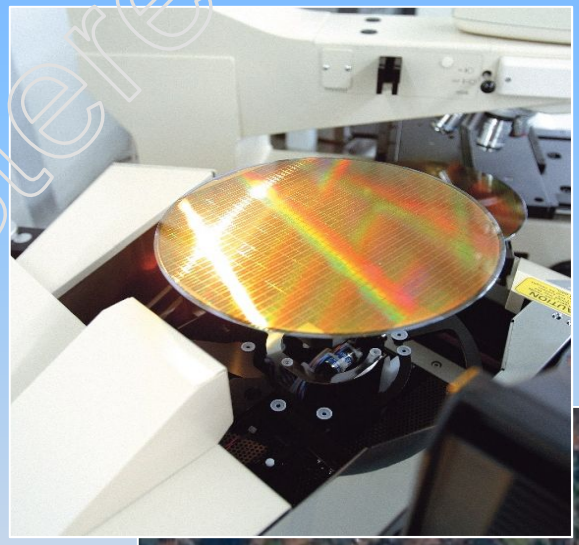
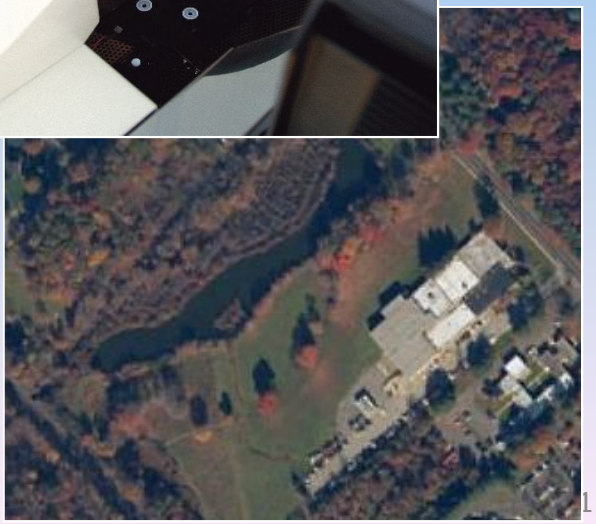
TEMPORARY BONDING ADHESIVE for Thin Wafer Handling

SemiCon Taiwan

September 9, 2016





AI Technology, Inc

Princeton Junction, NJ

Kevin Chung, PhD

Fred Lo, PhD

16 Acres of Manufacturing and Development Center in Princeton Junction, NJ

One of the most comprehensive lines of microelectronic packaging and wafer processing materials

BUREAU VERITAS Certification

AMERASIA INTERNATIONAL TECHNOLOGY INC.
70 WASHINGTON ROAD
PRINCETON JUNCTION, NJ, 08550 USA

Bureau Veritas Certification certifies that the Management System of the above organization has been audited and found to be in accordance with the requirements of the management system standards detailed below

Standards

ISO 9001:2008

Scope of certification

Design and manufacture adhesive, thermoplastic, interface, and specialty materials serving various industries in both domestic and international markets

Certification cycle start date: **12 August 2014**

Subject to the continued satisfactory operation of the organization's Management System, this certificate expires on: **11 August 2017**

Original certification date: **19 August 1999**

Certificate No. US007100-1

Certification Authority

ANAB ACCREDITED

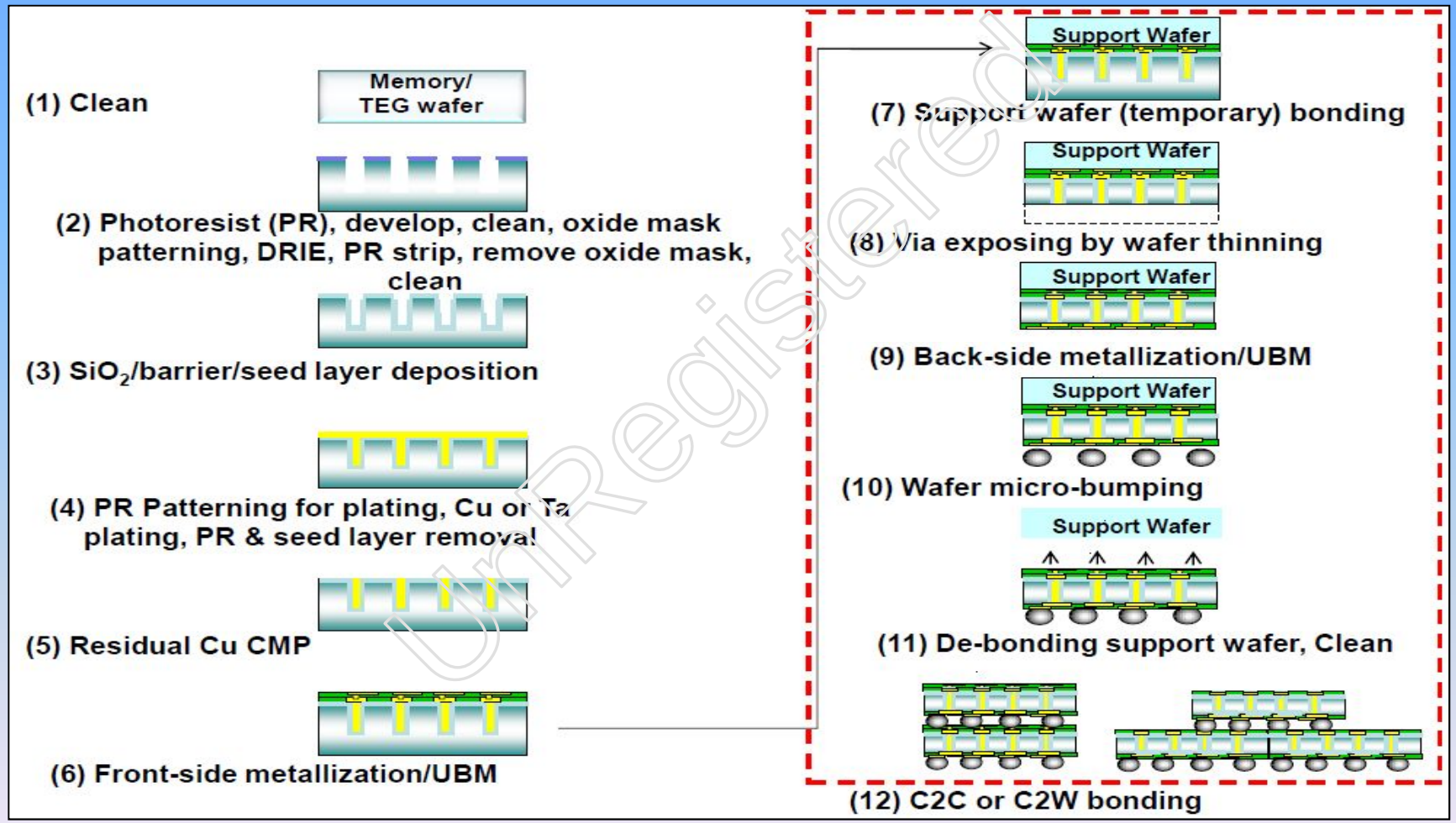
Local office: Bureau Veritas Certification North America, Inc.
350 Sentar Drive, Houston, Texas, USA
www.us.bureauveritas.com/bvc

Further clarifications regarding the scope of this certificate and the applicability of the management system requirements may be obtained by consulting the organization. To check this certificate validity please call +(800) 937-9311.

