### Thermagon's Complete Line Of Thermally Conductive Materials

<table>
<thead>
<tr>
<th>Material Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>T-flex™ 200 Series</td>
<td>Thermally Conductive Elastomers, Flexible, Ultra-High Conductivity</td>
</tr>
<tr>
<td>T-grease™</td>
<td>Thermally Conductive Grease Material, Conducts heat away from components</td>
</tr>
<tr>
<td>T-putty™ 500 Series</td>
<td>Thermally Conductive Putty Material, Ultra-soft, Compound for heat transfer</td>
</tr>
<tr>
<td>T-dux™ Interface</td>
<td>Thermally Conductive Silicone Interface. A reinforced silicone elastomer</td>
</tr>
<tr>
<td>T-film™ 200 Series</td>
<td>Thermally Conductive Film Material, Conducts heat away from components</td>
</tr>
</tbody>
</table>

### Flexibility for Customizing Your Design

- **PCB Construction Using IMPCB™ Laminate, T-preg™ Dielectric & DSL Material**
  - **Single-Layer Construction Using IMPCB Laminate**
    - Can be processed like standard single-sided “print and etch” or “pad and etch” processing.
    - Printed circuit board is produced directly through a PCB fabricator, using Thermagon’s IMPCB laminate, T-preg™ dielectric, and DSL material.
- **Multilayer Construction—All the advantages of single-layer IMPCB construction, but allowing for increased circuit density in the inner layers.**
  - Designed for high circuit density in the inner layers, making it ideal for high-performance applications.

### T-lam System

- Large volume production is available through Thermagon.
- Small volume production are available through Thermagon for obtaining: 1) IMPCB laminate, 2) T-preg dielectric, and 3) DSL material.
- Prototypes and selected PCB fabricators to help design circuit boards using Thermagon’s Complete Line of Thermally Conductive Materials.

### Printed Circuit Board Using T-preg™ Dielectric & DSL Material

<table>
<thead>
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<tbody>
<tr>
<td>Top Layer</td>
<td>Copper Foil Circuitry</td>
</tr>
<tr>
<td>Top Laminate</td>
<td>T-preg Dielectric</td>
</tr>
<tr>
<td>Middle Layer</td>
<td>DSL Laminate</td>
</tr>
<tr>
<td>Middle Core</td>
<td>Metal Core PCB</td>
</tr>
<tr>
<td>Bottom Layer</td>
<td>Copper Foil Circuitry</td>
</tr>
<tr>
<td>Bottom Laminate</td>
<td>T-preg Dielectric</td>
</tr>
</tbody>
</table>

### Mounting Hole

- Holes filled in situ with T-preg material.
- Can be used as one side of the chassis.

### Uses

- Hardware and also serve the need for cooling metal base can eliminate the heat dissipation needed for cooling hardware and acts as one side of the chassis.

### All statements, technical information and suggestions are presented without guarantee or responsibility on our part and users should make their own tests to determine the suitability of our products in any specific application. Products are, however, warranted to be free from defects in material and construction, but no representation is made as to the suitability thereof.

### Contact Information

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- Info: info@thermagon.com
- Tel: 216-741-7659
- Fax: 216-741-3943

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**IMPCB™ Laminate–The Material for Single-Sided Metal-Based Printed Circuit Boards**

**What is IMPCB Laminate?**

**IMPCB** laminate functions similarly to conventional prepreg materials. However, the T-preg™ laminate offers unique and beneficial properties that set it apart from other materials:

1. **Thermal Conductivity**
   - The T-preg™ laminate offers superior thermal conductivity compared to conventional FR-4 or fiberglass reinforced laminates.

2. **High Thermal Resistance**
   - The thermal resistance of T-preg™ laminate is significantly lower than that of conventional FR-4 or fiberglass reinforced laminates.

3. **Excellent Electrical Properties**
   - The laminate provides exceptional electrical properties similar to conventional FR-4 or fiberglass reinforced laminates.

4. **Improved Manufacturing Compatibility**
   - The T-preg™ laminate is compatible with existing manufacturing processes and equipment.

5. **Easy Drilling and Routing**
   - The laminate is easy to route and drill, reducing manufacturing time and cost.

