22ND INTERNATIONAL CONFERENCE & EXHIBITION ON DEVICE PACKAGING
SHERATON GRAND AT WILD HORSE PASS PHOENIX, AZ
MARCH 2-5, 2026 • WWW.DEVICEPACKAGING.ORG

APPLIED MATERIALS™

Thermo Mechanical Reliability of Through Glass Vias: Modelling, Material Design and Process Co-optimization



Poulomi Mukherjee

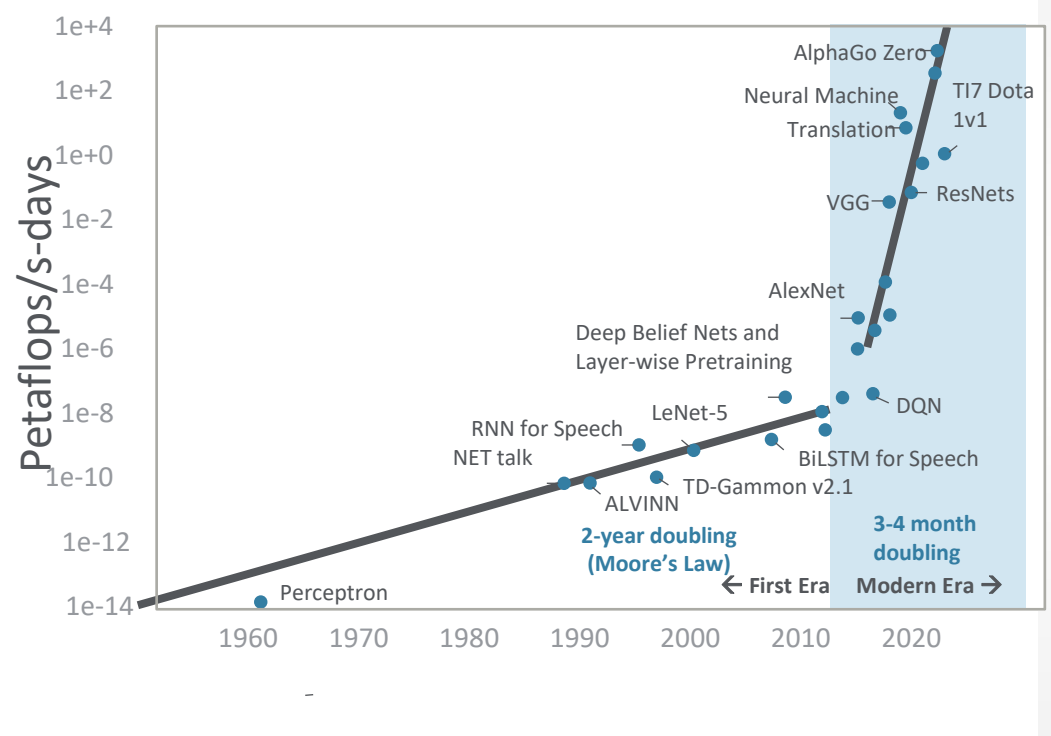
Packaging Engineer, Heterogeneous Integration,
Applied Materials Inc.

March 4th, 2026

AI Revolution| Reshaping The World Of Packaging

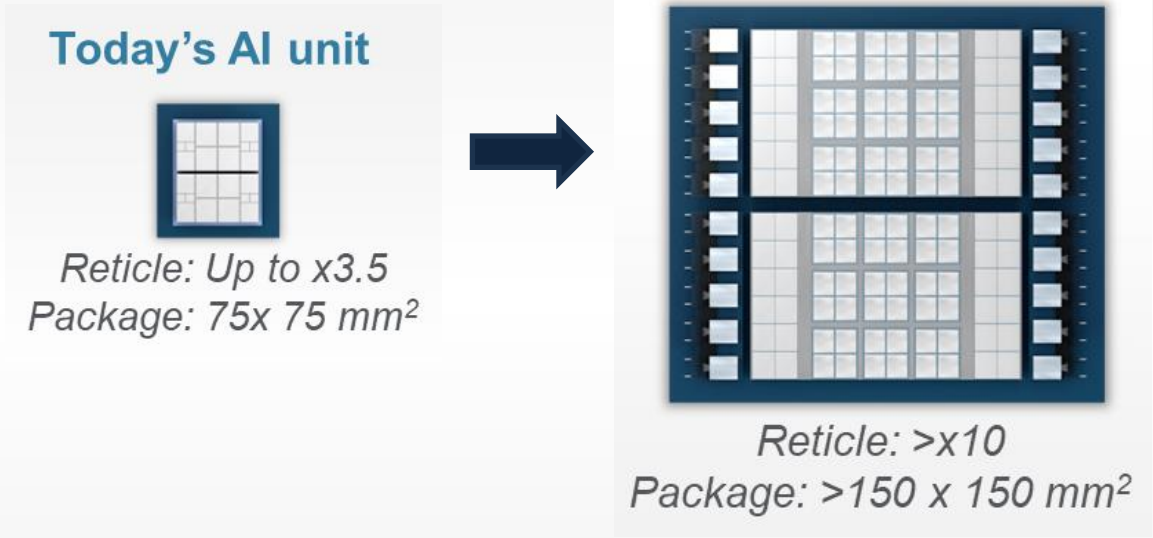
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AI Training Workloads Accelerating- Moore's law scaling slowing down



