

Selecting Dielectric Materials

Dielectric Layer

The technology of Thermal Clad resides in the dielectric layer. It is the key element for optimizing performance in your application. The dielectric is a proprietary polymer/ceramic blend that gives Thermal Clad its excellent electrical isolation properties and low thermal impedance.

The polymer is chosen for its electrical isolation properties, ability to resist thermal aging and high bond strengths. The ceramic filler enhances thermal conductivity and maintains high dielectric strength. The result is a layer of isolation which can maintain these properties even at 0.003" (76µm) thickness. See high power lighting applications for thinner dielectric information. This guide will help you select the best dielectric to suit your needs for watt-density, electrical isolation and operating temperature environment.

Standardized Methods For Measuring Thermal Conductivity

There are several different test methods for determining a material's thermal conductivity value. Results can be different depending on the method chosen, so it is important to use similar test methods in material comparisons. See chart at right.

Standard test methods include ASTM D5470 and ASTM E1461. ASTM D5470 is a steady state method and is referred to as the guarded hot plate. This method provides an analytically derived value and does not use approximations. ASTM E1461 is a transient method referred to as Laser Flash Diffusivity. In E1461, thermal diffusivity is the test output and thermal conductivity is calculated.

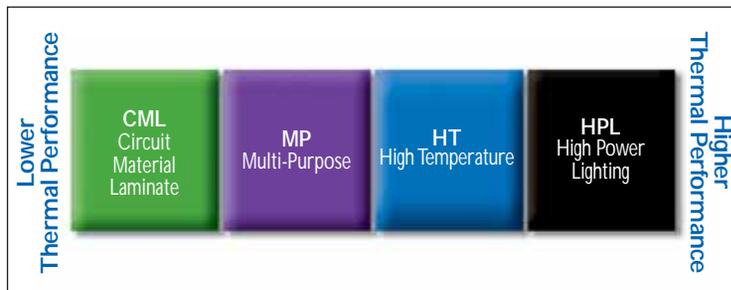
Non-Standard In-House Test Methods

The adjacent chart shows how vastly different thermal conductivity values can be achieved by using "in-house" or non-standard test methods. For example, when the same dielectric is chosen we can derive a completely different and much higher thermal conductivity value by testing a stack-up or laminate with base layer. We can modify the test further by using different materials for the substrate to obtain even higher results. Although thermal conductivity values are still relative to one another so a comparison can be made, these test methods do not give us an accurate depiction of true thermal performance in the application. Included in the chart is a modeled value for thermal conductivity, a respected model for predicting the effective thermal conductivity of anisotropic particulate composites, but not helpful for determining thermal performance in application. We emphasize using standard test methods such as ASTM D5470 and ASTM E1461, which are universally accepted and repeatable.

Note: The hot disk method is not a method we use for comparison because typically this method measures the conductivity of the dielectric alone, which neglects thermal interfacial resistance between layers and carrier holding the dielectric. These values must be understood in order to calculate the actual thermal impedance or thermal performance data. See section regarding thermal impedance on page 7.

Thermal Conductivity

Thermal conductivity is relevant to the application's thermal performance when the thickness of the dielectric material, interfacial resistance and area are taken into consideration. See "Thermal Impedance" section for more information, as this data will be the most relevant to your application.



Part Number	Standardized Test Methods (W/m-K)	
	ASTM D5470 ¹	ASTM E1461 ²
HT-04503	2.2	1.97
HT-07006	2.2	1.97
MP-06503	1.3	1.17

Method Description

- 1 - ASTM D5470
Guarded Hot Plate
- 2 - ASTM E1461
Laser Flash Diffusivity

Part Number	Non-Standard Thermal Conductivity Test Methods and Model (W/m-K)				
	Model ¹	Guarded Hot Plate Laminate ²	Guarded Hot Plate Laminate ³	Laser Flash Laminate ²	Laser Flash Laminate ³
HT-04503	9.0	32.2	36.4	67.6	115
HT-07006	9.0	21.5	23.3	46.0	86.5
MP-06503	4.5	14.0	24.0	34.9	102

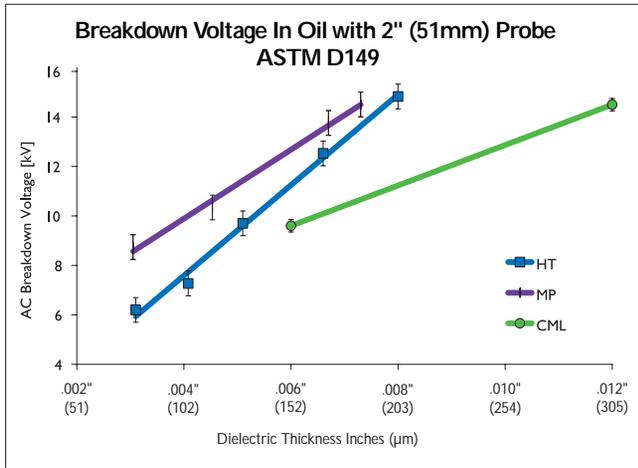
Method Description

- 1 - Bruggeman Model
- 2 - Tested with 0.062" (1.57mm) 5052 aluminum substrate and 2 oz. (70µm) copper foil
- 3 - Tested with 0.062"(1.57mm) 1100 copper substrate and 2 oz. (70µm) foil

