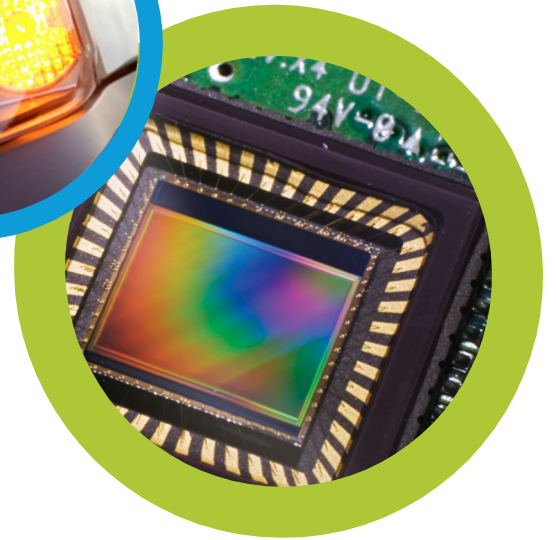




Smart Technology. Delivered.

Thermal Interface Solutions

Laird designs and manufactures customized, performance-critical products for wireless and other advanced electronics applications.





Smart Technology. Delivered.



About Laird

Laird is a global technology business focused on enabling wireless communication and smart systems, providing components and systems that protect electronics. Laird operates through three divisions, Connected Vehicle Solutions, Wireless and Thermal Systems, and Performance Materials. Laird's Connected Vehicle Solutions includes Telematics products, antenna solutions, smart antennas and devices for transportation markets. Wireless and Thermal Systems solutions include antenna systems, embedded wireless modules, wireless automation and control solutions and engineered thermal systems. Performance Materials solutions include electromagnetic interference shielding, thermal management, and signal integrity products. As a leader in the design, supply and support of innovative technology, our products allow people, organizations, machines and applications to connect effectively, helping to build a world where smart technology transforms the way of life. Custom products are supplied to major sectors of the electronics industry including the handset, telecommunications, IT, automotive, public safety, consumer, medical, rail, mining, and industrial markets. Providing value and differentiation to our customers through innovation, reliable fulfillment, and speed, Laird PLC is listed and headquartered in London, and employs over 9,000 people in more than 58 facilities located in 18 countries.

Thermal Interface Solutions

As an industry leader in high-performance, cost-effective Thermal Interface Materials (TIMs) and technologies, Laird designs and manufactures thermal products; including gap fillers and putties, phase change materials, thermal grease, and thermally-conductive insulator materials that meet the demands of any application.

Meeting Ever-Increasing Thermal Demands

Today's electronics are smaller and more powerful than ever before, leading to ever increasing thermal challenges for the systems designer. While fans, heat sinks, and even liquid cooling and thermoelectric devices can be used to provide enough cooling power, the problem remains transferring the heat from the hot components into the cooling hardware. TIMs are designed to fill in air gaps and microscopic irregularities, resulting in dramatically lower thermal resistance and thus better cooling. Laird is the world leader in material development for TIMs and offers the broadest line of products to meet every design challenge. With gap filler pads, dispensable gap fillers, electrically insulating and electrically conductive pads, Laird's thermal interface products can solve any TIM design challenge. In addition, Laird provides phase change TIMs that soften and fill tiny gaps at operating temperature, as well as thermally conductive greases that conform to any surface irregularity. Laird's thermal interface materials offer operating temperatures up to 200°C, thermal conductivities over 8 W/mK in the Z axis, and tremendous flexibility in form factor and packaging to support any manufacturing scenario.

