MOSAIC microsystems

Thin Glass Substrates with Through-Glass Vias

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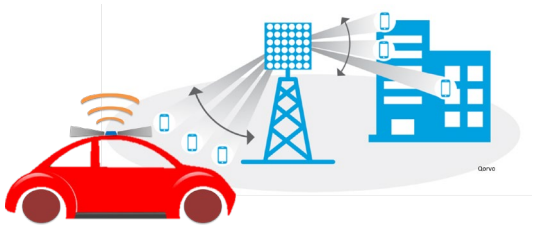
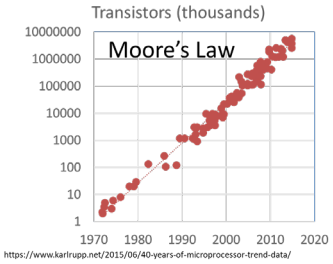
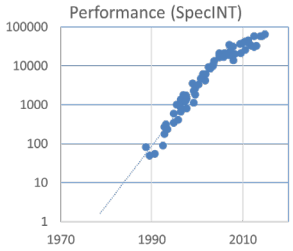
Outline/Agenda

- Motivation
- Advantages of glass packaging solutions
- Handling challenges
- Solutions to enable volume manufacture
- Summary
- Q & A

Forces of change



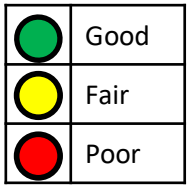




IC performance is not keeping pace with Moore's Law

- New material solutions are needed to address needs in RF communications
- New packaging solutions are needed to extend industry performance targets

Glass has advantages over other materials



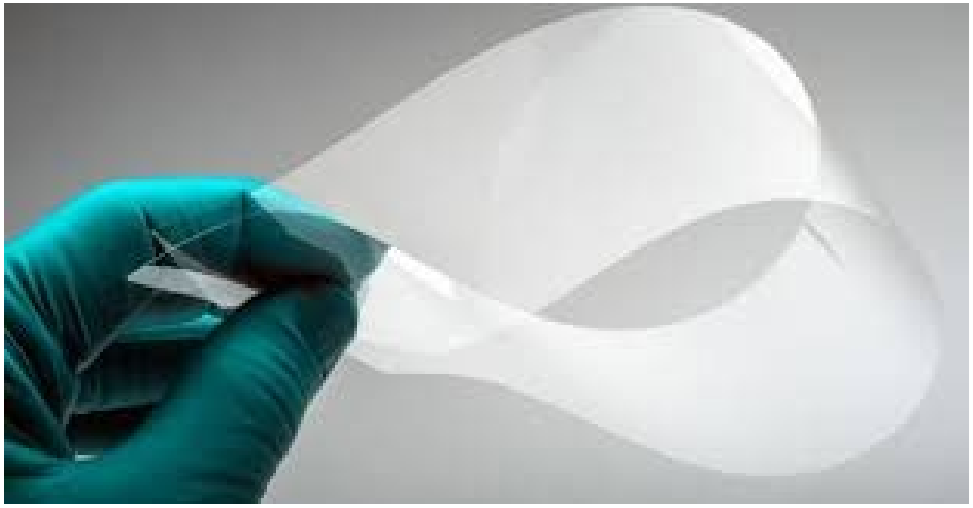
Based on chart from Georgia Tech PRC

Characteristic	Ideal property	Materials			
		Glass	Si	Organic	Ceramic
Electrical	• High resistivity • Loss loss, low k	🟢	🔴	🟢	🟢
Physical	• Smooth surface • Large area scalability • Ultra thin	🟢	🟡	🟡	🟡
Thermal	• High conductivity	🟡	🟢	🔴	🟡
Mechanical	• High strength, modulus • Low warpage	🟡	🟡	🔴	🟡
Chemical	• Resistance to process chemistry	🟢	🟡	🟡	🟡
Via and RDL cost	• Low cost for both	🟡	🔴	🟡	🔴
Reliability	• CTE match to Si and PWB	🟢	🟢	🟡	🟡
Cost/mm^2	• @25 um I/O pitch	🟢	🔴	🔴	🔴

- ✓ Low loss
- ✓ CTE match
- ✓ Smooth
- ✓ Cost-effective
- ✓ Scalable

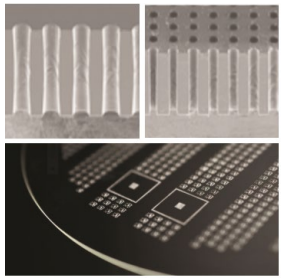
Flat, smooth, and extremely thin glass is available in the market

