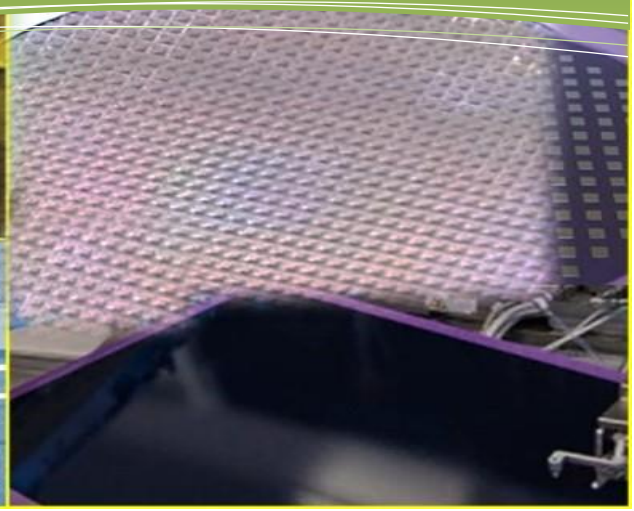
WAFER AND PANEL ELECTRONIC ENCAPSULATING FILM-SHEETS-LIQUIDS MOLDING COMPOUNDS

- *Matching CTE to below Copper slightly Above the 3-D Interconnection Core Board Substrate and Silicon Chips for Low Shear and Engineered Compressive Stress Molded Protection*
- *Nano-Fillers for Micron Scale Interconnections Encapsulation in Film-Sheet and Liquid Formats*



Compression and lamination encapsulation molding compounds (EMC) in place of traditional transfer molding process is critical providing molded protection for the high density interconnected (HDI) chiplets, 3-D wafer and panel scale heterogenous integration. Film-sheet based and liquid-based molding compounds having much high flow with CTE controlling nano-sized silica fillers are the enabling technology.

Features and Distinctions

- Compatible with conventional HDI microcircuit fabrication processes, including oxide treatment and wet chemical plated-through-hole drilling and cleaning processing
- Engineered CTE to less than 12 ppm/°C different from molded underfill (MUF) to provide overall slight compressive stress protection with minimal shear stresses for device reliability
- Molecularly engineered to absorb stresses
- Ultra-low moisture absorption for superior moisture resistance
- Excellent insulation resistance
- Fulfill both underfill and over-molding protection

Laminate Configurations

- Lamination molding film-sheet thickness: 50 to 300um for thin and large area beyond 650mm
- Low CTE liquid-based compression molding compound for standard panel-level packaging molding

Processing and Applications

- Low melt-molding temperature-pressure and shorter dwell time for higher productivity
- High temperature stability to withstand soldering at 300°C
- Max Op Temp: >175°C
- Low CTE designed for fan-out wafer level processing (FOWLP) and fan-out panel-level processing (FOPLP) molded encapsulation protection

FILM-SHEETS & LIQUIDS WAFER LEVEL ENCAPSULATION MOLDING COMPOUNDS (EMC)