Thermal Interface Materials

Gap Fillers

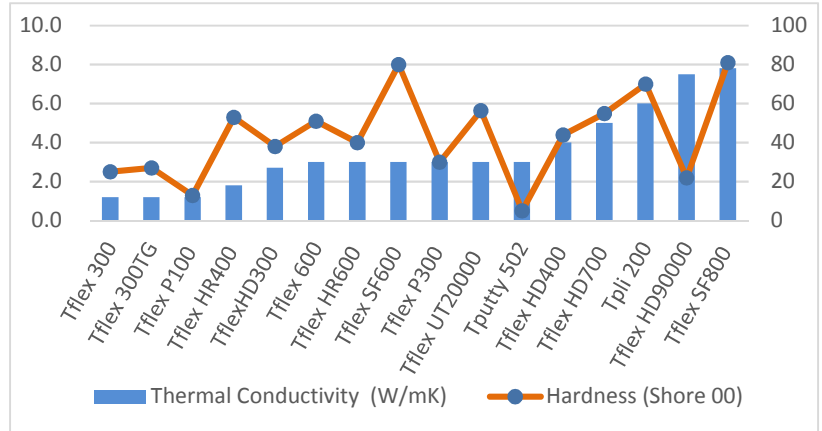
(Tflex™, Tpli™, Tputty™)

Laird gap fillers are used to bridge the interface between hot components and a chassis or heat sink assembly to increase the overall heat transfer from the system. The unique combination of thermal conductivity and softness reduces mechanical stress while maintaining thermal performance. Laird's extensive gap filler product lines includes a wide range of performance capabilities, including ultra-thin gap fillers, a high deflection series, and materials that provide electrical isolation.



APPLICATIONS

- Telecom – wireless infrastructure, routers, and VOIP phones
- IT – notebooks, servers, memory modules, hard disk drives, solid state drives, scanners, and printers
- Consumer – gaming systems, LCD PDP televisions, and displays
- Industrial – LED lighting, power supplies, lighting ballasts, controllers, scanners, and power converters
- Aerospace and military – power supplies, microwave radio, and controllers



Dispensable Gap Fillers

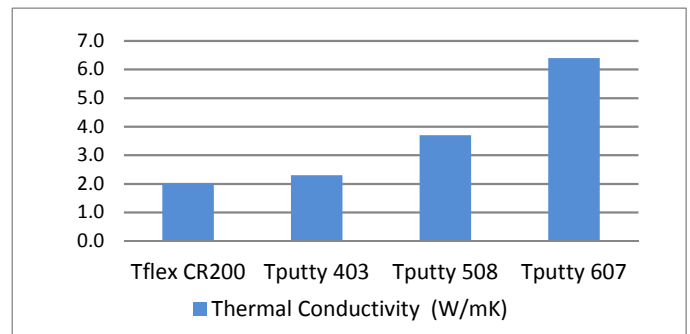
(Tflex™ and Tputty™)

Laird dispensable gap fillers are used to bridge the interface between hot components and a chassis or heat sink assembly when elimination of mechanical stress or bulk automated dispensing are critical design considerations. These materials can be dispensed to fill large and uneven gaps in assemblies and due to their super compliant nature; little to no pressure is transferred between interfaces. Laird's dispensing product portfolio includes both one and two-part materials, as well as products specifically designed for vertical stability and consistent dispensing.



APPLICATIONS

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High-Performance Products (Tpcm™ and Tgrease™)

High-performance products are used in applications where mechanical tolerances and general design has been optimized for thermal performance.

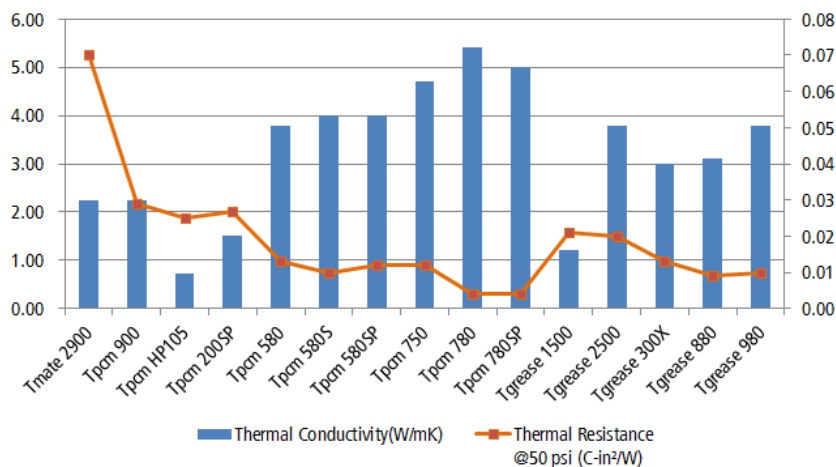
The Tpcm phase change product line is used in applications where reliability, repeatability, and handling must be controlled to optimize the performance as part of the total thermal solution. The Tpcm product line is available in a screen printable formulation that offers the reliability and performance of a phase change material with the low-cost handling of thermal grease.

