TGV and Integrated Electronics

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ASAHI GLASS CO., LTD.

Ambient Intelligence

semi

Smart Mobility

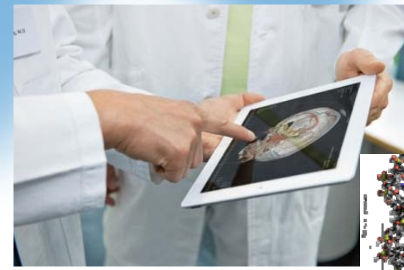
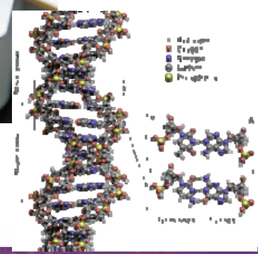
Green Energy/Environment

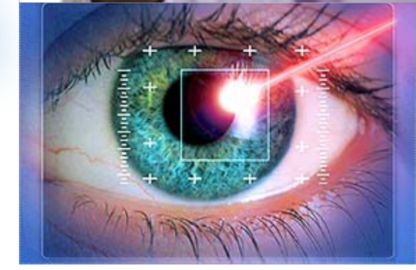
Smart Factory

BIG DATA

AI & IOT & SENSORS

Smart Mobile Devices



Bio/Medical


Security/Biometrics

Glass and Electronics

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Designing /Decorative material

Opening material

Laboratory glass

Display devices

Optical component

Human interface devices

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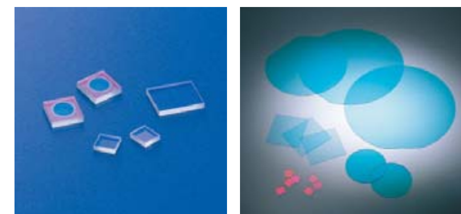

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GLASS FOR SEMICONDUCTOR PACKAGING

Glass for Semiconductor Packaging

- Image Sensor
- MEMS
- Integrated Passive Devices
- Photonic Devices
- 2.5D/3D Integrated Packaging
  - Interposer

Glass for "Diverse Packaging"

Comparison – Substrate Core

good | fair | poor

Characteristic	Ideal Properties	Substrate Core		
		Organic	Si	Glass
Electrical	- High resistivity - Low loss, Low K	good	poor	good
Physical	- Smooth surface - Thin and Large size availability	fair	fair	good
Thermal	- High Conductivity	fair	good	poor
Mechanical	- High Strength, High modulus - Low warpage	poor	fair	fair
Chemical	- Resistance to process chemicals	fair	fair	fair
Reliability	- CTE matched Si and PCB	fair	good	good
Cost	- At 25um pitch I/O	poor	poor	

Today's technologies are too expensive. .. Looking for "Third Option".

Motivation for Glass Interposer

- Large glass core
- Low warpage
- Good electrical properties with low loss, low dielectric constant and high resistivity