Temporary Bonding Essential to 3D Technology

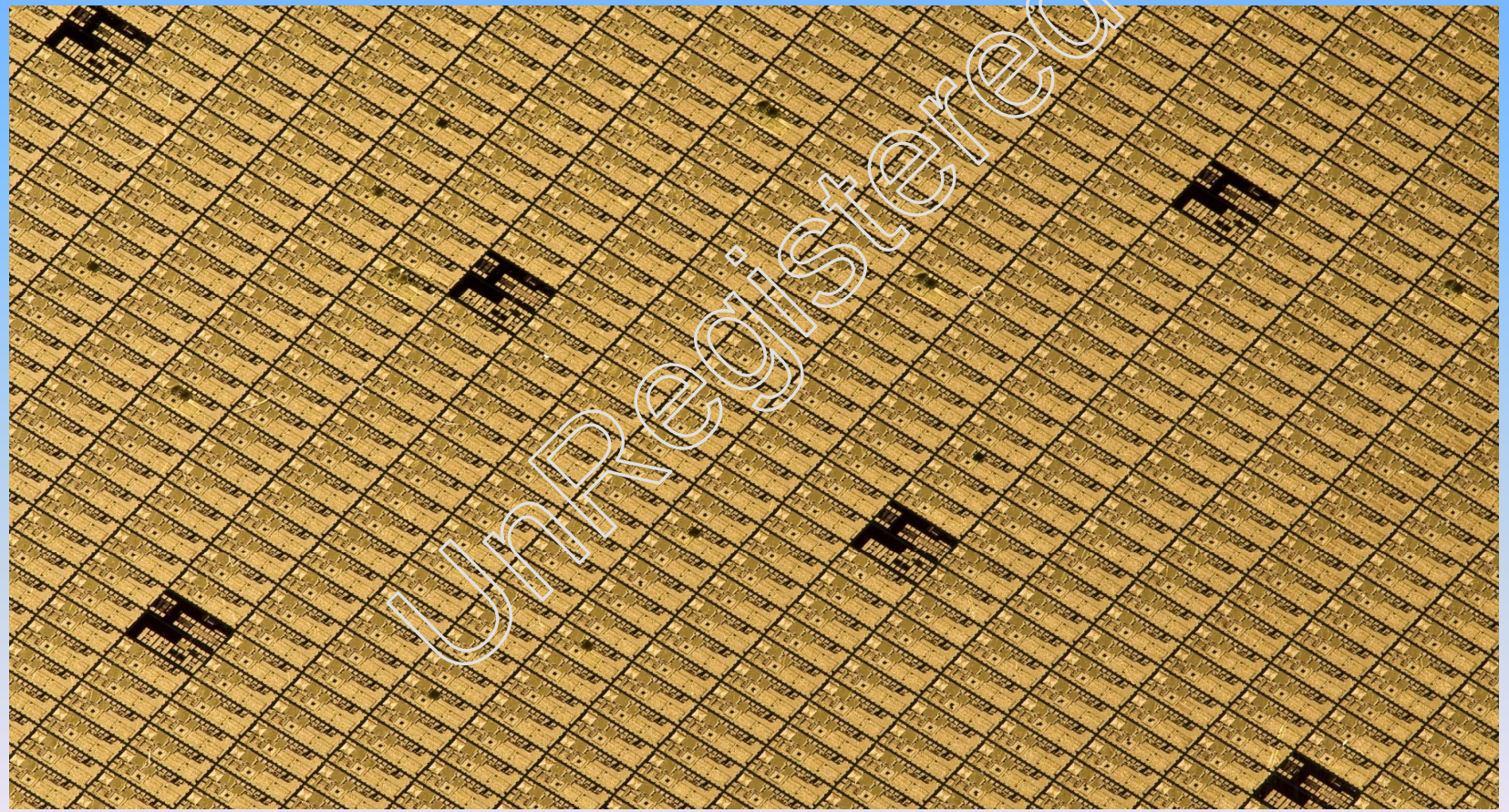
- Thin wafer becomes flexible
- Easy to crack without a support carrier
- Many processing steps after wafer thinning
- Process temperature from 20°C to 320°C
- Chemical resistance to wide range of liquid reagents and gases
- Flatness tolerance and warpage control
- Void and contamination free in the adhesive

Thin Wafer Processing



Source: ITRI

3D Wafer Level and TSV Processing
Needs New Specialty Temporary Bonding Adhesives



Temporary Bonding Debonding Adhesive

Ideally one TBDB adhesive to satisfy all processing

- Low to high temperature
- Resistance to all types of chemicals
- Physical mechanical properties

In practice choice of different TBDB depends on

- Wafer materials and types
- Device types and sensitivity
- Support carrier types
- Bonding conditions
- Process conditions
- Debonding conditions
- Residues and cleaning issues

Temporary Bonding Debonding Adhesive Types by Temperature

Processing temperature ranges

- 20 – 120°C for singulation or back-grinding of fabricated wafers, thin films, ceramics, sensors, lenses, solar cells
- 120 – 180°C for thermoset curing, sputtering
- 180 – 260°C for TSV, etching, bumping, reflow
- 260 – 320°C for plasma, sputtering, metallization

Temporary Bonding Debonding Adhesives by Materials Classification

Bonding materials may include

- Low temperature waxes
- Hydrocarbon oligomers and polymers
- Acrylates modified
- Epoxy modified
- Silicones modified
- High temperature thermoplastics

Temporary Bonding Debonding Adhesives by Debonding Mechanism

Debonding methods

- Mechanical separation
- UV curing and release
- Heat curing and release
- Thermal sliding
- Chemical activation or solvent swelling
- Laser activation

Temporary Bonding Debonding Adhesive Application Types

Tapes

- Supporting and protecting wafers in high temperature processes
- Dicing or grinding

Waxes

- Hot melt glue – melt temperatures range 50 to 180°C

Liquid Adhesives

- Bonding by a curing the glue to solid state

Film Adhesives

- Compression bonding or vacuum lamination

High Temperature Temporary Bonding
Adhesive Tape

- High temperature adhesive supported on high temperature polymer film such as PET, PI, PS, LCP
- High temperature from 150 - 250°C
- CTE and shrinkage consideration
- Cooling down allowing cohesion to minimize residues
- High bond strength but lower modulus
- Double sided sheet available for bonding to carrier

Temporary Bonding Debonding Adhesive

IPA Soluble Wax Liquid or Film

- Low viscosity solution in isopropyl alcohol
- Spin coating up to 3000 rpm to get thin coating of rigid non-tacky adhesive layer onto a wafer carrier
- Bonding to a wafer at 85°C
- Over 1000 psi adhesion strength
- Heat slide off at 120 – 130°C
- Rinsing with IPA to remove all residues
- Varieties of IPA-soluble wax to cover temperature ranges from 60°C to 160°C
- Also available as wax-film which can be laminated on to a wafer carrier at 85°C and then bonding to wafer

High Temperature Temporary Bonding
Hydrocarbon Base Adhesive

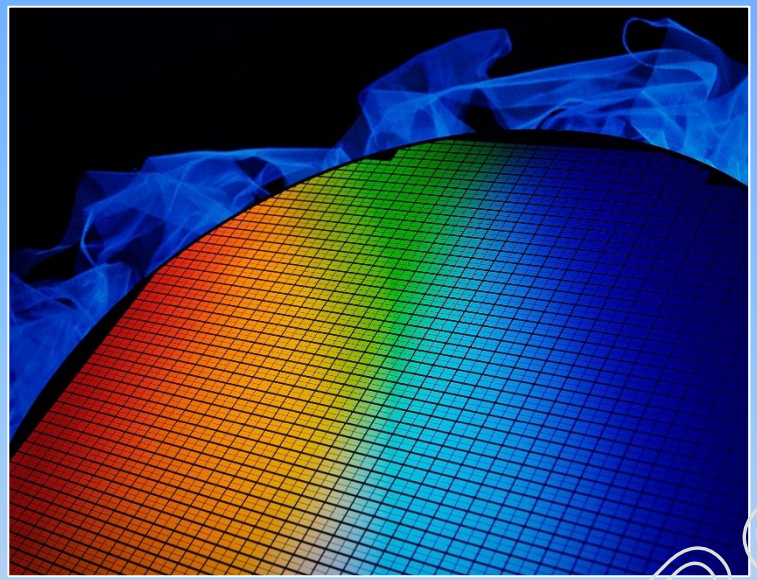
- Hydrocarbon base adhesive modified to give adhesion and thermal stability at 150 – 250^{o}C
- Excellent resistance to acids, bases, and polar solvents
- Adhesive in liquid form dissolved in hydrocarbon fluid can be spin coated into thin layer on wafer carrier
- Adhesive in film format can be laminated at 150^{o}C as thin film on wafer carrier
- Adhesive film protected by release liner on both side
- Relatively low bond strength
- Dismount by heat sliding or using non-polar solvents such as naphtha and mineral spirit.

