THERMAL INTERFACE SOLUTIONS

Laird designs and manufactures customized, performance-critical products which enable and protect advanced electronics applications.

Laird™

About Laird Performance Materials

Laird Performance Materials enables high-performance electronics. We create advanced protection solutions for electronic components and systems. World-leading technology brands rely on us for improved protection, higher performance and reliability, custom structural designs and faster time-to-market. We solve design issues through innovative products such as EMI suppression or absorption materials, thermal interface materials, structural and precision metals, magnetic ceramic products, and multi-functional solutions. This latter product family solves multiple EMI, thermal, and structural design issues simultaneously using a single process solution. Thousands of custom and standard products are supplied to major sectors of the electronics industry including the telecommunications, IT, industrial, consumer, wearables, automotive, and medical markets. Laird employs more than 4,000 people and they work in dozens of Laird-owned manufacturing sites, sales and service offices throughout Europe, North America, China and Asia. Laird is an Advent International company whose global footprint is strategically designed to be as close as possible to our customers.
Visit Laird at www.laird.com.

Thermal Interface Solutions

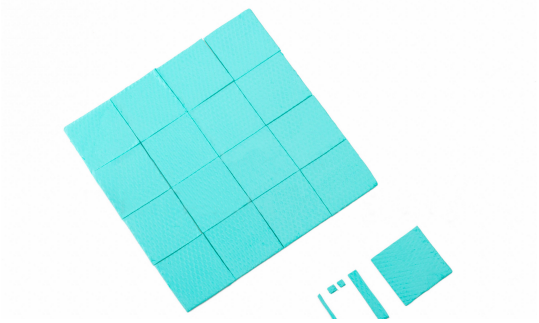
As an industry leader in high-performance, cost-effective Thermal Interface Materials (TIMs) and technologies, Laird designs and manufactures thermal products; including gap fillers and putties, phase change materials, thermal grease, and thermally-conductive insulator materials that meet the demands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

Meeting Ever-Increasing Thermal Demands

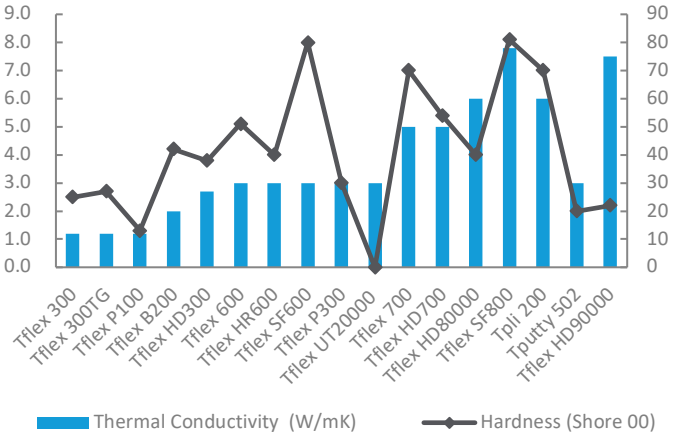
Today's electronics are smaller and more powerful than ever before, leading to ever increasing thermal challenges for the systems designer. While fans, heat sinks, and even liquid cooling and thermoelectric devices can be used to provide enough cooling power, the problem remains transferring the heat 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

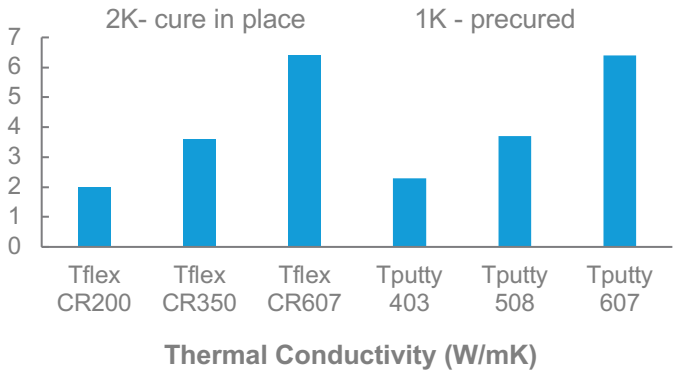
- **Telecom/Datacom** – wireless infrastructure, routers, servers, memory modules, hard disk and solid-state drives
- **Consumer** – gaming systems, tablets, notebooks, smart home devices
- **Industrial** – LED lighting, automation, test instrumentation, motion control
- **Aerospace and military** – power supplies, controllers, drones, satellites
- **Automotive** – ADAS, infotainment, powertrain/ECU

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

- **Telecom/Datacom** – wireless infrastructure, routers, servers, memory modules, hard disk drives, solid state drives
- **Consumer** - gaming systems, portable devices, notebooks
- **Industrial** – power supplies, lighting ballasts, controllers, test & measurement
- **Aerospace and military** – power supplies, drones, satellites
- **Automotive** – ADAS, infotainment, wireless charging units, lighting

