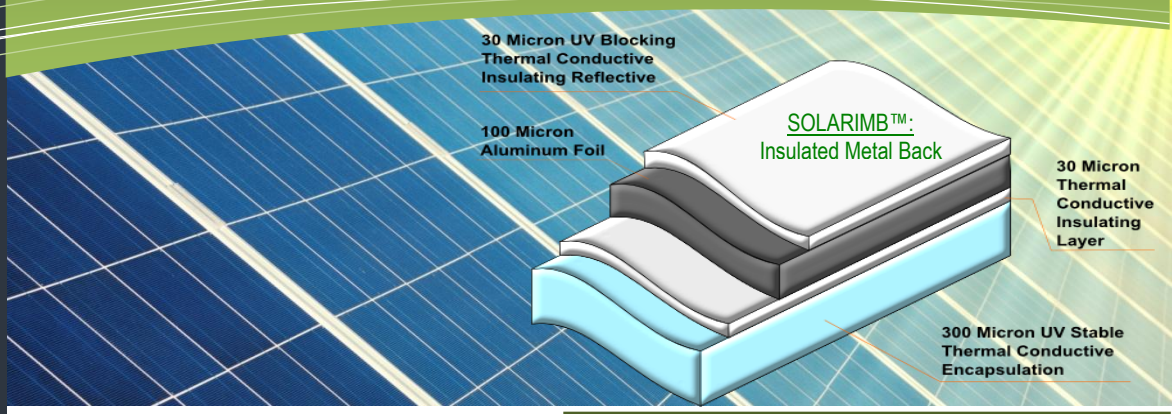
SOLAR-IMB™ & SOLAR-TDB™

Single Ply Fluorinated Melt-Encapsulating Thermal Conductive Insulated Metal Back-sheet for Higher Efficiency



HIGHER EFFICIENCY

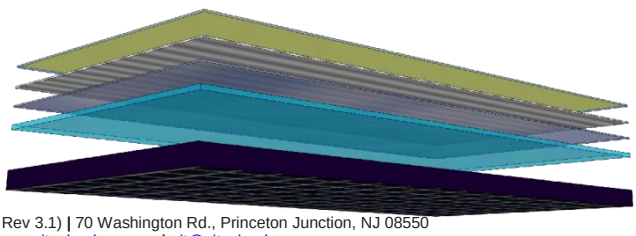
UV Resistant Thermally Conductive Encapsulating Insulated Metal Back Sheet

The traditional PVF/PET/PVF (T/P/T) back sheet is used in layers with EVA for protecting and encapsulating the back side of the solar panel. The layers are co-laminated with the front sheet that also includes EVA layered over a glass sheet. This lamination process is done at a temperature of 140-160°C under vacuum for up to 15-30 minutes. Both the layering process and vacuum lamination are difficult to automate and thus costly as a manufacturing process. In addition, the reliability factor of the EVA under heat-moisture condition is still an unknown factor.

AIT SOLAR-IMB™ (insulated metal solar back sheet) and SOLAR-TDB™ (thermal dissipative solar back sheet without metal layer) back sheets are thermally dissipative thermoplastic laminates that provide instant melt-encapsulating capability for the backside of the solar modules while providing mechanical strength and electrical insulation as good as that of T/P/T. Melt-encapsulation processing without the need for curing enables roll-to-roll lamination production of thin film solar panels. This melt-encapsulating process with UV resistant and moisture-resistant materials dramatically enhances the processing and performance of solar panels.