Electronic Molded Encapsulant Properties	EMF7883 -NP	EMF7883 -FP	EML7883 -NP	EML7883 -FP
Coefficient of Thermal Expansion (CTE, ppm/°C, 25°C to 150°C)	<12	<9	<12	<9
Filler Size Max Cut (µm)	<0.5	<10	<0.5	<10
Moisture Absorption and Retention (%, 85%RH/85°C/168hr)	<0.2	<0.2	<0.2	<0.2
HAST Reliability (85%RH/ 130°C)	336Hr, Pass	336Hr, Pass	336Hr, Pass	336Hr, Pass
Electrical Resistivity (Ω-cm)	$>10^{14}$	$>10^{14}$	$>10^{14}$	$>10^{14}$
Dielectric Strength @ 25 Micron Thickness (Volts/mil)	>1000	>1000	>1000	>1000
Dielectric Constant (Dk>1 MHz)	2.9	3.0	2.9	3.0
Dielectric Loss Factor (Df>1 MHz)	<0.005	<0.005	<0.01	<0.01
Glass Transition Temp. (°C)	220	220	220	220
Peel Strength (Pound/inch)	8	8	8	8
Device Push-off Strength (psi)	>3000	>3000	>3000	>3000
Hardness (Type D)	80 (D)	85 (D)	80 (D)	85 (D)
Cured Density (gm/cc)	2.4	2.5	2.4	2.5
Thermal Conductivity (W/m-°K)	0.5 W/m-°K	0.5 W/m-°K	0.5 W/m-°K	0.5 W/m-°K
Modulus of Elasticity (GPa)	8	8	10	10
Maximum Continuous Operation Temp. (°C)	>175	>175	>175	>175
Decomposition Temperature @5% weight loss (°C)	>450	>450	>450	>450
Recommended Molding Temperature/Time (°C/min)	150-175/5-3	150-175/5-3	150-175/5-3	150-175/5-3
Max. Film Width (mm)	680	680	Flowing Paste	Flowing Paste
Available Film Thicknesses (µm)	50-300	50-300	Flowing Paste	Flowing Paste

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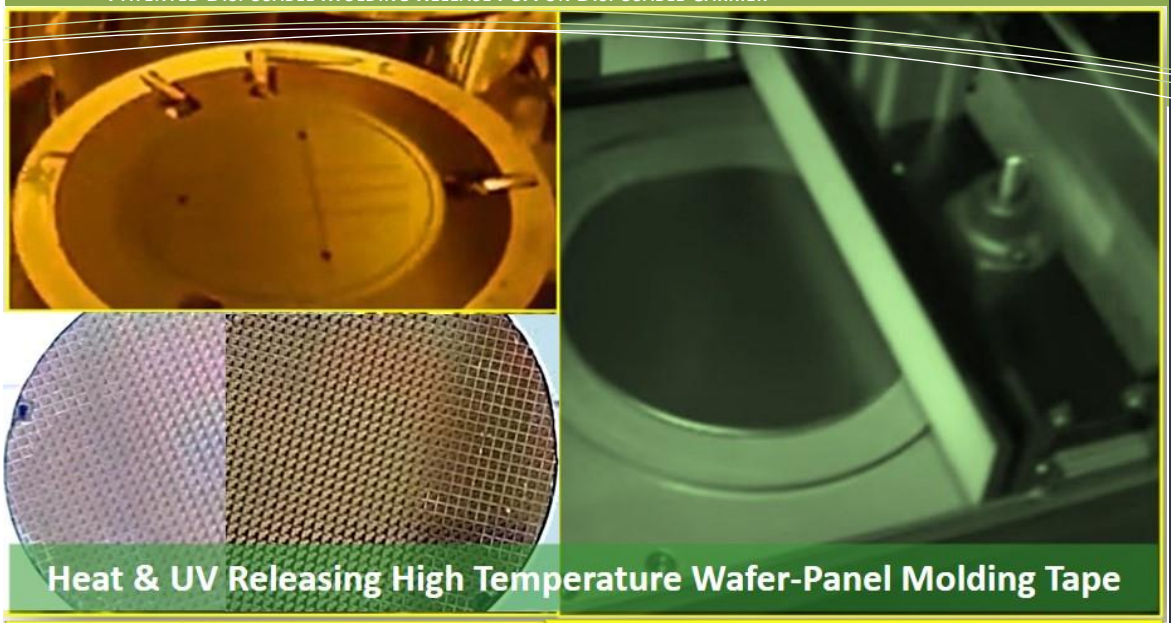
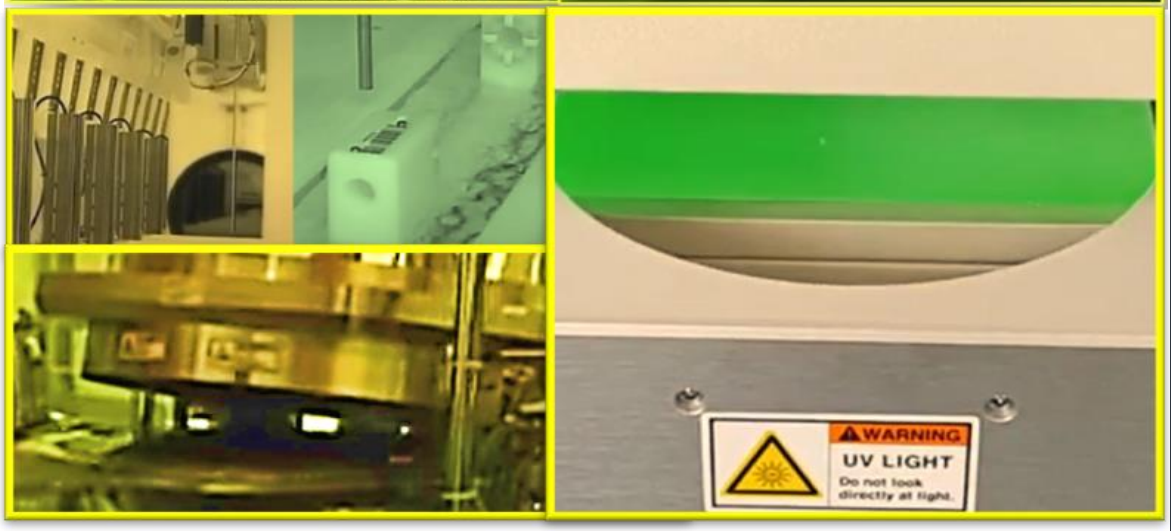
WAFER-PANEL LEVEL PROCESSING (FOWLP-FOPLP) TEMPORARY BONDING MOLD RELEASE TAPES

