THERMAL INTERFACE SOLUTIONS

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

Laird™
A DuPont Business

About Laird Performance Materials

Laird Performance Materials, a DuPont business, 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, faster compliance, and faster time-to-market.

We solve design issues through innovative products such as EMI (Electromagnetic interference) shielding, suppression or absorption materials, thermal interface materials enabling effective heat transfer, structural and precision metals, inductive components, 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 global electronics industry including the telecommunications, data infrastructure, industrial, consumer, wearables, automotive, medical, and aerospace and defense markets. As a DuPont line of business, Laird employs more than 4,000 people. They work in dozens of Laird-owned manufacturing sites alongside sales and service offices throughout Europe, North America and Asia. To serve you better, our company also utilizes a large network of distributors located around the world. Laird strategically positions its people and manufacturing facilities, so we are as close as possible to our customers.

Visit Laird at www.laird.com.

Thermal Interface Solutions

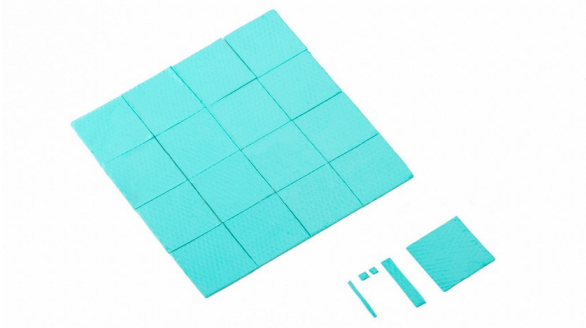
As an industry leader in high-performance, cost-effective Thermal Interface Materials (TIMs) and technologies, Laird designs and manufactures thermal management products. The line includes gap fillers and liquid gap fillers, thermal phase change materials, thermal grease, thermally conductive tapes and adhesives, thermally conductive electrically isolating insulators, thermally conductive PCB (Printed Circuit Board), graphite materials, and specialty TIMs such as Coolzorb™ which meet the demands of any application.

We Meet Ever-Increasing Thermal Transfer Demands

Today's electronics are smaller, more powerful, more densely packed, and hotter 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, liquid 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 air 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, extremely high thermal conductivities up to 34 W/mK, and tremendous flexibility in form factor and packaging to support any manufacturing scenario.

Thermal Interface Materials

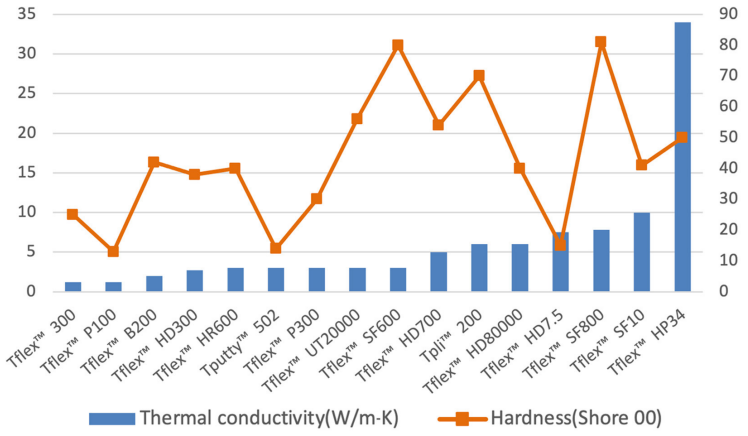
Laird™ Gap Fillers (Tflex™, Tpli™, Tputty™)



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 providing 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

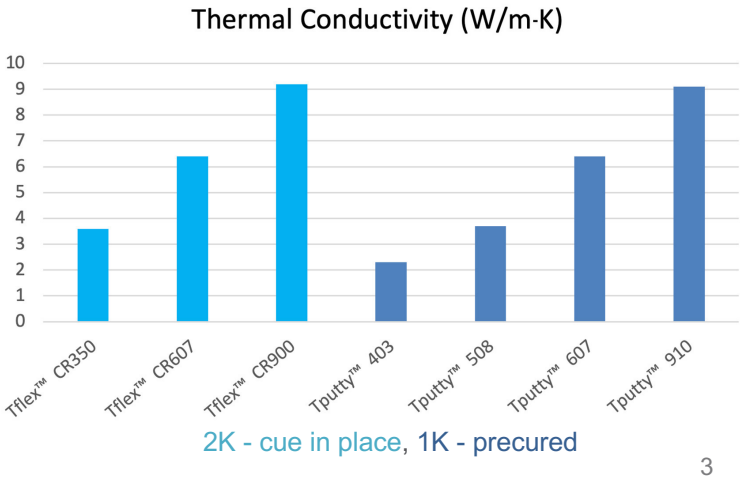


Dispensable Gap Fillers (Tflex™ and Tputty™)