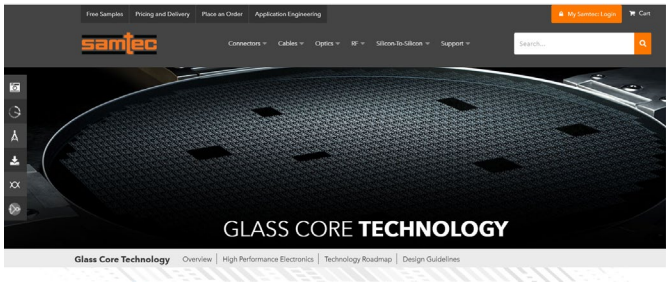
www.mtixtl.com

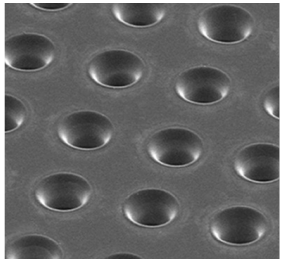


Through-glass via (TGV) solutions have been developed

TGV examples (not exhaustive)







AGC
https://www.agcem.com/index.php/advanced-packaging/3-en-a1-glass-for-tgv-wlp-and-mems

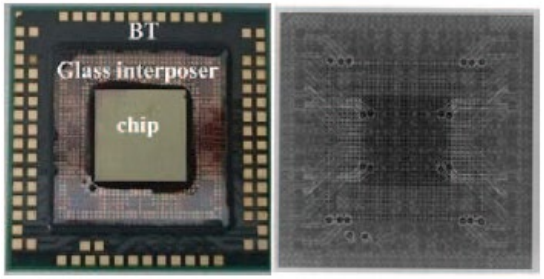
Schott
https://www.us.schott.com/english/news/press.html?NID=com4588&wss_setorigin=1&wss_iso=en-US

3D GS Enabling the GHz Generation

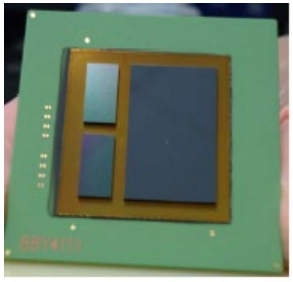
Microplex, Inc.

Many demonstrators and products have been made
Blind via and through via processes