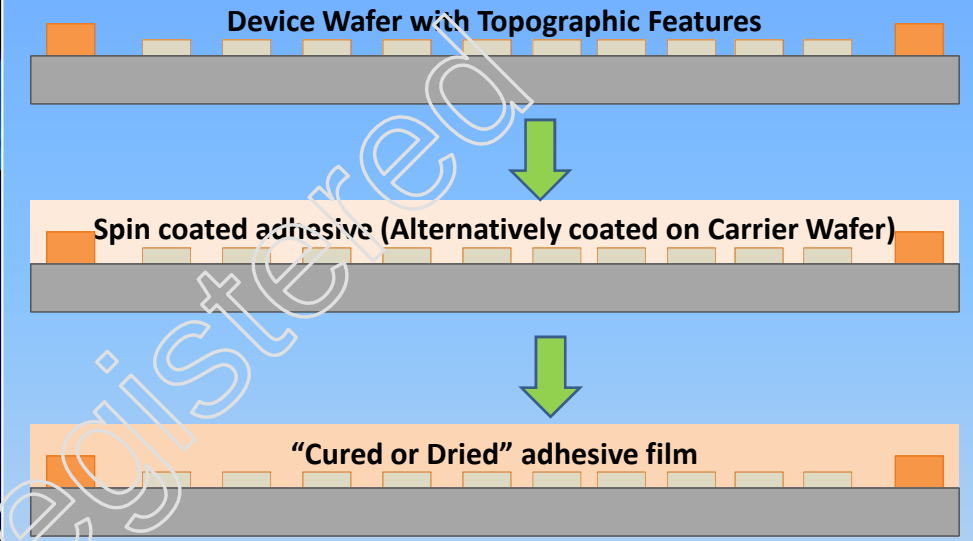
High Temperature Temporary Bonding

Engineering Polymers Adhesives – Liquid and Film

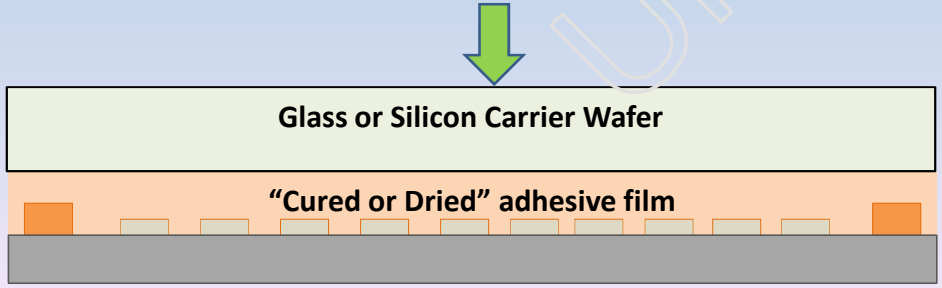
- Modified engineering polymers to give adhesion and thermal stability at 250- 320°C
- Excellent resistance to acids, bases, and thermal degradation
- Liquid adhesives spin coated onto wafer carrier to form a thin adhesive layer
- Film Adhesive laminated at 150°C as thin film on wafer carrier
- Bonding to wafer or components from 160-250°C
- Excellent thermal stability 320°C up to 1 hours
- Dismount using polar solvents such as or customized stripping liquid
- Perforated carrier necessary to allow faster absorption of solvents into the adhesive layer

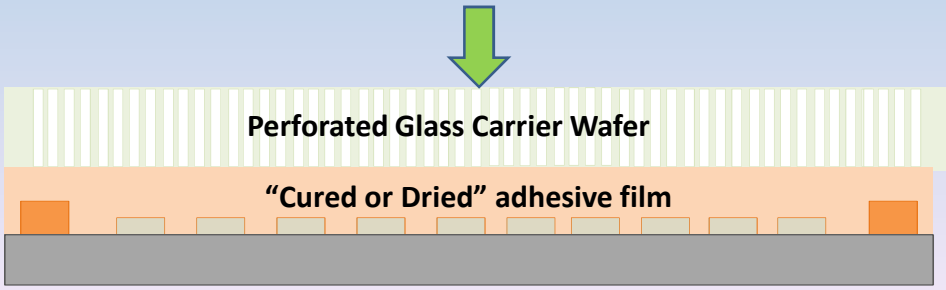
Spin Coating
Thin-Wafer Processing Adhesive





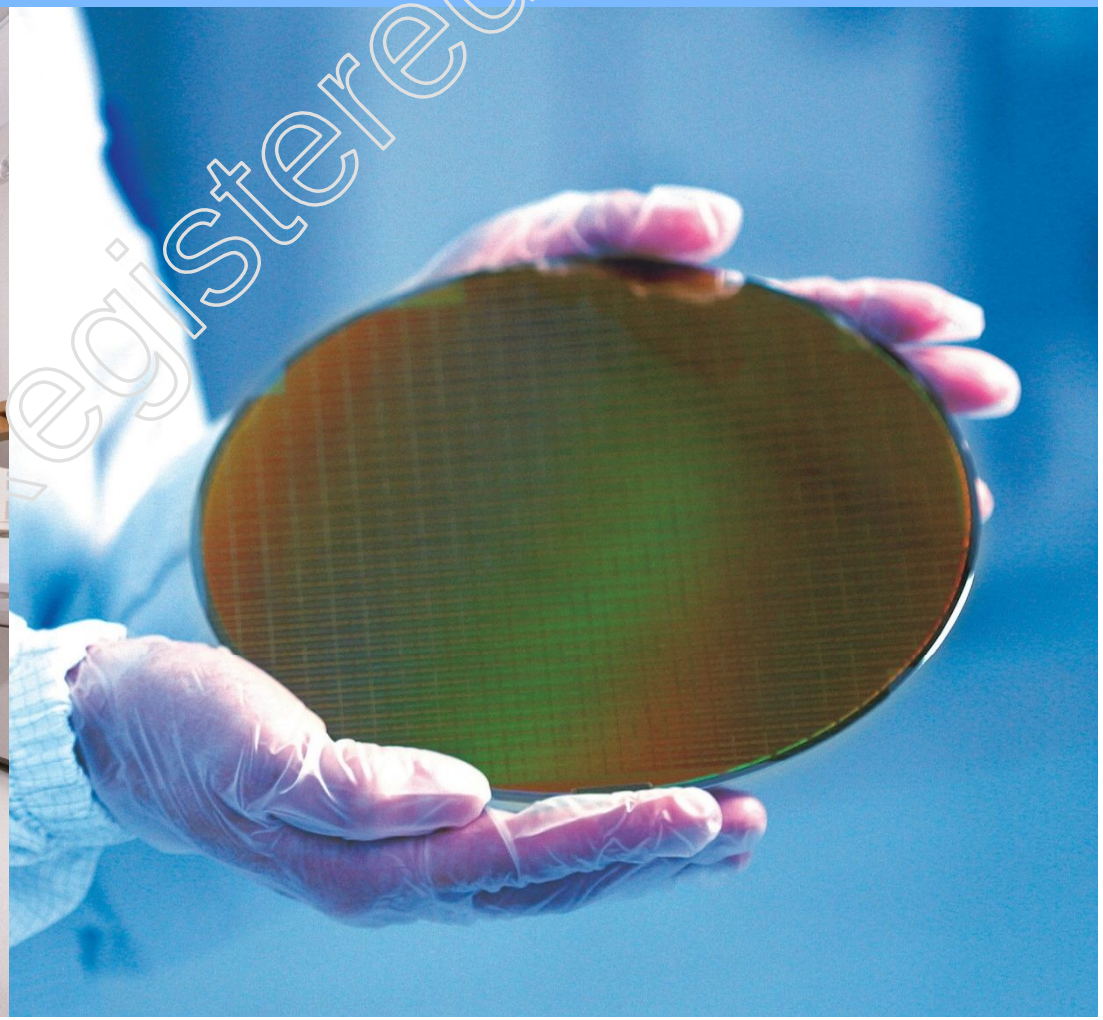
Device and Carrier Wafers are Melt-Bonded Under Vacuum and Pressure



