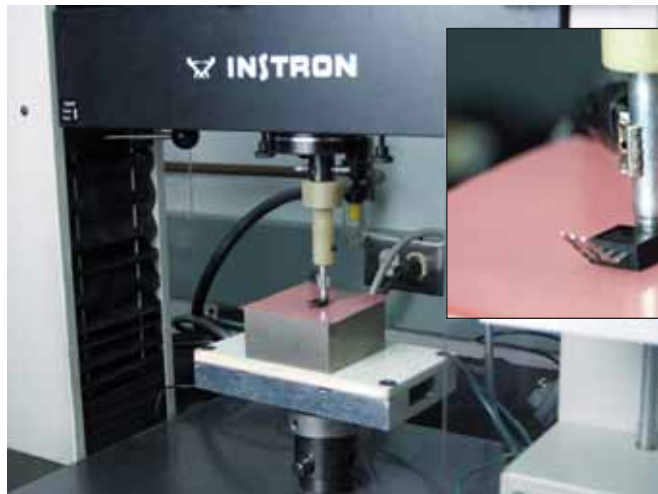


Mechanical and Electrical Properties

Mechanical Properties

Woven fiberglass and films are used in Sil-Pad products to provide mechanical reinforcement. The most important mechanical property in Sil-Pad applications is resistance to cut-through to avoid electrical shorting from the device to the heat sink.



Cut-Through Resistance - Bergquist introduced its TO-220 cut-through test to help customers better understand typical application performance.

Mounting Techniques and Mounting Pressure

Typical mounting techniques include:

- A spring clip, which exerts a centralized clamping force on the body of the transistor. The greater the mounting force of the spring, the lower the thermal resistance of the insulator.
- A screw in the mounting tab. With a screw-mounted TO-220, the force on the transistor is determined by the torque applied to the fastener.

In extremely low-pressure applications, an insulator with pressure sensitive adhesive on each side may give the lowest thermal resistance since the adhesive wets-out the interface easier than the dry rubber. This decreases the interfacial thermal resistance.

Devices with larger surface areas need more pressure to get the insulator to conform to the interface than smaller devices. In most screw-mount applications, the torque required to tighten the fastener is sufficient to generate the pressure needed for optimum thermal resistance. There are exceptions where the specified torque on the fastener does not yield the optimum thermal resistance for the insulator being used and either a different insulator or a different mounting scheme should be used.

Interfacial thermal resistance decreases as time under pressure increases. In applications where high clamping forces cannot be used, time can be substituted for pressure to achieve lower thermal resistance. The only way to know precisely what the thermal resistance of an insulator will be in an application is to measure it in that application.

Electrical Properties

If your application does not require electrical insulation, Q-Pad II or Q-Pad 3 are ideal grease replacement materials. These materials do not provide electrical isolation but have excellent thermal properties. Hi-Flow phase change materials should also be considered for these applications. (Reference pages 36-48 of this guide.)

The most important electrical property in a typical assembly where a Sil-Pad insulator is used is dielectric strength. In many cases the dielectric strength of a Sil-Pad will be the determining factor in the design of the apparatus in which it is to be used.

Here are some general guidelines regarding electrical properties to consider when selecting a Sil-Pad material:

- Q-Pad II and Q-Pad 3 are used when electrical isolation is not required.
- Dielectric breakdown voltage is the total voltage that a dielectric material can withstand. When insulating electrical components from each other and ground, it is desirable to use an insulator with a high breakdown voltage.

SIL-PAD TYPICAL ELECTRICAL PROPERTIES

Material	BREAKDOWN VOLTAGE	DIELECTRIC STRENGTH		DIELECTRIC CONSTANT	VOLUME RESISTIVITY
	(kV)	(Volts/mil)	(kV/mm)	(1000 Hz)	(Ohm-Meter)
Sil-Pad 400 - 0.007	3.5	500	20	5.5	10 ¹¹
Sil-Pad 400 - 0.009	4.5	500	20	5.5	10 ¹¹
Sil-Pad 900S	5.5	600	24	6.0	10 ¹⁰
Sil-Pad 1200 - 0.009	6.0	667	26	7.0	10 ¹⁰
Sil-Pad A1500	6.0	600	24	7.0	10 ¹¹
Sil-Pad 2000	4.0	400	16	4.0	10 ¹¹
Sil-Pad K-4	6.0	1000	39	5.0	10 ¹²
Sil-Pad K-6	6.0	1000	39	4.0	10 ¹²
Sil-Pad K-10	6.0	1000	39	3.7	10 ¹²
Test Method	ASTM D149* * Method A, Type 3 Electrodes	ASTM D149* * Method A, Type 3 Electrodes		ASTM D150	ASTM D257

- Breakdown voltage decreases as the area of the electrodes increases. This area effect is more pronounced as the thickness of the insulator decreases.
- Breakdown voltage decreases as temperature increases.
- Breakdown voltage decreases as humidity increases.
- Breakdown voltage decreases in the presence of partial discharge.
- Breakdown voltage decreases as the size of the voltage source (kVA rating) increases.
- Breakdown voltage can be decreased by excessive mechanical stress on the insulator.

Dielectric strength, dielectric constant and volume resistivity should all be taken into consideration when selecting a Sil-Pad material. If your application requires specific electrical performance, please contact a Bergquist Sales Representative for more detailed testing information.

Thermal Properties

The thermal properties of a Sil-Pad material and your requirements for thermal performance probably have more to do with your selection of a Sil-Pad than any other factor.

Discrete semiconductors, under normal operating conditions, dissipate waste power which raises the junction temperature of the device. Unless sufficient heat is conducted out of the device, its electrical performance and parameters are changed. A 10°C rise in junction temperature can reduce the mean-time-to-failure of a device by a factor of two. Also, above 25°C, the semiconductor's total power handling capability will be reduced by a derating factor inherent to the device.

The thermal properties of Sil-Pad products are thermal impedance, thermal conductivity and thermal resistance. The thermal resistance and conductivity of Sil-Pad products are inherent to the material and do not change. Thermal resistance and thermal conductivity are measured per ASTM D5470 and do not include the interfacial thermal resistance effects. Thermal impedance applies to the thermal transfer in an application and includes the effects of interfacial thermal resistance. As the material is applied in different ways, the thermal impedance values will vary from application to application.

- The original Sil-Pad material, Sil-Pad 400, continues to be Bergquist's most popular material for many applications.
- Sil-Pad A1500 is chosen when greater thermal performance is required. Sil-Pad A2000 is ideal for high performance, high reliability applications.

Beyond these standard materials, many things can contribute to the selection of the correct material for a particular application. Questions regarding the amount of torque and clamping pressure are often asked when selecting a Sil-Pad material. Here are some guidelines:

- Interfacial thermal resistance decreases as clamping pressure increases.
- The clamping pressure required to minimize interfacial thermal resistance can vary with each type of insulator.
- Sil-Pad products with smooth surface finishes (Sil-Pad A1500, Sil-Pad A2000, Sil-Pad K-4, Sil-Pad K-6 and Sil-Pad K-10) are less sensitive to clamping pressure than Sil-Pads with rough surface finishes (Sil-Pad 400) or smooth and tacky finishes (Sil-Pad 1500ST).

Sil-Pad Thermal Performance Overview (TO-220 Test @ 50 psi)

