



DIE-ATTACH FILM (DAF) FOR STACKED CHIP APPLICATIONS

- INTEGRATED WITH WAFER AND DICING TAPE MOUNTING EQUIPMENT FOR REDUCED PROCESSING TIME AND COSTS PER WAFER
- 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.
- Proven low moisture absorption for packaging meeting MSL Level 1 packaging.
- Stress management with advanced polymer molecular engineering.
- AIT DAF wafer mounting is faster with rolling pressure at 60-70°C in 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 wafer processing at lower costs.

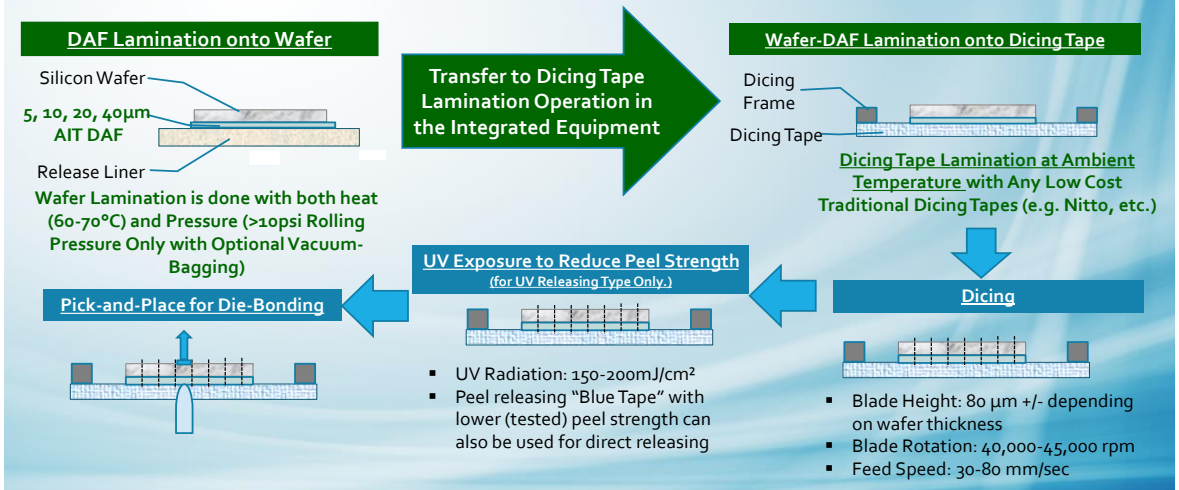
AI Technology provides DAF in the following formats:

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.



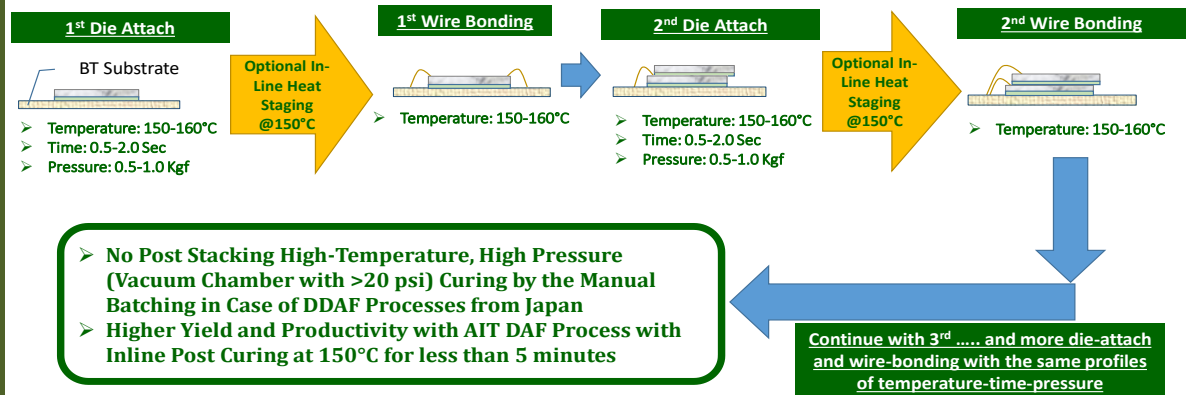
Separating Die-Attach Film and Dicing Tape Mounting Processes for:

- 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





FILM ADHESIVE FOR STACKED-CHIP, FLOW-OVER-WIRE (FOW) AND UNDER-FILLING DIE-ATTACH FILM (UF-DAF) FOR FLIP-CHIP AND TSV PACKAGING



FLOW-OVER-WIRE (FOW) DAF ADHESIVES:

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.

