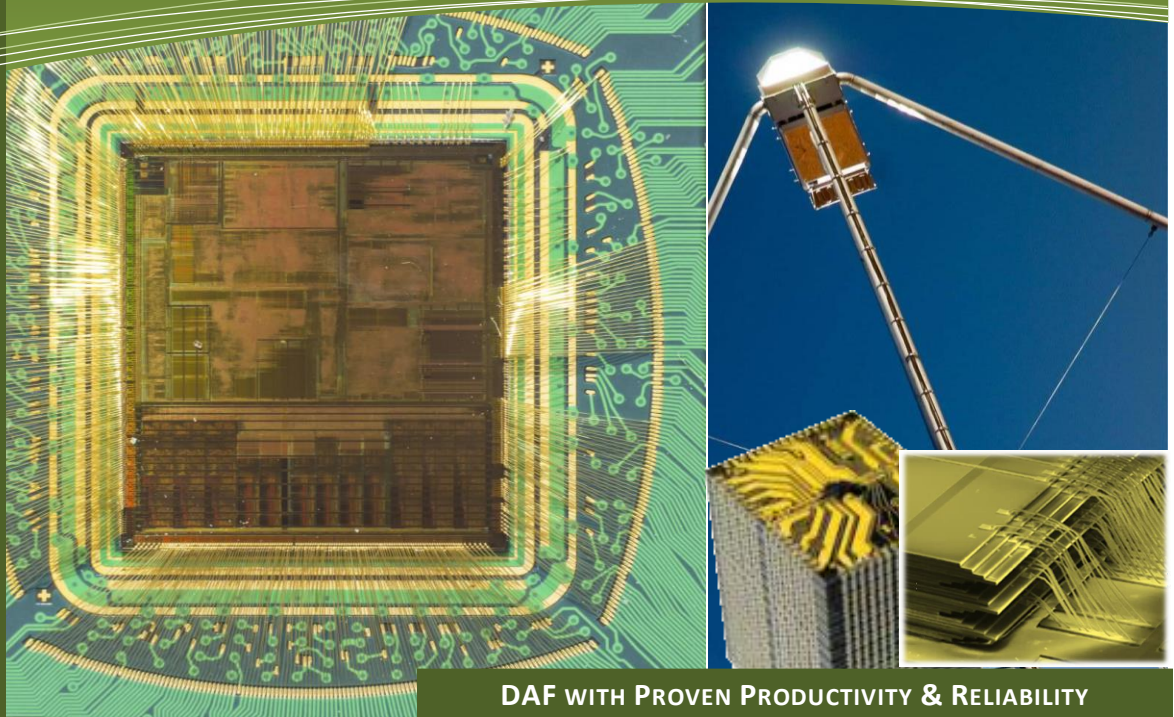




# DIE-ATTACH FILM (DAF) ADHESIVES WITH PROVEN AND UNPARALLELED PERFORMANCE



DAF WITH PROVEN PRODUCTIVITY & RELIABILITY

AI Technology, Inc. (AIT), a pioneer in the technology of self-supporting die-attach film (DAF) adhesive has increased its manufacturing capacity in 2014 to more than 10 million square feet of its 10-micron thick **ESP7660** series of insulating DAF for memory stacked chip applications and its 20 micron thick **ESP8660** series of conductive DAF for power devices.

Since the 1990's, AIT has been known for manufacturing high performance die-attach film adhesives for stacked chips of over 20 layers with military reliability. Now, AIT's engineering team has successfully implemented an advanced automated line of DAF manufacturing and advanced PLC for even better control of thickness and higher capacity. This adoption of a higher capacity line under a clean room environment represents AIT's commitment to provide the best products for its semi-conductor customers domestically as well as internationally. AIT's new DAF manufacturing line is able to make DAF for the newer 450mm wafer technology that will become more important in coming years.

AIT's scientists created DAF, like the **ESP7660-SC** and **ESP8660-SC** series in response to market needs for higher productivity with faster curing without pressure and faster wire-bonding at temperature as high as 250°C and molding operation up to 200°C.