Source: OpenAI, "AI and Compute" 2018

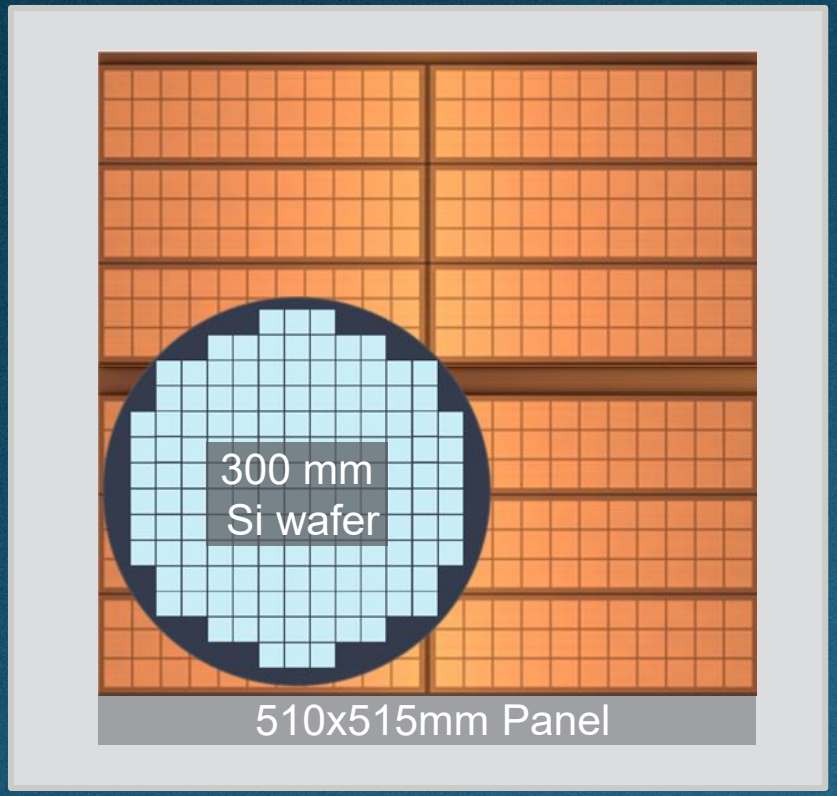
Advanced Packaging- The Driving Force

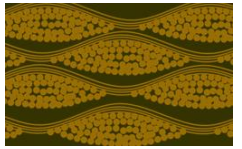


- Larger modules- fit more logic and memory
- Interconnect scaling- high density connections

- With Moore's law scaling slowing down next generation packages need to drive both material and frequency scaling.
- Advanced Packaging has emerged as key enabler for AI revolution with increasing packaging sizes and shrinking interconnects.

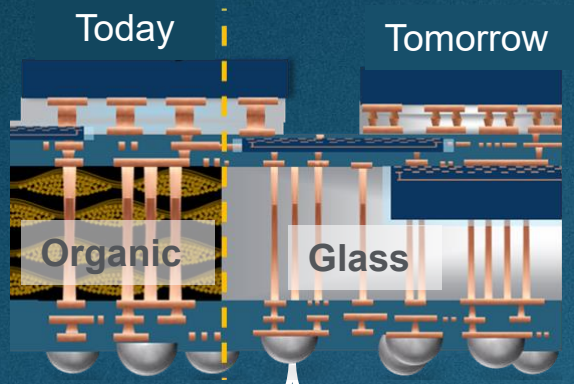
Panel Scale Packaging| Material of Choice



AI Package Requirements	Material Properties	Organic *FR-4*	Glass
			
Larger Packages	Mechanical stiffness	1X	6X
	Thermal expansion	1X	0.1X
Faster Signal Propagation	Loss tangent	1X	4X

- Today substrates are built with Organic fiberglass reinforced cores enabling smoother transition from wafer-based process.
- The transition to glass in the future will be driven by scaling and improved functionality and Performance.