1. SOLAR-IMB™ and SOLAR-TDB™ back encapsulation sheets instantly melt bond to solar cells without an EVA interface layer during the same vacuum lamination process for solar panels. SOLAR-IMB™ and SOLAR-TDB™ are ideal for both thin film and m-Si and p-Si solar panels. The ambient bond strength to silicon backside and metallization is well over 1,000 psi and maintains at least 50% of the mechanical strength up to 85°C.
2. SOLAR-IMB™ is a laminate of SG7115/Aluminum Foil/SG7135 laminate to provide the highest thermal dissipative capability with the use of an aluminum outer skin while providing more than 1500V insulation. The SG7115/Aluminum Foil/SG7135 laminate also provides a metal moisture barrier which contributes to the long term reliability of thin film solar panels.
3. SOLAR-TDB™ is a single ply of SG7115/SG7135 melt-encapsulation sheet to provide good thermal dissipative capability and more than 1500V insulation. It replaces both T/P/T and EVA in traditional solar panels.
4. RoHS, REACH and WEEE compliant that meets UL94V-0 rating.

Instant Melt-Encapsulation Back-Sheets Reduce Processing Cycle Times



In solar module manufacturing, the encapsulation layers, supporting layers, and the processing time contribute to a significant proportion of the panel cost. However, the cost of solar cells is dropping, thus necessitating a reduction in supporting material costs while maintaining if not improving solar panel performance. This material challenge requires multi-discipline innovations.

With over 30 years of experience in formulating and manufacturing specialty materials and adhesives for electronic applications, AIT has developed a series of fluorinated melt-encapsulating front sheets, heat-dissipating back sheets, UV stable coatings, sealant-adhesives and conductive tabbing without soldering.

The melt-encapsulating fluorinated back sheet materials are engineered to allow 10 times reduction in vacuum laminating-curing processing time over traditional solar panels with EVA.

With the introduction of this thermally conductive melt-flow back sheet coupled with an encapsulating front sheet, AIT offers material technologies to assist solar panel manufacturers implement inline lamination processing rather than batch based vacuum encapsulation processing. Other material benefits include:

- Melt bonding fluorinated conductive tabs to reduce tabbing temperature
- UV resistant fluorinated transparent coating for glare reduction

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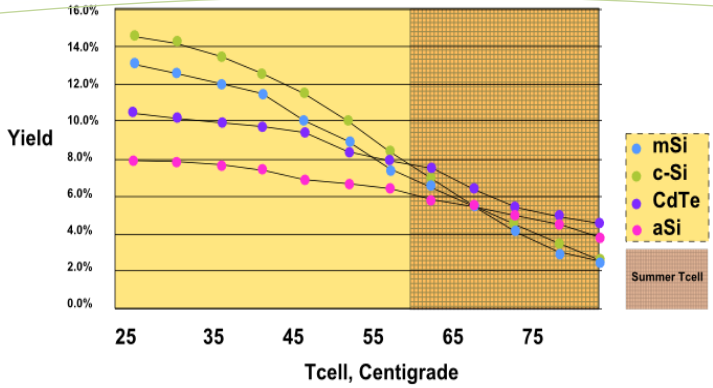
Tel: 609-799-9388 | www.aitechnology.com | ait@aitechnology.com

SOLAR-IMB™: UV Resistant Insulated Metal Back-sheet

Instant Melt-Bonding Encapsulating and Insulated Metal Back-sheet Laminate
NO "POT- OR SHELF-LIFE," NO curing or Post Curing or EVA Based Chemical Reactivity
Enhanced Thermal Conductivity and Dissipation to Improve Panel Efficiency



** Results extracted from Dr. Abu-Zaid at Masdar. Tested in UAE field conditions.*

Properties of Solar-IMB™ Back-Sheet Laminate (IMB 7135)

Insulated metal thermal back sheet

- Laminate of modified PVDF with embedded thermal conductivity
- Aluminum backing to optimize thermal dissipation with normal air current
- Modified thermal coating on the aluminum backing to maintain long-term reliability

Low moisture ingression from edges

- Ideal for frameless panel construction
- Compatible with aluminum honeycomb structures to optimize thermal dissipation and mechanical integrity

Outstanding compatibility and melt-bonding adhesion to solar cells and metal tabs