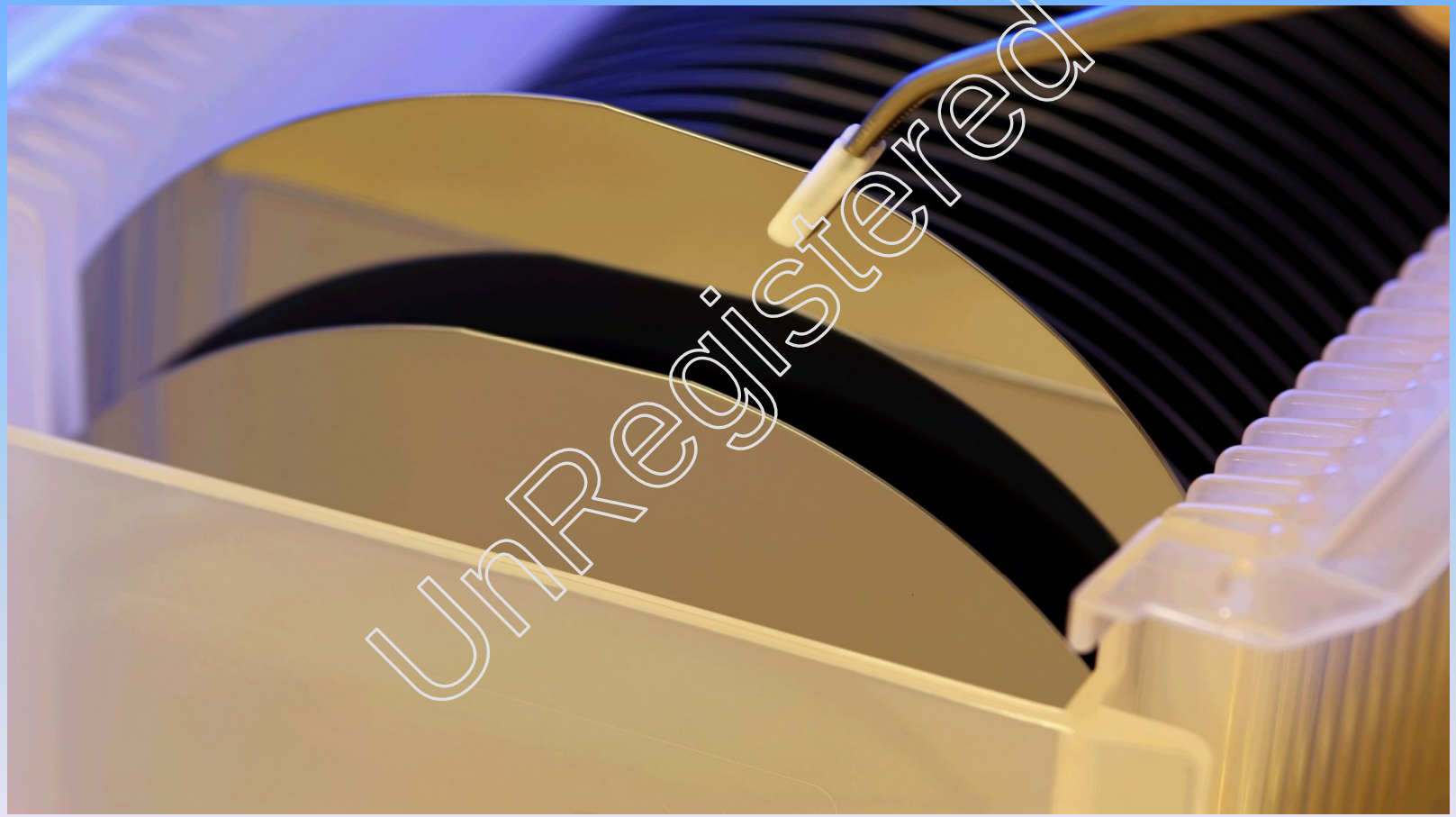


Film Adhesive Simplified

Application of Temporary Bonding Adhesive

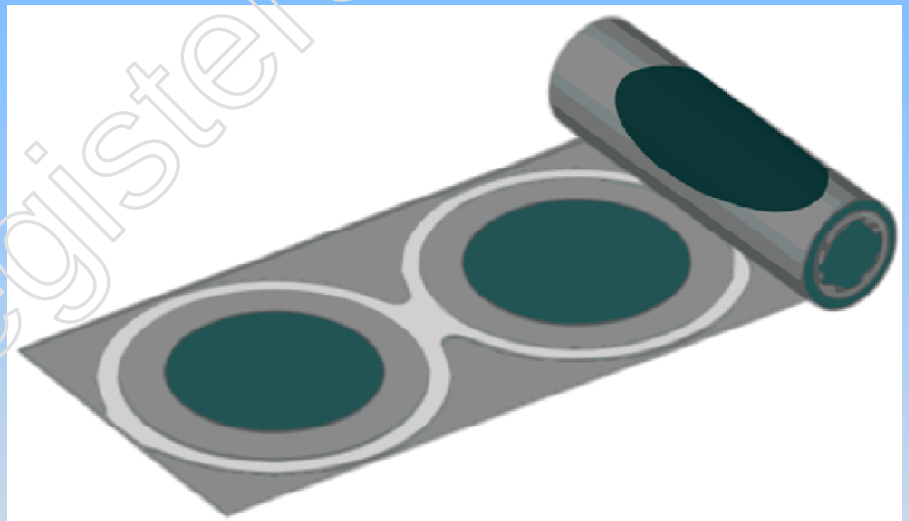


3D Wafer Level and TSV Processing Productivity will be Dramatically Improved with a Properly Engineered Temporary Bonding Film Instead of Spin Coating Adhesive



THIN-WAFER PROCESSING FILM ADHESIVES

- **Melt-Flow Temporary Film Bonding Adhesive in 10, 20, 40 and 80 Micron thickness to compliment the spin coating solution**



- **Negligible weight loss up to 320°C in air**
- **Higher temperature capable in vacuum or inert atmosphere**
- **Heat-sliding, laser or solvent assisted debonding**

Compression Bonding Under Vacuum

VACUUM CHAMBER

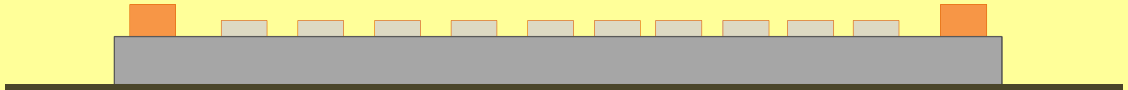
(Must To Remove Trapped Air Bubbles Along the Bonding Interfaces)