- *Wafer and Panel Level Processing for Fan-Out and Heterogeneous Integration Molding Release*
- *Novel Heat and/or UV Releasing without Heat Generated "Bubbling"*
- *Patented Disposable Molding Release PSA on Disposable Carrier*



Heat & UV Releasing High Temperature Wafer-Panel Molding Tape



Heat, Peel and UV Releasing Wafer-Panel Molding Tapes

PARAMETER	WPA-UVR-265 WPA-HR-265-DS WPA-PRCL-265	GD-UVR-265-PET GD-UVR-265-DS GD-UVR-265-CXP	GD-PRCL-265-PET GD-HR-265-DS GD-PRCL-265-KP
Releasing Adhesive Configuration and Application Process	• PSA film adhesive on release liners • WPA-UVR for UV and/or heat releasing • WPA-PRCL supports any suitable carriers	• PSA on disposable carrier (PET or CXP) • UV and/or heat releasing with 0% residual for processing to 265°C	• PSA on disposable carrier (PET or KP) • Peel Release with 0% residual for processing to 265°C
Adhesive Thickness	• 20-200µm	• 20-200µm	• 20-200µm
Temperature Capability	• Up to 265°C with 0% residual • Up to 350°C with cleaning	• Up to 180°C with 0% residual for -PET • Up to 265°C with 0% residual for -CXP	• Up to 180°C with 0% residual for -PET • Up to 265°C with 0% residual for -KP
Peel Strength in Operation (ppi)	• >300 ppi (300gm/25mm)	• >300 ppi (300gm/25mm)	• >300 ppi (300gm/25mm)

Novel and patented (US 11,222,864) temporary bonding and releasing adhesive technology for wafer and panel level processing in fan-out and heterogeneous integration. Ideal for large area wafer and panel molding encapsulation.