AIT's **ESP7455-HF** and **ESP8450-HF** also improve the reliability of larger devices of stacked chips with polymer molecular engineering which absorbs the interfacial stress of bonding. Additionally, these films also offer improved film integrity before tacking and curing. With these new developments, AIT was the first to produce 8-10 micron insulating DAF consistently for even the largest wafer dimension of 450mm. For power devices requiring silver filled conductive DAF, AIT's **ESP8660-HK** has been proven to work best with thicknesses of 20 microns.

## Description of AIT DAF Technologies:

Die-Attach film (DAF) adhesive has become popular and mandatory when stack chips are used to accomplish larger capacity in 3-D packaging of flash memory devices. The push now is for even thinner insulating die-attach adhesive that can properly handle interfacial stresses in stacking chips with bond-lines as thin as 8-10 microns or less to help mobile devices to achieve even lower profiles.

In addition to offering a thinner bond-line for stacked chip devices, film adhesives that are properly engineered for die-attach provide several advantages over traditional paste adhesives for almost all semi-conductor devices:

- ✦ By eliminating the paste dispensing requirement of low viscosity, AIT produces DAF film adhesives with proper melt-flow and bonding characteristics with engineered molecular structures to manage stress, thermal stability and moisture absorption and sensitivity with unparalleled performance.
- ✦ By laminating the DAF film adhesives with controlled thicknesses from 3-20 micron, AIT DAF adhesives melt-flow at temperatures around 60-70°C and are thus ambient storable for shipping and handling for one year at ambient temperature before or after dicing.
- ✦ AIT is also one of the first to provide proven DAF adhesives that are electrically conductive for power devices in the thickness of 20 micron.
- ✦ AIT is also one of the first to provide thermally conductive DAF adhesives that are electrically insulating but thermally conductive with years of proven successes manufacturing thicknesses of 20 micron.
- ✦ AIT DAF adhesives are engineered to melt-flow and bond onto substrates at temperature of 65-150°C with minimal pressure of around 5 psi and continue for full cure at the same temperature without applying pressure. Unlike paste, the die position will not shift, thus allowing ultra precise packaging needed in multi-chip modules (MCM) or SiP (System-in-package).

In addition to offering a DAF adhesive with unparalleled performance in managing interfacial stresses even at low bond-line thicknesses, ultra-low moisture-temperature sensitivity, and thermal stability, all with high enough glass transition temperature of 175°C and beyond in enabling high productivity of wire-bonding up to 250°C, AIT DAF adhesives also feature more common properties used in worldwide production:

1. RoHS and REACH compliant.
2. Availability of width for wafers of all sizes for all thicknesses from 3-20 micron thickness.
3. Proven low moisture absorption that can help components to meet the MSL level 1 requirements.
4. Manufactured in clean room environment with scalable capacity of more than 10 million square ft per year in the United States.



# DIE-ATTACH FILM (DAF) FOR STACKED CHIP APPLICATIONS

- ONE INTEGRATED WAFER-DICING TAPE MOUNTING MACHINE WITH REDUCED PROCESSING TIME PER WAFER FOR LOWER COSTS AND HIGHER PRODUCTIVITY
- HIGHER PERFORMANCE (INCLUDING DAF WITH THERMAL AND/OR ELECTRICAL CONDUCTIVITY)

ESP7660-SC among the extensive AIT's DAF adhesives is designed for more productive stacked chip applications with the following benefits:

