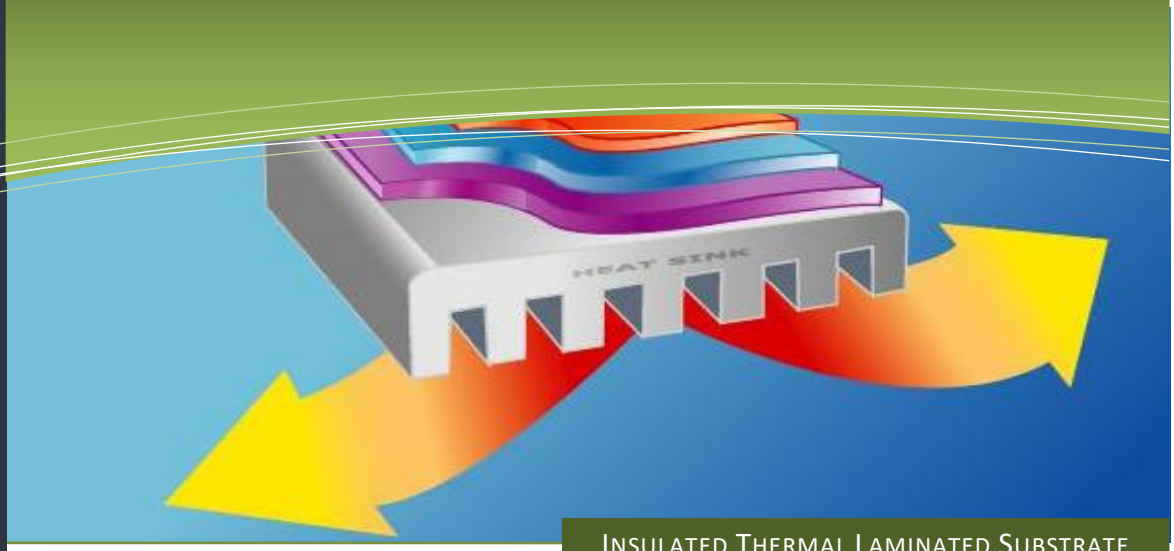
COOL-PREG™: THERMALLY CONDUCTIVE MULTILAYER PRE-PREG

FOR LAMINATED THERMAL SUBSTRATES APPLICATIONS IN POWER MODULES AND DEVICES INCLUDING: LED LIGHTING, INVERTERS, CONVERTERS, CONTROLLERS, DRIVERS, ETC.



INSULATED THERMAL LAMINATED SUBSTRATE

The proper selection of thermal interface materials from thermal grease, thermal gel, phase-change thermal pads and film or thermal adhesives is one of the most critical aspects of thermal management for long-term reliability. COOL-PREG™ is one of the best dielectric thermally conductive pre-preg laminate adhesives with stress-relief capability and high temperature operation reliability that is embedded with the lowest thermal resistance interface material.

AI Technology has more than 30 years of providing state-of-the-art materials and solutions for thermal management:

- Industry first low pressure, low temperature and rapid curing laminate that is ambient storable for one year
- Industry first diamond prepregs
- Industry first 25 micron pre-pregs
- Patented compressible phase-change thermal pads
- Lowest thermal resistance thermal interface pads
- Lowest thermal resistance greases used for over-clocking computing industries
- Lowest thermal resistance diamond adhesives that were first used in supercomputers more than 15 years ago

Description of COOL-PREG™ Thermally Conductive Insulated Prepreg

Insulated metal substrates have been used to replace direct bonded copper (DBC) substrates for power modules and devices mostly for cost and flexibility. The effectiveness of the insulated metal such as aluminum or copper as a thermal substrate depends on the dielectric adhesive layer to provide high thermal transfer from the power generated by the semi-conductor chip or component while maintaining high dielectric insulation. Any delaminating between the copper circuit trace from the metal heat spreading substrate will be detrimental to the performance in terms of temperature run away and thus dramatically shorten the useful life of the power device.

COOL-PREG™ provides the possibility of making multilayered circuits with a substrate such as COOL-CLAD™ (AIT insulated metal thermal substrate) or other third party material, including making your own in-house insulated metal thermal substrates.

What distinguishes AIT COOL-PREG™ thermally conductive dielectric Pre-preg for multilayer laminated substrates including special insulated metal substrates is that it provides the following unparalleled thermal, dielectric and mechanical properties:

1. Ultra-low thermal resistance between copper circuit traces and the heat-spreader layer that is 20-100% lower than what is achieved via an extra thin thermally conductive dielectric bond-line thus producing the industry's first 25 micron and/or diamond filled pre-preg.
2. Industry's first self-supporting and low pressure lamination (15 psi rather than 300 psi) prepreg with rapid curing.
3. Ultra-low moisture absorption and sensitivity.
4. COOL-PREG™ SK series is designed to be cost competitive with industry standards with improved thermal conductivity and lower thermal resistance.
5. COOL-PREG™ UTK series is an industry first that has the capability for continuous use of up to 350°C.
6. COOL-PREG™ LA series is designed for large area power modules.
7. The mechanical peel strength of over 6 lb/in maintains the highest mechanical integrity.
8. Dielectric constant of less than 4.5 balanced with the high thermal conductivity of 2.0, 4.0 and 18.0 W/m-K and more than 1000V/mil dielectric strength yields high performance in high frequency applications.
9. RoHS, REACH and WEEE compliant that meets UL94V-0 rating.