Glass| For Packaging Technology Scaling



Scaling

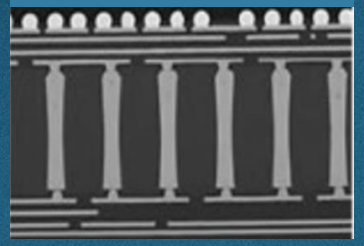
Reduced metal layer count

L/S scaling <2/2



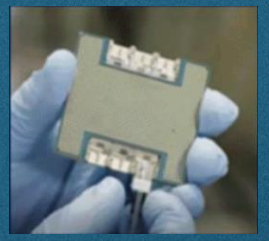
Increased Interconnect Density

TGV Pitch <100um



Functionality and Performance

Embedded components and co-packaged optics



High Speed I/O and low loss with TGVs



Enables 50% larger Die complex area

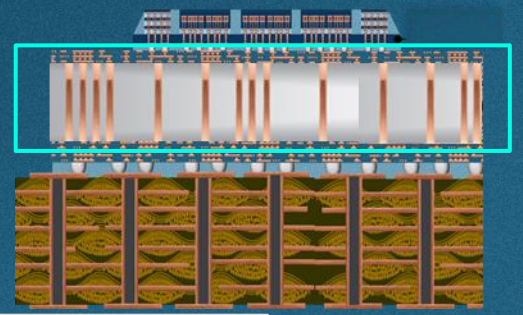


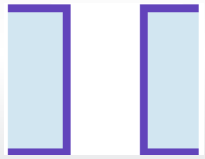
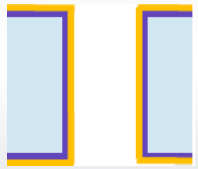
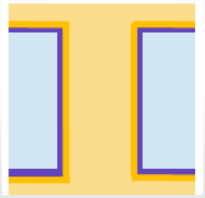
Pictures adapted from Intel iMPAS (2025) presentation on Heterogeneous integration: Panel Scale Packaging Technologies by Tarek Ibrahim.

- Glass is an important material for advanced packaging with the ability of enabling compute scaling and frequency scaling.
  - Glass offers high mechanical stiffness and CTE tunability enabling scaling for different form factor packages.

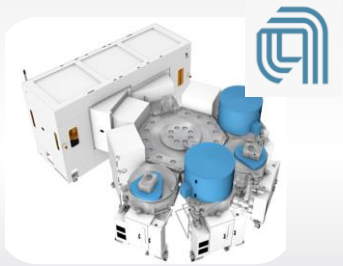
Applied Materials Enabling Glass Core Technology

Glass Via



Via Formation (Wet Etch)	Liner Deposition	Seed Deposition	Plating	CMP
				

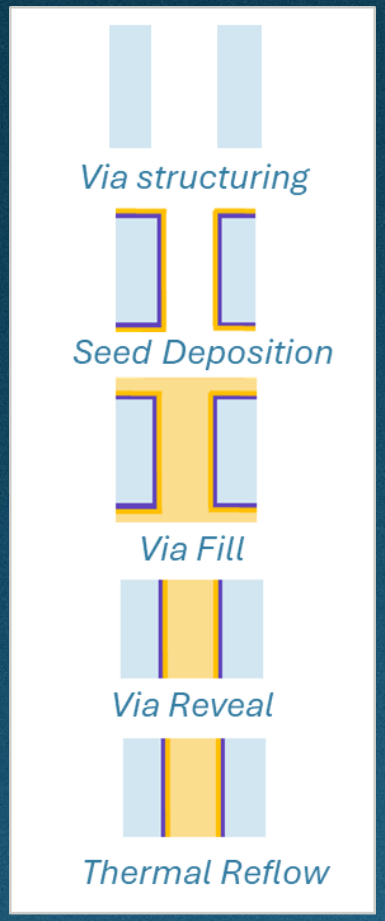
Reliable glass via technology development is a key to transform to glass panel packaging and presents unique challenge from a tool and process standpoint