Tgrease is used in applications where a minimum bond line, constant pressure, and ease of screen printing are desired for optimal performance. Laird's high-performance Tgrease products are designed to maximize reliability by eliminating pump out in most applications.



APPLICATIONS

- IT – servers, desktops, notebooks, and memory modules
- Industrial – power supplies, lighting, LED lighting, and industrial electronics
- Telecom – routers and wireless infrastructure
- Consumer – gaming systems and portable devices

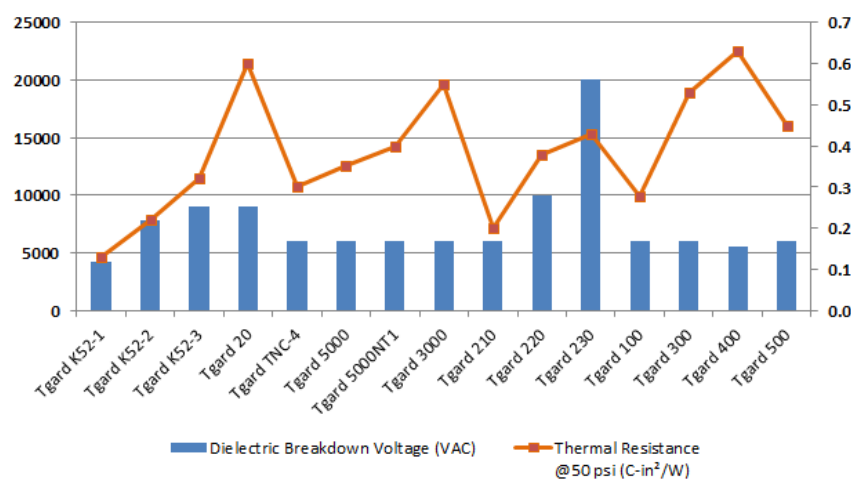


Electrical Insulators (Tgard™)

Tgard thermally conductive electrical insulators are used where electrical isolation is a critical design consideration, along with reliability, cut-through resistance, and thermal conductivity. The Tgard product line has a wide variety of materials for the unique performance, handling, and assembly considerations required in electronics devices.

APPLICATIONS

- Switching mode power supplies for:
 - Power semiconductors
 - Consumer electronics
 - Audio and video components
 - Automotive control units
 - Power conversion equipment
- Electrical power generators
- UPS Unit
- Computers
- Industrial
- Instrumentation
- Medical

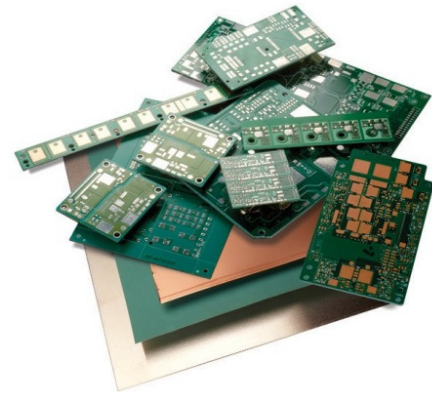


Thermally Conductive Printed Circuit Board (Tlam™ and Tpreg™)

Tlam thermally conductive circuit boards are designed with Laird's unique dielectric materials 1KA and HTD. Tlam technology improves thermal performance while retaining good dielectric isolation.

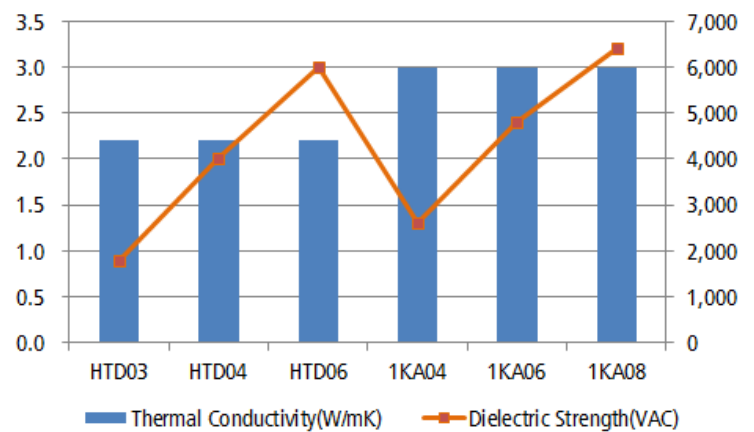
The 1KA material offers high thermal conductivity for applications where a thick dielectric is required. The 1KA material is available as a freestanding Tpreg to facilitate multilayer and FR4 hybrid circuit boards.

