BERGQUIST®

SELECTION GUIDE

THERMAL MANAGEMENT FOR LED

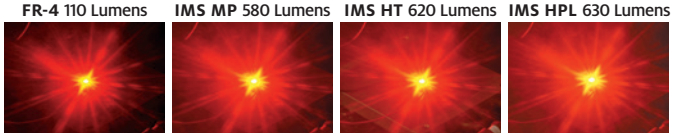
Henkel

Thermal Solutions For Long-Term Reliability Of Power LEDs

Henkel's Bergquist brand Thermal Solutions Ensure Color Consistency And Maximum Lifecycles For Your LEDs.

Bergquist TCLAD in a typical leaded Power LED package.

Light Emitting Diodes (LEDs) have been around for years, primarily concentrated in such markets as cell phones, PDAs and other consumer electronics. Since most of these products have relatively short lifecycles, protecting LEDs wasn't a primary concern because the product would fail or become obsolete long before the LED failed. Today, as technological advancements in LED design and processes are continually boosting light output to rival incandescent, fluorescent, and even halogen light sources, the need to protect the LEDs against heat build-up is greater than ever before. Three and five-watt LEDs are now commonplace, and industry experts are predicting 10-watt LED availability in the next few years. Power LEDs of greater than one-watt are almost always surface mounted devices. This is because the axial leads to the die in a leaded package do not conduct enough heat away from the LED. Chip-on-board (COB), ceramic submounts and other thermally efficient packages are emerging as the standard thermal management packaging solution for Power LEDs.



Light output of the same LED die on different circuit board materials at a maintained die temperature of 80ºC.

The Effect of Temperature

The LED's color, or wavelength, will change with temperature. As the die temperature increases, the wavelength of the color increases. This is particularly important with white light. The human eye can differentiate small color changes in white light. When Power LEDs are populated in an array, consistent thermal resistance from one die to the next assures consistent color. Because of the comparatively low thermal resistance Thermal Clad offers versus FR-4, die temperature is less affected by slight variances in the junction-to-case thermal resistance that occurs with eutectic or epoxy-die mounting techniques. It is also possible to pack the die more closely in an assembly that utilizes good thermal management techniques, thereby reducing the effects of temperature.

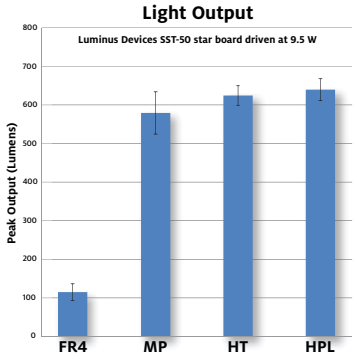
Generally, a 30-50 percent drop in light output for a constant-forward current indicates end-of-life for Power LEDs. Power LED lifetimes have been extrapolated to over 50,000 hours.

Cost of Heat Summary

Better thermal management allows more forward current to be applied to the LED, which means more light and possibly reducing the number of LEDs required for the desired light output. Maintaining a cooler assembly at an equivalent power equates to more light per die.

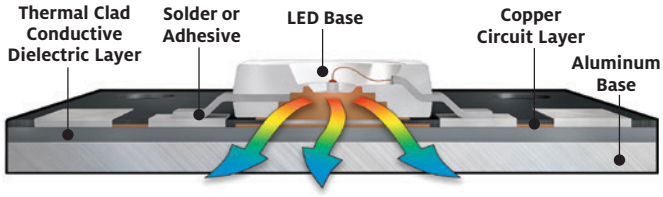
Circuit Board Comparison

Metal core PCB and standard FR-4 are commonly used circuit board materials in conjunction with Power LEDs. Bergquist's Thermal Clad dielectric is a thin, thermally conductive layer bonded to an aluminum or copper substrate for heat dissipation (see illustration below). The key to Thermal Clad's superior performance lies in its dielectric layer. This layer offers electrical isolation with high thermal conductivity and bonds the base metal and circuit foil together. Other manufacturers use standard prepreg as the dielectric layer, but prepreg doesn't provide the high thermal conductivity and resulting thermal performance required to help assure the lowest possible operating temperatures and brightest light output for high-intensity LEDs. Thermal Clad circuit board materials are available from The Bergquist Company in three different thermal conductivities, High Power Lighting (HPL), High Temperature (HT), and Multi-Purpose (MP).