Interposers

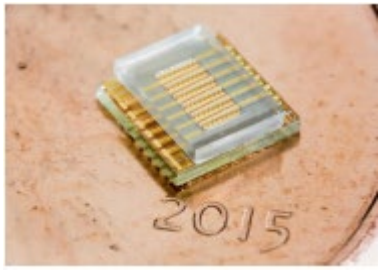


Lee et al.
IMPACT 2016



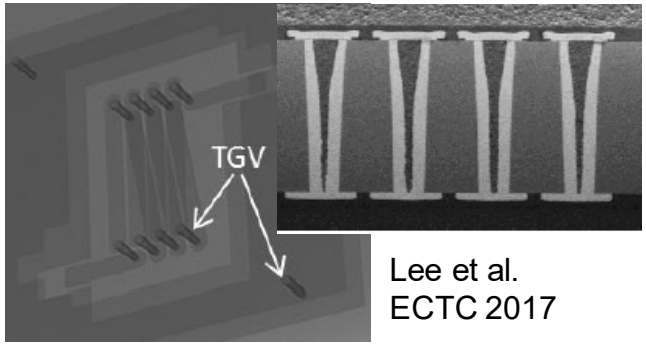
Hedrick et al.
ECTC 2016

MEMs

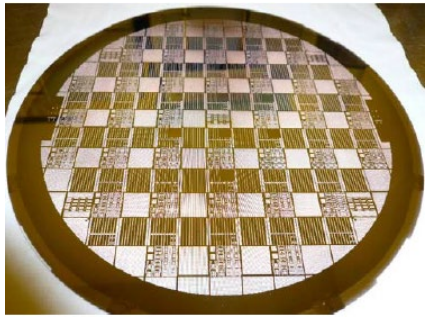


Moran et al.
EuMW 2016

IPD

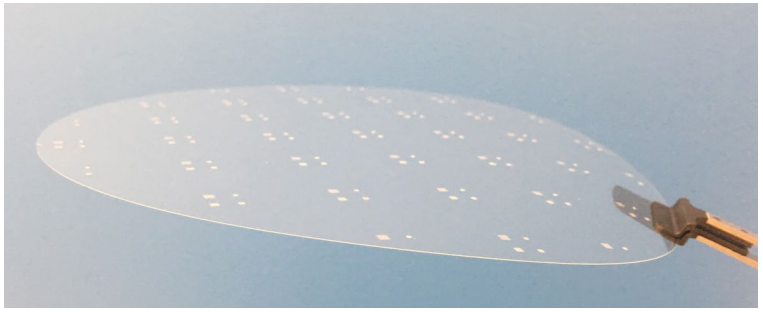


Lee et al.
ECTC 2017

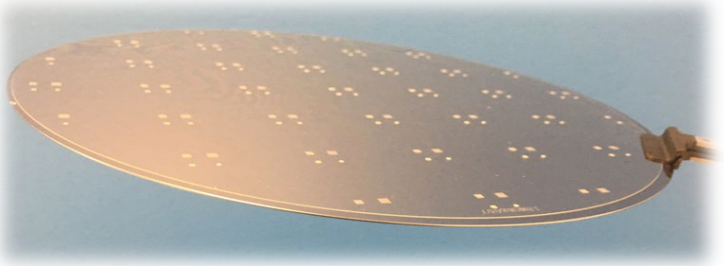


Kuramochi et al.
ECTC 2014

Industry gaps still exist for thin-glass TGV

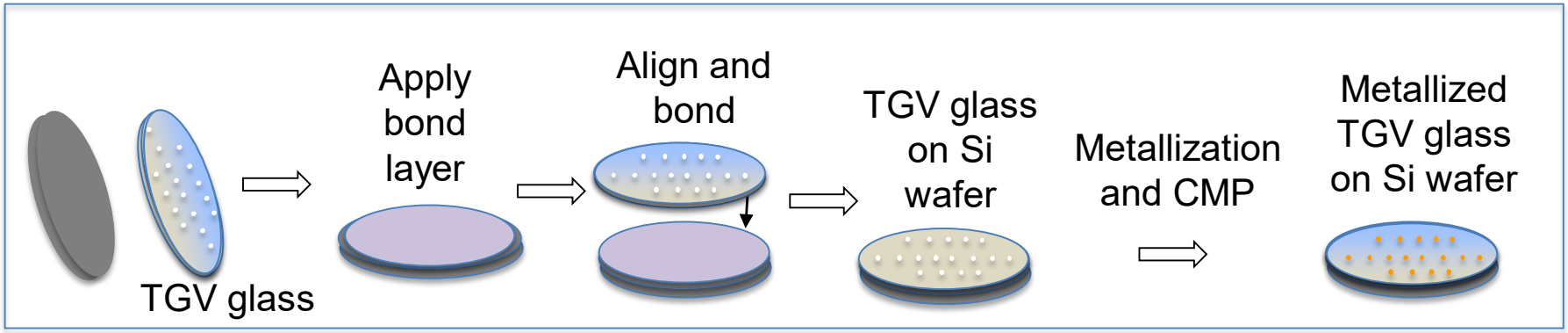


New approach to enable thin glass

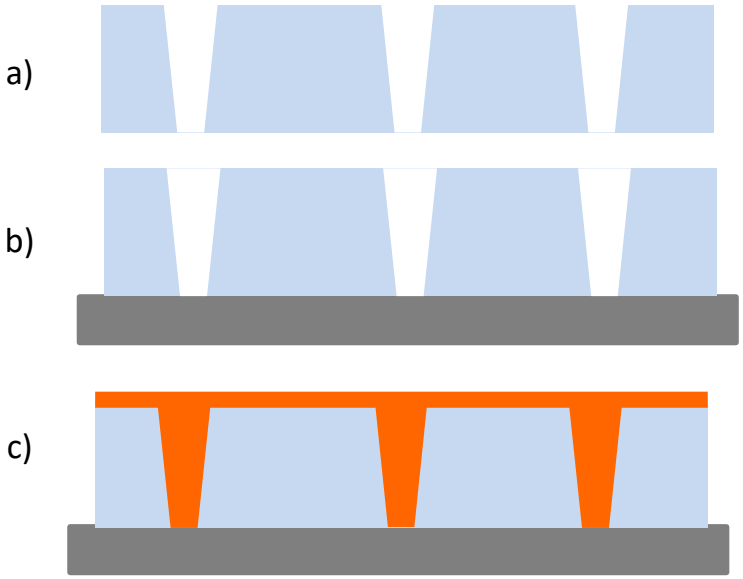


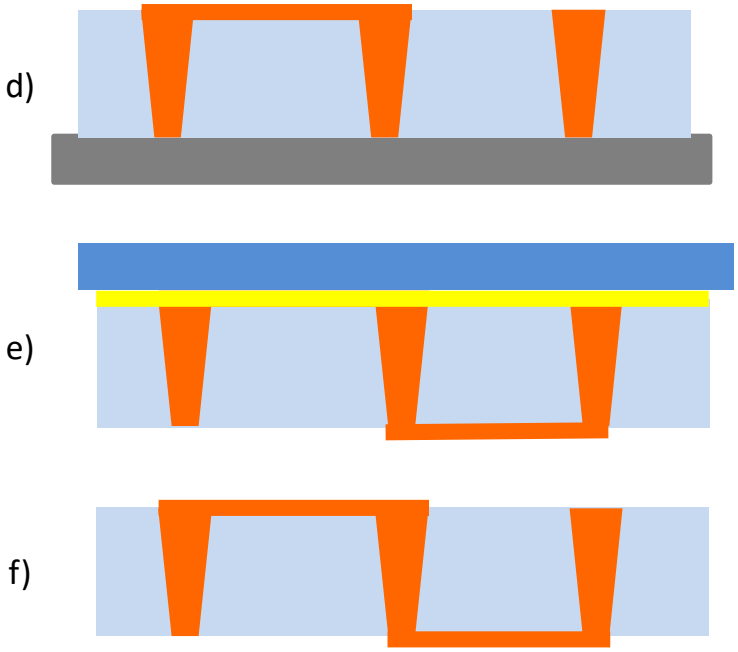
Can be processed like a standard silicon wafer