Laird liquid 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 designed specifically 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 and measurement
- **Aerospace and defense** – power supplies, drones, satellites
- **Automotive** – ADAS, infotainment, wireless charging units, lighting

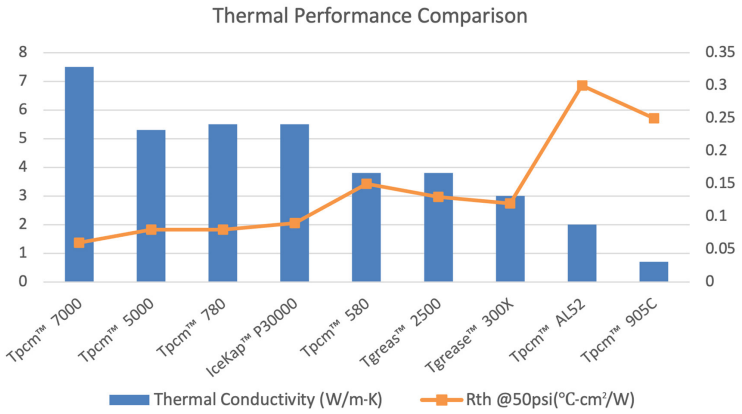


Laird™ High-Performance Products (Tpcm™ and Tgrease™)

High-performance products are used in applications where lowest thermal resistance is required. These are thin bondline (<50µm), high thermally conductive materials such as thermal greases and phase change materials.

The Tpcm™ phase change materials are used in applications where lowest possible thermal resistance is required, along with superior reliability, and easy handling (peel and stick). The Tpcm™ product line is also available in a screen printable format, similar to thermal grease but offering the reliability and performance of a phase change material.

The Tgrease™ product is used in screen printing applications where lowest possible thermal resistance is required. Tgrease™ products are designed to maximize reliability by limiting pump out in most applications.



APPLICATIONS

- **Consumer** – CPUs, graphics card, custom ASICs
- **Telecom/Datacom** –5G infrastructure, servers, routers
- **Automotive** – infotainment, autonomous driving and LED lighting
- **Industrial** – DC/DC Converters, IGBTs, discretes
- **Aerospace and defense** – avionics, power supplies, satellites

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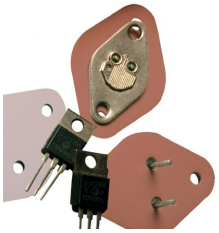
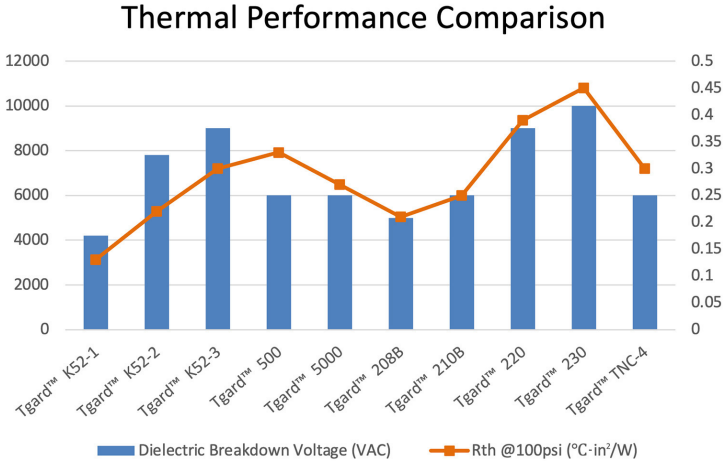
Laird™ Electrically Isolating Insulators (Tgard™)

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.