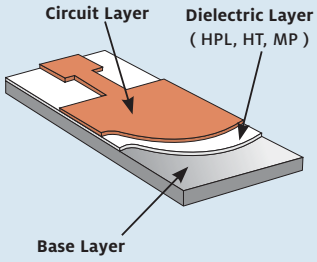
Packaging Conclusion

There are several options available for thermal management of Power LEDs. The most critical thermal path in the stack is the one with the highest thermal resistance. Good practice suggests that you reduce the thermal resistance of that layer with Thermal Clad dielectric instead of FR-4.



A Power LED's light output and life expectancy are directly attributed to how well the LED is managed thermally. As the LED generates heat, the dielectric of the Bergquist Thermal Clad metal core PCB quickly transfers it to the aluminum base, significantly improving the LED's performance.

Anatomy of a Thermal Clad Board



	PRODUCT FAMILY		PRODUCT PERFORMANCE			DIELECTRIC PERFORMANCE			OTHER	
	Part Number	(1) Thickness (.000"/µm)	(2) Thermal Performance (ºC/W)	(3) Impedance (ºC in2/W) / (ºC cm2/W)	(2) Conductivity (W/m-K)	(5) Breakdown (kVAC)	(6) Permittivity (Dielectric Constant)	(4) Dielectric Conductivity (W/m-K)	(7) Glass Transition (°C)	(8) Peel Strength (lbs/in) / (N/mm)
HPL	HPL-03015	1.5/38	0.30	0.02/0.13	7.5	5.0	6	3.0	185	5/0.9
HT	HT-04503 HT-07006	3/76 6/152	0.45 0.70	0.05/0.32 0.11/0.71	4.1 4.1	8.5 11.0	7 7	2.2 2.2	150 150	6/1.1 6/1.1
MP	MP-06503	3/76	0.65	0.09/0.58	2.4	8.5	6	1.3	90	9/1.6

Method Description: 1-Optical 2-MET-5.4-01-40000-Test Thermal Performance of Insulated Metal Substrates (IMS)
3-Calculation from ASTM 5470 4-Extended ASTM 5470 5-ASTM D149 6-ASTM D150 7-MET-5.4-01-7800 7-ASTM D2861

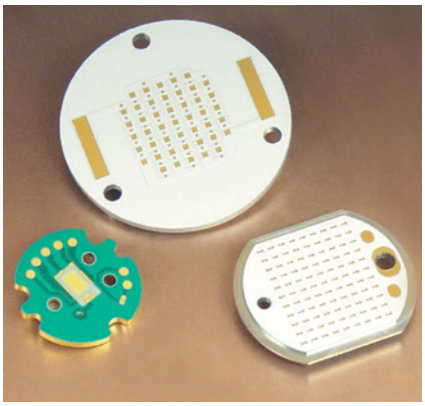
Thermal Clad Metal Core PCB

Thermal Clad Metal Core PCB

Thermal Clad is a dielectric (ceramic-polymer blend) coated metal base with a bonded copper circuit layer. Improved reliability, processing advantages and exceptional cost performance makes Thermal Clad a superior alternative to traditional FR4 and non-thermally conductive constructions.

Thermal Clad panels are available in a variety of thicknesses depending on the base metal and circuit foil thickness. Standard sheet sizes are 18" x 24", 18" x 25" and 20" x 24". Material selection should be based on thermal, dielectric and mechanical application requirements.

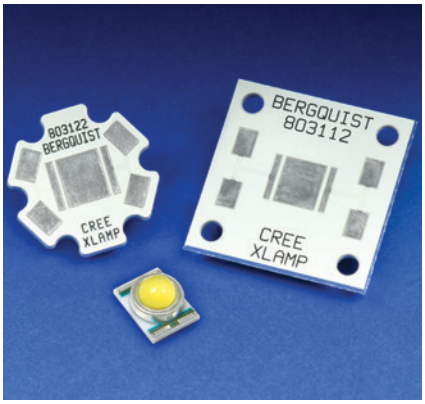
- Circuit layer - 35µm to 350µm
- Dielectric layer - HPL, HT, MP
- Base plate available in:
  Copper 0.020"-0.125"
  (0.51mm-3.18mm)
  Aluminum 0.020"-0.190"
  (0.51mm-4.83mm)



Thermal Clad Printed Circuit Boards (PCB)

Thermal Clad circuit boards are the answer for designers wanting the best of both worlds. Power LED light output and lifecycles are directly attributed to how well the package is managed thermally. A Thermal Clad PCB offers superior heat transfer. As a metal based material, Thermal Clad can be configured for shapes, bends and thicknesses allowing installation in virtually any application. With a Thermal Clad PCB you're assured of the lowest operating temperature, maximum LED color consistency and life.