UNDERFILL DIE-ATTACH FILM ADHESIVES:

UF-CXP7680 adhesive is a special form of die-attach film adhesive that are totally transparent before bonding. The high melt-flow index allowed ease in flowing over the stud and/or micro-bumps for chip to compression bond to the contacts or stacked chip bonding. The outstanding polymer backbone temperature stability enables reflow bonding between bumps and contacts up to 300°C.

DAF FILM ADHESIVES FOR POWER DEVICES AND MCM BESIDES STACK-CHIP:

DAF is not for stack-chip manufacturing of memory devices only. The following AIT thermally and/or electrically conductive DAF have proven uses in the manufacturing of:

- ❖ ESP7669-HK has been proven successes in bonding of high power devices in MCM and other critical systems with close spacing between chips and devices.
- ❖ ESP8660-HK not only affords close spaced die-bonding needing both electrical conductive and high thermal dissipation capability of the conductive die-attach films.

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)
ESP7660-FOW	<ul style="list-style-type: none"> Wafer level pre-lamination @70-80°C Wafer level packaging for up to 450mm Melt-flow for bonding @90-150°C Outstanding stress absorption and moisture barrier 	>1x10 ¹⁴	0.2 (Unfilled)	>5,000	175

DAF Adhesives for Stack-Chip, Power Devices, MCM and TSV-Flip Chip Underfill

AIT Product	Characteristics	Electrical Resistivity (ohm-cm)	Thermal Conductivity (Watt/m-°K)	Die-shear (psi)	Tg (°C)	Film Thickness
ESP7660-SC (For Stack-Chip)	<ul style="list-style-type: none"> Proven low moisture absorption suitable for MSL Level 1 and AEC Grade-0 packaging Die-bond at 150°C with 5-10 psi for 0.5 sec. Wire-bond at 150°C to 250°C Inline post-curing without pressure Meets MIL-STD-883F 5011.4 Proven reliability for multilayer stack 	>1x10 ¹⁴	>0.2	>4,000	125	10µm, 20µm, 3µm, 5µm
ESP8660-FP (For Power Devices)	<ul style="list-style-type: none"> Proven low moisture absorption suitable for MSL Level 1 and AEC Grade-0 packaging Die-bond at 150°C with 12-15 psi for 0.5 sec. Wire-bond at 150°C to 250°C Meets MIL-STD-883F 5011.4 Proven reliability for high power devices 	<5x10 ⁻⁴	>8.0	>3,000	125	20µm, Custom Thickness
ESP7669-HK (For Power Devices)	<ul style="list-style-type: none"> Proven low moisture absorption suitable for MSL Level 1 and AEC Grade-0 packaging Die-bond at 150°C with 5-10 psi Wire-bond at 150°C to 250°C Meets MIL-STD-883F 5011.4 Proven reliability for MCP, COB, and other precision bonding applications Low thermal resistance 	>1x10 ¹⁴	>12	>2,000	175/90	20µm, 40µm
CXP7686	<ul style="list-style-type: none"> High temperature continuous usage to 300°C 	>1x10 ¹⁴	>3.8	>3,000	240/90	20-40 µ
ESP8450-HF	<ul style="list-style-type: none"> Optimizing flexibility-strength for larger dies 	<4x10 ⁻⁴	>8.0	>2,000	90/-50	20-40 µ
UF-CXP7660 (Film Underfill)	<ul style="list-style-type: none"> Film underfill for TSV stack-chip applications High temperature stable with molecularly built-in stress relief capability High melt-flow index for ease of underfilling 	>1x10 ¹⁴	>0.2	>4,000	220/80	30-55 µ