**IMPCB Laminate Benefits**

- **Thermal Conductivity:** The T-preg™ laminate offers superior thermal conductivity compared to conventional FR-4 or fiberglass reinforced laminates.
- **High Thermal Resistance:** The thermal resistance of T-preg™ laminate is significantly lower than that of conventional FR-4 or fiberglass reinforced laminates.
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**T-preg™ Dielectric & DSL™ Material: Keys to the T-lam™ System**

**Thermal Management for High Power & Densely Packed Circuit Boards**

- Increased power output and higher component densities require more efficient heat dissipation systems.
- Traditional FR-4 or fiberglass reinforced laminates are limited in their thermal performance capabilities.
- T-preg™ laminate offers superior thermal conductivity and high thermal resistance, enabling better heat dissipation and improved system reliability.

**Select IMPCB Laminate for Your Metal-Based Printed Circuit Boards**

IMPCB laminate is designed for use in high-power, high-density applications. It provides superior electrical and thermal performance compared to conventional FR-4 or fiberglass reinforced laminates.

**IMPCB Laminate Comparison**

- **Thermal Conductivity:** T-preg™ laminate offers superior thermal conductivity compared to conventional FR-4 or fiberglass reinforced laminates.
- **High Thermal Resistance:** The thermal resistance of T-preg™ laminate is significantly lower than that of conventional FR-4 or fiberglass reinforced laminates.
- **Excellent Electrical Properties:** The laminate provides exceptional electrical properties similar to conventional FR-4 or fiberglass reinforced laminates.
- **Improved Manufacturing Compatibility:** The T-preg™ laminate is compatible with existing manufacturing processes and equipment.
- **Easy Drilling and Routing:** The laminate is easy to route and drill, reducing manufacturing time and cost.

**T-lam System Helps You Meet Performance Demands**

- Advanced chip sizes and higher component densities require better heat dissipation systems.
- Traditional FR-4 or fiberglass reinforced laminates are limited in their thermal performance capabilities.
- T-preg™ laminate offers superior thermal conductivity and high thermal resistance, enabling better heat dissipation and improved system reliability.

**Metal Base-Paste Properties**

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<th>Base Material</th>
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**DSL™, Double-Sided Laminate Material: The Means for MultiLayer Construction**

- DSL™ laminate is constructed of T-preg™ dielectric with copper foil. It offers superior electrical and thermal performance compared to conventional FR-4 or fiberglass reinforced laminates.
- DSL™ laminate is ideal for high-power applications and offers improved heat dissipation and reliability.

**T-lam Performance Properties**

- **Thermal Conductivity:** T-preg™ laminate offers superior thermal conductivity compared to conventional FR-4 or fiberglass reinforced laminates.
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- DSL™ laminate is ideal for high-power applications and offers improved heat dissipation and reliability.

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**DSL™, Double-Sided Laminate Material: The Means for MultiLayer Construction**

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IMPCB™ Laminate–The Material for Single-Sided Metal-Based Printed Circuit Boards

Select IMPCB Laminate for Your Metal-Based Printed Circuit Boards

IMPCB laminate with its metal base plate, an electrically conductive, dielectrically thick layer, and copper circuitry layers, can be used to make a single-sided circuit board capable of dissipating many times more heat than an FR-4 counterpart. In many configurations the IMPCB single-sided printed circuit board can outperform alumina in heat dissipation capability.

Multilayer and non-core printed circuit boards can be produced using an IMPCB dielectric and DSL material, our thermal-conductive double-sided laminate.

IMPCB Laminate Benefits

• The thermal conductivity of approximately 5 W/m°C of the T-preg helps provide 10 times the heat dissipation capability of FR-4 for comparable thicknesses. Allows higher packing densities.

• Thermal conductivity and electrical properties comparable to FR-4. Can process IMPCB laminate in the same way as conventional 'make and break' or 'tape and etch' boards. Useable in thicker layers for higher packing densities.

• The copper foil circuitry layer is thinner than high-thickness FR-4, allowing very thin copper trace pitches.

• Copper base plate can provide better current carrying capability than aluminum thick film circuits.

IMPCB laminate with its integral metal base plate can eliminate the need for additional cooling hardware.

IMPCB laminate can be designed using copper trace weights of 14 oz. to 16 oz. and metal base thicknesses from 0.020 in. to 0.032 in. The thickness of the T-preg dielectric material can also be selected.

IMPCB laminate provides the necessary thermal conductivity in non-thickened multimetal printed circuit boards. Standard PCB processing is used for fabricating “green” and “plan” and “rack and pin” printed circuit boards.