- Circuit layer - 35µm to 350µm
- Dielectric layer - HPL, HT, MP
- Base plate available in: Copper 0.020"-0.125" (0.51mm-3.18mm)
  Aluminum 0.020"-0.190"
  (0.51mm-4.83mm)



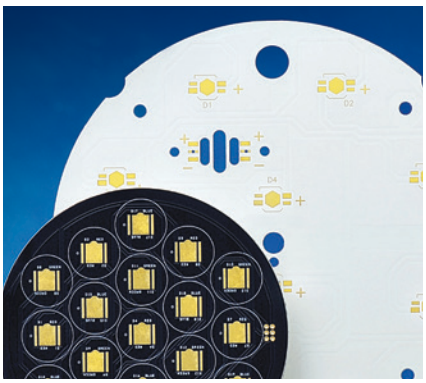
Thermal Clad Standard Configurations

Thermal Clad Standard Configurations are specifically designed to help jump-start your design. Available in different LED footprints, they give you the freedom to select the LED component's color, brightness and power necessary to fit your needs.

Provided in star or square footprints, they can be ordered in single, strip or array configurations. Optimize the prototyping process with the lowest possible operating temperatures and the brightest light output for your next Power LED application.

- Circuit layer - 35µm (1 oz.) copper circuit foil
- Dielectric layer - .076mm (3 mil) MP
- Base plate - Aluminum 5052 1.57mm (0.062")
- Surface Finish - White solder mask, Pb-free HASL solder pads (RoHS compliant)
- Choose numerous footprints from such LED manufacturers as Osram, Cree, Lite-On®, Lumileds™, Seoul, Avago, Nichia and Lumex

Thermal Clad Dielectric Options

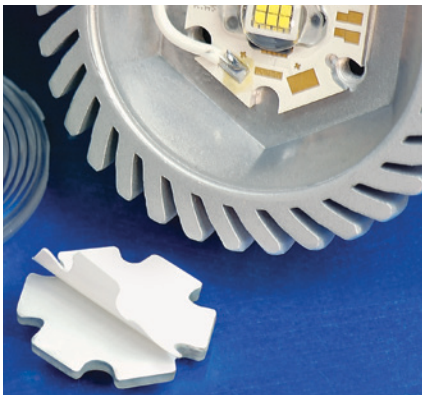


Thermal Clad panels and PCBs are available in four dielectric types meeting the unique thermal and mechanical requirements of various LED applications. Thermal Clad dielectrics are named to describe their typical application.

MP (Multi-Purpose), twenty plus years industry proven dielectric for a multitude of applications including LEDs, HT (High Temperature) a dielectric resistant to degradation from high temperature exposure and features high dielectric breakdown characteristics, HPL (High Power Lighting) meeting the increased thermal performance requirements of Power LEDs.

Available as: • Panels • Printed circuit boards (PCB)

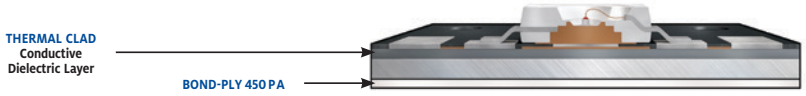
Thermally Conductive Adhesives, Compounds and Fillers

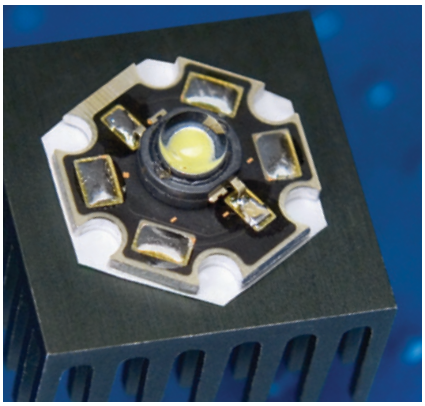


Thermal Clad PA (Pre-applied) Substrates

Bergquist's Thermal Clad PA substrates include pre-applied BOND-PLY 450. This allows you to adhere your mounted LEDs to a variety of heatsinks and surfaces while thermally optimizing your application. This version of "peel and place" Thermal Clad can withstand the high temperatures of solder reflow during LED assembly and then be positioned in the lighting application using its strong thermally conductive adhesive.