Many Challenges for Glass Interposer

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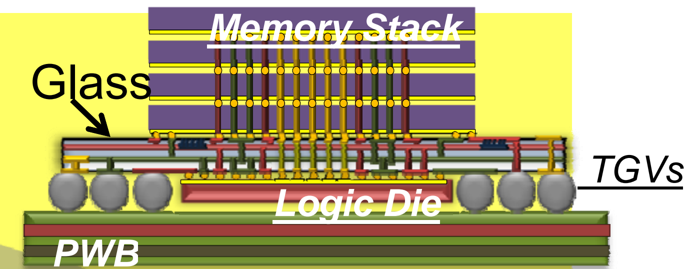
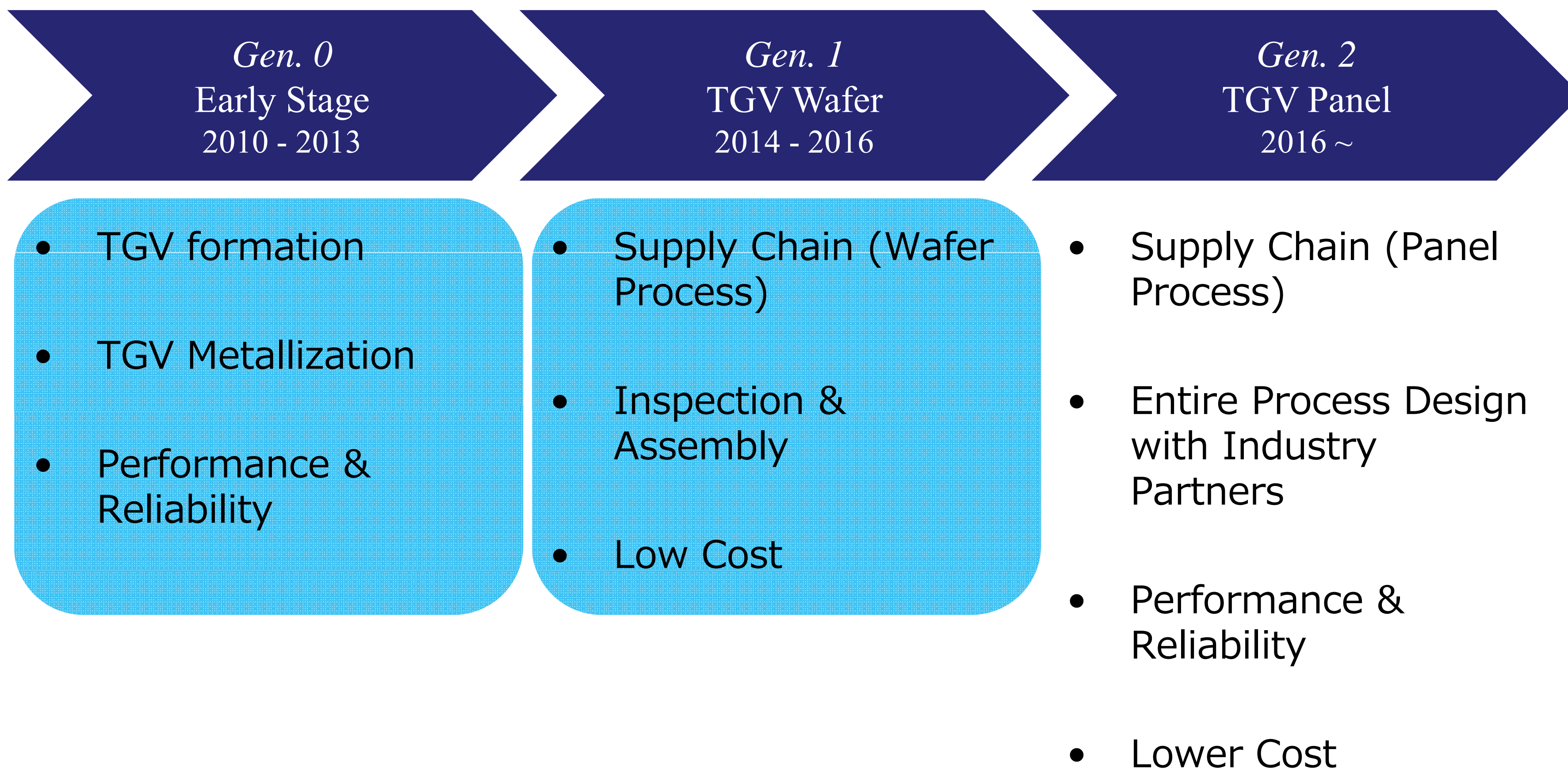
Technical Challenges (driven by Industrial Consortia)
- Productive TGV formation
- Fine wiring
- Micro bumping & Interconnection
- Assembly
- Inspection
- Demonstration
- Characterization and Reliability
- Low cost technical concept



Industrial Challenges
- Process Integration
- Supply chain
- Standardization
- Low cost and higher yield
- Volume