The copper foil circuitry layer is high density, electrically conductive copper. The copper weight or thickness determines its thermal conductivity. Lower copper weight or thickness is used for fine lines and spaces in your circuitry, whereas higher weight or thicker copper is used for high power and high current-carrying capability.

Choose the metal base for your IMPCB laminate from the following:

• Aluminum—most common because of its excellent thermal conductivity, light weight, and lower cost.

• Copper—used in its very high thermal conductivity and complete compatibility with coating printed circuit board assemblies.

• Copper-Molybdenum-Copper (C-Mo-Cu) or Copper-Molybdenum-Copper (CIC)—used for lower CTE, matching thermal expansion of thermal expansion.

T-preg Dielectric & DSL Material: Keys to the T-lam System

T-preg material functions similarly to conventional prepreg materials used for making high-temperature multilayer and multilayer multiconnector PCBs. However, Thermagon's thermally conductive materials used in printed circuit board construction, DSL material has a low dielectric constant of 3.5. This results in lower capacitance.

What Is IMPCB Laminate?

Thermagon's dielectric, electrically conductive T-preg dielectric layer, which serves as the bonding agent for laminating the copper foil circuit layer to a heat dissipating metal base (usually aluminum). The T-preg dielectric layer serves three major functions:

1. Conducts heat.
2. Insulates electrically.
3. Serves as the adhesive.

The copper foil circuitry layer is high density, electrically conductive copper. The copper weight or thickness determines its thermal conductivity. Lower copper weight or thickness is used for fine lines and spaces in your circuitry, whereas higher weight or thicker copper is used for high power and high current-carrying capability.

T-preg dielectric with its outstanding electrical insulating capability makes T-lam system metal-based printed circuit boards steps above traditional printed circuit boards when it comes to thermal conductivity. As temperatures rise, no filler materials or thermal spreaders in printed circuit board construction are needed to keep the circuitry cool.

IMPCB laminate has several key advantages over other metal dielectric materials used to insulate metal in printed circuit board applications:

1. High thermal conductivity and correspondingly lower thermal resistance.

2. Used in thicker layers for improved thermal strength and capacitance.

3. More easily drilled and machined.

4. Contains no abrasive fillers.

5. Good for plasma etching.

6. Can process in one pass into hole filling.

7. Used in a free standing layout, for producing multilayer boards.

8. Available in any thickness of 8 mils or greater.

IMPCB laminate from the following:

• Aluminum

• Copper-Molybdenum-Copper (C-Mo-Cu)

• Copper-Molybdenum-Copper (CIC)

Thermagon’s T-preg dielectric layer, which serves as the bonding agent for laminating the copper foil circuit layer to a heat dissipating metal base (usually aluminum). T-preg material functions similarly to conventional prepreg materials used for making high-temperature multilayer and multilayer multiconnector PCBs. However, Thermagon's thermally conductive materials used in printed circuit board construction, DSL material has a low dielectric constant of 3.5. This results in lower capacitance.

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IMPCB Laminate–The Material for Single-Sided Metal-Based Printed Circuit Boards

What is IMPCB Laminate?

Insulated Metal Printed Circuit Board (IMPCB) laminate features Thermagon’s thermally conductive T-preg dielectric layer, which serves as the touch-through layer for laminating the copper foil circuitry layer to a heat dissipating metal base (usually aluminum). The T-preg dielectric layer serves three major functions:

1. Conduction
2. Insulates electrically
3. Serves as the adhesive

IMPCB laminate can be designed using copper foil weight at 12 oz/sq ft and metal base thickness from .125” to .200” thicknesses. The thickness of the T-preg dielectric material can also be selected.

IMPCB laminate provides the raw material for single-sided surface mount printed circuit boards. Standard PCB processing is used for fabricating “prime and stick” or “plate and stick” boards.

The copper foil circuitry layer is high density electroplated copper. The copper weight or thickness depends on the application. Lower copper weight or thickness is used for finer lines and spaces in your circuitry, whereas heavier weight or thicker copper is used for high power and high current carrying capability.

Choose the metal base for your IMPCB laminate from the following:

• Aluminum—most common because of its excellent thermal conductivity, light weight, and lower cost.
• Copper-used in its very high thermal conductivity and complete compatibility with coating printed circuit board chemistry.
• Copper-Molybdenum-Copper (C-Mo-C) or Copper-Molybdenum-Copper (C-CMo-C) for lower CTE, matching circuit board chemistry.
• Silver-Copper laminate.
• Stainless Steel.
• Aluminum Invar.
• Aluminum-Nickel.
• Stainless Steel-Nickel.
• Copper Nickel-Copper (CuNcCu) that provides an excellent combination of thermal expansion and dimensional stability.