- Circuit layer - 35µm to 350µm
  Dielectric layer - HPL, HT, MP
- Base plate copper or aluminum
  0.020"-0.125" (0.51mm-3.18mm)
- Pre-applied exclusively on Bergquist Thermal Clad PCBs
- Withstands the heat of solder reflow

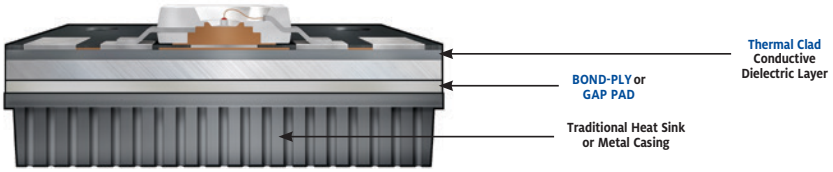


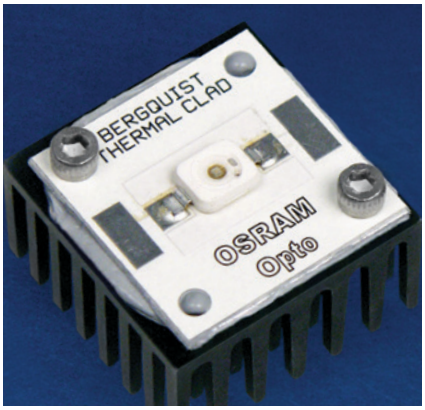


BOND-PLY Adhesive

Bond-Ply is a thermally conductive, pressure sensitive adhesive tape, available in either fiberglass reinforced or unreinforced. With its ability to have a high bond strength, it can eliminate the need for screws, clipmounts or fasteners.

- Good thermal performance
- Immediately bonds to target surface
- Eliminates need for mechanical fasteners or screws
- Alternative to heat-cure adhesives

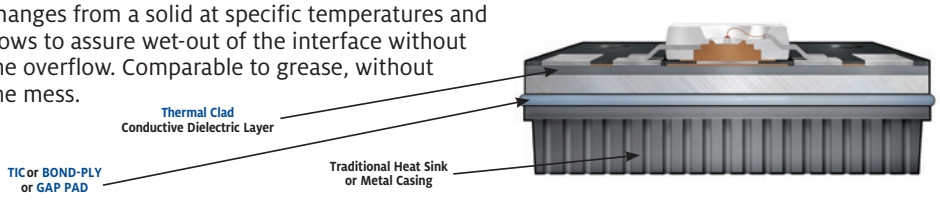


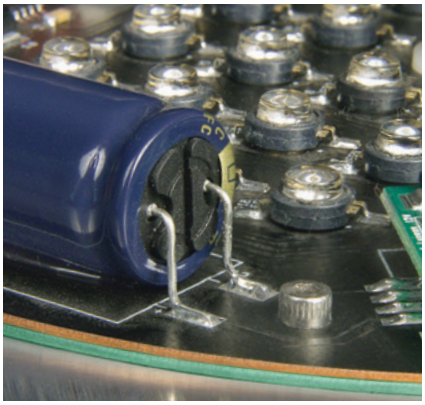


TIC Thermal Interface Compound and HI-FLOW

TIC is a high performing, thermally conductive grease designed for use as a thermal interface between an aluminum base and a heat sink or metal casing. The compound wets-out the thermal surfaces and flows to produce the lowest impedance for your LED application. HI-FLOW is a thermally conductive phase change material that changes from a solid at specific temperatures and flows to assure wet-out of the interface without the overflow. Comparable to grease, without the mess.

- High thermal performance
- Good thermal conductivity
- Can be screened
- No post "cure" required
- Room temperature storage
- Exceptional value

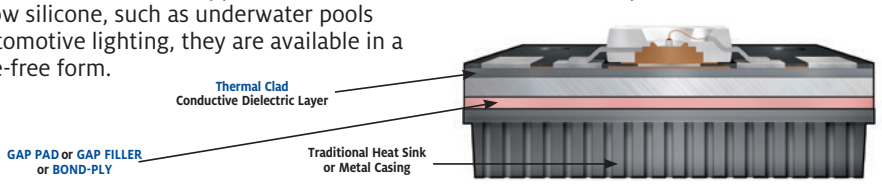




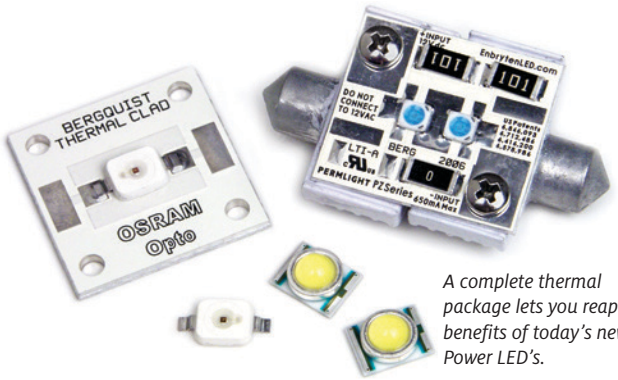
Silicone or Silicone-Free GAP PAD and GAP FILLER

GAP PAD and GAP FILLER are cost-effective, filled, thermally conductive interface materials. With shock dampening abilities, the GAP PAD line is recommended for applications that require a minimum amount of pressure between components. For sensitive applications that do not allow silicone, such as underwater pools and automotive lighting, they are available in a silicone-free form.