Applied Compression Force

Top Heated Chuck

Glass or Silicon Carrier Wafer

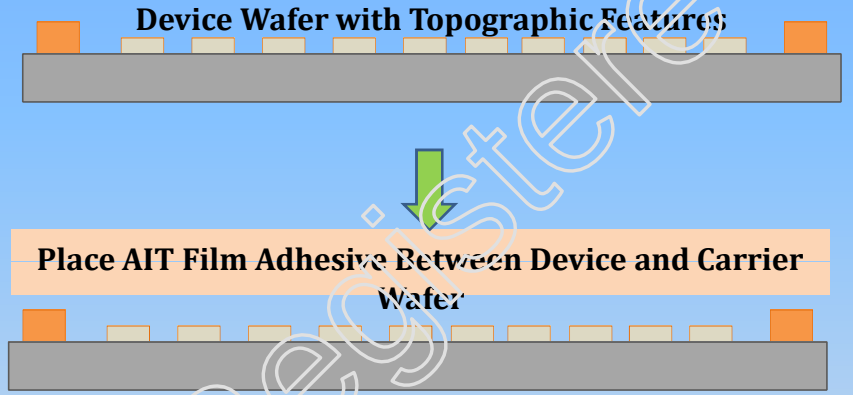
Thin-Wafer Processing Adhesive film



Rigid Bonding Tool

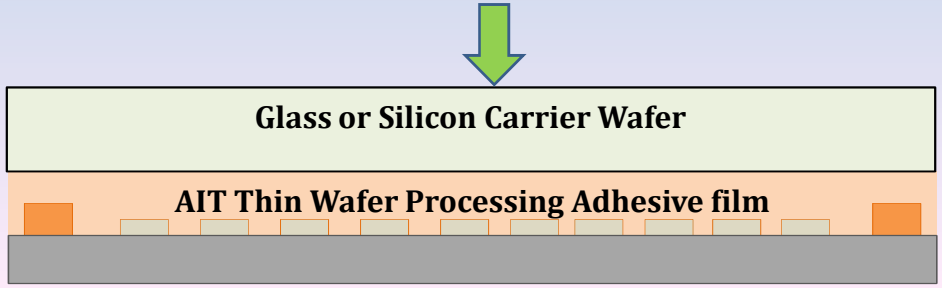
Bottom Heated Chuck

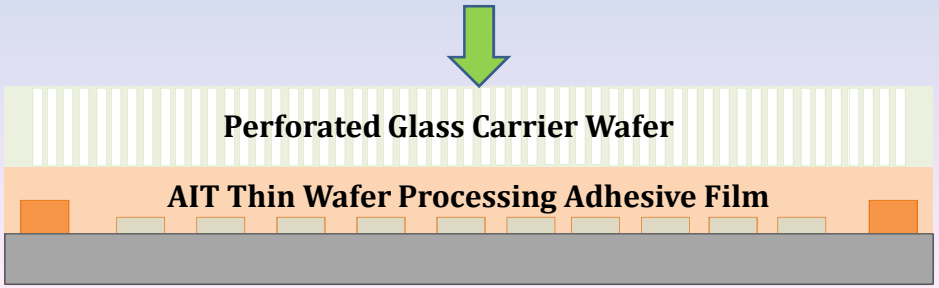
Thin-Wafer Processing Film Adhesive Enables Options Not Possible with Spin Coating Adhesive



Thin-Wafer Adhesive Films are available up to 80 or more micron while spin coating may need multiple coatings on both the carrier and device wafer to achieve the same for high topographic wafer

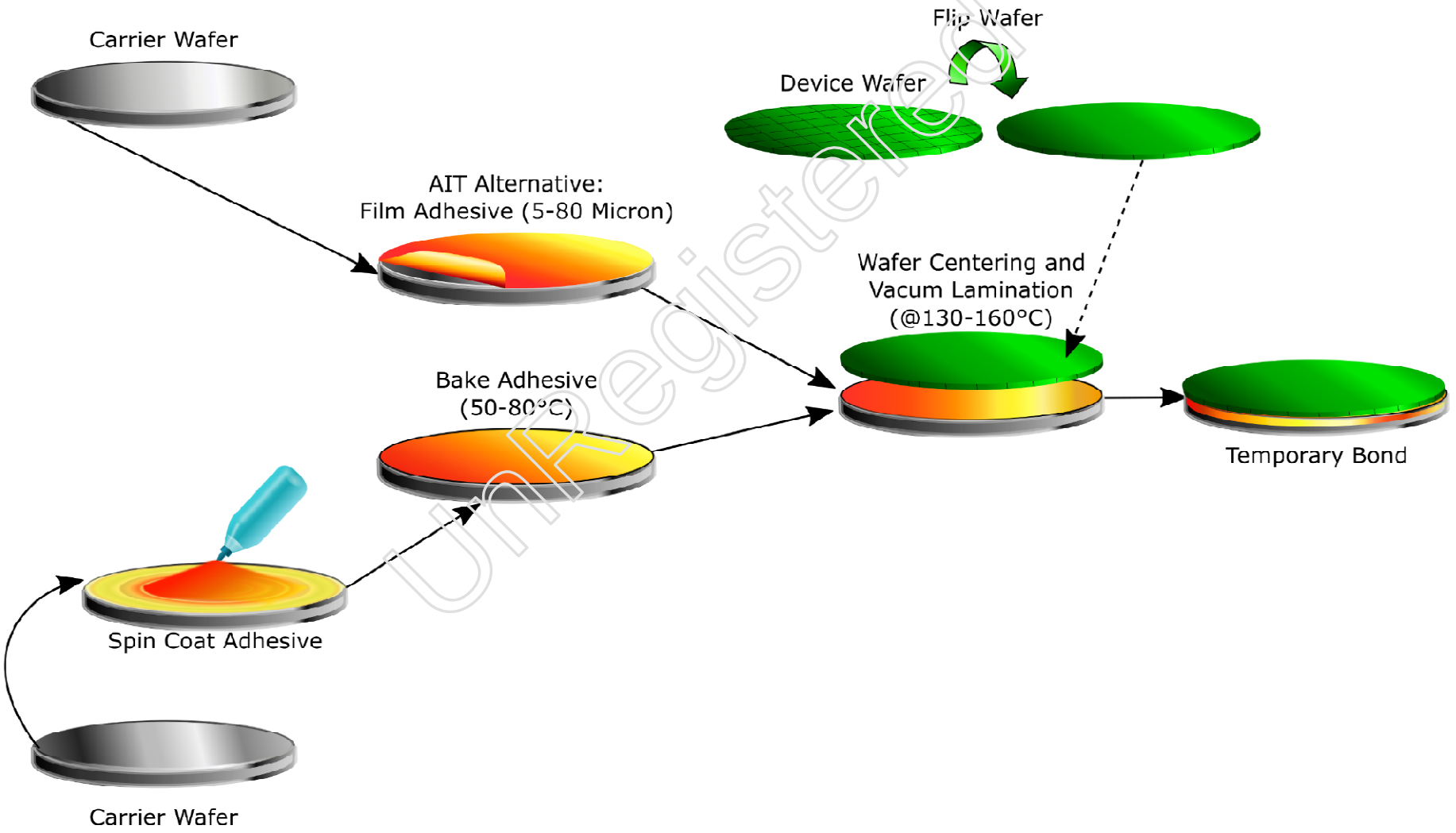
Device and Carrier Wafers are Melt-Bonded Under Vacuum and Pressure



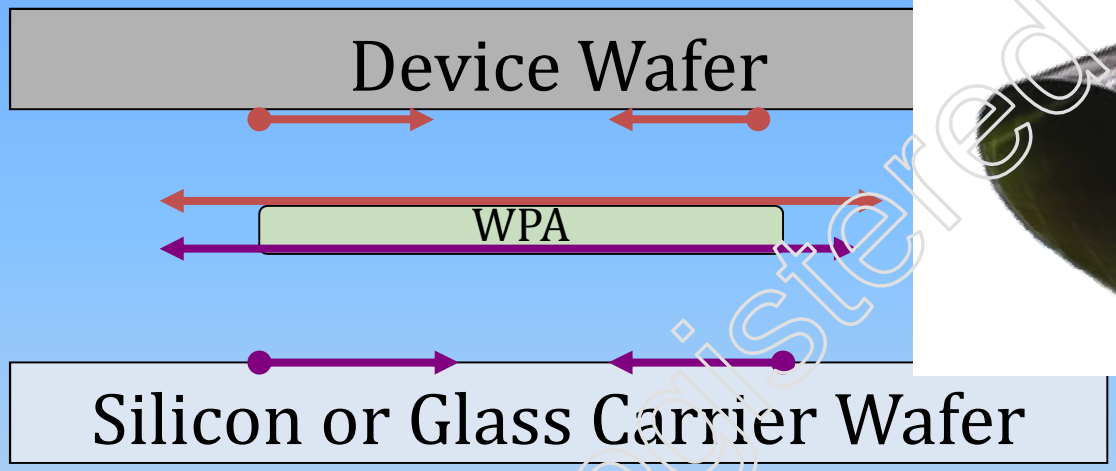


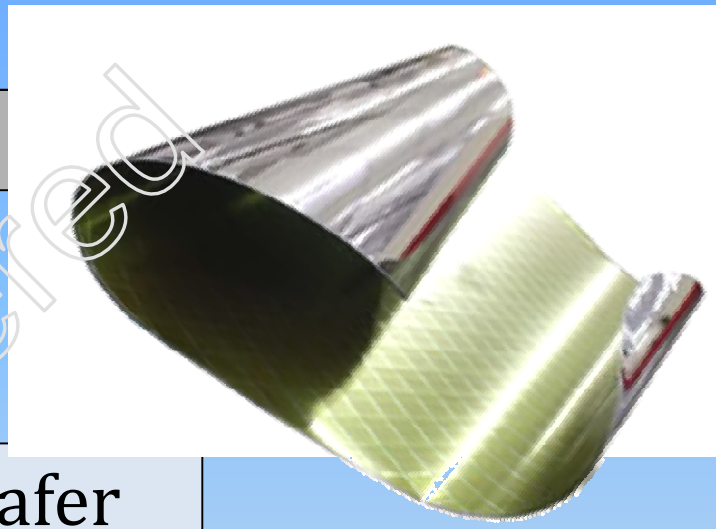
Use of Wafer Processing Film Adhesive More Compatible with Clean Room Operations