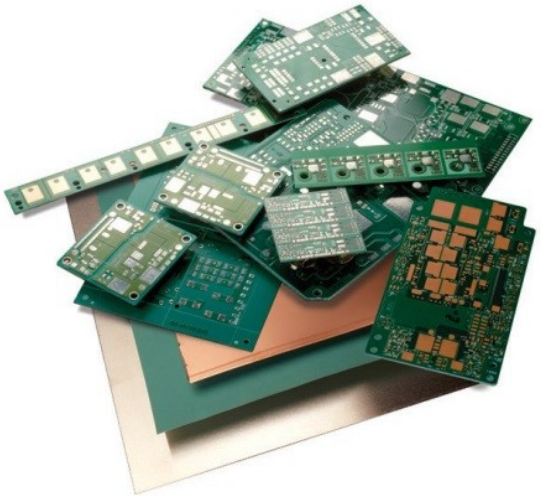
APPLICATIONS

- **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 defense** – power supplies, motion controllers
- **Automotive** – motor controls, lighting, electronics

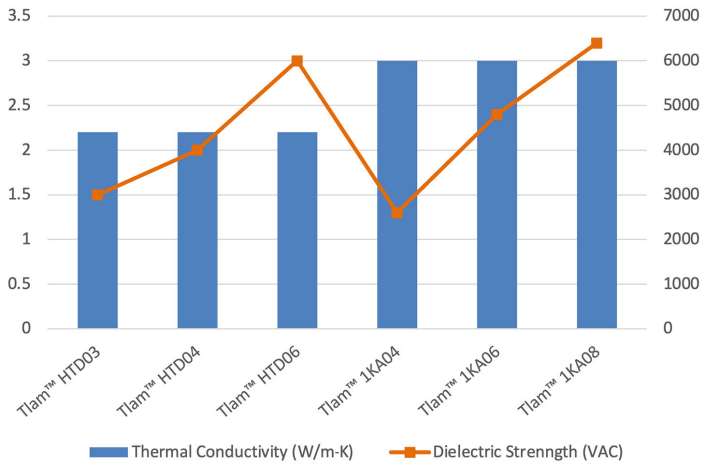
Laird™ Thermally Conductive Printed Circuit Board (Tlam™ and Tpreg™)

The Tlam™ product is a thermally conductive insulted metal PCB substrate system used for heat dissipation in electronics circuit boards

The heart of this system is the thermally conductive pre-preg, Tlam™ PP 1KA or Tlam™ PP HTD. These ceramically filled dielectric prepreg offers 8-10 times better thermal performance over FR4, while maintaining good adhesion and voltage breakdown properties. Tlam™ PP is a “B” State epoxy film providing room temperature stability for 6 months. Tlam™ PPs are provided in multiple thicknesses. Thinner films offer better thermal performance while thicker films offer better dielectric strength.



Tlam™ PPs can be used to build many different combinations of PCB laminates. The simplest Tlam™ is copper foil, Tlam™ PP dielectric and an aluminum base plate which acts as a heatsink and adds rigidity. Board complexity goes up from here offering multi-layer boards constructions and PCB structures can further include varying layers of Tlam™ PP and FR4 layers to give the thermal properties where need while maintaining cost effectiveness



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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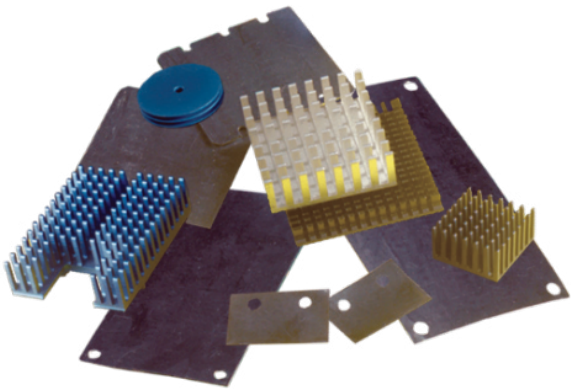
Laird™ Graphite Materials (Tgon™)