The HTD material is used where high withstand voltage (>5000 V DC) and continuous use temperature of 150°C are required.



APPLICATIONS

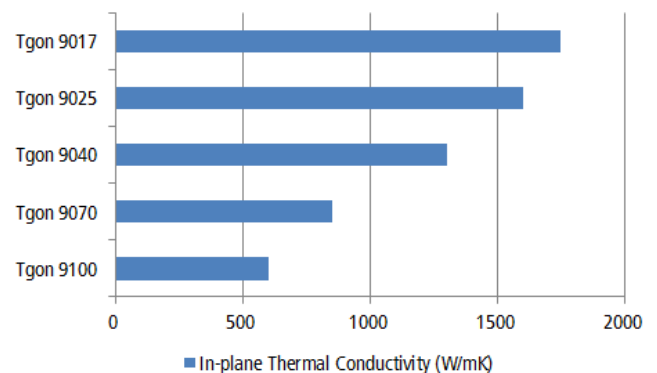
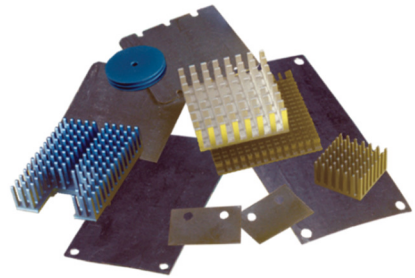
- LED lighting – architectural lighting and street/highway/parking/signal lighting
- Telecom – DC/DC convertors and basestations
- Automotive – motor control systems, power steering modules, ABS braking systems, headlights, brake lights, and daytime running lights
- Consumer – LCD LED backlighting units
- Industrial – solar voltaic, industrial voltage regulators, and power supplies



Graphite Materials (Tgon™)

Tgon 800 is a high-performance, cost-effective TIM that can be used where electrical isolation is not required. Tgon 800's unique grain oriented graphite plate structure provides 5 W/mK through the Z axis.

Tgon 9000 is ultra-thin, light-weight, flexible and offers excellent in-plane thermal conductivity. Ideal for a variety of heat spreading applications where in-plane thermal conductivity dominates and limited space.



APPLICATIONS

- Handheld devices
- Mobile computing
- Display
- Lighting
- Power conversion equipment
- Power supplies
- Large telecommunications switching hardware
- Where electrical grounding is required with good thermal conductivity