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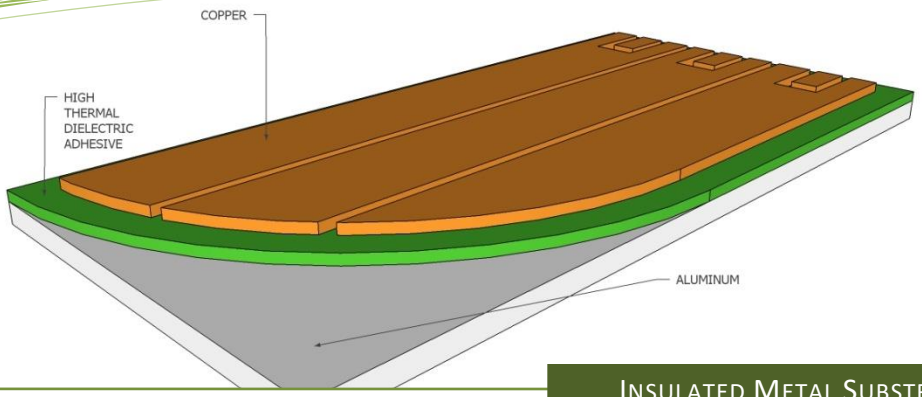

INSULATED METAL SUBSTRATE

AIT patented pre-pregs (US patent# 7,154,046; 6,717,819; 6,580,035; 6,581,276; 6,108,210; 6,297,564; 6,665,193; 6,973,716) applied to laminates and insulated metal substrates provide unparalleled thermal and reliability performance. Unlike traditional Insulated Metal Substrate thermal circuit substrates which use a rigid fiberglass thermally conductive epoxy laminate, AIT uses a proprietary self-supporting thermal dielectric insulating layer resulting in stress-free and warp-free thermal copper-clad laminates.

Key benefits of AIT's Insulated Metal substrate include:

- High temperature stability to withstand soldering at 300°C.
- Multi-layer capability with the same flexible dielectric copper-clad pre-preg that can be laminated at less than 15 psi pressure and at 125°C or higher.
- Base metal plates in aluminum or copper and select thicknesses.
- Thinner insulated metal substrate and pre-preg are available in 12 inch wide rolls. Thicker insulated metal substrate and pre-preg are available in 12-inch by 24-inch sheets.
- Unparalleled adhesion to copper and aluminum even without chemical etching or treatment.
- Ideal for power and LED components and modules.

Typical Properties - Cool-Preg™ SK Series

PROPERTY/PARAMETER	VALUE
Electrical Resistivity	$>10^{14}$ ohm-cm
Dielectric Strength @ 25 Micron Thickness (Volts/mil)	>1000 V/mil
Glass Transition Temp. (°C)	130
Peel Strength (Pound/inch)	>6
Device Push-off Strength (psi)	>3000
Hardness (Type)	> 90 (D)
Cured Density of Dielectric (gm/cc)	2.5
Thermal Conductivity	> 2.0 W/m-°K
Linear Thermal Expansion Coefficient (ppm/°C)	33 (X-Y=Z, Isotropic)
Maximum Continuous Operation Temp. (°C)	> 180
Decomposition Temperature @5% weight loss (°C)	>450
Recommended Lamination Pressure/Temperature/Time (psi/°C/min)	15/150/5

COOL-PREG™ SK-025, SK-050, SK-075 and SK-100, are low pressure pre-pregs at 25 micron, 50 micron, 75 micron and 100 micron in nominal thicknesses respectively.

Typical Properties - Cool-Preg™ HK Series

PROPERTY/PARAMETER	VALUE
Electrical Resistivity	$>10^{14}$ ohm-cm
Dielectric Strength @ 25 Micron Thickness (Volts/mil)	>1000 V/mil
Glass Transition Temp. (°C)	130
Peel Strength (Pound/inch)	>6
Device Push-off Strength (psi)	>3000
Hardness (Type)	> 90 (D)
Cured Density of Dielectric (gm/cc)	2.5
Thermal Conductivity	> 4.0 W/m-°K
Linear Thermal Expansion Coefficient (ppm/°C)	19 (X-Y=Z, Isotropic)
Maximum Continuous Operation Temp. (°C)	> 180
Decomposition Temperature @5% weight loss (°C)	>450
Recommended Lamination Pressure/Temperature/Time (psi/°C/min)	15/150/5

COOL-PREG™ HK-075 and HK-100 are low pressure pre-pregs at 75 micron and 100 micron in nominal thicknesses respectively.