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

Laird™ Gap Filler Comparison Table

	Tflex™ 300	Tflex™ P100	Tflex™ B200	Tflex™ HD300	Tflex™ 600	Tflex™ HR600	Tflex™ SF600	Tflex™ P300	Tputty™ 502
Construction	Ceramic filled silicone sheet	Tgard lined elastomer	Ceramic filled silicone elastomer	Ceramic filled silicone elastomer	Ceramic filled silicone elastomer	Ceramic filled silicone sheet	Boron Nitride filled gap pad	Polyimide lined elastomer	Reinforced boron nitride filled silicone elastomer
Color	Light Green	Yellow	Grey	Pink	Blue-Violet	Dark Grey	Rose	Purple	White
Thickness Range	0.020" - 0.200" (0.50 mm - 5.08 mm)	0.020" - 0.200" (0.50 mm - 5.08 mm)	0.040" - 0.20" 1.02 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)	0.020" - 0.200" (0.5 mm - 5.08 mm)
Thermal Conductivity	1.2 W/m-K	1.2 W/m-K	2 W/m-K	2.7 W/m-K	3 W/m-K	3 W/m-K	3 W/m-K	3 W/m-K	3 W/m-K
Density	1.78 g/cc	2.3 g/cc	2.2 g/cc	3.1 g/cc	1.34 g/cc	2.5 g/cc	1.27 g/cc	3.1 g/cc	1.37 g/cc
Hardness (Shore 00)	51.4 (20-30 mil) 25.2 (40-200 mil)	13	42	38	51	40	80	30	14
Outgassing TML	0.56%	0.62%	0.32%	0.39%	0.13%	0.19%	1.30%	0.20%	0.11%
Outgassing CVCM	0.10%	0.11%	N/A	0.10%	0.05%	0.07%	0.63%	0.05%	0.06%
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	-45°C to 200°C
UL 94 Flammability Rating	V-0	V-0	V-0	V-0	V-0	V-0	V-0	V-0	V-0
Rth@ 40 mils, 10 psi	0.98°C-in^2/W	1.50°C-in^2/W	1.10°C-in^2/W	0.573°C-in^2/W	0.62°C-in^2/W	0.35°C-in^2/W	0.81°C-in^2/W	0.592°C-in^2/W	0.49°C-in^2/W
Dielectric Constant @ 1 MHz	4.5 @10GHz	7.45	TBD	6.62	4.0 @10GHz	19	3.5	4.6	3.6 @10GHz
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}	1 x 10^{14}	2 x 10^{14}	5 x 10^{13}

	Tflex™ UT20000	Tflex™ HD700	Tflex™ HD80000	Slim TIM™ 10000	Tpli™ 200	Tflex™ HD7.5	Tflex™ 800	Tflex™ SF10	Tflex™ HP34
Construction	Ceramic filled silicone sheet	Ceramic filled silicone sheet	Ceramic filled silicone sheet	Non-silicone based thin gap filler	Boron nitride filled silicone elastomer	Ceramic filled silicone sheet	Ceramic filled non-silicone based sheet	Ceramic filled non-silicone based thermoplastic	Aligned Graphite
Color	Grey	Pink (option for dark grey)	Teal	Grey	Varies by Thickness	Grey	Grey	Grey	Grey
Thickness Range	0.008" - 0.040" (0.2 mm - 1.02 mm)	0.020" - 0.200" (0.5 mm - 5.08 mm)	0.040" - 0.20" (1 mm - 5 mm)	0.005" - 0.009" (0.125 mm - 0.25 mm)	0.010" - 0.200" (0.25 mm - 5.08 mm)	0.040" - 0.200" (1.0 mm - 5.0 mm)	0.020" - 0.160" (0.5 mm - 4.0 mm)	0.020" - 0.160" (0.5 mm - 4.0 mm)	0.040"-0.200" (1 mm - 5 mm)
Thermal Conductivity	3 W/m-K	5 W/m-K	6 W/m-K	5.5 W/m-K	6 W/m-K	7.5 W/m-K	7.8 W/m-K	10 W/m-K	34 W/m-K
Density	3.2 g/cc	3.3 g/cc	3.3 g/cc	2.52 g/cc	1.4 g/cc	3.4 g/cc	3.21g/cc	3.7 g/cc	2.3 g/cc
Hardness (Shore 00, 3 sec)	83.3 (200-375 um) 56.4 (400-1000 um)	54	40	80	70	15	81	41 (1mm-4mm) 70 (0.5mm-0.75mm)	50
Outgassing TML	0.34%	0.23%	0.30%	0.44%	0.46%	0.20%	N/A	0.33%	0.57%
Outgassing CVCM	0.09%	0.07%	0.04%	0.19%	0.15%	0.02%	N/A	0.15%	0.30%
Temperature Range	-50°C to 200°C	-50°C to 200°C	-40°C to 150°C	-40°C to 125°C	-45°C to 200°C	-40°C to 125°C	-25°C to 120°C	-40°C to 125°C	-40°C to 125°C
UL 94 Flammability Rating	V-0	V-0	V-0	V-0	94 HB	V-0	V-0	V-0 (pending)	V-0
Rth@ 40 mils, 10 psi	0.25°C-in^2/W (200 um)	0.287°C-in^2/W	0.330°C-in^2/W	0.05°C-in^2/W (0.125mm)	0.25°C-in^2/W	0.119°C-in^2/W	0.237°C-in^2/W	0.203°C-in^2/W (1.5mm, 30% deflection)	0.096°C-in^2/W (1.5mm, 30% deflection)
Dielectric Constant @ 1MHz	5.9	5	9	3.85	3.21 @10GHz	7.94	16	9	N/A
Volume Resistivity (ohm-cm)	2.2 x 10^{15}	1.4 x 10^{14}	1.0 x 10^{16}	1.1 x 10^{14}	5 x 10^{13}	1.1 x 10^{14}	5 x 10^{12}	1 x10^{14}	10