BACK-GRINDING & THINNING TEMPORARY BONDING TAPE SOLUTIONS FOR WAFERS & SUBSTRATES

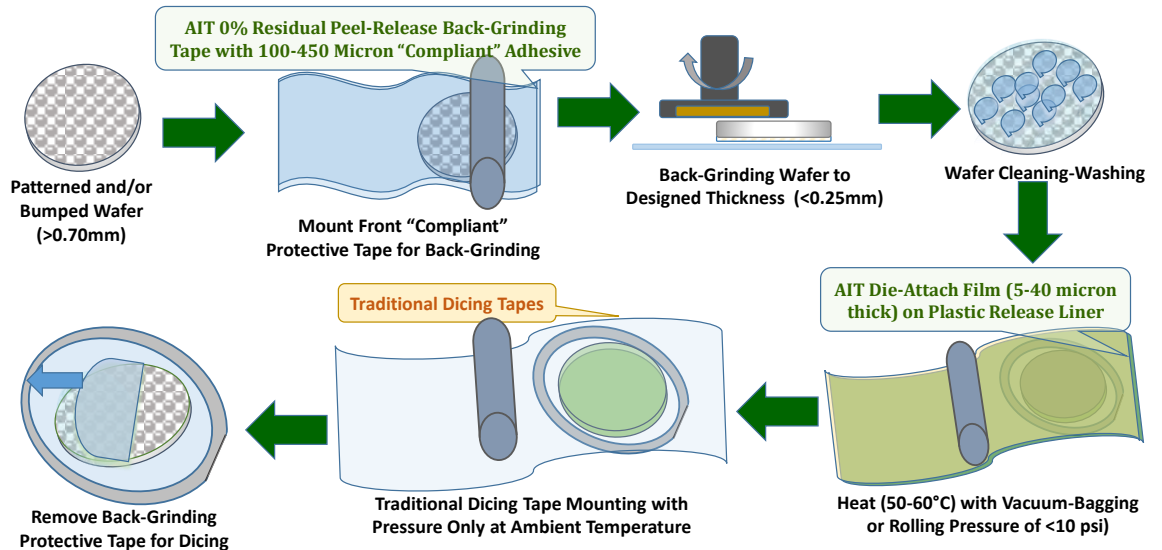
- UV, HEAT & PEEL RELEASING TAPES FOR BUMPED WAFER OR SUBSTRATE
- HIGH TEMPERATURE & ANTI-STATIC FOR MORE RELIABLE OPERATIONS
- LOW TOTAL THICKNESS VARIATION OF LESS THAN 5 MICRONS

Non-Silicone, Non-EVA Based Compressible Back-grinding and Thinning Temporary Bonding Tapes for Bumped Wafers and Substrates with up to 250 Micron Bump Heights

The configuration of the temporary bonding tapes are engineered for high reliability for wafers and substrates with extensive bumped features or flat with nominal or no features.

- ❖ Protect and encapsulate the gold, solder or copper bumps or columns during the back-grinding and thinning process.
- ❖ All component materials in the temporary bonding tapes are engineered with high molecular stability to withstand high temperature exposure up to 200°C and 270°C respectively for plastic and Polyimide carrier film.
- ❖ Typical temporary bonding and back-grinding operations leave no or minimal residuals on the wafers or substrates and require no cleaning.
- ❖ The bonding and protective adhesive-buffer layer are made to bond strongly onto dimensionally stable plastic and PI carrier film with outstanding thickness control. AIT design the buffer-adhesive to conform at recommend lamination temperature range of 60-120°C to allow further planarization to as ultimate TTV control before back-grinding operation to very thin wafers.
- ❖ Proven to leave 0% residual even after extended high temperature and/or high pressure operations.

AIT-and-Partner will also Provide Integrated Wafer Back-Grinding Equipment and Material Systems with the Integrated Wafer DAF and Dicing Tape Mounter