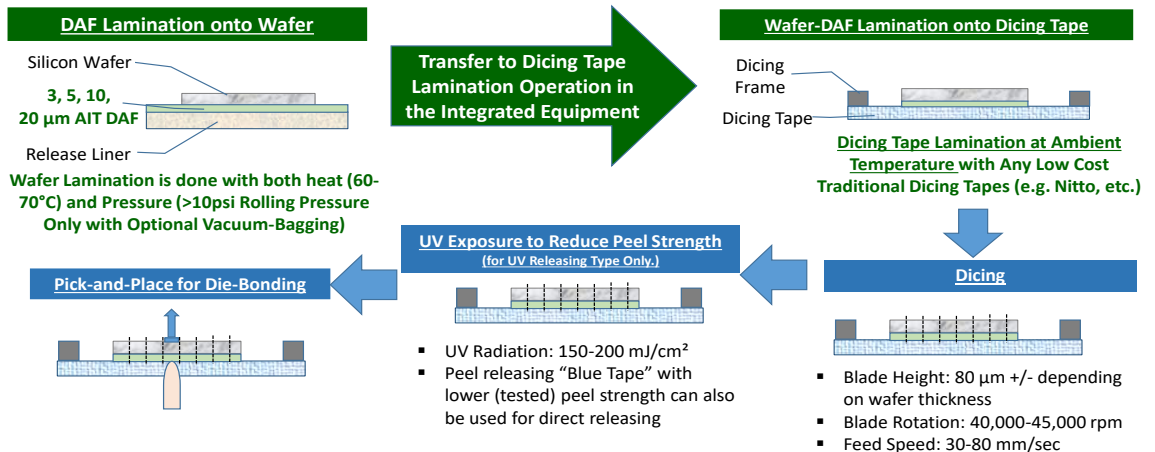
- Controlled and defined bond-line thickness with 10 and 20 microns for standard applications and 3 and 5 microns for extra thin stack applications.
- AIT DAF can be stored at ambient for 3 months.
- Stress management with advanced polymer molecular engineering
- AIT DAF wafer mounting is faster with rolling pressure at 60°C to 70°C in less than 10 sec.
- The wafers with pre-laminated DAF can be stored for 3 months and thus facilitate manufacturing in multiple locations.
- UV releasing or peel-releasing dicing tape and dicing operations can be performed as if the wafer is without the DAF as long as the dicing tape is compatible.
- AIT does not directly provide Die-Attach Film (DAF) adhesive pre-laminated onto a compatible dicing tape in the same repeat pattern with designated pitch as traditional DDAF format. AIT partners with wafer mounting equipment in providing an integrated total material-equipment-process solution for faster per wafer processing at a much lower costs.

- AI Technology provides DAF in the following formats:
1. Sheet or die-cut rolls of DAF preforms for any size wafers over release liner
  2. "Liquid Version" of AIT DAF materials are available for custom pre-application onto wafers of any size-thickness. AIT liquid versions of DAF are available in viscosity suitable for screening and spin-coating.



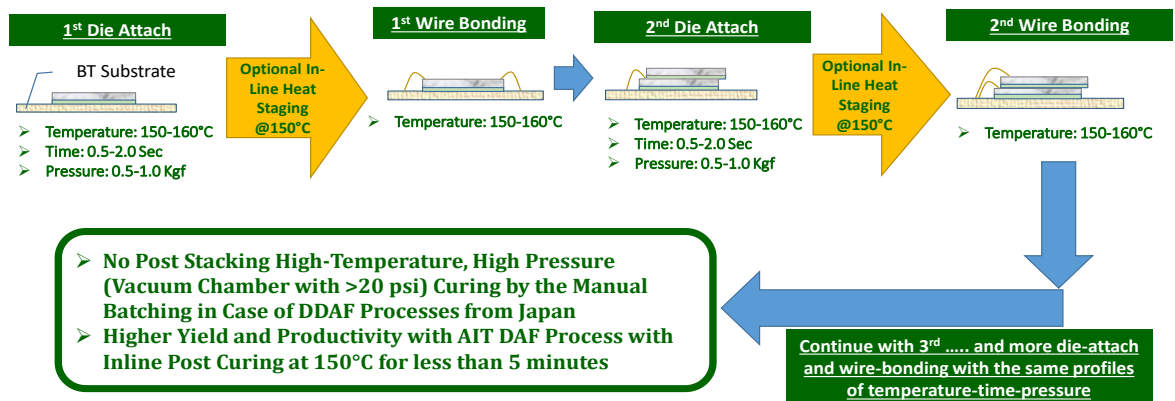
## Separating Die-Attach Film and Dicing Tape Mounting Processes for:

- One Integrated Wafer-Dicing Tape Mounting Machine with Reduced Processing Time per wafer
- Lower Costs and Higher Productivity
- Higher Performance (Including DAF with Thermal and/or Electrical Conductivity)