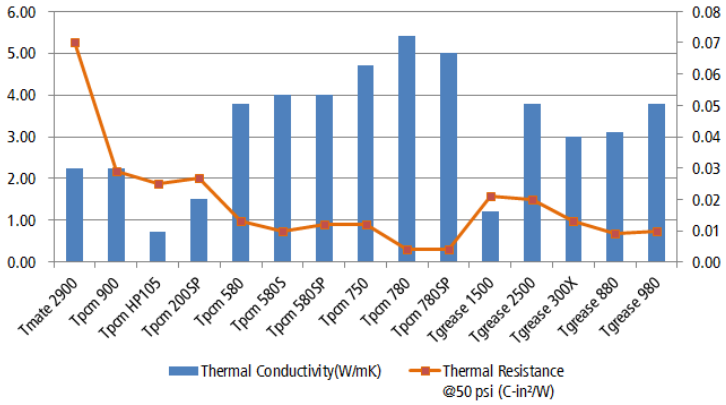


High-Performance Products (Tpcm™ and Tgrease™)

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.

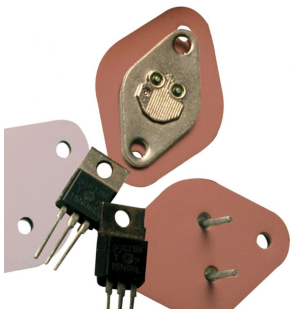


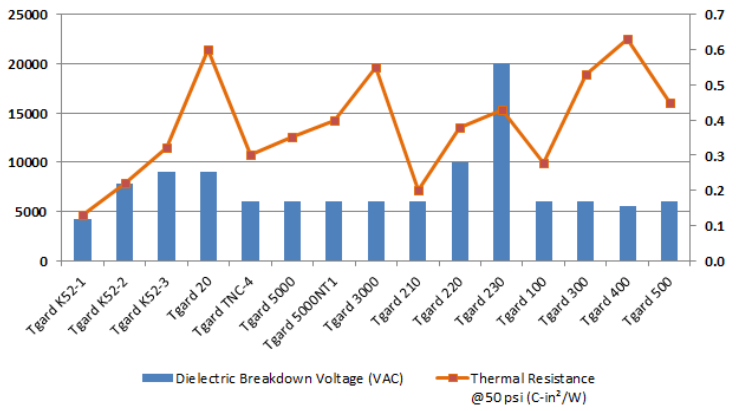
APPLICATIONS

- **Telecom/Datacom** – servers, routers, wireless infrastructure
- **Consumer** – graphics cards, notebooks, PCs, tablets
- **Industrial** – DC/DC Converters, IGBTs
- **Aerospace and military** – power supplies, drones, satellites
- **Automotive** – LED lighting, radar, camera

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

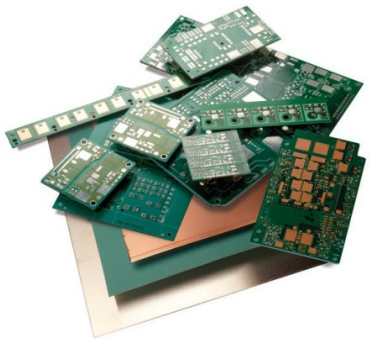
- **Telecom/Datacom** – wireless infrastructure, data servers
- **Consumer** – Audio and video components
- **Industrial** – LED lighting, power supplies, lighting ballasts, motor controls, and power converters
- **Aerospace and military** – power supplies, motion controllers
- **Automotive** – motor controls, lighting, electronics

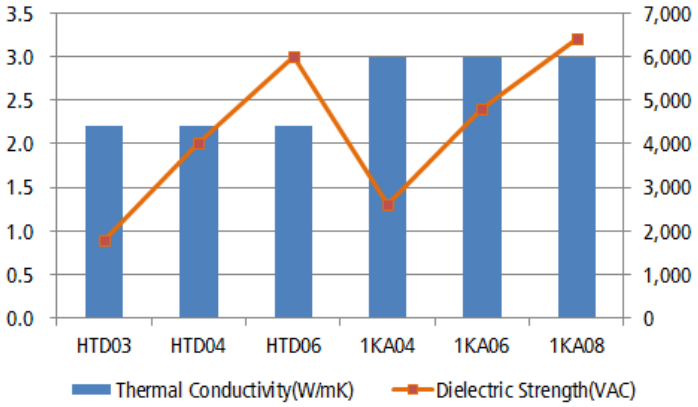
Thermally Conductive Printed Circuit Board (Tlam™ and Tpreg™)

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

- **Industrial** - LED lighting, architectural lighting and street/highway/ parking/signal lighting
- **Telecom** – DC/DC convertors and base stations
- **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

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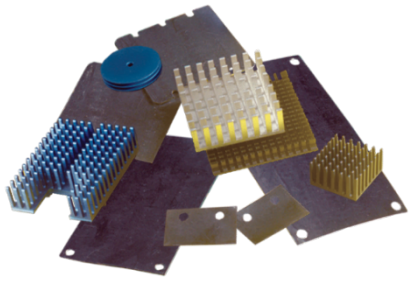
Graphite Materials (Tgon™)

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.