Back-Grinding and Protection Tapes for Bumped Wafers and Re-distributed Panels

PARAMETER	GD-BGF- (7080, 7120, 7160) (20, 100, 200, 400 μm)	GD-UVR-(200, 270) (20, 100, 200, 400 μm)	GD-PRCL-350- (20, 100, 200, 400 μm)
Release Mechanism-Material and Thickness	High temperature Capable IPA Soluble Wax Film (>900 psi die-shear)	High temperature Capable UV Release @100gm/25mm	High temperature Capable Clean Peel Release
Carrier Support Film and Thickness	• Plastic Carrier @100 microns	• Transparent Carrier @100 microns	• High Temperature Substrate @75 microns
Thickness of Compressible-Compliant Layer	• 100, 200-micron for stud, micro-bump wafers • 400-micron for BGA • 20-micron for protection	• 100, 200-micron for stud, micro-bump wafers • 400-micron for BGA • 20-micron for protection	• 100, 200-micron for stud, micro-bump wafers • 400-micron for BGA • 20-micron for protection
Peel Strength in Operation (GPI)	• >900 psi die-shear	• 100 ppi (100gm/25mm)	• >350 ppi (100gm/25mm)
Peel Strength for Release (GPI)	• Melt-release • IPA Cleaning	• 10 ppi (Post UV Exposure)	• >350 ppi (100gm/25mm)
Temperature Capability	• 60, 100 and 150°C	• 200°C To 270°C	• Up to 350°C
Chemical Resistance	Outstanding	Outstanding	Outstanding
Water Jet Resistance	Outstanding	Outstanding	Outstanding



High Conformability to BGA Bumps of 200 Micron or Higher with Outstanding Total Thickness Variation (TTV) Upon Lamination (0% Residual Upon Release after up to 350°C exposure)

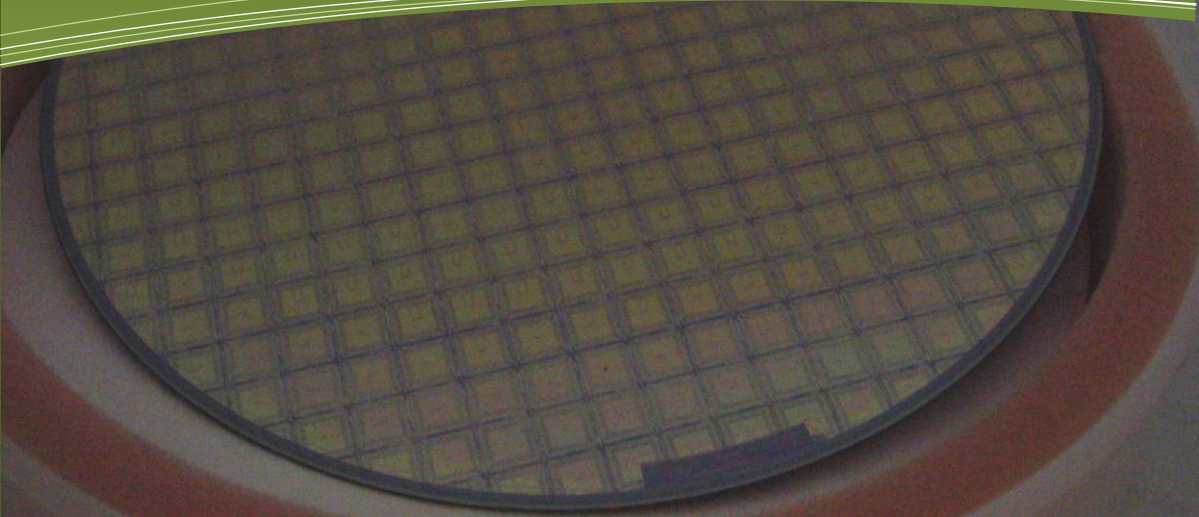


High Elevated Temperature Conformability to Flip-Chip Bumps of 50 Micron or Higher with Outstanding Total Thickness Variation (TTV) Upon Lamination (0% Residual Upon Release after up to 350°C exposure)



WAFER PROCESSING ADHESIVES THAT ENABLE:

- 20, 100, 200, 450 MICRON CONFORMING WAFER PROCESSING TEMPORARY BONDING ADHESIVE
- THE ONLY 0% RESIDUAL WPA FOR STRESS-FREE TEMPERATURE PROCESSING UP TO 350°C
- MODIFIED SPECIALTY CONFORMABLE STRESS-FREE TEMPERATURE PROCESSING UP TO 350°C
- INDUSTRY FIRST: NO RINSE, NO CLEAN, PEEL-RELEASE 0% RESIDUAL ON WAFER INTERFACE AND GLASS CARRIER INTERFACE, WITH OR WITHOUT SUPPORTING FLEXIBLE INTERFACE SUBSTRATE (PATENT PENDING)