## Dicing and Wire-Bonding Equipment and Processes Maintain the Same with Optional Productivity Enhancement of:

1. Use of In-Line Heat-Staging (OPTIONAL) for Higher Productivity while awaiting Wire-Bonding
2. Without Needing Manual High Pressure Post-Stacking Curing





# FLOW-OVER-WIRE (FOW) SPACER FOR STACKED-CHIP AND UNDER-FILLING DIE-ATTACH FILM (DAF) FOR FLIP-CHIP PACKAGING

## FLOW-OVER-WIRE (FOW) DAF:

FOW DAF adhesive has an additional processing capability to flow over the wire of the wire-bonded section of the stacked chip. The same process of pre-lamination onto the wafer before dicing is achieved with lower pressure at slightly lower temperature for AIT FOW DAF. The adhesive film behaves more like a liquid adhesive once it reaches the designed temperature of 90-150°C. AIT FOW DAF is engineered with high Tg and molecular stress absorption capability.

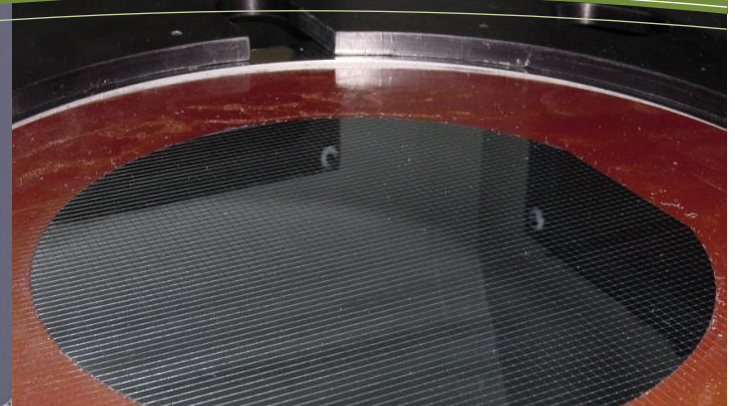
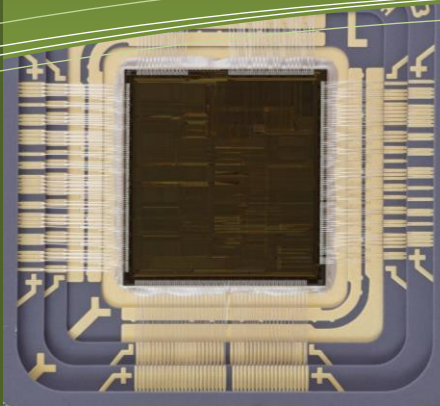
AIT Flow-Over-Wire encapsulations have proven performance in meeting MSL Level-1 and AEC Grade-0 packaging requirements.

## WAFER PROCESSING ADHESIVES FOR WAFER BACKGRINDING AND 3D PROCESSING:

AI Technology, Inc. is the only US company that is well known to manufacture its own wafer processing and dicing tapes for wafer dicing in the United States since 2005. While AIT manufactures more traditional controlled peel, UV and heat induced releasing dicing and grinding tapes, one of its pioneering technologies in the controlled clean peel releasing tape for back-grinding and wafer processing applications that withstand high temperature exposure up to 350°C.

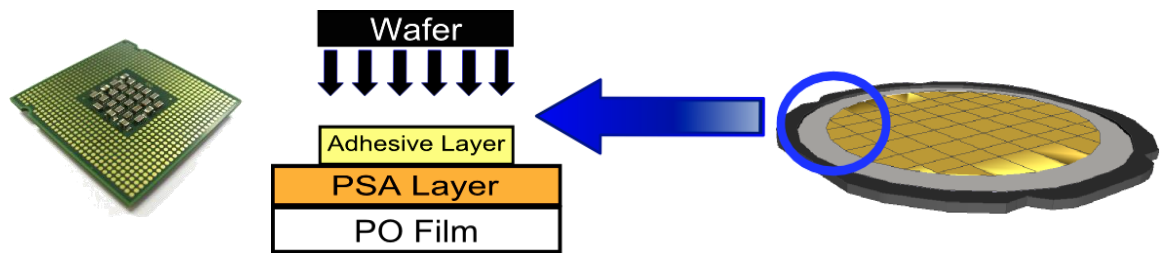
AIT has developed a series of wafer processing adhesives and solutions that are either UV and/or heat releasing or clean peel releasing wafer processing adhesives and tapes with patent-pending solution using carriers to replace traditional glass or wafer carrier.