- Melt-flow and encapsulate tin-plated copper tab of 0.2 mm (8 mil) thick
- Melt-flow and encapsulate SOLAR-TAB (melt-flow conductive adhesive on passivated copper)

Outstanding bond strength and compatibility with AIT transparent fluorinated front sheet (ST7130)

Molecularly compatible and high bond strength to cross-linkable polyolefin front sheet encapsulate

Good compatibility and melt-bonding adhesion to EVA for traditional front sheet encapsulate

Instant Melt Bonding

AIT patent-pending panel construction and process with thermoplastic melt-encapsulation has the potential to dramatically change the paradigm of solar panel manufacturing without changing the manufacturing infrastructure. The insulating metal thermal back sheet enhances thermal dissipation and solar panel performance during the hottest days.

REPRESENTATIVE PROCESS

1. Front and Back Sheets Handling
   a. SOLARTHRU™ and SOLAR-IMB™ laminates can be stored in ambient conditions for at least 12 months (3-4 times longer than that of traditional laminates).
   b. No pre-staging is necessary.
2. Tabbing and Panel Preparation
   a. Tab and interconnect all solar cells in series into module.
   b. If AIT conductive adhesive tabbing solution is used, the temperature of tabbing may be lowered to 150°C.
   c. Inspect and test for functionality
3. Front & Back Sheet Encapsulation
   a. Use flat and planar backing for the front sheet.
   b. Vacuum or roll encapsulate the solar module with the front and back sheets either separate or together @150°C and close to 14 psi vacuum.
   c. If roll-lamination is to be used, make sure that trapped air is repelled during the melt flow process.
   d. Inspect and submit to QC for functionality.
4. Inspection and Rework
   a. Make sure the back film adhesive has flowed to minimize trapped air bubbles
   b. The lamination process can be repeated in case less than desirable flow is observed
5. Trimming and Framing
   a. Trim off excess material that flowed out during manufacturing
   b. Frame the finished panel or use frameless support
6. Finishing Operation
   a. Inspect for quality
   b. Test and certify panel

PROPERTY/PARAMETER	VALUE
Electrical Resistivity	$>10^{14}$ ohm-cm
Dielectric Strength of Laminate (Volts)	>1500 V
Elastic Modulus (psi)	20,000 psi
Device Push-off Strength with Solar Cells (psi)	>1000
Cured Density of Composite Dielectric (gm/cc)	1.8
Thermal Conductivity	> 1.6 W/m-°C
Linear Thermal Expansion Coefficient (ppm/°C)	90 (X-Y=Z, Isotropic)
Maximum Continuous Operation Temp. (°C)	> 130
Elongation Before Breakage	300%
Recommended Melt-Lamination Pressure/Temperature/Time (psi/°C/Second)	>14/>140/>0.5

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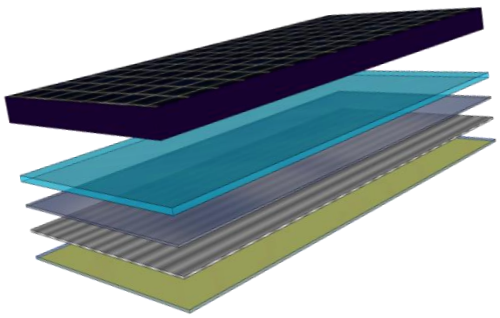
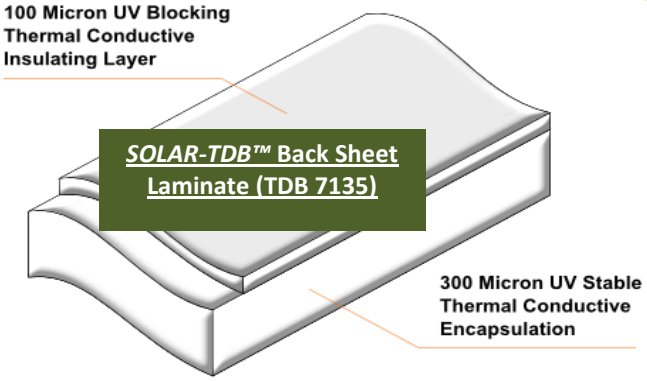
SOLAR-TDB™: UV Resistant Thermal Dissipative Back-Sheet