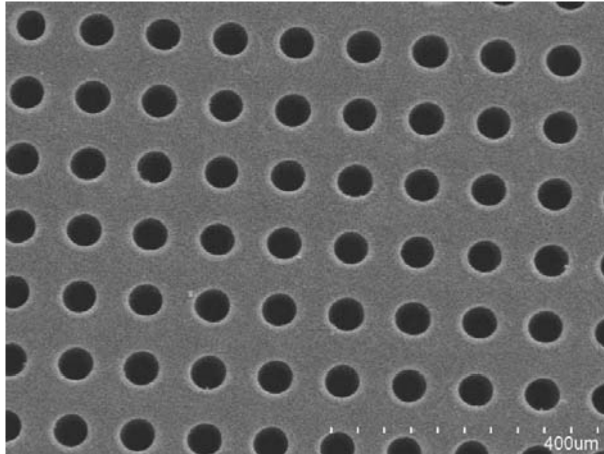
Key Challenges



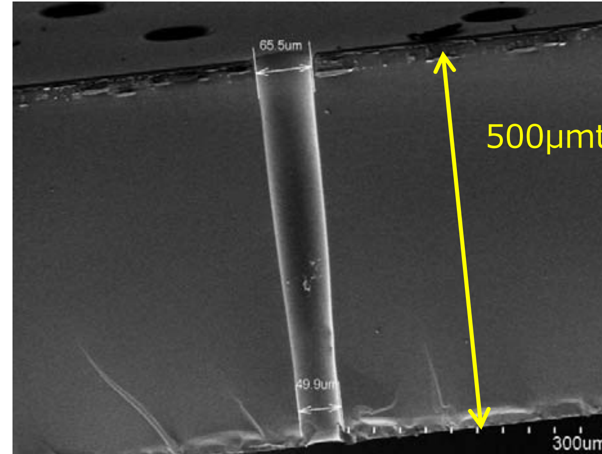
RECENT RESEARCH ACTIVITIES FOR GLASS INTERPOSER

Glass is only the beginning…

Pitch: 120um, Diameter: 60μm(TOP)
(Thickness: 300um)

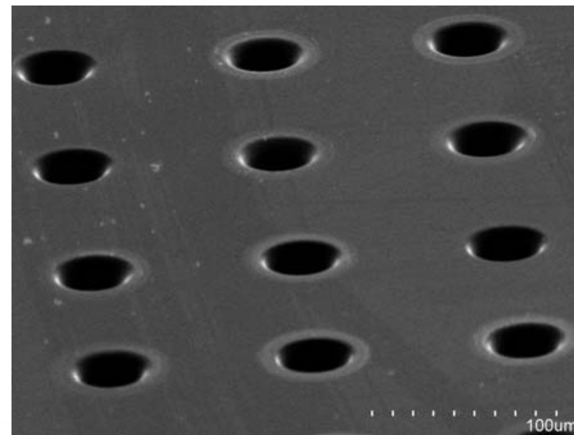


Pitch: 150μm, Diameter: 65μm(TOP)
(Thickness: 500um)

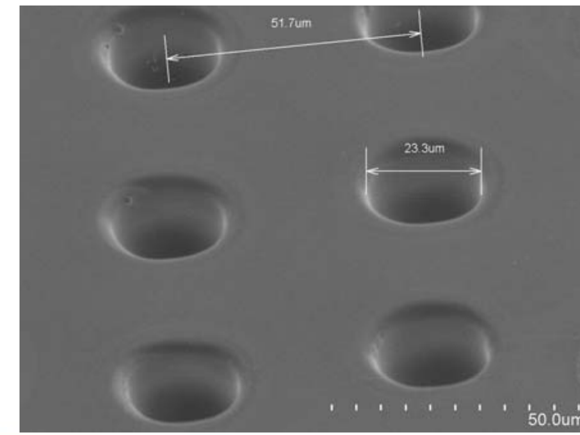


for Thick Glass…

Pitch: 100um, Diameter: 60μm(TOP)
(Thickness: 180um)