Temporary Bonding (Applicable for Both WPA-TS and WPA-TL)



Stresses within Temporary Wafer Processing Must be Minimized with Stress Absorbing Adhesive





$\sigma = \varepsilon_A \times E_A$

$= (\alpha_A - \alpha_S)\,\Delta T \times E_A$

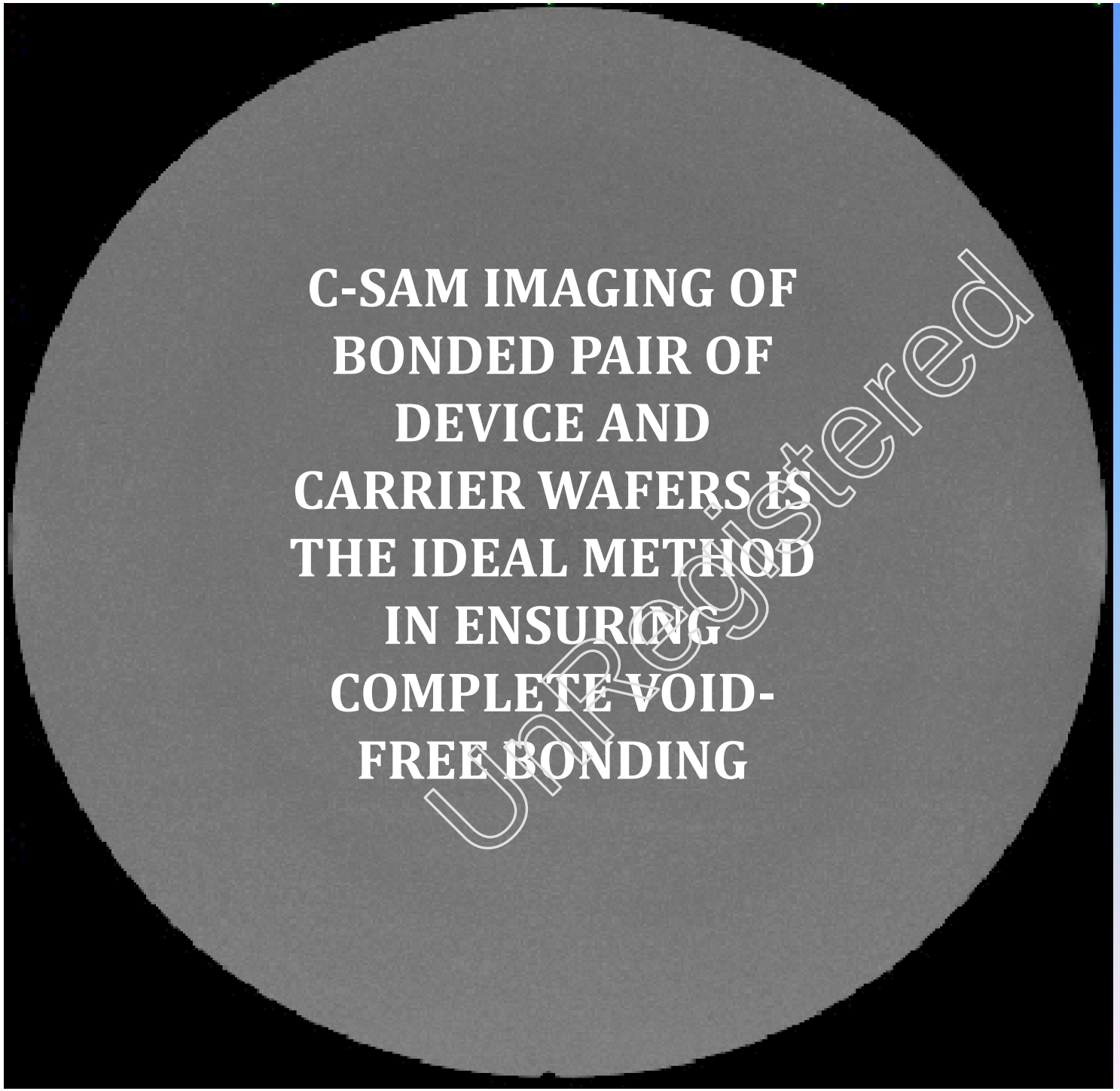
E_A = Modulus of Adhesive

ε_A = Strain

1-D Model (AIT, 1986)

$$\tau = \frac{\Delta T(\alpha_1 - \alpha_2)}{K\kappa \cosh(\kappa L)} \sinh(\kappa x)$$

3-D Model (Suhir)



It is critical and necessary criterion that wafer processing are performed with **void-free bonded** device and carrier wafers.

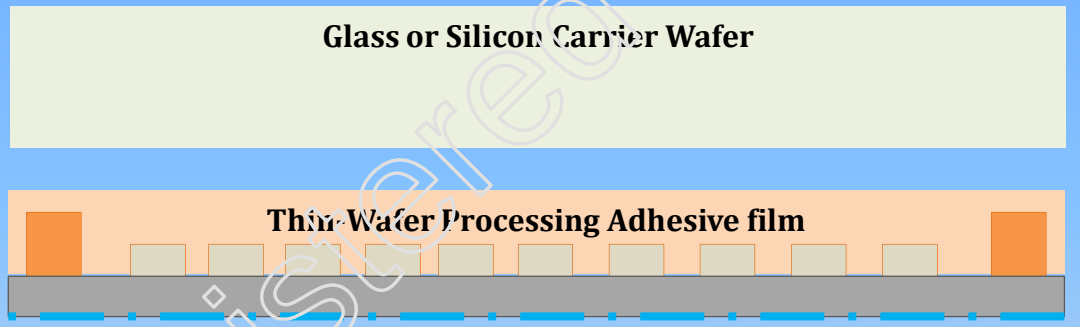
Voids in the bond-line can lead to defects including poor grind finish, poor uniformity, stress to thinning wafer during high-vacuum processes, and others.

Thin-Wafer Processing Adhesive

Maintain Bonding Integrity When Exposed to Acid, Solvent and Vacuum Exposures

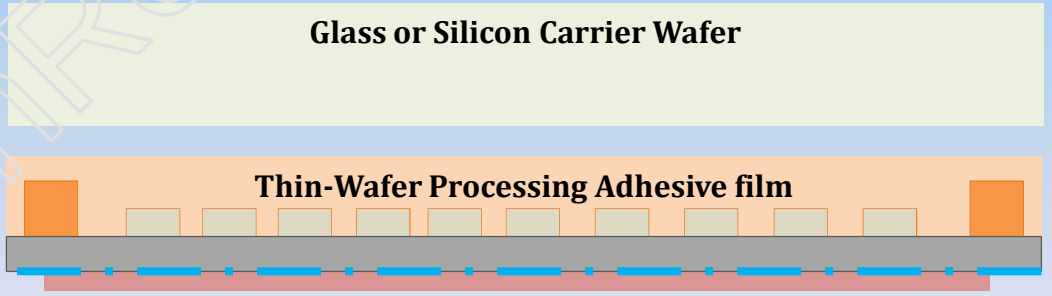
Lithography + CVD Oxide Dry Etch + Resist Removal:

- **Solvent resistance**
- **Plasma resistance**
- **Stripper resistance**



Sputtering + Lithography + Electro-Plating + Resist Removal :