Mosaic Process Flow

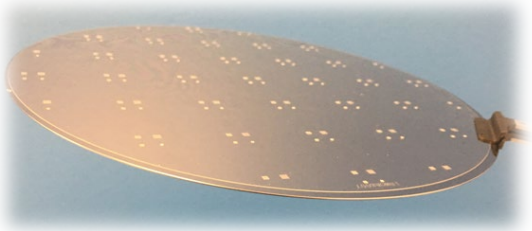


Mosaic Process Flow – Via fill



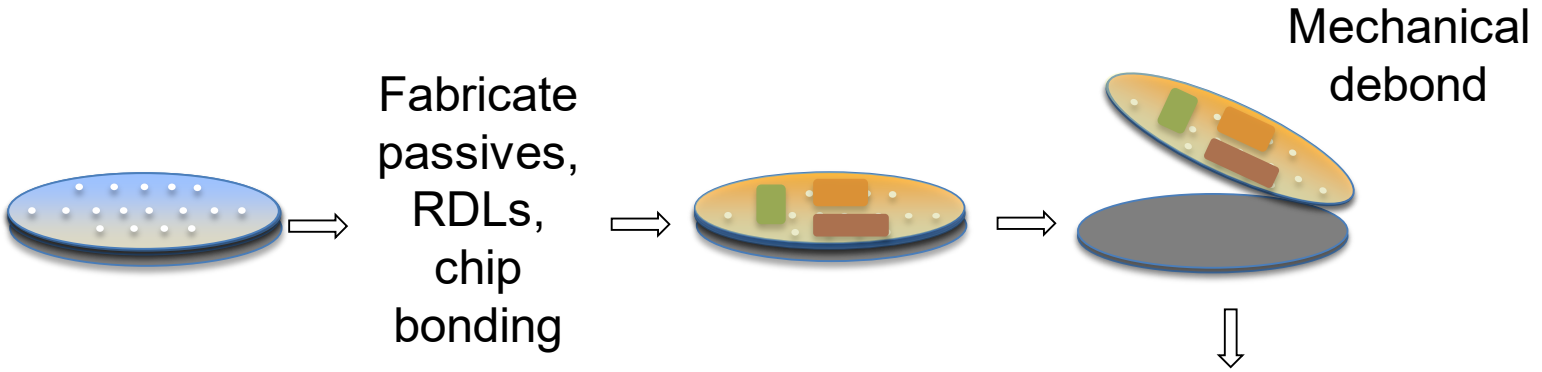


New proprietary bond approach is key

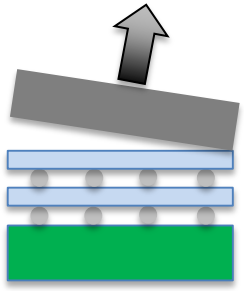


Mechanical de-bond with low force

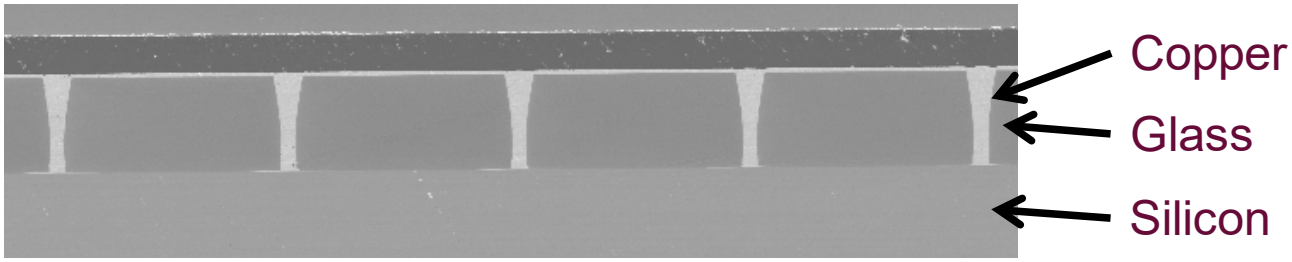
Integrating with downstream processes is straightforward