Gap Filler Comparison Table

	Tflex 300	Tflex P100	Tflex HR400	Tflex HD300	Tflex 600	Tflex HR600	Tflex SF600	Tflex P300
Construction	Ceramic filled silicone sheet	Tgard lined Elastomer	Ceramic filled silicone elastomer	Ceramic filled silicone elastomer	Boron nitride filled silicone elastomer	Ceramic filled silicone sheet	Boron Nitride filled gap pad	Silicone gap filler with an integrated polyimide liner
Color	Light Green	Yellow	Dark Grey	Pink	Blue-Violet	Dark Grey	Rose	Purple
Thickness Range	0.020" - 0.200" (0.50 mm - 5.08 mm)	0.020" - 0.200" (0.50 mm - 5.08 mm)	0.020" - 0.400" (0.50 mm - 10.16 mm)	0.020" - 0.200" (0.50 mm - 5.08 mm)	0.020" - 0.200" (0.50 mm - 5.08 mm)	0.010" - 0.200" (0.25 mm - 5.08 mm)	0.010" - 0.140" (0.25 mm - 3.56 mm)	0.020" - 0.200" (0.5 mm - 5.08 mm)
Thermal Conductivity (W/m-K)	1.2	1.2	1.8	2.7	3.0	3.0	3.0	3.0
Density (g/cc)	1.8	2.3	1.9	3.1	1.3	2.5	1.3	3.1
Hardness (Shore 00)	51 (20-30 mil) 25 (40-200 mil)	13	53	38	51	40	80	30
Outgassing TML (%)	0.56	0.32	0.32	0.39	0.13	0.19	1.30	0.20
Outgassing CVCM (%)	0.10	0.05	0.09	0.10	0.05	0.07	0.63	0.05
Temperature Range	-40°C to 160°C	-40°C to 200°C	-50°C to 160°C	-40°C to 200°C	-45°C to 200°C	-45°C to 200°C	-20°C to 125°C	-40°C to 125°C
UL 94 Flammability Rating	V-0	V-0	V-0	V-0	V-0	V-0	V-0	V-0
Rth@ 40 mils, 10 psi (°C-in2/W)	0.98	1.50	1.10	0.47	0.62	0.35	0.81	0.59
Dielectric Constant @ 1 MHz	4.5 (@ 10 GHz)	7.5	4.8	6.6	3.3 (@10 GHz)	19.0	3.1 (@10 GHz)	4.6
Volume Resistivity (ohm-cm)	1 x 10 ¹³	1.3 x 10 ¹²	2 x 10 ¹³	1.2 x 10 ¹⁴	2 x 10 ¹³	1 x 10 ¹³	1x 10 ¹⁴	2 x 10 ¹⁴

	Tputty 502	Tflex UT20000	Tflex HD400	Tflex HD700	Slim TIM 10000	Tpli 200	Tflex HD90000	Tflex SF800
Construction	Reinforced boron nitride filled silicone elastomer	Ceramic filled silicone sheet	Ceramic filled silicone elastomer	Ceramic filled silicone sheet	Silicone free thin gap filler	Boron nitride filled silicone elastomer	Ceramic filled silicone elastomer	Ceramic filled silicone free gap filler
Color	White	Grey	Blue	Pink	Grey	Varies by Thickness	Grey	Grey
Thickness Range	0.020" - 0.200" (0.50 mm - 5.08 mm)	0.008" - 0.040" (200 µm - 1000 µm)	0.020" -0.200" (0.50 mm- 5.08 mm)	0.020" - 0.200" (0.50 mm - 5.08 mm)	0.005" - 0.009" (125 µm – 250 µm)	0.010" - 0.200" (0.25 mm - 5.08 mm)	0.040" - 0.200" (1000 µm- 5000 µm)	0.020" - 0.160" (0.50 mm - 4.06 mm)
Thermal Conductivity (W/m-K)	3.0	3.0	4.0	5.0	5.5	6.0	7.5	7.8
Density (g/cc)	1.3	3.2	3.0	3.3	2.5	1.4	3.5	3.2
Hardness (Shore 00)	5	83 (200-375 um) 56 (400-1000 um)	44	66 (20-30 mil) 55 (40-200 mil)	80	70	22	81
Outgassing TML (%)	0.11	0.34	0.22	0.23	0.44	0.51	0.17	-
Outgassing CVCM (%)	0.06	0.09	0.04	0.07	0.19	0.17	0.01	-
Temperature Range	-45°C to 200°C	-50°C to 200°C	-40°C to 200°C	-50°C to 200°C	-40°C to 200°C	-45°C to 200°C	-50°C to 125°C	-20°C to 120°C
UL 94 Flammability Rating	V-0	V-0	V-0	V-0	V-0	94 HB	V-0 pending	V-0
Rth@ 40 mils, 10 psi (°C-in2/W)	0.49	0.25 (@200 um)	0.36	0.28	0.05 (@ 0.125mm)	0.25	0.19	0.24
Dielectric Constant @ 1MHz	3.6 (@10 GHz)	5.9	10.7	5.0	3.9	3.2 (@ 10 GHz)	8.1	15.9
Volume Resistivity (ohm-cm)	5x 10 ¹³	2.2x 10 ¹⁵	2.7 x 10 ¹⁴	1.4 x 10 ¹⁴	1.1 x 10 ¹⁴	5x 10 ¹³	8.7×10 ¹³	5x 10 ¹²



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