Pitch: 50um, Diameter: 25-30μm(TOP)
(Thickness: 100um)



for Thin Glass…

Glass Interposer Manufacturing

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Process Flow

1. Glass hole formation

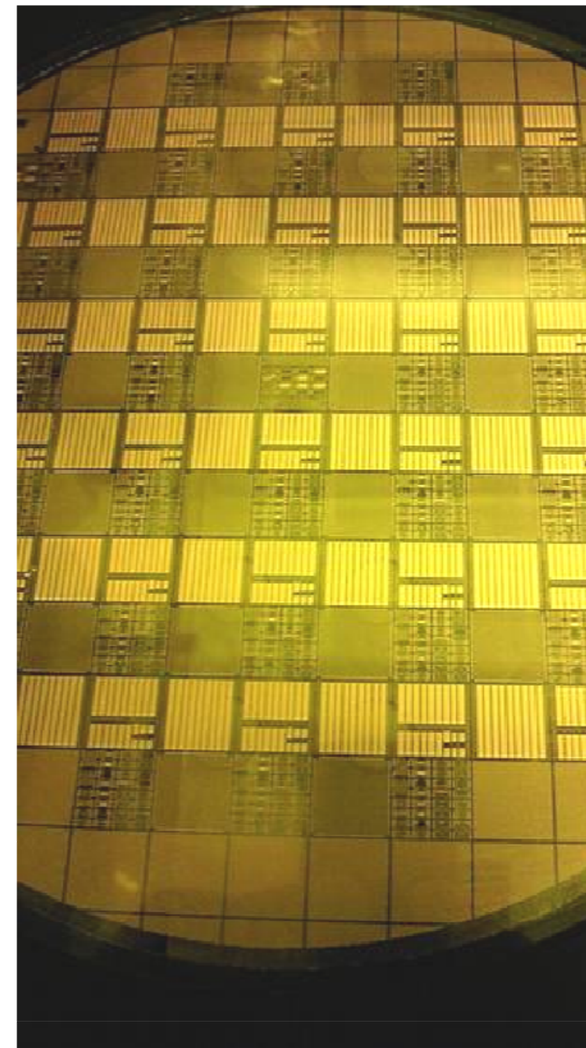
2. Cu plating & CMP

3-1. Dielectric forming

3-2. Seed deposition & Photo litho

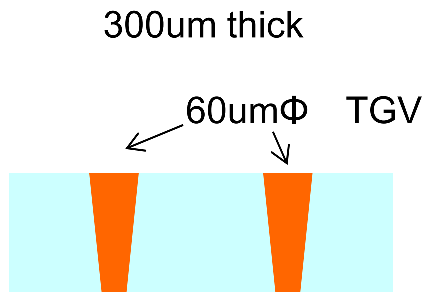
3-3. Cu/Au/Ni plating & Seed etching

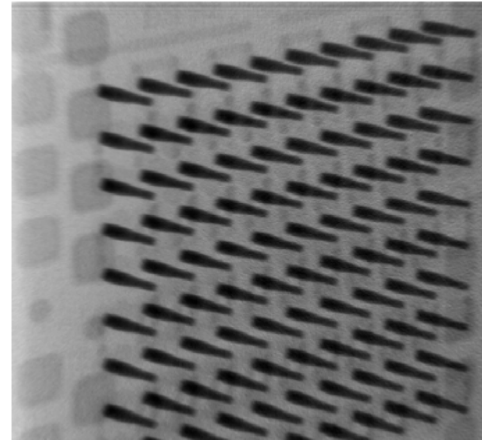
4.