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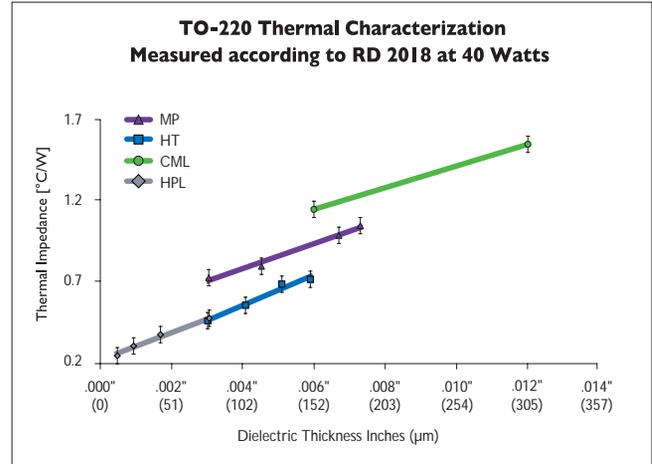
Electrical Isolation - Power Applications

Dielectrics are available in thicknesses from 0.003" (76µm) to 0.009" (229µm), depending on your isolation needs. See "Electrical Design Considerations" on pages 16-17 to help determine which thickness is appropriate for your application.



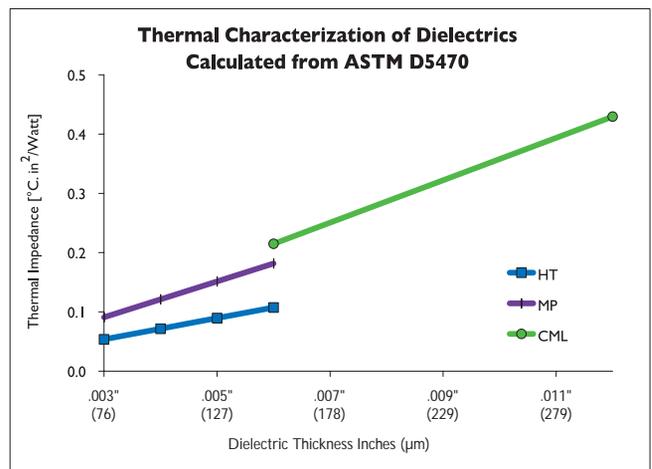
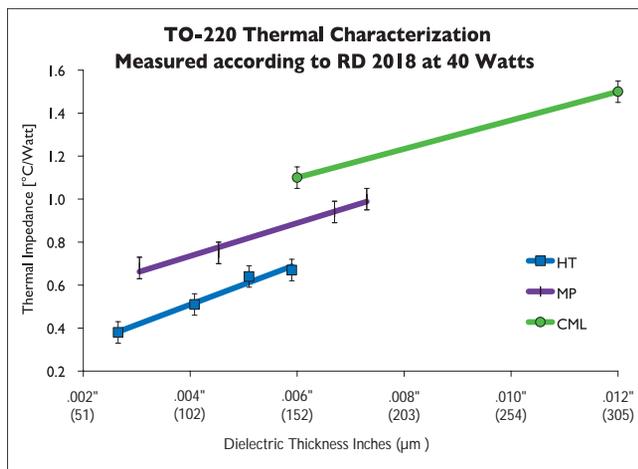
High Power Lighting Applications

HPL is a dielectric specifically formulated for high power lighting LED applications with demanding thermal performance requirements. This thin dielectric at 0.0015" (38µm) has an ability to withstand high temperatures with a glass transition of 185°C and phenomenal thermal performance of 0.30°C/W. For detailed information, call Bergquist Sales or go online.



Thermal Impedance Determines Watt Density

Thermal impedance is the only measurement that matters in determining the watt density capability of your application because it measures the temperature drop across the stack-up for each watt of heat flow. Lower thermal impedance results in lower junction temperatures. The lower the thermal impedance, the more efficiently heat travels out of the components.



$$\text{TOTAL IMPEDANCE} = \frac{\text{Sample Thickness}}{\text{Thermal Conductivity}} + \text{Interfacial Resistance}$$

Lower Thermal Impedance = Lower Junction Temperatures