Partnership	CVD5000PLP	TOPAZ PVD	Partnership	Partnership
				

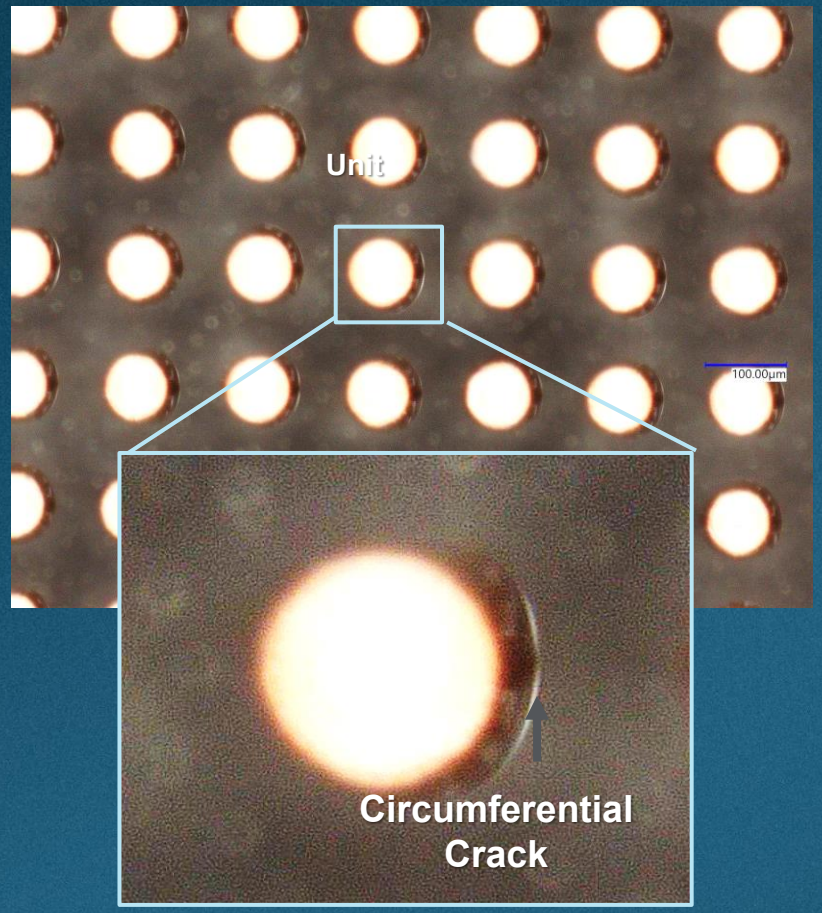
- Applied is enabling reliable glass via flow at a panel scale through first of the kind equipment portfolio, novel material solutions, and key industrial partnerships.

TGV Reliability Challenge| Glass Cracking

Process steps

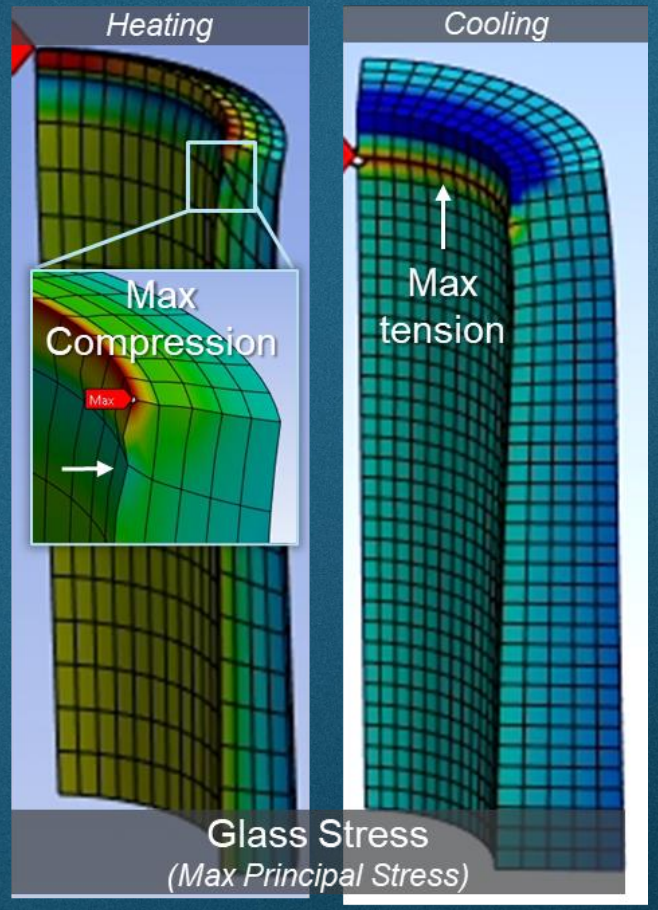


Experimental Data (Applied Materials Internal Structure)





Modelling

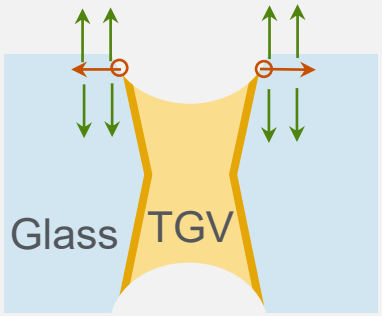


- **High Value Problem:** The difference in CTE between Cu and glass generates stress that cracks the glass resulting in reliability risk.