- Exceptional thermal conductivity
- Electrically isolating
- Highly conformable, low hardness
- Efficient gap filling material for minimizing component stress
- Silicone-free options available



Thermal Management for Today's Power LEDs



A complete thermal package lets you reap the benefits of today's new Power LED's.

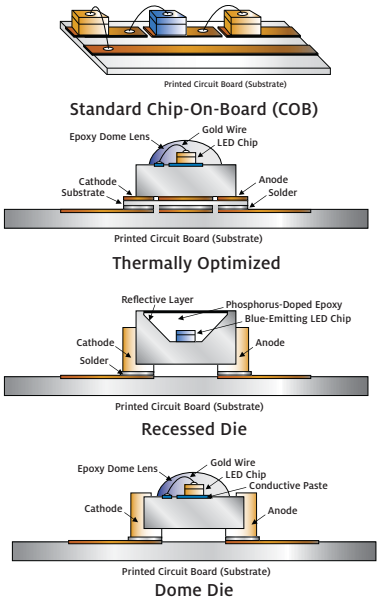
The Power Factor Evolves

With the era of brighter and more powerful LEDs, we are witnessing the world of lighting changing forever. Power LEDs are entering nearly every market niche as the light source of choice. Advancements in LED technology has led to a cost-effective alternative to incandescent, fluorescent and halogen lighting. With these bring significant opportunities to LED manufacturers and integrators.

Power LED packaging has evolved to adapt to higher power dissipation demands. For these Power LED packages, the lowest possible thermal resistance packaging is paramount to a long and reliable service life. By combining Bergquist thermal management materials with this new and innovative packaging, progress in both light output and light quality can be achieved.

Henkel has established itself as one of the world's foremost leaders in thermal management solutions. From innovative new products to global support, Bergquist is your total thermal management supplier. With the depth of our product portfolio, Bergquist promises to make these challenging new thermal hurdles less daunting. Whether you're a manufacturer, an integrator or a company that procures the final package, you'll benefit from a Bergquist solution.

Typical Types of LED Packages



A Bright New Chapter Unfolds

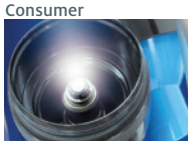
Now that Power LEDs are capable of unprecedented levels of white LED brightness and luminous efficacy, they are being used in many products that are part of our daily lives. Although today the initial cost of Power LEDs is higher, many applications have demonstrated LED lighting as the most cost or energy efficient solution for future installations. Equipment manufacturers worldwide are making devices with Power LEDs for both the commercial and consumer segments.

With smaller footprints, our products lead the way in reducing the buildup of heat and maximize the LED's potential benefits. Bergquist provides critical thermal management support for a myriad of Power LED applications that include: medical, signage, signal, transportation, aircraft, automotive, security, portable, theatrical, commercial, residential and street lighting.

Street Lighting

Automotive

Consumer



Signage

Bergquist thermal products are hard at work keeping the world's best known products reliably cool.

Whether indoors or outdoors, the range of uses for Power LEDs is ever expanding. Leading automotive manufacturers have not only begun to move Power LEDs into interiors and signals, but forward LED lighting is now available on an ever increasing number of vehicles. Bergquist's silicone-free materials are an excellent choice for automotive and submersible applications. By using copper based Thermal Clad, along with Silicone-Free GAP PAD, unique agency requirements for UL approval in underwater lighting applications, such as pools, can be met. As a one-source supplier, this right combination of thermal interface and substrate materials allows customers to quickly meet their objectives.

Easing The Thermal Issues Ahead

Be confident specifying your Power LEDs at their maximum power levels by partnering with an expert in thermal management. Our vast experience in the thermal field, coupled with our solid customer-focused solutions, makes us the best choice for thermal design choices. Rely on Bergquist to stay on top of Power LED packaging and continue to innovate and market thermal material solutions for this rapidly expanding technology. Extend performance, durability and reliability by including us in your Power LED equation.

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