Temporary Bonding and Releasing Film and Liquid

- PSA film on release liners for use with glass or other carriers.
- Proven applicable for processing up to 265°C and yet release clean for no-clean processing. Minor cleaning for processing up to 350°C
- Available on flexible disposable carriers for ultimate productivity

Precision Chip-Component Placement and Positioning

- Pressure-sensitive at ambient temperature for ease of chip positioning
- High shear bonding for molding stability

Compatible with Wet and Dry Processing

- Acid plating bath and water-based cleaning
- Maintain high shear bonding for drilling and mechanical grinding

Fast and Residual-Free No-Clean Releasing

- Compatible with molding compound in post-molding releasing
- PRCL-series for peel release on carriers including metal foils with 7-11ppm/°C CTE
- UVR-series for rapid UV flash release without residual on glass or PET UV transparent carriers.
- HR-series for heat-releasing after molding

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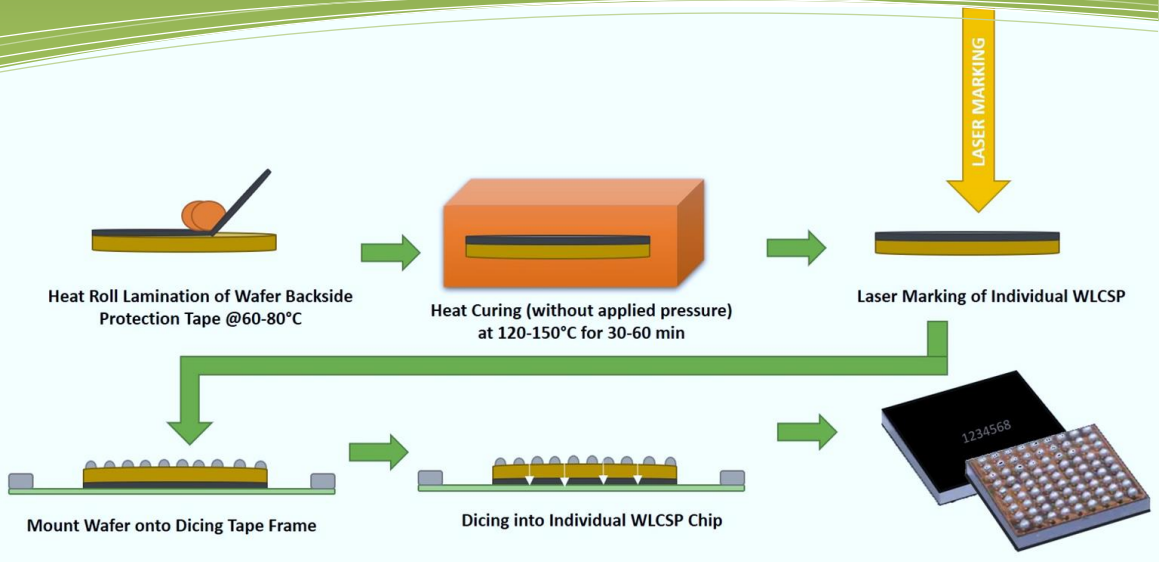
WAFER BACKSIDE PROTECTION TAPES

CHOICES BASED ON WLCSP PROCESSING:

- ***Molding Compound CTE Matching Protection Film to Form Part of the Device***
- ***Peel Releasable Protection Tapes with Low CTE***
- ***UV- Peel Releasable Protection Tapes with Low CTE***



Laser Marking Wafer Back Protection Tapes:

AI Technology, Inc. (AIT) pioneered the first self-supporting (no glass-mesh) film adhesives in 1980s for semiconductor applications. AIT has since developed film adhesives for different applications from die-attach to flexible circuits, build-up films with much more stringent controlled CTE matching 3-D core boards, copper traces and now molding compound sheets and wafer processing backside protection tapes with the following characteristics:

- Laser markable for clear individual chip identifications
- Choices of thickness for different processing and/or device requirements
- Low pressure and temperature for high productivity wafer lamination
- Low warpage with

AIT wafer backside protection tapes offer more choices for processing and device engineering:

- WPA 2260-PR is a peel-releasable tape with high temperature processing capability to over 270°C without inducing excessive peel strength when removal is intended
- WBP 2270-UVPR is unique in the property for wafer scale chip scale processing. The adhesive film is unique in reduction of bond strength for peel releasing with UV exposure.
- WBP 7773 cures into molding compound CTE matching and compatible protective film that forms part of the permanent protection and stayed with the CSP device.