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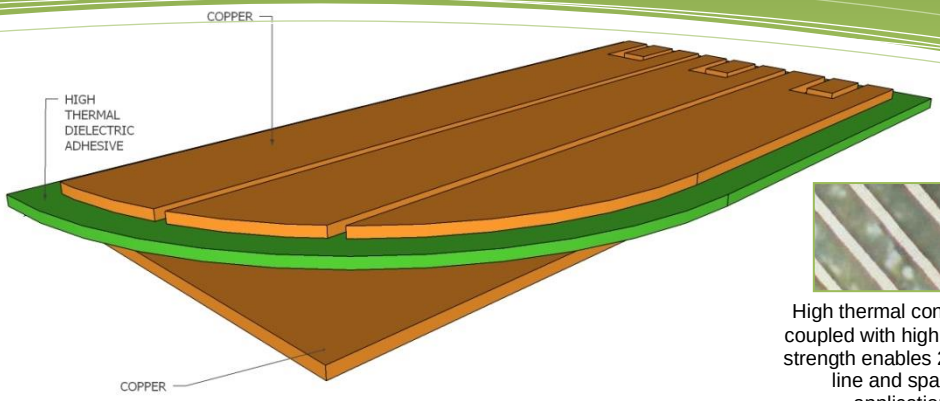

High thermal conductivity coupled with high dielectric strength enables 25 micron line and spacing application.

HIGH THERMAL CONDUCTIVITY

Typical Properties - Cool-Preg™ UTK Series

PROPERTY/PARAMETER	VALUE
Electrical Resistivity	$>10^{14}$ ohm-cm
Dielectric Strength @ 25 Micron Thickness (Volts/mil)	>1000 V/mil
Glass Transition Temp. (°C)	240
Peel Strength (Pound/inch)	>6
Device Push-off Strength (psi)	>3000
Hardness (Type)	> 90 (D)
Cured Density of Dielectric (gm/cc)	2.5
Thermal Conductivity	> 18.0 W/m-°C
Linear Thermal Expansion Coefficient (ppm/°C)	19 (X-Y=Z, Isotropic)
Maximum Continuous Operation Temp. (°C)	> 300
Decomposition Temperature @5% weight loss (°C)	>550
Recommended Lamination Pressure/Temperature/Time (psi/°C/min)	15/150/5

COOL-PREG™ UTK-025 is a low pressure pre-pregs at 25 micron nominal thickness. Other thicknesses are available on special request only.

Typical Properties - Cool-Preg™ LA Series

PROPERTY/PARAMETER	VALUE
Electrical Resistivity	$>10^{14}$ ohm-cm
Dielectric Strength @ 25 Micron Thickness (Volts/mil)	>1000 V/mil
Glass Transition Temp. (°C)	240
Peel Strength (Pound/inch)	>6
Device Push-off Strength (psi)	>3000
Hardness (Type)	> 90 (D)
Cured Density of Dielectric (gm/cc)	2.5
Thermal Conductivity	> 18.0 W/m-°C
Linear Thermal Expansion Coefficient (ppm/°C)	19 (X-Y=Z, Isotropic)
Maximum Continuous Operation Temp. (°C)	> 300
Decomposition Temperature @5% weight loss (°C)	>550
Recommended Lamination Pressure/Temperature/Time (psi/°C/min)	15/150/5

COOL-PREG™ LA-075 and LA-100 are low pressure pre-pregs with 75 micron and 100 micron nominal thicknesses respectively. AIT's COOL-PREG™ LA series features low Tg and low modulus for stress absorption in large area module applications.

AIT COOL-PREG™ when used as a pre-preg for multi-layered insulated metal substrate circuits can be handled in exactly the same method and infrastructure as commonly used in standard PWB and flex circuits.

Panel & Lamination Material Handling
- COOL-PREG™ pre-pregs laminate can be stored in ambient conditions for at least 12 months (3-4 times longer than that of traditional pre-pregs).
- No pre-staging is necessary.
- Laminate at 15 psi, 150°C for as short as 5 minutes.