Laird™ Dispensable Comparison Table

	Tputty™ 403	Tputty™ 508	Tputty™ 607	Tputty™ 910	Tflex™ CR350	Tflex™ CR607	Tflex™ CR900
Construction	One-part ceramic filled silicone elastomer	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	Two-part ceramic filled silicone elastomer
Color	White	Green	Blue	Red	part A Pink / part B White	part A Blue / part B White	part A Red / part B Purple
Minimum Bondline thickness	50µ	90µ	150µ	190µ	85µ	150µ	200µ
Thermal Conductivity (W/m-K)	2.3	3.7	6.2	9.1	3.6	6.4	9.2
Density (g/cc)	2.48	3.2	3.45	3.2	3.2	3.43	3.26

Laird™ Phase Change Material and Thermal Grease Comparison Table

	Tpcm™ 7000	Tpcm™ 5000	Tpcm™ 780	Tpcm™ 580	Tgrease™ 2500	Tgrease™ 300X
Construction	Free standing, filled, non-silicone based thermoplastic	Free standing, filled, non-silicone based thermoplastic	Free standing, filled, non-silicone based thermoplastic	Free standing, filled, non-silicone based thermoplastic	Non-silicone based thermal grease	Silicone thermal grease
Color	Grey	Grey	Grey	Grey	White	Grey
Minimum Bondline thickness	35µ	25µ	25µ	25µ	50µ	25µ
Thermal Conductivity (W/m-K)	7.5	5.3	5.4	3.8	3.8	3
Thermal resistance 10psi @70℃ 50psi@70℃	0.1℃-cm²/W 0.06℃-cm²/W	< 0.2℃-cm²/W < 0.1℃-cm²/W	0.12℃-cm²/W 0.085℃-cm²/W	0.4℃-cm²/W 0.15℃-cm²/W	0.15℃-cm²/W 0.13℃-cm²/W	0.2℃-cm²/W 0.12℃-cm²/W
Softening temperature range	50℃ to 70℃	50℃ to 70℃	45℃ to 70℃	50℃	N/A	N/A

Laird™ Thermally Conductive and Electrically Isolating Insulators Comparison Table

	Tgard™ K52-1	Tgard™ K52-2	Tgard™ K52-3	Tgard™ 500	Tgard™ 5000	Tgard™ 208B	Tgard™ 210B	Tgard™ 220	Tgard™ 230	Tgard™ TNC-4
Construction	Phase change on film	Phase change on film	Phase change on film	Silicone on fiberglass	Silicone on film	Silicone on fiberglass	Silicone on fiberglass	Silicone on fiberglass	Silicone on fiberglass	Epoxy on film
Color	Amber	Amber	Amber	Brown	Tan	White	White	Blue	Green	Black
Dielectric breakdown voltage	4200 VAC	7800 VAC	9000 VAC	6000 VAC	6000 VAC	5000 VAC	6000 VAC	9000 VAC	10000 VAC	6000 VAC
Thermal resistance @100psi	0.13°C-in^2/W	0.22°C-in^2/W	0.3°C-in^2/W	0.33°C-in^2/W	0.27°C-in^2/W	0.21°C-in^2/W	0.25°C-in^2/W	0.39°C-in^2/W	0.45°C-in^2/W	0.3°C-in^2/W
Hardness	N/A	N/A	N/A	80 Shore A	75 Shore A	80 Shore A	80 Shore A	80 Shore A	80 Shore A	N/A
Thickness	2mil (0.05mm)	3mil (0.076mm)	4mil (0.102mm)	9mil (0.23mm)	5mil (0.127mm)	8mil (0.2mm)	10mil (0.25mm)	20mil (0.51mm)	30mil (0.75mm)	5mil (0.127mm)

www.laird.com

Connect with Laird to obtain samples

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