Instant Melt-Bonding Encapsulating and UV Resistant Coated Back Sheet
NO "POT- OR SHELF-LIFE," NO Curing, Post Curing or EVA Based Chemical Reactivity
Enhanced Thermal Conductivity and Dissipation to Improve Panel Efficiency





Enhanced Thermal Conductivity

Properties of SOLAR-TDB™ Back Sheet Laminate (TDB 7135)

PROPERTY/PARAMETER	VALUE
Electrical Resistivity	$>10^{14}$ ohm-cm
Dielectric Strength of Laminate (Volts)	>1500 V
Elastic Modulus (psi)	20,000 psi
Device Push-off Strength with Solar Cells (psi)	>1000
Cured Density of Composite Dielectric (gm/cc)	1.8
Thermal Conductivity	> 1.2 W/m-°C
Linear Thermal Expansion Coefficient (ppm/°C)	90 (X-Y=Z, Isotropic)
Maximum Continuous Operation Temp. (°C)	> 125
Elongation Before Breakage	300%
Recommended Melt-Lamination Pressure/Temperature/Time (psi/°C/Second)	>14/>150/>0.5

1. Laminate of different modified PVDF with embedded thermal conductivity
2. Outstanding compatibility and melt-bonding adhesion to solar cells, tabs and ST7130 front sheet
3. Good compatibility and melt-bonding adhesion to EVA

Properties of SOLAR-GRIP™ Back Sheet Encapsulant (SG 7115)

PROPERTY/PARAMETER	VALUE
Electrical Resistivity	$>10^{14}$ ohm-cm
Dielectric Strength of Laminate (Volts)	>1500 V
Elastic Modulus (psi)	20,000 psi
Device Push-off Strength with Solar Cells (psi)	>1000
Cured Density of Composite Dielectric (gm/cc)	1.6
Thermal Conductivity	> 1.5 W/m-°C
Linear Thermal Expansion Coefficient (ppm/°C)	95 (X-Y=Z, Isotropic)
Maximum Continuous Operation Temp. (°C)	> 105
Elongation Before Breakage	300%
Recommended Melt-Lamination Pressure/Temperature/Time (psi/°C/Second)	>14/>140/>0.5

1. Modified polyethylene single ply encapsulant and back sheet
2. Good melt-bonding adhesion to solar cells, metal tabs and ST7130 front sheet
3. Outstanding compatibility and melt-bonding adhesion to EVA and polyolefin encapsulant

SOLAR-GRIP™: UV Resistant Single Ply Back-Sheet Encapsulant

- Instant Melt-Boding Encapsulating & UV Resistant Coated Back-Sheet
- NO "POT- or SHELF-LIFE," NO Curing, Post Curing or EVA Based Chemical Reactivity

SG 7115 is AIT's high melt-flow encapsulating back sheet and encapsulant combination single ply material. SG 7115 features melt-flow at a melting temperature above 130°C and "re-crystallizes" to provide mechanical strength up to 105°C.

Curing and post-curing chemical fastening process is replaced by the physical-fastening of the melt-crystallites built into the polymer network.

SG7115 is comprised of a 3 mil thick PVDF polymer alloy that blocks UV at both molecular and microscopic scales and contains white pigments to provide 100% reflectivity to UV.

The inside encapsulant layer of SG7115 is a high flow polyethylene alloy with bond strength of over 1000 psi shear bond strength to backside metallization and silicon. SG7115 is also compatible with and bonds well with a traditional EVA or polyolefin based front sheet encapsulant.

The combination of PVDF and a polyethylene structure provides an outstanding shield from UV induced degradation, moisture ingress and absorbs very low moisture that deminishes most panel performance.