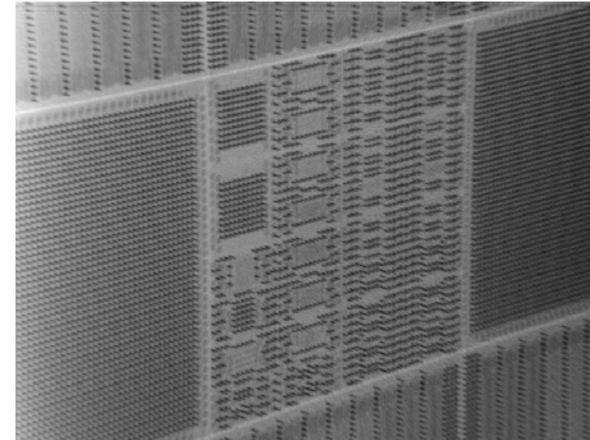


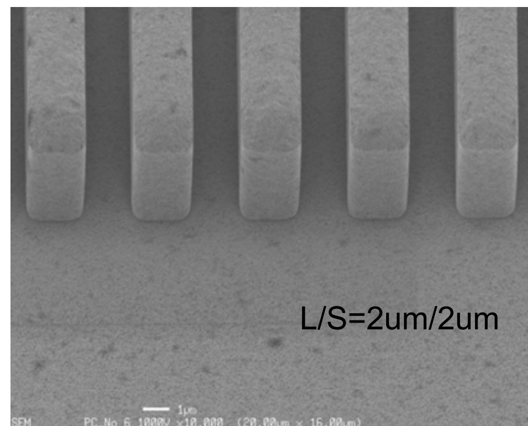
DNP

Cu Metallized Via and Fine Cu Wiring



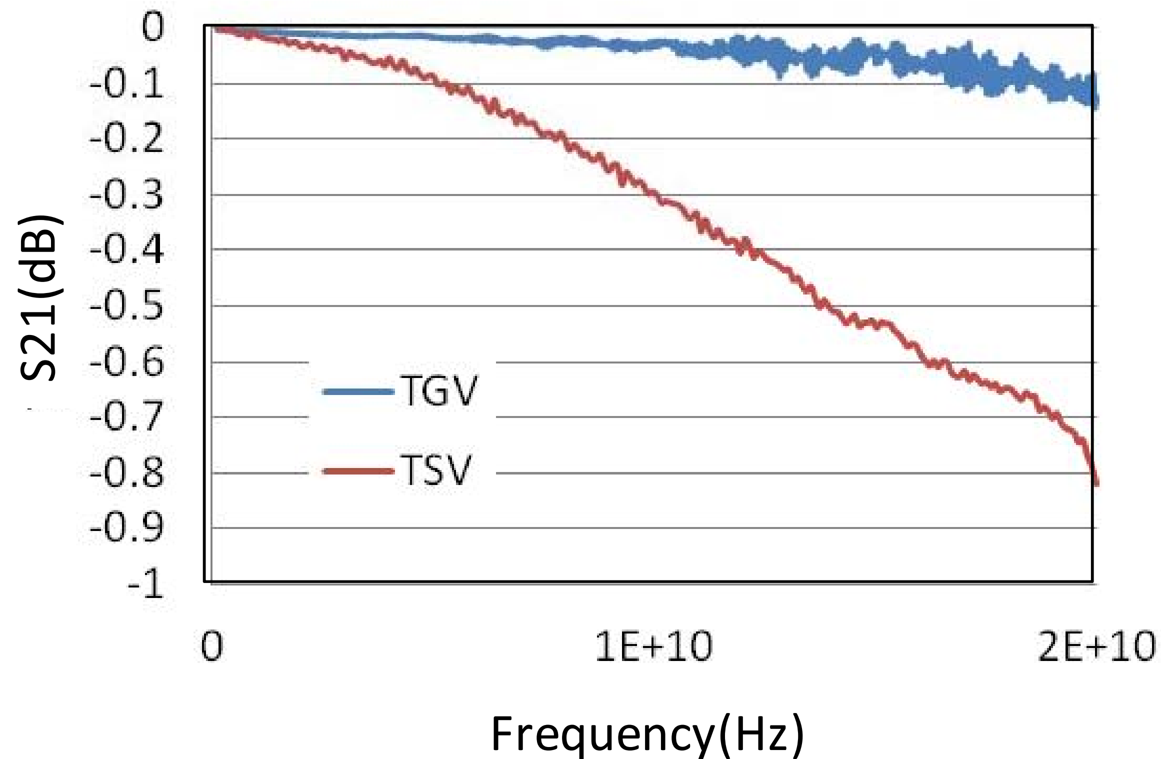






Fine Cu wiring fabricated by SAP (semi-additive process)