- Straightforward integration with existing infrastructure (Si fab, TSV processes)
- Mechanical de-bond provides attractive integration approach
- Overall process is scalable

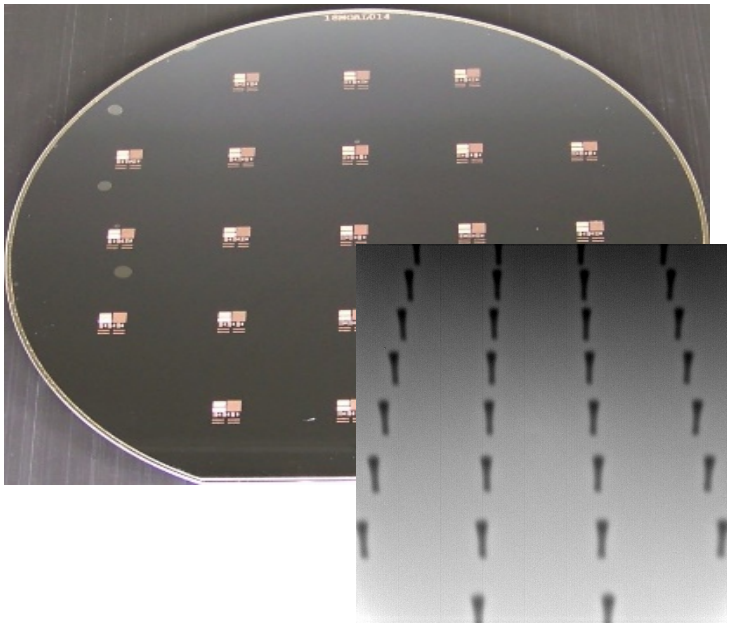


Via Fill: Mosaic TGV plated on Si carrier SG3, 100 um thick



- Achieved void free via fill – important for reliability

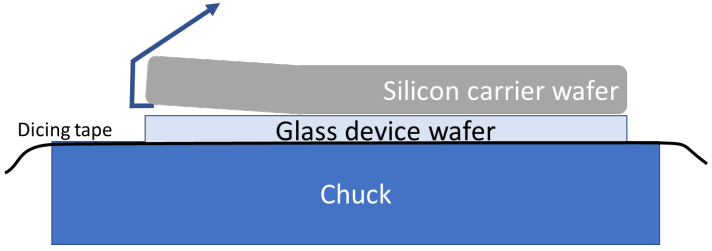
CMP: Wafer after via fill and CMP

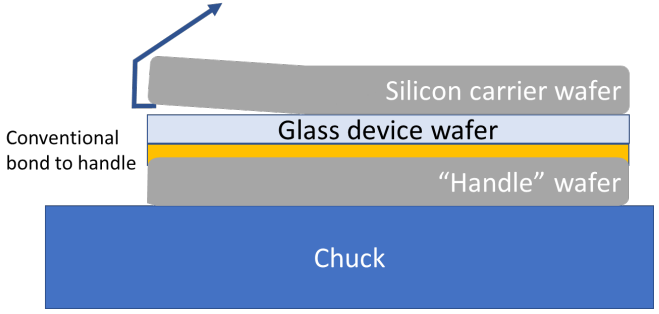


- All wafers successful Cu overburden removal/CMP

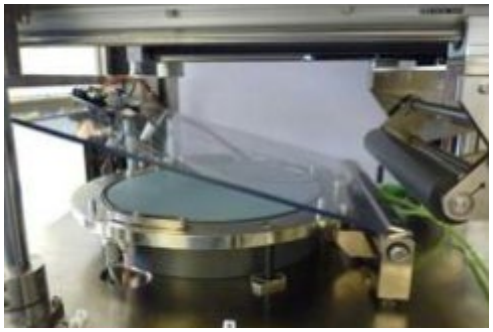
Mechanical De-bond Options

- Glass “device” wafer mounted to dicing tape
- Carrier wafer is removed (mechanical deformation is on carrier, not thin glass)