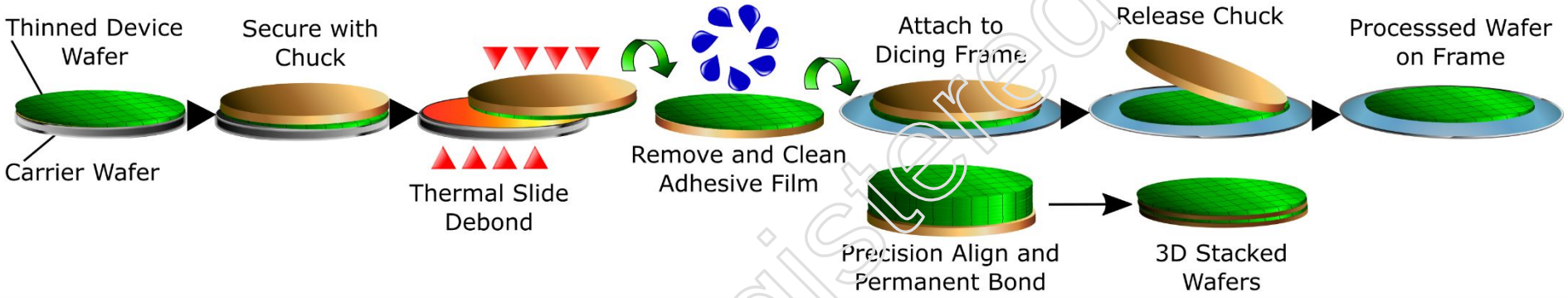
- **Non-Outgassing in vacuum**
- **Acid resistance**
- **Stripper resistance**



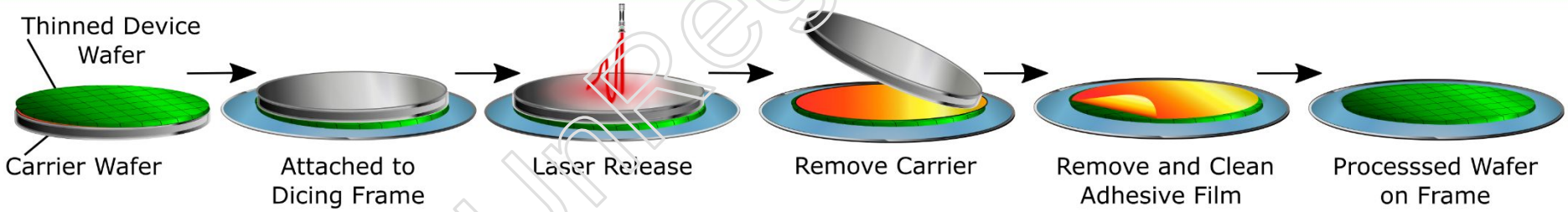
Thin-Wafer Processing Film Adhesives

Debonding and Separating Methods

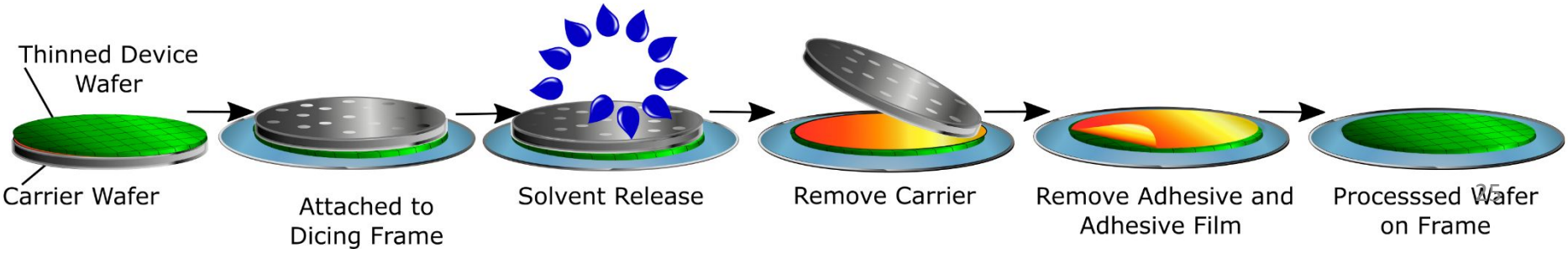
DEBONDING METHOD I: Heat Sliding (Applicable for Both WPA-TS and WPA-TL)



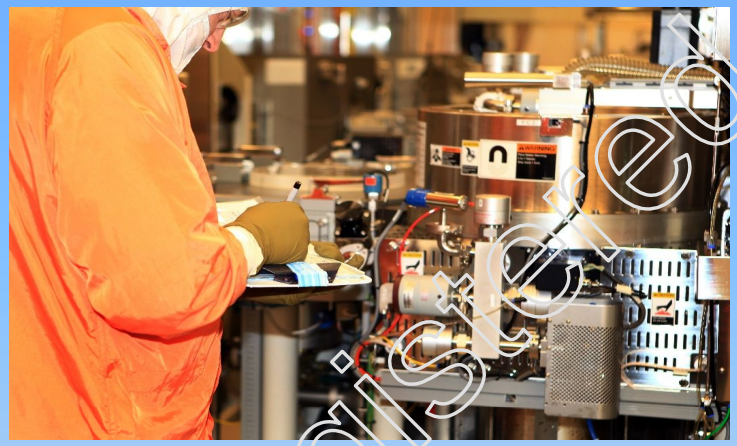
DEBONDING METHOD II: Laser Assisted (Alternative for WPA-TL Only)

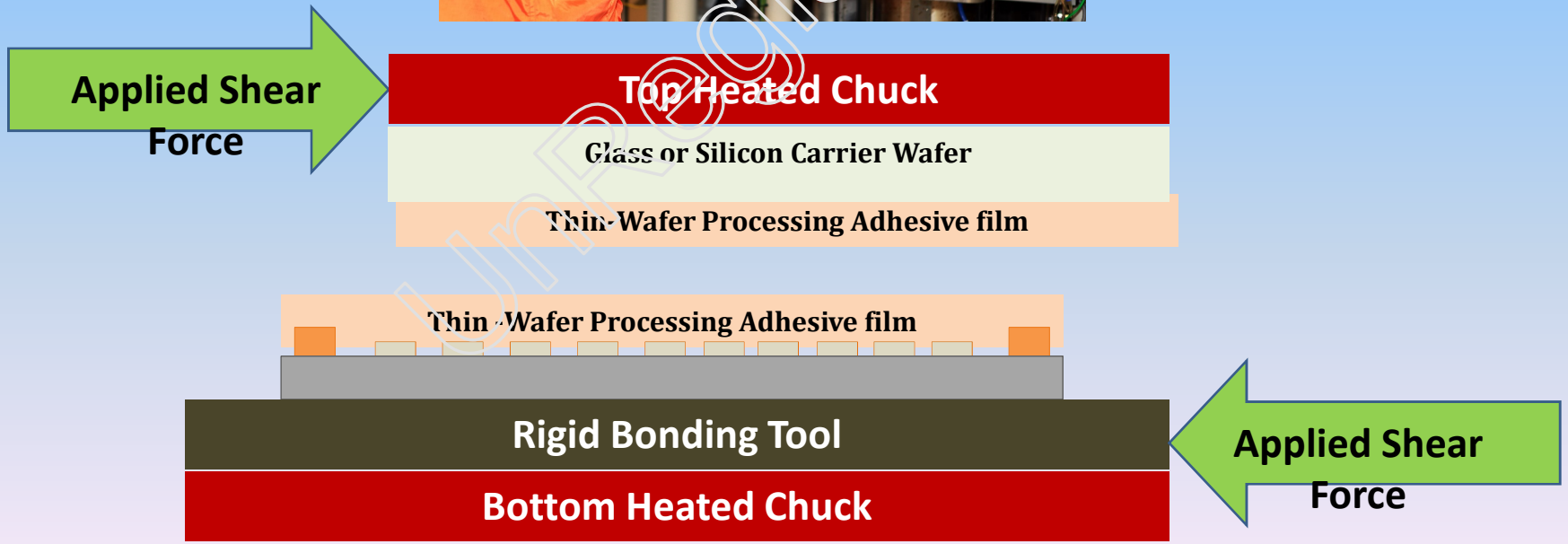


Solvent Assisted Debonding: Applicable for the WPA-TL and WPA-TS with Perforated Carrier Wafer



