materials by adding fillers such as boron nitride, aluminum oxide and powdered metals to increase their thermal conductivity.

Table 1 is a compilation of several potting adhesives and staking materials commonly used in spacecraft applications, the thermal conductivity reported by their manufacturers and that measured by the MEB (when available). Note: Thermal conductivity will vary with mix.

Table 2 shows how the thermal conductivity of a material from Table 1 can be increased by using selected filler materials. Thermal conductivities up to 10 times greater than for unfilled materials and 2 to 5 times greater than for commercially available filled materials are achievable.

Remember that fillers can change material properties other than thermal conductivity. Viscosity, adhesion, tensile strength, electrical, and other properties can be significantly altered depending on the type and quantity of fillers added. Any modified material should be evaluated to verify critical performance requirements prior to its use in flight hardware.

Table 1. Thermal Conductivity of Commercially-Available Thermal Interface Materials

Material	Manufacturer's data		MEB data		
	cal/(sec cm°C) x10^{-4}	[W/(m K)]	cal/(sec cm°C) x10^{-4}	[W/(m K)]	Date of measurement
Polyurethanes					
Uralane 5750 A/B(LV)			7 ± 2	0.3 ± 0.1	Sep-96
Uralane 5753-A/B(LV)	3.9	0.16	12 ± 2	0.5 ± 0.1	Oct-95
S-113/C-113-300 (100/73)	5.0	0.21			
Conathane EN-11	4.5	0.19			
Conathane EN-20	5.1	0.21			
Epoxies					
Sycast 2651	15	0.63			
Stycast 3050	10	0.4			
EPO-TEK H74	3.4	0.14			
Scotchcast 281	26	1.1			
Silicones					
RTV566	7.4	0.31	12 ± 2	0.5 ± 0.1	Apr-96
CV-2942	25	1.0	29 ± 2	1.2 ± 0.1	Nov-95
CV-2943	30	1.3	38 ± 2	1.6 ± 0.1	Nov-95
CV-2946			43 ± 2	1.8 ± 0.1	Aug-96
CV-2948			48 ± 2	2.0 ± 0.1	Aug-96
CV-2960			17 ± 2	0.7 ± 0.1	Nov-95
DC6-1104	2.8	0.11			
DC 93-500	3.5	0.15			

Table 2. Thermal Conductivity of Custom Thermal Interface Materials

Material	Filler material and Fraction (by weight)	MEB data		
		cal/(sec cm °C) x10^{-4}	[W/(m K)]	Date of measurement
Polyurethanes				
Uralane 5753LV A/B	13% BN (1)	12 ± 2	0.5 ± 0.1	Oct-95
	50% BN (1)	43 ± 2	1.8 ± 0.1	Oct-95
	55% BN (1)	43 ± 2	1.8 ± 0.1	Oct-95
	60% BN (1)	50 ± 2	2.1 ± 0.1	Oct-95
Notes:	BN (1) boron nitride powder grade SHP-325, Carborundum Co.			