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SOLARGRIP™: UV Stable Adhesive Sheets and Sealing Caulk

High Moisture Barrier Adhesive Sheet and Sealing Caulking Adhesives with UV Stability

SOLARBLOC™: UV Stable Coatings

High Moisture Barrier Sheet Adhesives with UV Stable Adhesion and Flexibility

High Moisture Barrier

Adhesive-Coating for Solar Cell, Panel & Installation

Solar applications encounter some of the most challenging material applications. AIT has developed a specific series of adhesives in film, paste and coatings with different properties for the solar cell, module, panel and installation applications. All of these specialty adhesives and coatings are made with proven fluorinated polymers engineered for outstanding adhesion on metal, glass and most plastics used in solar applications. They possess proven UV stability and an outstanding moisture barrier. They are embedded with designed electrical conductivity or high dielectric strength or anti-static properties for the intended application.

These applications of UV resistant, high moisture barrier adhesive-coatings are specifically engineered to be compatible for the melt-bonding process so to advance the speed of manufacturing, a known hurdle to reduce the cost of solar applications. The previous pages discussed tabbing and panel lamination. This page discusses some of the applications of AIT's protective coatings and sealant-adhesives for long-term reliability.

UV Blocking Coating with Moisture Barrier Characteristics

FUNCTION	AIT PART #	UV, MOISTURE, THERMAL, ELECTRICAL & Other PROPERTIES
Insulating Coating & Moisture Barrier	SOLARBLOC™ SB 7155	• Insulating flexible moisture barrier coating with high voltage insulation • Ideal for terminations & electrical junction protection with ease of rework
Anti-static Coating & Moisture Barrier	SOLARBLOC™ SB 9133	• Semi-conductive anti-static flexible moisture barrier coating • Designed to provide unparalleled discharge protection for plastics enclosures
Tinted Transparent & Moisture Barrier in Film or Liquid	SOLARBLOC™ SB7131-LC SB7131-FC	• Modified PVDF specialty coating with reduced optical transmission • Molecular bonding with over 30 years direct sun exposure stability • Spray and film designed for traditional outdoor glass window protection

Transparent Anti-Glare Coating with Moisture Barrier Performance

FUNCTION	AIT PART #	UV, MOISTURE, THERMAL, ELECTRICAL & Other PROPERTIES
Anti-Glare Transparent and Moisture Barrier	SOLARTHRU™ SG7130	• PVDF specialty coating with better than 95% transparency • Molecular bonding with over 30 years direct sun exposure stability • Sprayable and applicable for solar and outdoor glass window protection

UV Resistant Sealants & Adhesives for Solar Applications

FUNCTION	AIT PART #	UV, MOISTURE, THERMAL, ELECTRICAL & Other PROPERTIES
Anti-Glare Transparent and Moisture Barrier	SOLARTHRU™ SG7130	• PVDF specialty coating with better than 95% transparency • Molecular bonding with over 30 years direct sun exposure stability • Sprayable and applicable for solar and outdoor glass window protection

UV Resistant Thermal Interface Materials for Solar Applications

FUNCTION	AIT PART #	UV, MOISTURE, THERMAL, ELECTRICAL & Other PROPERTIES
Insulating Thermal Interface	COOL-PAD™ CPR7153	• Low thermal resistance interface, electrical insulating pad • Compressible, phase-change interface pad
Electrical Interface Grease	COOL-GREASE™ CGR8550	• Non-curing, electrically conductive interface grease for moving parts • Lowest thermal resistance non-silicone grease, proven long-term stability
Thermal Interface Grease	COOL-GREASE™ CGR7093	• Lowest thermal resistance, electrically insulating interface grease • Non-curing, non-silicone, 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 interconnections 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 for the past fifteen years. By managing interfacial stress induced by differential coefficients of thermal expansion between bonding adherents, AIT's 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 an 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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