Panel Prep
- Tooling/Registration
- Scrubbing
- Chemical Cleaning
- Base Metal Protection

Imaging
- Dry Film Application
- Wet Film Application
- Screened Image Application

Wet Chemistry Processing
- Etching
- Stripping
- Post Etch/Strip Clean

Solder Mask Application
- Screen, Spray or Curtin Coat Thermal Solder Mask
- UV Cured Solder Mask

Second Step Drill or Punch

Finishing Operation
- HASL
- OSP
- Tin
- Ni/Au

Finishing Fabrication
- Rout
- Score
- Punch

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APPLICATIONS IN POWER MODULES AND DEVICES INCLUDING:
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THERMALLY CONDUCTIVE MATERIALS

Cool-Preg™ Laminates & Standard AIT Cool-Clad™ IMTS Products

AIT PART#	COPPER (Oz/sq ft)	Dielectric Thickness	Aluminum Thickness
LB 1.0CU 025A 1000AL	1.0 (35 micron)	25 micron (nominal)	1000 micron (40 mil)
LB U2.0CU 025A 1000AL	2.0 (70 micron)	25 micron (nominal)	1000 micron (40 mil)
COOL-PREG™ SKO25, SK050, SK075, SK100	As Designed	25, 50, 75 and 100 micron (nominal)	As Designed
COOL-PREG™ UTK 025	As Designed	25 micron (nominal)	As Designed
HT 1.0CU 100A 1000AL	1.0 (35 micron)	100 micron (nominal)	1000 micron (40 mil)
HT 2.0CU 100A 1000AL	2.0 (70 micron)	100 micron (nominal)	1000 micron (40 mil)
COOL-PREG™ HK 075 & COOL-PREG™ HK100	As Designed	75 & 100 micron (nominal)	As Designed
LA 1.0CU 100A 1000AL	1.0 (35 micron)	100 micron (nominal)	1000 micron (40 mil)
LA 2.0CU 100A 1000AL	2.0 (70 micron)	100 micron (nominal)	1000 micron (40 mil)
COOL-PREG™ LA 075 & COOL-PREG™ LA100	As Designed	75 & 100 micron (nominal)	As Designed

Notes: Pre-preg of each type of dielectric is available with copper layer as option. Otherwise, pre-preg is made of dielectric B-staged thermal adhesive only.

Other AIT Thermal Interface Materials for HB LED & SOLAR Applications

FUNCTION	AIT PART#	THERMAL, ELECTRICAL, & other RELEVANT PROPERTIES
Die-Attach Adhesive	PRIMA-BOND™ ME8638-LED	• Rapid curing, electrically conductive die-attach for HB LED chips • Lowest thermal resistance, ambient storable single component silver paste
Thermal Adhesive	COOL-BOND™ CB7135-T	• Low thermal resistance, electrically insulating interface pad • Compressible, instant melt-bonding phase-change adhesive
Thermal Adhesive	COOL-BOND™ RTK7655-T	• Low thermal resistance, electrically insulating interface pad • Compressible, rapid heat curing tacky film adhesive
Thermal Adhesive	COOL-BOND™ HB-2	• Low thermal resistance, electrically insulating interface paste adhesive • Flexible for large area bonding & field repair, 1:1 Mix Fast ambient curing
Thermal Interface	COOL-PAD™ CPR7065-LB	• Low thermal resistance interface, electrical insulating pad • Compressible, phase-change interface pad
Thermal Interface	COOL-SILVER™ PAD CPR8850-LB	• Lowest thermal resistance, electrically non-conductive interface pad • Compressible, phase-change interface pad
Electrical Interface	COOL-GREASE™ CGR8550	• Non-curing, electrically conductive interface grease for moving parts • Lowest thermal resistance non-silicone grease, proven long-term stability

About AI Technology, Inc.

Since pioneering the use of flexible epoxy technology for microelectronic packaging in 1985, AI Technology has been one of the leading forces in developing advanced materials and adhesive solutions for electronic interconnection and packaging.

Besides pioneering the use of "phase-change" materials (PCM) as thermal interface materials (TIM), AIT has provided the microelectronic packaging industry with its flexible epoxy thermal adhesives. By managing interfacial stress induced by differential coefficient of thermal expansion between bonding adherents, these thermal management materials have found extensive use and success in critical military and aerospace applications.

The same stress-free dielectric adhesives are now adapted for use in insulated metal substrates with copper and aluminum clad. The key advantage of these thermal management materials is their unparalleled long-term reliability attributed to their ability to withstand repeated thermal cycling and stress-free bonding between the heat-spreader plate and the circuit layer. AIT also offers the same flexible epoxy pre-preg with high thermal conductivity for more advanced multilayer insulated metal substrate circuits and modules. This novel class of thermal management materials provides a platform and infrastructure for large area thermal management of power modules such as solar cells, LED panels, etc.

AIT has a full line of die and substrate attach films and pastes, thermal interface materials, (EMI/RFI) mitigation material solutions, conductive caulks and adhesives and advanced flexible and Insulated Metal Circuit Substrates. AIT is located in a ISO9001:2000 certified manufacturing and R&D facility on a 16-acre campus in Princeton Junction, NJ. Sales support includes company direct offices in Shenzhen-HK China and sales reps in Europe and Asia.

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