These wafer processing adhesives have proven applications for back-grinding and compatible with solvent-chemical, vacuum and plasma etching processes for 3D wafer processing.



## Properties of AIT Flow-Over-Wire (FOW) Die-Attach Film Adhesive

AIT Product	Characteristics	Electrical Resistivity (ohm-cm)	Thermal Conductivity (Watt/m-°K)	Die-shear (psi)	Tg (°C)
<b>ESP7660-FOW</b>	<ul style="list-style-type: none"> <li>Wafer level pre-lamination @70-80°C</li> <li>Wafer level packaging for up to 450mm</li> <li>Outstanding stress absorption and moisture barrier for MSL Level-1 and AEC Grade-0 packages</li> </ul>	>1x10 <sup>14</sup>	0.2 (Unfilled)	>5,000	175
<b>CXP7660-FOW</b>	<ul style="list-style-type: none"> <li>Wafer level pre-lamination @70-90°C</li> <li>Wafer level packaging for up to 450mm</li> <li>Outstanding stress absorption and moisture barrier for MSL Level-1 and AEC Grade-0 packages</li> <li>Proven for use for temperature &gt;200°C</li> </ul>	>1x10 <sup>14</sup>	0.2 (Unfilled)	>5,000	110/240



## Wafer Processing Adhesives for Wafer Back-Grinding and 3D Processing

AIT Product	Characteristics	Peel Strength (gm-per-inch)	Film Thickness
<b>GD-UVR-200</b> <b>GD-UVR-270</b> <b>WPA-UVR-270</b>	<ul style="list-style-type: none"> <li>Capable for wafer processing up to 200°C and 270°C with PET and AIT proprietary carrier film respectively</li> <li>Clean UV release with no residual: no cleaning post processing</li> <li>GD-series incorporating transparent carrier replacement substrate</li> <li>WPA-series require the use of glass or wafer carrier</li> <li>Compatible for solvent-chemical, vacuum and plasma etching</li> </ul>	100(Pre UV)/10(Post UV)	Custom with or without carrier film substrate Adhesive thickness from 20µm to 400µm
<b>GD-PRCL-350-AI</b> <b>WPA-PRCL-350</b>	<ul style="list-style-type: none"> <li>Clean release with no residual: no cleaning post processing</li> <li>Controlled and stable peel strength</li> <li>Wafer processing at temperature up to 350°C processing</li> <li>GD-series incorporating carrier replacement substrate</li> <li>WPA-series require the use of glass or wafer carrier</li> <li>Compatible for solvent-chemical, vacuum and plasma etching</li> </ul>	>350	Custom with or without carrier film substrate Adhesive thickness from 20µm to 400µm



# DIE-ATTACH FILMS FOR STACK-CHIP, CHIP-ON-BOARD, MULTI-CHIP, HIGH POWER AND HIGH TEMPERATURE DIE-ATTACH APPLICATIONS

## About AI Technology, Inc. (AIT)

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

AIT produce its products in an ISO9001:2000 certified manufacturing and R&D facility on a 16-acre campus in Princeton Junction, NJ. AIT also owns a supporting laboratory in Shenzhen-China and Philippines along with international sales reps in Europe and Asia.