TGV Glass Cracking| The Mechanism

During Heating- Crack Initiation

Cross section illustration

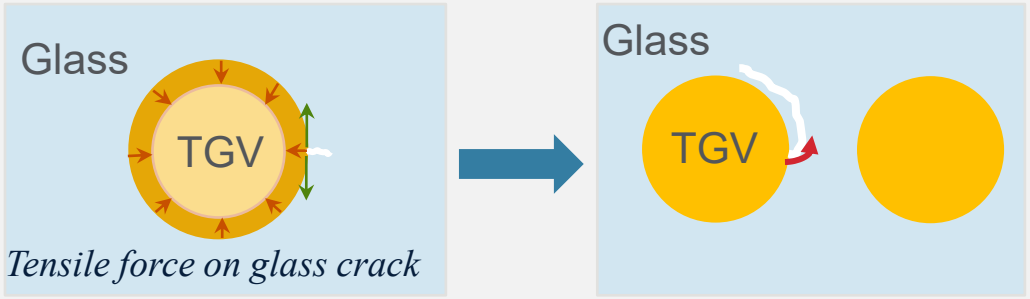


↑ Tension
↑ Compression

Cu forms 3-point stress location and exerts excessive compressive stress on glass

During Cooling- Crack Propagation

Top-Down illustration



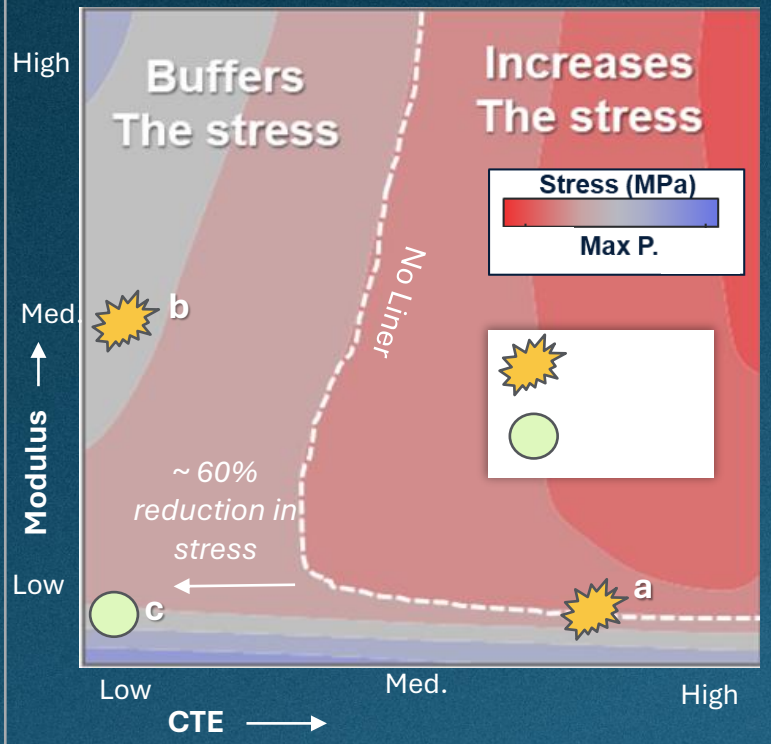
Cu contraction generates axisymmetric tensile force leading to circumferential crack propagation.

Understanding the crack initiation and propagation mechanism helps predict the potential region of glass cracking and understand the requirement of a stress buffer material solution to reduce glass cracking.