WAFER BACKSIDE PROTECTION AND MARKING LAMINATION TAPES

Wafer Backside Protection Tape	WBP 2260-PR (Peel Releasable)	WBP 2270-UVPR (UV & Peel Releasable)	WBP 7773 (Part of Device)
Color for Laser Marking	Black	Black	Black
Coefficient of Thermal Expansion (CTE, ppm/°C, 25°C to 150°C)	30	35	8-12
Filler Size Max Cut (µm)	NA	NA	10
Moisture Absorption and Retention (%, 85%RH/85°C/168hr)	<0.8	<1.1	<0.2
HAST Reliability (85%RH/ 130°C)	336Hr, Pass	336Hr, Pass	336Hr, Pass
MSL for Finished Package	1 for WLCSP	1 for WLCSP	1 for WLCSP
Recommended Roll Lamination Pressure /Temperature	5-15psi/60-80°C	5-15psi/60-80°C	5-15psi/60-80°C
Device Push-off Strength (psi)	>600	>800 (Pre-UV Exposure)	>3000
Hardness (Type D)	70 (D)	70 (D)	95 (D)
Cured Density (gm/cc)	1.3	1.3	2.5
Thermal Conductivity	>0.1 W/m-°K	>0.1 W/m-°K	>0.5 W/m-°K
Modulus of Elasticity (GPa)	7	7	9
Maximum Continuous Operation Temp/Glass Transition Temp(°C)	>175/200	>175/200	>175/200
Decomposition Temperature @5% weight loss (°C)	>400	>300	>400
Film Thicknesses (µm)	20, 25, 40	20, 25, 40	15, 25, 30, 50
Max. Film Width (mm)	230, 330	230, 330	230, 330

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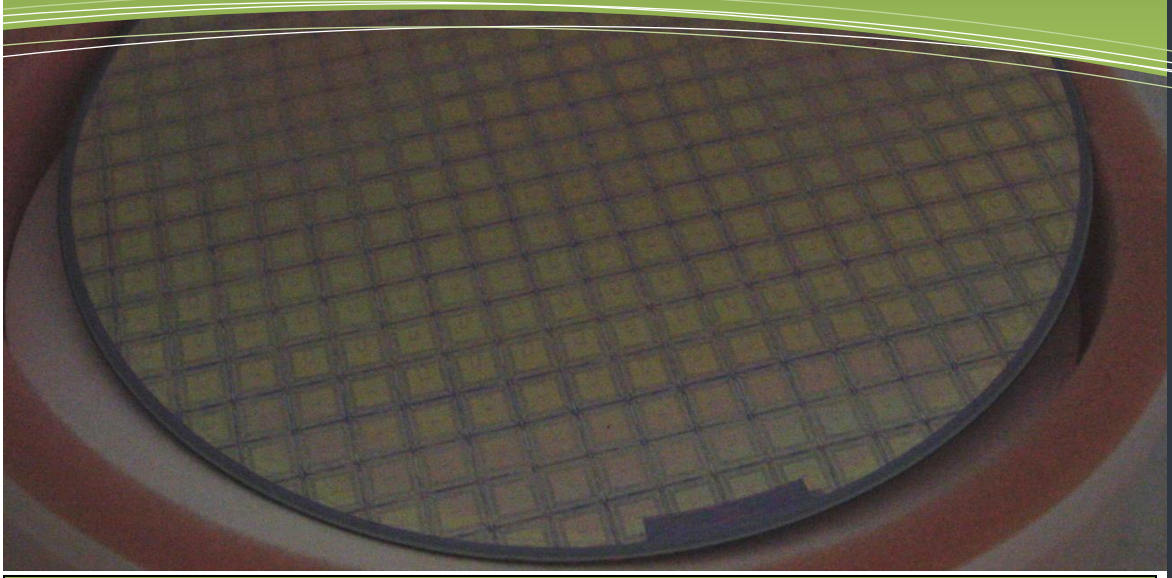
INTEGRATED MATERIAL TECHNOLOGIES FOR WAFER AND PANEL LEVEL PROCESSING