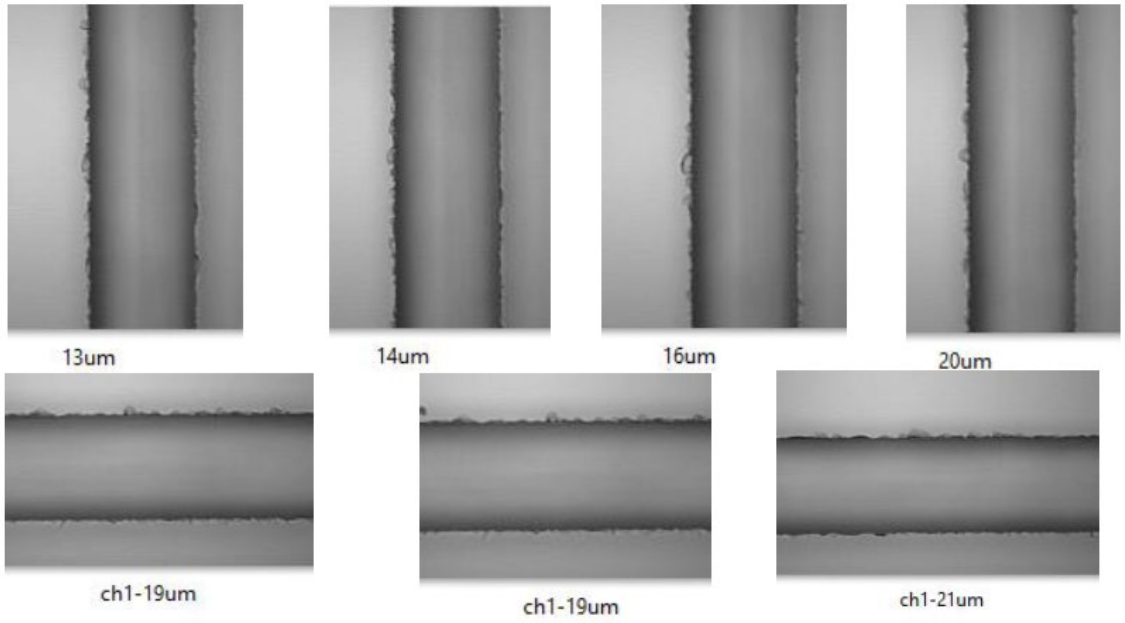
Mosaic Mechanical De-bond Demonstrated with Commercial Tools



https://www.slideserve.com/siyavash-tareq/room-temperature-temporary-bonding-debonding-processes-for-2-5-3d-integration

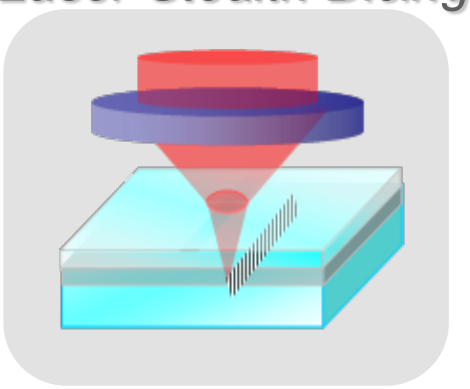
- Onto dicing tape
- Onto Brewer Science temporary bond to handle