Heat-Sliding Separation-Debonding
at 250-300°C with Shear Forces

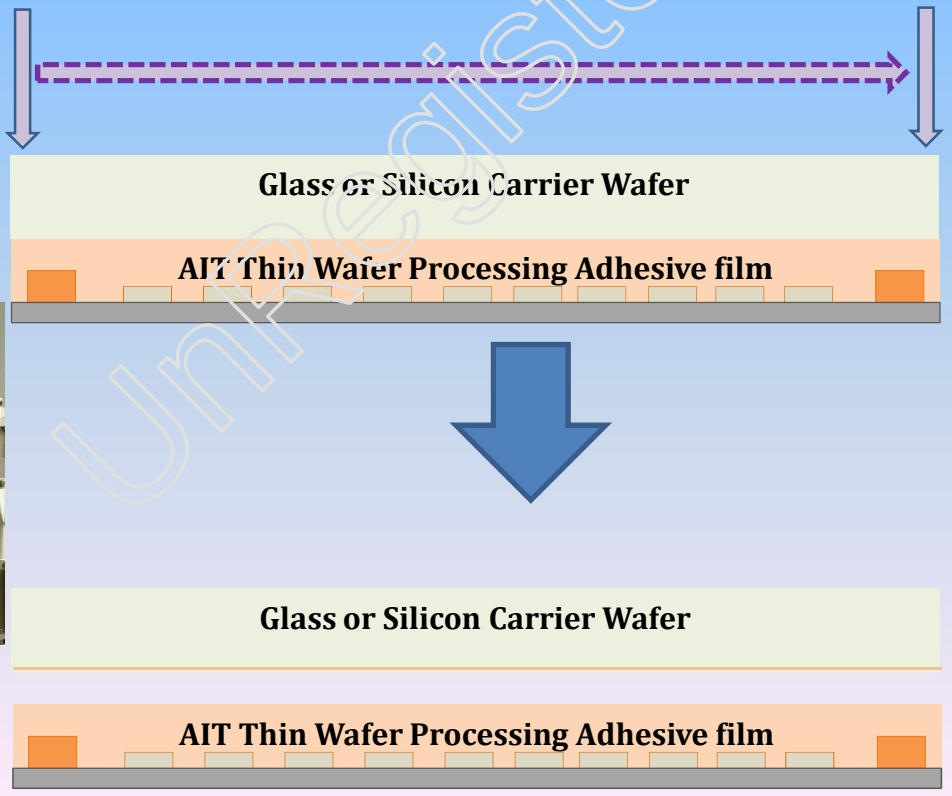




Thin-Wafer Processing Film Adhesive

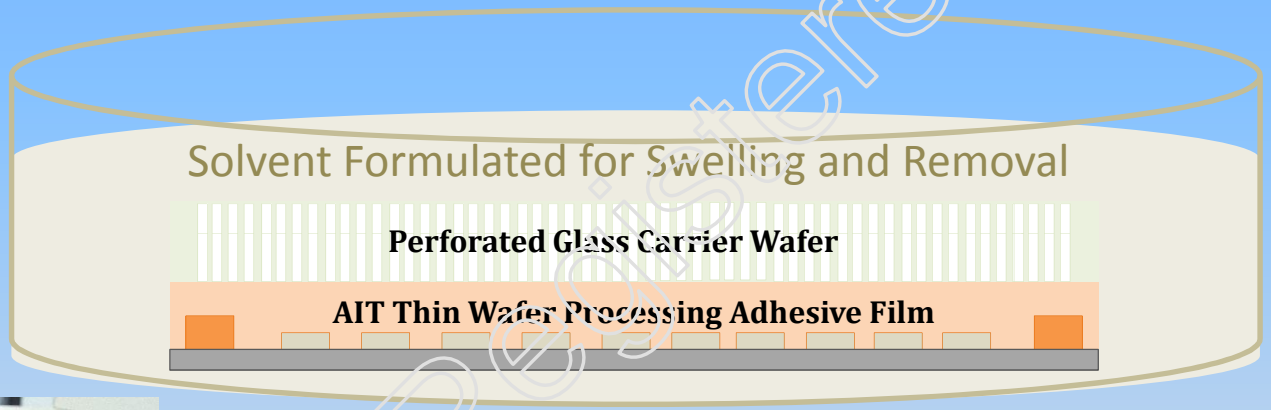
Ablated by Laser to Allow Ease of Debonding Separation Between Device and Carrier Wafer

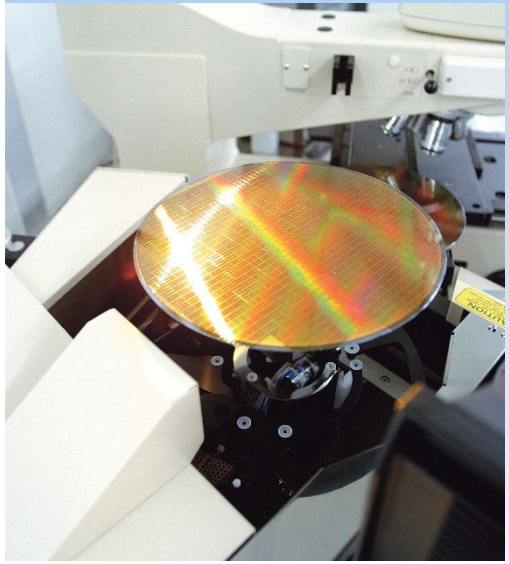
Tuned Laser Programmed to Pass Through the Glass Carrier and Focused Energy to Heat Up the AIT WPA-TL-330 Layer Below the Carrier Wafer to Locally Decompose a Thin Layer of Adhesive for Debonding-Separation

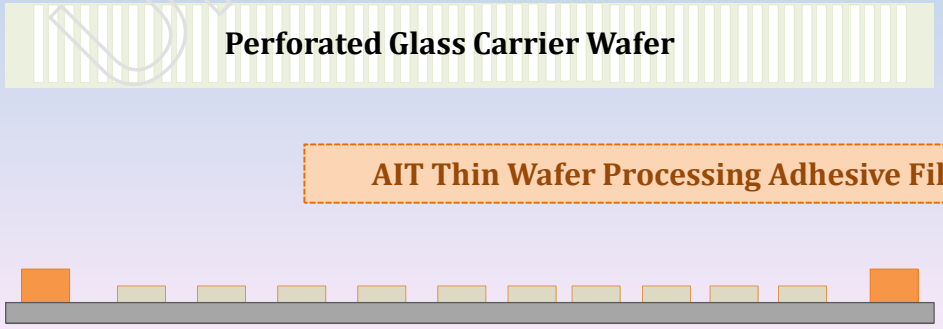


Thin-Wafer Processing Film Adhesives

Removed by Specially Formulated Stripper Solution to Separate the Device and Carrier Wafers







Temporary Bonding Debonding Adhesive
Summary Remarks

A diversified portfolio of materials for temporary bonding allows for many different innovative approaches insolving the thin wafer processing issues in many different types of processing

Debonding after high temperature processing remains challenging in many applications

Open-minded collaboration among the user, equipment manufacturers, and material suppliers is important for future advance.

THANK YOU!

AI Technology, Inc. (AIT)

www.aitechnology.com

Corporate Headquarters in Princeton, New Jersey

Company History

- AI Technology, Inc. headquarters is located in the company owned complex in Princeton Junction, New Jersey with close to 52,000 square feet office and manufacturing facilities within a 16 acre site. In addition to the New Jersey headquarters, the company has offices in Hong Kong and Shenzhen China. AIT has approximately 80 employees world-wide.
- AIT is an ISO 9001:2000 quality management certified manufacturing company.

Pioneering and Innovative Products and Materials Technologies for Highest Performance and Reliability

1. Pioneered the use of flexible, stress adhesive films and pastes used in most advanced commercial and military applications since 1985
2. More than 30 US patents in materials for electronics and microelectronics manufacturing
3. First phase-change thermal adhesives and pads, patented compressible phase-change thermal interface pads, lowest thermal interface resistance greases and gels, compressible and conformable thermal gap-pads
4. Advanced DDAF: 3 micron thickness for up to 450mm wafer
5. Patent-pending thermally conductive solar back-sheets
6. Insulated metal thermal substrate with 2xtimes thermal conductivity for metal-core printed wiring boards
7. First thin wafer processing temporary bonding film adhesive

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ANAB ACCREDITED

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