About AI Technology, Inc. (AIT)

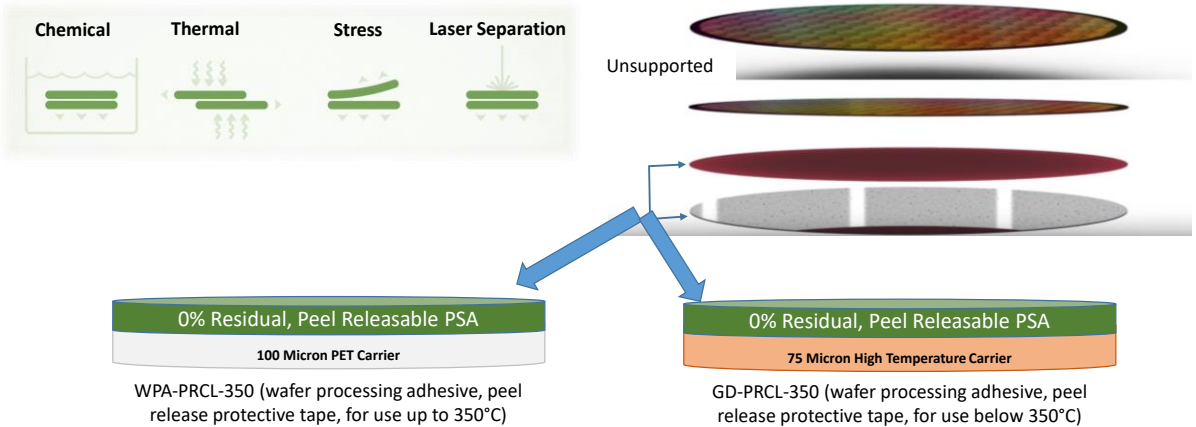
Since pioneering the use of flexible epoxy technology for electronic packaging in 1985, AI Technology has been one of the leading forces in developing advanced materials and adhesive for electronic interconnection and packaging.

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)

AIT Wafer Processing Adhesive (WPA) are Among the Highest Proven Performance Temporary Bonding Films for Wafer Processing



Properties of AIT Wafer Processing Adhesives for 3D-TSV Integration:

- Short bonding time of seconds at moderate temperature of 20-80°C and <14 psi so as not to induce undue internal stress (Except WPA-PRCL-350 that must be applied at 140-160°C with <14 psi)
- Molecular thermal stability and compressive strength for 3D processing at temperature of 200-350°C without degradation

PARAMETER	WPA-UVR-200 (270)	WPA-PRCL-350	GD-PRCL-350
Release-Separation Mechanism	<ul style="list-style-type: none"> • UV releasing on glass carrier interface • Peel release for wafer interface 	<ul style="list-style-type: none"> • Thermal releasing on glass or other carrier interface • Peel release for wafer interface 	<ul style="list-style-type: none"> • Peel Release with supporting dimensionally stable flexible carrier
Polymer and Temperature Capability	<ul style="list-style-type: none"> • 200, 270°C for > 30 min with 0.0 % weight loss 	<ul style="list-style-type: none"> • 350°C for > 30 min with 0.0 % weight loss 	<ul style="list-style-type: none"> • 350°C for >30 min with 0% weight loss
Separation-Release Temperature and Cleaning	<ul style="list-style-type: none"> • Preferably adhesion on transparent carrier film • 0% residual on wafer and glass carrier, no rinse-clean 	<ul style="list-style-type: none"> • Preferably adhesion on transparent carrier film • 0% residual on wafer and glass carrier, no rinse-clean 	<ul style="list-style-type: none"> • Peel release at ambient • 0% residual, requires no rinsing and no cleaning
Chemical and Acid-Base Compatibility	<ul style="list-style-type: none"> • Withstand most solvents and water for typical cleaning • Not affected by acid or base solutions for electro-plating, etc. 		
Etching and Other Processes	<ul style="list-style-type: none"> • Dry and wet etching, CMP, and PVD • Outstanding bonding and withstand 30 minutes or more up to the designed temperature range as specified for 200°C, 270°C, and 350°C 		