Applied' s CVD Solution| TGV Cracking Reduction

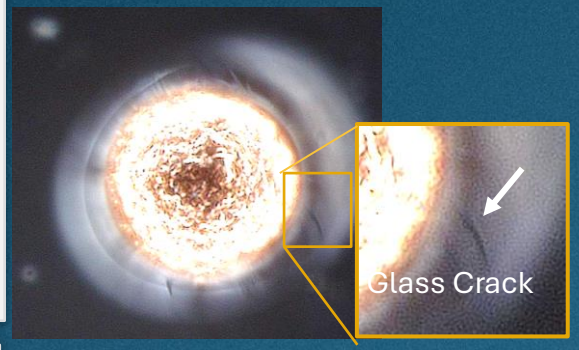
Modeling

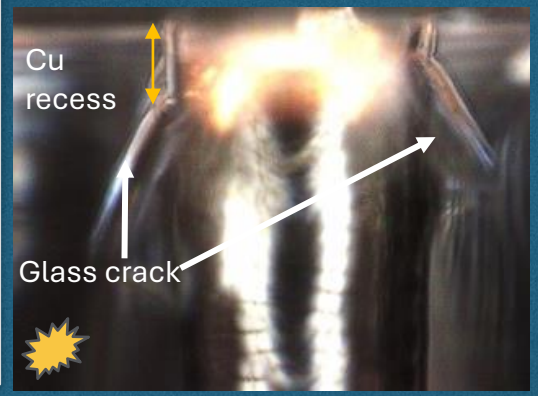
a. Impact of Liner properties



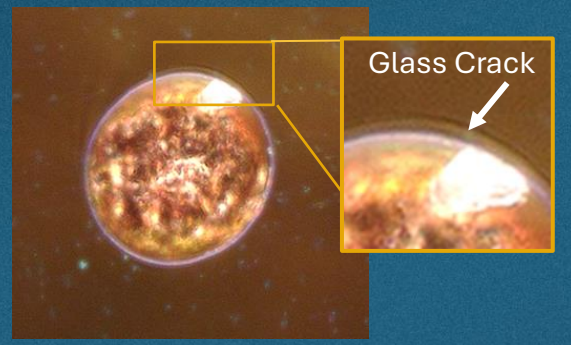
Experimental Data (Applied Materials Internal Structure)

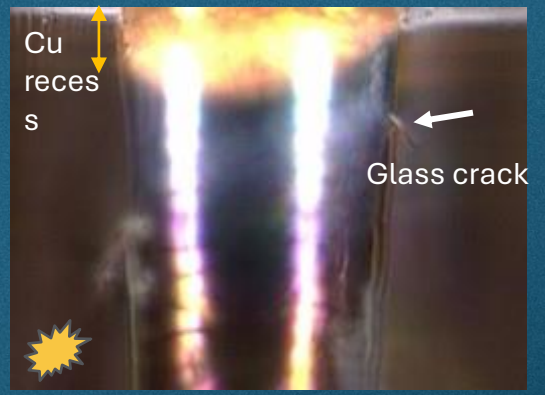
b. High Mod. High CTE liner





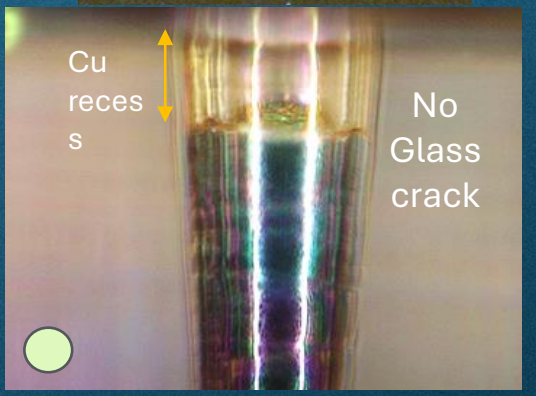
c. High Mod. Low CTE liner





d. Low Mod. Low CTE liner





Top Down

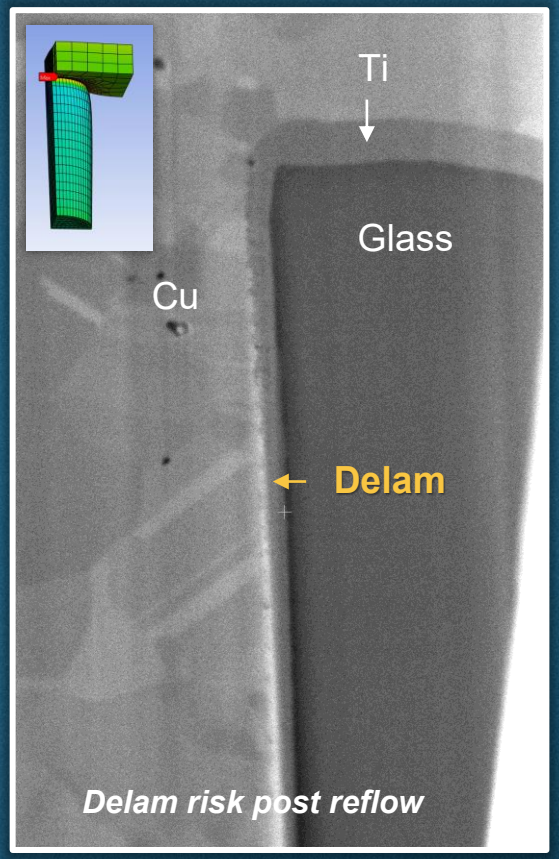
X-section

Applied' s novel CVD material solution acts as a stress buffer film between glass and seed and successfully mitigates glass cracking issue to demonstrate reliable TGV structure.