The following are some of the representative microelectronic packaging material solutions patented and/or pioneered by AIT:

1. Molecularly flexible die-attach paste and film adhesives (Since 1985)
2. Self-supporting curable pressure-sensitive die and substrate attach epoxy film adhesives (Since 1988)
3. Self-supporting die-attach film adhesive for high reliability stacked chips (Since 1990)
4. Flexible conductive adhesive for electronic interconnection (US 6,108,210; US 6,297,564)
5. Use of film underfill for flip-chip packaging (US 6,399,178)
6. Lid-sealing technologies and solutions with pre-applied adhesive and lid (US 6,136,128; 6,428,650; 6,432,253; 7,743,963)
7. Phase-change and compressible phase-change thermal interface material (TIM) pads for processor chips (Since 2000, US 6,496,373)
8. The only US company that manufactures dicing and grinding tapes in the United States since 2005
9. Use of specialty materials in solar panel manufacturing and performance enhancement (US 8,394,650)
10. High glass transition die-attach film adhesive with stress absorbing capability (Since 2013)



The following table DAF data are not comprehensive and meant for reference purposes only

AIT Product	Characteristics	Electrical Resistivity (ohm-cm)	Thermal Conductivity (Watt/m <sup>2</sup> ·K)	Die-shear (psi)	Tg (°C)	Film Thickness
<b>ESP7660-SC</b> [WL- ESP7660- SC]	<ul style="list-style-type: none"> <li>Proven low moisture absorption suitable for MSL Level 1 and AEC Grade-0 packaging</li> <li>Die-bond at 150°C with 5-10 psi for 0.5 sec.</li> <li>Wire-bond at 150°C to 250°C</li> <li>Inline post-curing without pressure</li> <li>Meets MIL-STD-883F 5011.4</li> <li>Proven reliability for multilayer stack</li> </ul>	>1x10 <sup>14</sup>	>0.2	>4,000	125	10µm, 20µm 3µm, 5µm
<b>ESP7669-FP</b> WL- ESP7669-FP	<ul style="list-style-type: none"> <li>Proven low moisture absorption suitable for MSL Level 1 and AEC Grade-0 packaging</li> <li>Die-bond at 150°C with 5-10 psi</li> <li>Wire-bond at 150°C to 250°C</li> <li>Meets MIL-STD-883F 5011.4</li> <li>Proven reliability for MCP, COB, and other precision bonding applications</li> <li>Low thermal resistance</li> </ul>	>1x10 <sup>14</sup>	>12	>2,000	175/90	20µm, 40µm
<b>ESP8660-FP</b> WL- ESP8660-FP	<ul style="list-style-type: none"> <li>Proven low moisture absorption suitable for MSL Level 1 and AEC Grade-0 packaging</li> <li>Die-bond at 150°C with 12-15 psi for 0.5 sec.</li> <li>Wire-bond at 150°C to 250°C</li> <li>Meets MIL-STD-883F 5011.4</li> <li>Proven reliability for high power devices</li> </ul>	<5x10 <sup>-4</sup>	>8.0	>3,000	125	20µm, Custom Thickness
<b>CXP8660-FP</b> WL- CXP8660-FP	<ul style="list-style-type: none"> <li>Proven low moisture absorption suitable for MSL Level 1 and AEC Grade-0 packaging</li> <li>Die-bond at 150°C with 12-15psi for 0.5 sec.</li> <li>Wire-bond at 150°C to 250°C</li> <li>Meets MIL-STD-883F 5011.4</li> <li>Proven reliability for up to &gt;200°C applications</li> </ul>	<1x10 <sup>-3</sup>	>8.0	>3,000	110/240	20µm, Custom Thickness
<b>CXP7669-FP</b> WL- CXP7669-FP	<ul style="list-style-type: none"> <li>Proven low moisture absorption suitable for MSL Level 1 and AEC Grade-0 packaging</li> <li>Die-bond at 150°C with 12-15psi for 0.5 sec.</li> <li>Wire-bond at 150°C to 250°C</li> <li>Meets MIL-STD-883F 5011.4</li> <li>Proven reliability for up to &gt;200°C applications</li> </ul>	>1x10 <sup>14</sup>	>12	>3,000	110/240	20µm, Custom Thickness

**AIT DAF product line includes fillers such as alumina, diamond, boron nitride for dielectric thermal interface, and silver, silver-copper and gold-clad fillers for electrical and thermal interfaces. Other commonly used AIT DAF includes: ESP7450-HF, ESP8450-HF, ESP8680-HF, ESP7679-LB, CXP7450, CXP8450. Please consult AIT sales engineers.**