IMPCB Laminate Benefits

• The thermal conductivity of approximately 5 W/m°C of the T-preg provides 10 times the heat dissipating capability of FR-4 for comparable thicknesses. Allows higher packing densities.
• Conventional processability and variability comparable to FR-4, but can process IMPCB laminate virtually the same way as conventional ‘‘make up’’ on a panel and easily routed, punched or holes (PTHs) and thermal vias.
• The copper foil circuitry layer provides outstanding thermal performance with high thermal conductivity and low thermal resistance.
• The pure copper mass provides better current carrying capability than aluminum thick film circuits.
• IMPCB laminate with its integral metal base plates can dominate the need for additional cooling hardware.

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• The pure copper mass provides better current carrying capability than aluminum thick film circuits.
• IMPCB laminate with its integral metal base plates can dominate the need for additional cooling hardware.
Flexibility for Customizing Your Design

Thermagon works with OEMs and selected PCB fabricators to help design circuit boards using Thermagon’s T-pli™ 200 Series, T-flex™ 200 Series, T-gene™ 200 Series, and DSL material.

Specifying Guidelines

Thermagon will work with you to help choose the best options for achieving: 1) IMPCB laminate, 2) T-preg dielectric, 3) DSL material. All these materials are available in the following sizes: 12” x 18”, 16” x 18”, 18” x 24”, 24” x 36”, 48” x 48”, 48” x 96”.

For IMPCB Laminate Specify:

- Copper Foil Circuitry
- Metal Core Material
- Metal Core Thickness
- Metal-based Thickness

For T-preg Dielectric Specify:

- Thickness
- Materials

For DSL Material Specify:

- Number of Layers of T-preg
- Copper Circuitry Weight
- T-preg Dielectric Thickness
- Metal-base Thickness
- Metal Base Material
- Thickness


Multilayer Construction—All the advantages of single-layer IMPCB construction, but allowing for increased circuit density in the inner layers. Blinds and埋盲 via are all possible with T-lam technology.

PCB Construction

Using IMPCB™ Laminate, T-preg® Dielectric & DSL Material

Thermagon’s Complete Line Of Thermally Conductive Materials

The T-lam™ System

For Making Thermally Conductive Printed Circuit Boards
Thermagon’s Complete Line Of Thermally Conductive Materials

The T-lam™ System
For Making Thermally Conductive Printed Circuit Boards

PCB Construction
Using IMPCB™ Laminate, T-preg™ Dielectric & DSL Material

Flexibility for Customizing Your Design
Thermagon works with OEMs and selected PCB fabricators to help design circuit boards using the T-lam System. Prototypes and small volume productions are available through Thermagon. Large volume production is produced directly through a PCB fabricator using Thermagons’ IMPCB laminate, T-preg dielectric, and DSL material.

Specifying Guidelines
Thermagon will work with you to help you choose the many options available: IMPCB laminate, T-preg dielectric, and DSL materials. All three materials are available in the following sizes: 12" x 18"; 16" x 18"; 18" x 24".

For IMPCB Laminate Specify:
• Copper Foil Circuitry & DSL Material
• Metal Base Material: Aluminum, Copper, Cu-Mo-Cu, C/C.
• Metal Base Thickness: ≥ .250".

For T-lam Dielectric Specify:
• Thickness: Standard: 8, 10, 12 mil. Others: 9 to 100 mil.
• Optional: Fiber glass cloth. 1 or 2 layers.

For DSL material specify:
• Copper Foil Circuitry: T-pli™ 200 Series: Printed in USA
• Number of Layers of T-lam dielectric: 4 to 100 mil.
• T-lam Dielectric Thickness: 8 to 100 mil.
• Optional: Fiber glass cloth. 1 or 2 layers.

Multilayer Construction—All the advantages of single-layer IMPCB construction, but allowing for increased circuit density in the inner layers. Drill thru holes and metal base are all possible with T-lam technology.

Single-Layer Construction Using IMPCB Laminate—Can be processed like standard single-sided print and etch. “Plates and rebadging” allowsTheta to quickly produce small quantities of circuit boards from the same cavity by applying polyester masking tape. The heat dissipating metal base can eliminate the need for cooling hardware and metal serve as one side of the chassis.