Multipurpose Liner| Seed Adhesion Improvement

HVPs: *The glass to Cu seed adhesion is poor leading to processing challenges and reliability risks. The current adhesion improvement solutions are multi-step and require high temperature processing.*

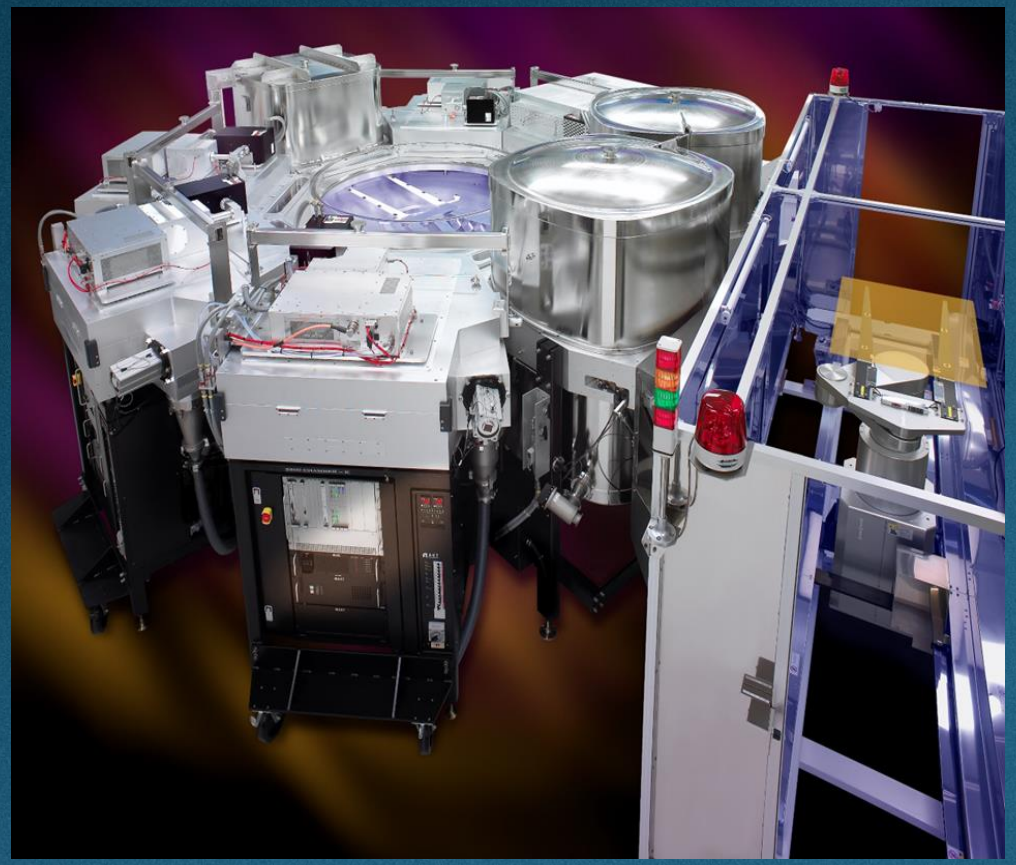




Applied' s CVD liner solution improves the Ti/Cu seed adhesion to up to 2x thus improving TGV reliability without needing a high temperature post process step.

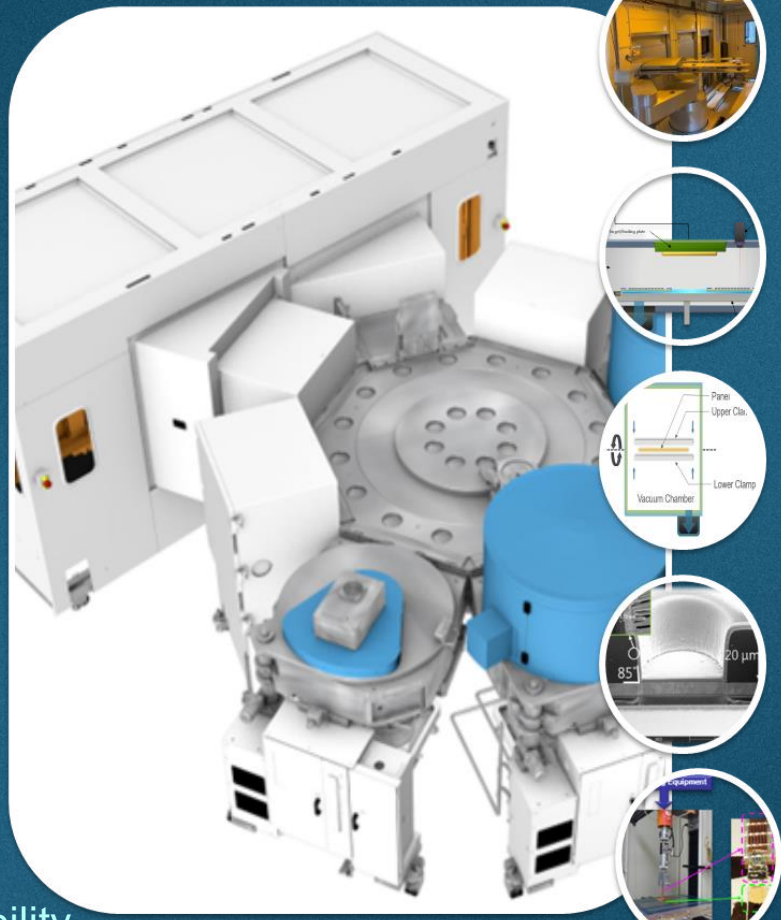
Applied’ s Unique Panel Packaging Portfolio