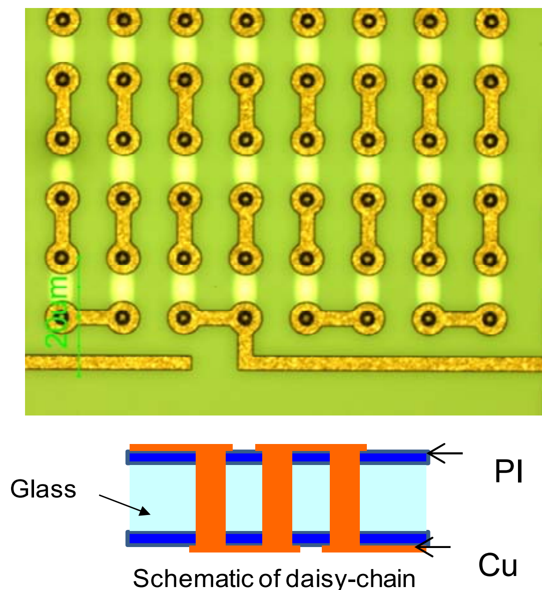
High Frequency Test

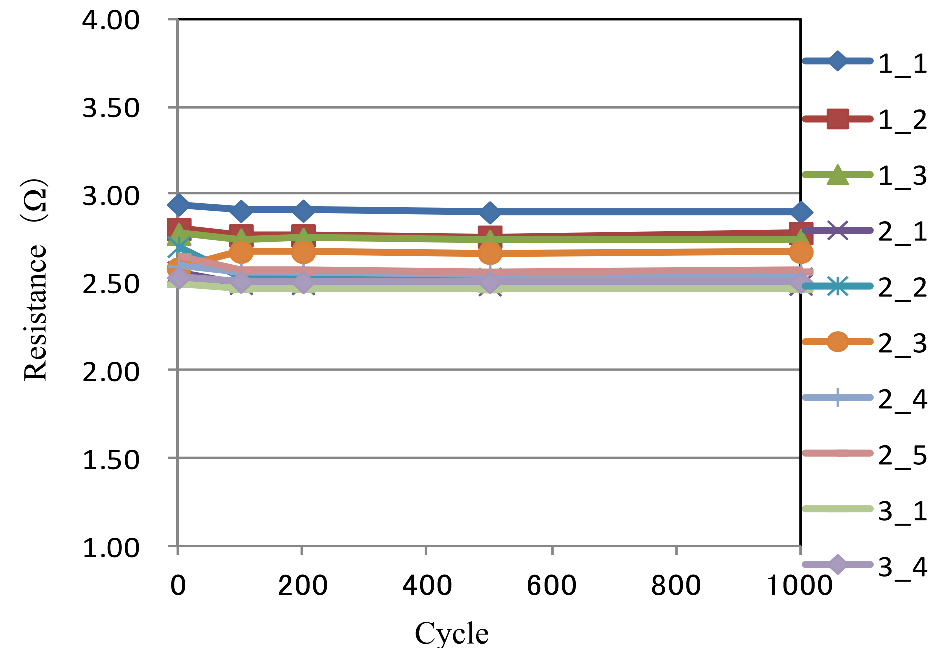


Highly bulk resistance of TGV resulted in insertion loss less than -0.12dB at 20GHz.

