POLYMARK RESIN SYSTEMS

THERMAL CONDUCTIVITY

Users of epoxies, silicones and polyurethanes frequently need to determine the ability of a cured resin system to conduct heat. In the SI system, ***thermal conductivity*** is measured in **W**atts per **m**eter **K**elvin (W/mK). Similarly, *thermal conductance and thermal resistance* are sometime used to express the amount of heat that passes through a thickness of material over time, and the measure of a material to retard heat flow (respectively).

Thermal Conductivity of Common Electrical and Electronic Materials (W/mK):	
Still Air	0.025
Mylar	0.042
Transformer Oil	0.17
Unfilled Epoxy, Silicone, Urethanes	0.21
Epoxy + 40% silica	0.75
Epoxy + 70% Alumina	1.42
Alumina (Aluminum Oxide)	34.5
Eutectic Solder	41.9
Steel	58.6
Nickel	62.8
Silicon	125
Aluminum	196
Gold	197
Copper	268
Silver	293

Obviously, an unfilled epoxy, silicone or polyurethane resin is a much better thermal conductor than still air, but a much poorer one than metallic materials. However, the addition of inorganic fillers improves the conductivity of the resin. Silica, and most frequently, aluminum oxide are used as thermally conductive fillers used for systems requiring electrical isolation. Improvement in the thermal conductivity of a filled resin over that of an unfilled resin is not significant until the concentration of filler within the resin is high enough to establish point-to-point contact between the particles of filler.

The high levels of filler required to achieve thermal conductivity (as well as to obtain a lower coefficient of expansion) will increase a materials viscosity. While a formulation chemist can mitigate the effect of a high filler loading on viscosity, this becomes the limitation of thermally conductive adhesives and encapsulants.

The most popular thermally conductive filler, alumina or aluminum oxide, can settle in shipping and storage and the user may have to premix the resin prior to mixing with the hardener. Alumina is relatively hard and highly abrasive (see table below). When using an alumina filled encapsulant, the dispensing equipment must be designed specifically for that abrasive filler.

Commonly Used Fillers:	*MOH Scale Hardness (1=soft, 10=diamond)*
Talc	1
Calcium Carbonate	3
Aluminum Trihydrate	4
Silica	7
Aluminum Oxide	9