CVD5000PLP



Wider deposition temperature (80-400C) and process tunability

Topaz PVD



Thin Panel Handling

Substrate Temp. Control

Dual side Processing

Excellent Step Coverage

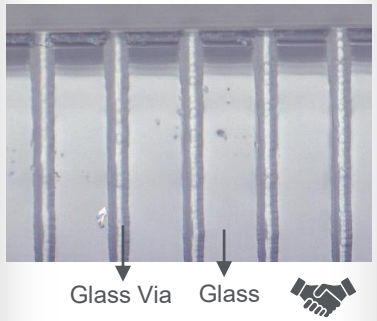
Excellent Film adhesion

Applied’ s Panel CVD offers a wide process range to tune the liner properties and thickness that offers unique capability to buffer stress for different TGV radius and ARs.

Co-optimized Solution| Towards Reliable Glass Via

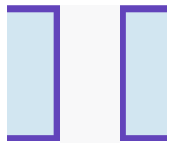
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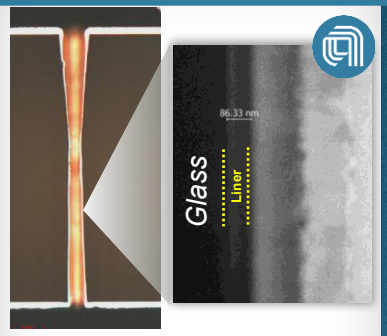
Wet Etching



- [x] Panel scale profile control

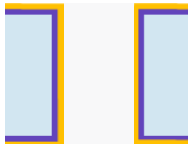
Liner Deposition

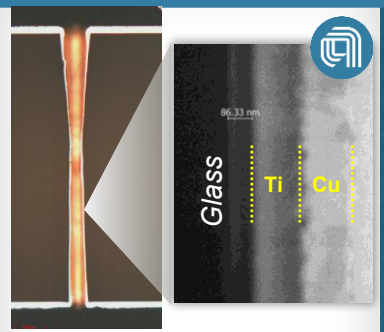




- [x] Stress buffer effect

Seed Deposition

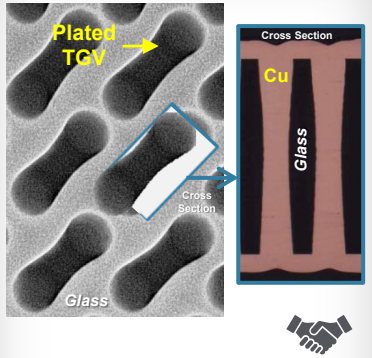




- [x] Step coverage for high AR via

Plating

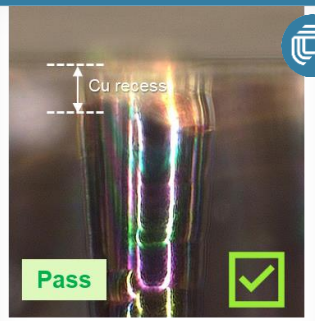




- [x] Uniform fill for TGV structure

Via Reveal & Annealing





- [x] Improved Reliability

Key HVPs addressed and co-optimized process demonstrated as a proof of concept for improved TGV Reliability

Applied' s unique co-optimized solution addresses the key challenges in the TGV process flow and helps improve TGV reliability which is a big step towards industry adaption of Glass for panel packaging.

Applied' s Differentiated Approach for TGV Reliability

- ✓ *Reliable Through Glass Via flow enablement is a key step towards adaption of glass for panel packaging.*
- ✓ *Glass cracking and low seed adhesion are identified as key challenges to reliable TGV flow enablement.*
- ✓ *Applied' s modelling enabled novel CVD liner technology improves TGV reliability by acting as a stress buffer layer (stress reduction up to 60%) to reduce glass cracking.*
- ✓ *The CVD liner solution additionally helps to improve seed adhesion to glass irrespective of the glass type thus giving flexibility of glass type selection.*
- ✓ *The co-optimized solution/ technology and methodology developed by Applied can be deployed to enable reliable TGV flow at Panel scale.*



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Material Innovation