Reliability Test

- Fully filled Cu vias
- -40C to 85C with a dwell-time of 30 min. at each temperature (MIL standard 833)



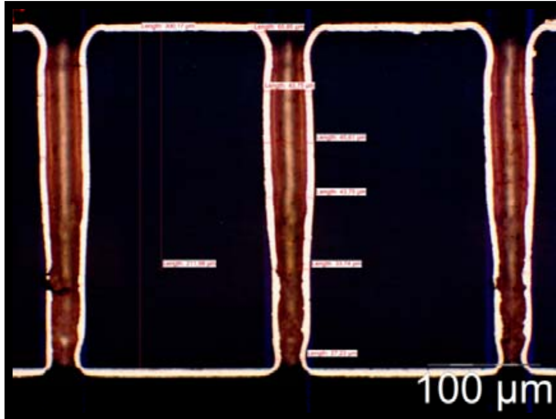


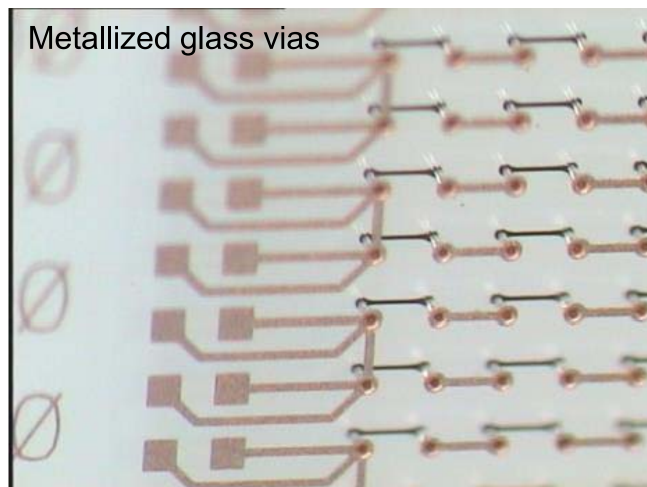
No significant resistance changes after 1000 cycles
Double side thick polymer worked as buffer to relax stress created by CTE mismatch

DNP

Conformal Cu Plating – Electrical Test

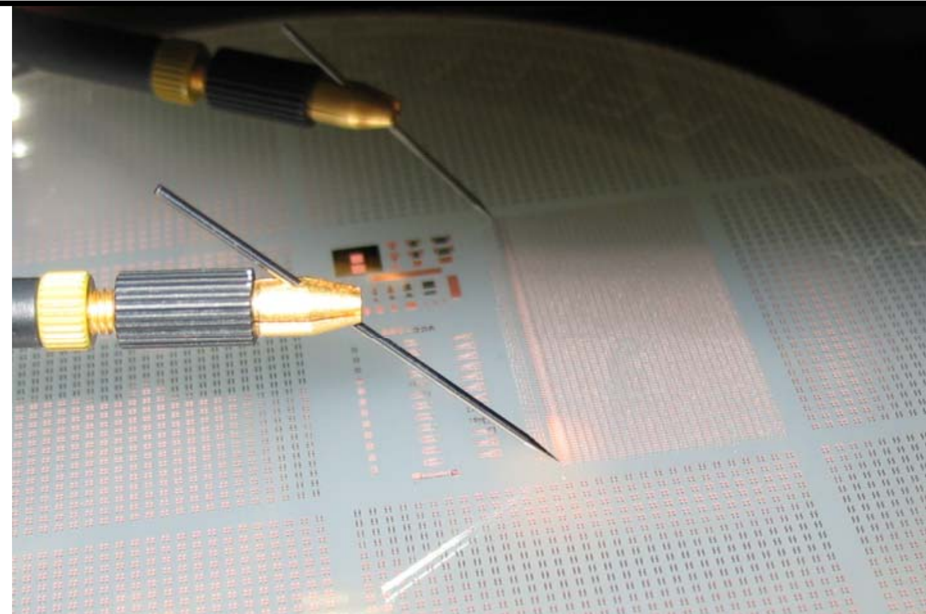
354nmTiW; 1950nmCu (both sides) + thin Cu layer plated