Singulation: Accretech saw dicing SG3 glass

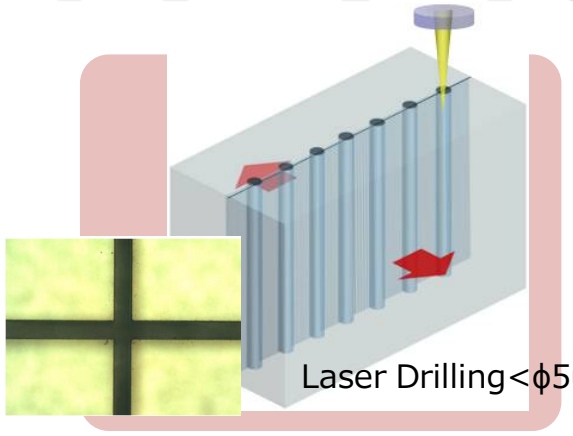


Singulation: Disco saw and laser
Experience with many glass types

Laser Stealth Dicing



Laser Enhanced Ablation Filling

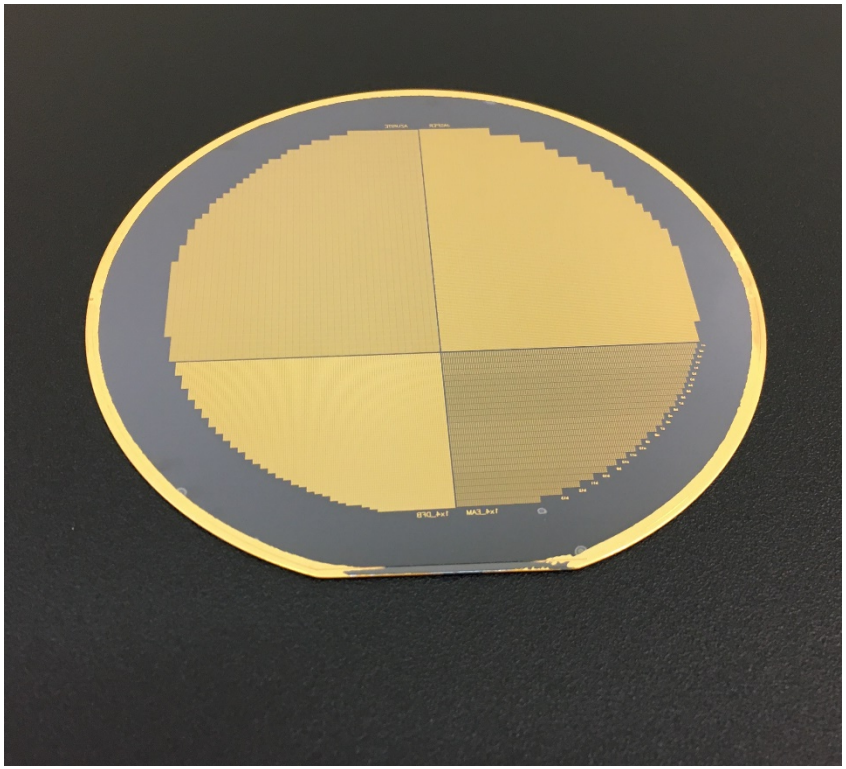


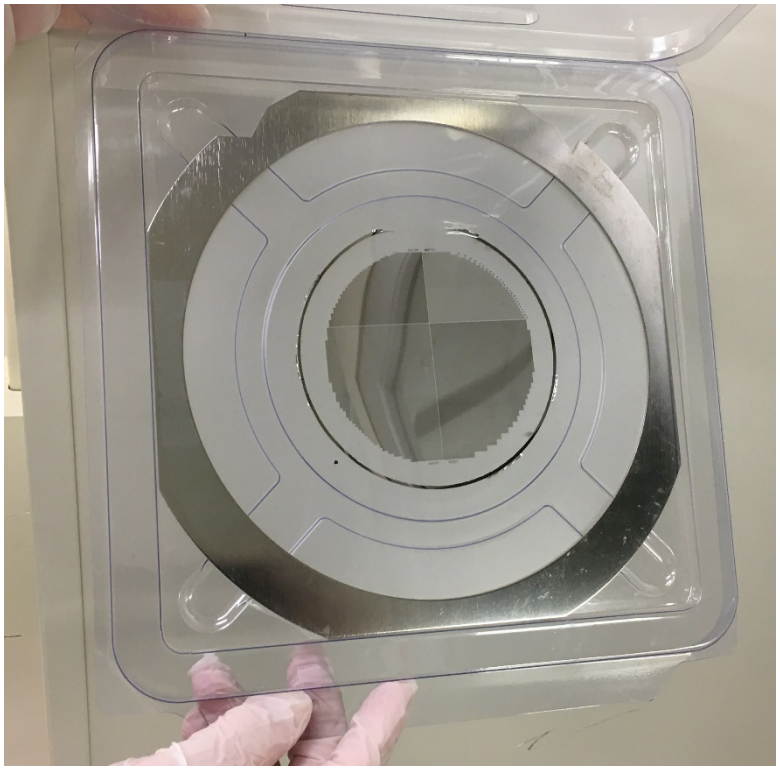
Blade Dicing

Glass Dicing	Laser Stealth Dicing	LEAF	Blade Dicing
Process Env't	DRY	DRY	WET
Process Speed	FAST	FAST	SLOW
Kerf	NARROW	NARROW	WIDE
Ancillary Process	TAPE EXPAND – THIN BREAKING – THICK	TAPE EXPAND – THIN BREAKING – THICK	NONE

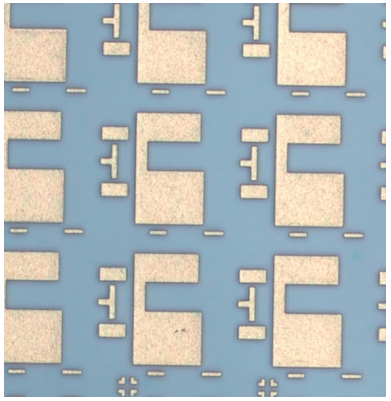
Recent 100x0.1 mm wafer – Plated and de-bonded