- *Over 35 Years of Proven History of Performance and Innovation in Electronic Packaging*
- *World First in Self-Supporting Epoxy Film Technology for Semiconductor Bonding Applications*
- *Accelerated Worldwide Expansion in Manufacturing and Service Capacity*



COMPLEMENTARY AIT UNDERFILLS, COATINGS AND ADHESIVES FOR BUILD-UP 3-D CIRCUIT AND DEVICE APPLICATIONS

FUNCTION	AIT PART#	THERMAL, ELECTRICAL, & Other RELEVANT PROPERTIES
Molded Underfill (MUF) Film-Sheets	UF-MF-7883-FP UF-MF-7883-NP	• Underfill film for compression molding for flip chip and board level protection • -FP and -NP for 10 µm and 500 nano cut-off fillers respectively • Engineered with 23 ppm/C CTE to provide compressive stress protection for solder bumps and shear stress for board level devices.
Molded Underfill (MUF) Liquids	UF-ML-7883-FP UF-ML-7883-NP	• Underfill liquids for molding for flip chip and board level underfilling protection • -FP and -NP for 10 µm and 500 nano cut-off fillers respectively • Engineered with 23 ppm/C CTE to provide compressive stress protection for solder bumps and shear stress for board level devices.
Capillary Underfill (CUF) Liquids	UF-MC7883-FP UF-MC-7883-NP	• Capillary flip chip and board level underfill protection • -FP and -NP for 10 µm and 500 nano cut-off fillers respectively • Engineered with 23 ppm/C CTE to provide compressive stress protection for solder bumps and shear stress for board level devices.
Corner-Edge Underfill (UF) Paste	UF-MC7883-CE	• High bond strength corner and edge chip on board positioning and protection • Controlled thixotropic index and green strength in fixing the chips on board • Engineered with 23 ppm/C CTE to minimize shear stress
Conductive Die-Attach Adhesive	ME8412	• Snap curing, electrically conductive die-attach for power devices • Low thermal resistance, ambient storable single component silver paste
Insulating Die-Attach Adhesive	ME7410-SSC	• Snap curing, electrically insulating die-attach for power devices • Outstanding high temperature stability and low moisture absorption • Ideal for stiffener bonding
Conformal Coating	SC7130-CC	• Proven for sulfur, acid gases, moisture laden corrosion protection • Moisture, salt-fog and salt-spray protection for aeronautic and automotive electronics
UV-Corrosion Protection Coating	SC7130-UVB	• Integrating UV blocking with the proven sulfur, acid gases, moisture laden corrosion protection • Moisture, salt-fog and salt-spray protection for aeronautic and automotive electronics exposed to direct outside exposure
Thermal Interface	COOL-PAD™ CPR7158	• 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
Masking Tape	MT300-S	• Circuit board masking tape for use up to 260°C reflow soldering • Anti-static and clean release without cleaning
Masking Film Forming Liquid	ML-150 ML-150-S	• Dispensable liquid that dried to peel-release masking film • Withstand soldering operations to 300°C • ML-150-S is an anti-static version of ML-150

About AI Technology, Inc.

Since pioneering the use of self-supporting film and 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.

The same stress-free dielectric adhesives are now adapted for use in flexible circuit copper clad laminates. This proprietary high temperature dielectrics are molecularly engineered to have lower dielectric constant and loss for faster circuit at microwave frequencies for communications devices.

With over 35 years of innovations in serving our customers, AIT has a full line of materials for high performance electronics:

- Die and substrate attach films and pastes
- Die-Attach Film on Dicing Tape
- Wafer Processing Temporary Bonding Adhesive
- Thermal interface adhesives, grease, gel and pads
- Conformal coatings of class of its own in protecting electronics from corrosion from moisture, sulfur, salt, acid gases laden air
- EMI/RFI coating and caulks
- Insulated metal substrates

AIT is located in an ISO 9001:2015 certified manufacturing and R&D facilities on a 16-acre and 18-acre campus in Princeton Junction, and Princeton, NJ.

Sales and supply support includes company direct offices in Shenzhen-HK China and sales reps in Europe and Asia.

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