APPLICATIONS

- **Telecom/DataCom** - Large telecommunications switching hardware
- **Consumer** - Handheld devices, notebooks, tablets
- **Industrial** – Power supplies, lighting, power conversion equipment

Gap Filler Comparison Table

	Tflex 300	Tflex P100	Tflex B200	Tflex HD300	Tflex 600	Tflex HR600	Tflex SF600	Tflex P300
Construction	Ceramic filled silicone sheet	Tgard lined Elastomer	Ceramic filled silicone sheet	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	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” - 0.200" (0.50 mm - 5.08 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	2.0	2.7	3.0	3.0	3.0	3.0
Density (g/cc)	1.8	2.3	2.2	3.1	1.3	2.5	1.3	3.1
Hardness (Shore 00)	51 (20-30 mil) 25 (40-200 mil)	13	42	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	0.07	0.10	0.05	0.07	0.63	0.05
Temperature Range	-40°C to 160°C	-40°C to 200°C	-40°C to 150°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	TBD	6.6	3.3 (@10 GHz)	19.0	3.1 (@10 GHz)	4.6
Volume Resistivity (ohm-cm)	1.0×10^{13}	1.3×10^{12}	2.0×10^{13}	1.2×10^{14}	2.0×10^{13}	1.0×10^{13}	1.0×10^{14}	2.0×10^{14}

	Tputty 502	Tflex UT20000	Tflex HD700	Slim TIM 10000	Tflex HD80000	Tpli 200	Tflex HD90000	Tflex SF800
Construction	Reinforced boron nitride filled silicone elastomer	Ceramic filled silicone sheet	Ceramic filled silicone sheet	Silicone free thin gap filler	Ceramic filled silicone sheet	Boron nitride filled silicone elastomer	Ceramic filled silicone elastomer	Ceramic filled silicone free gap filler
Color	White	Grey	Pink	Grey	Teal	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)	0.005" - 0.009" (125 µm – 250 µm)	0.040" - 0.200" (1000 µm- 5000 µm)	0.010" - 0.200" (0.25 mm - 5.08 mm)	0.020" - 0.200" (500 µm- 5000 µm)	0.020" - 0.160" (0.50 mm - 4.06 mm)
Thermal Conductivity (W/m-K)	3.0	3.0	5.0	5.5	6.0	6.0	7.5	7.8
Density (g/cc)	1.3	3.2	3.3	2.5	3.3	1.4	3.5	3.2
Hardness (Shore 00)	5	83 (200-375 um) 56 (400-1000 um)	54	80	40	70	22	81
Outgassing TML (%)	0.11	0.34	0.23	0.44	0.30	0.51	0.17	-
Outgassing CVCM (%)	0.06	0.09	0.07	0.19	0.04	0.17	0.01	-
Temperature Range	-45°C to 200°C	-50°C to 200°C	-50°C to 200°C	-40°C to 125°C	-40°C to 150°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)	0.28	0.05 (@ 0.125mm)	0.33	0.25	0.19	0.24
Dielectric Constant @ 1MHz	3.6 (@10 GHz)	5.9	5.0	3.9	9	3.2 (@ 10 GHz)	8.1	15.9
Volume Resistivity (ohm-cm)	5.0×10^{13}	2.2×10^{15}	1.4×10^{14}	1.1×10^{14}	1.0×10^{16}	5.0×10^{13}	8.7×10^{13}	50×10^{12}

Dispensable Comparison Table

	Tputty 403	Tputty 508	Tputty 607	Tflex CR200	Tflex CR350
Construction	One-part ceramic filled silicone elastomer	One-part ceramic filled silicone elastomer	One-part ceramic filled silicone elastomer	Two-part ceramic filled silicone elastomer	Two-part ceramic filled silicone elastomer
Color	White	Green	Blue	part A Yellow / part B White	part A Pink / part B White
Minimum Bondline thickness	50µ	90µ	150µ	25.4µ	85µ
Thermal Conductivity (W/m-K)	2.3	3.7	6.4	2.0	3.6
Density (g/cc)	2.48	3.2	3.45	2.47	3.2

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