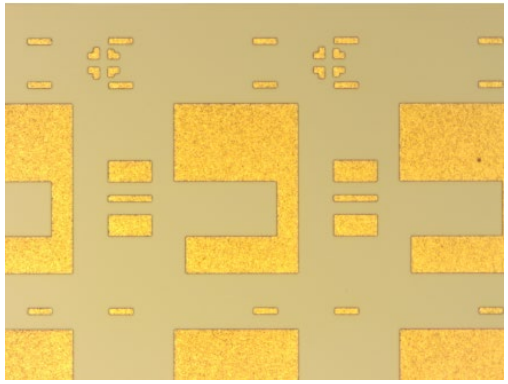
All wafers yielded

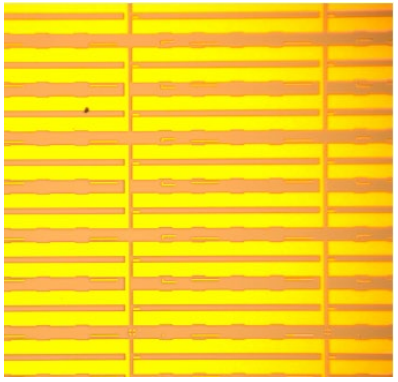


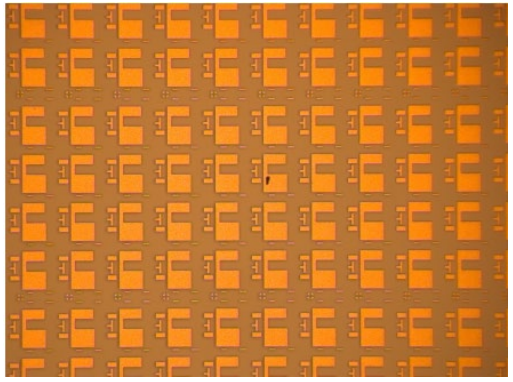


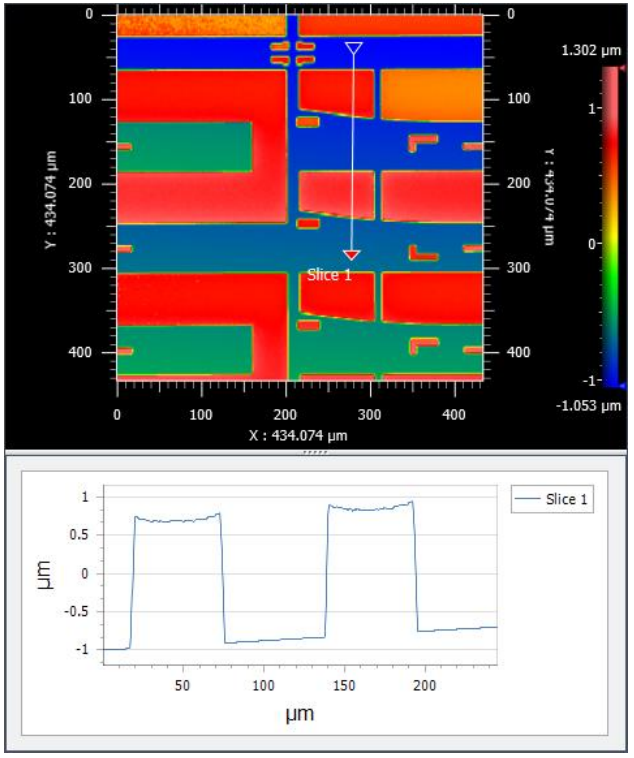
Recent 100x0.1 mm wafer ~2 um Ni/Au structures





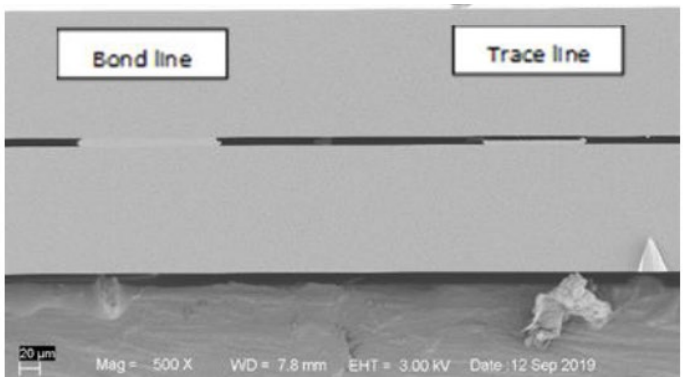


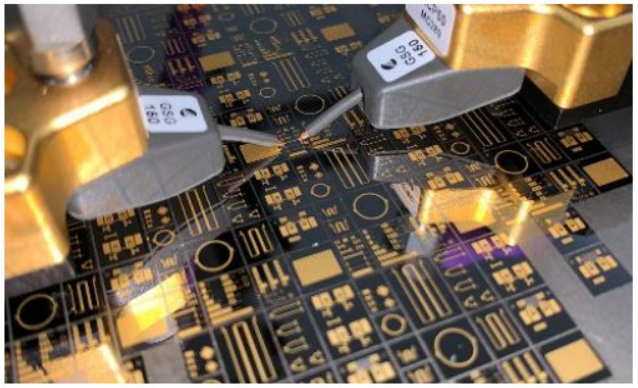




mmW packaging in glass

TEG design, process, test provided by GE Research





- 0.15 mm thick fused silica
- Thermal compression bond Au

Future implementation

- Multi-layer thin glass with integrated passive devices
- Mosaic handling approach suited for multi-layer structures

March 3 2020 - Press Release

Mosaic Microsystems Summary

Thank You!

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