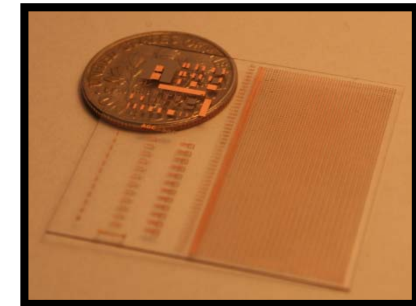


Daisy-chain via test:
- 5000 vias = 45 Ohm
- 2500 vias = 23 Ohm

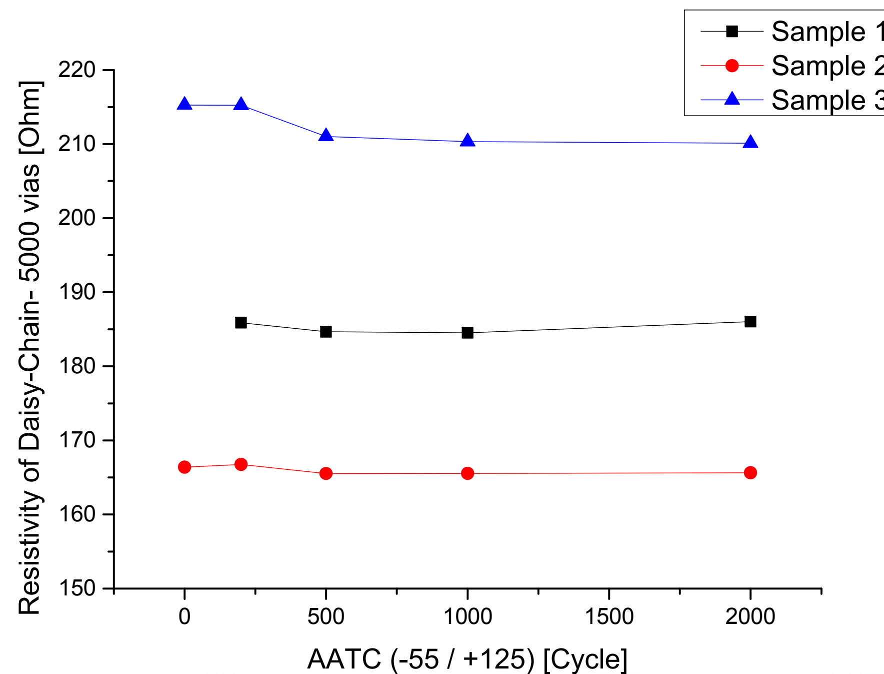
Single via resistance of 15-18mOhm



Conformal Cu Plating – Thermal Cycle Test



- Conformal vias
- 3 step cycling (-55C ; RT; 125C)
- Measurement of daisy-chain based on 100 vias
- Only 4 of 250 measured lines (each consist of 100 vias) show an open circuit
- 3 daisy-chains are measured without significant changes, which consist of 5000 vias

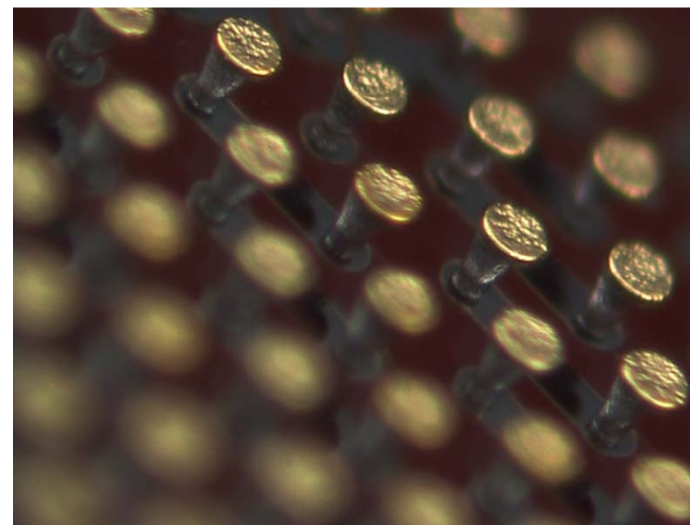


Conductive Paste Filling

Benefit:
Using CTE matched Cu for higher reliability and hermetic seal of TGV

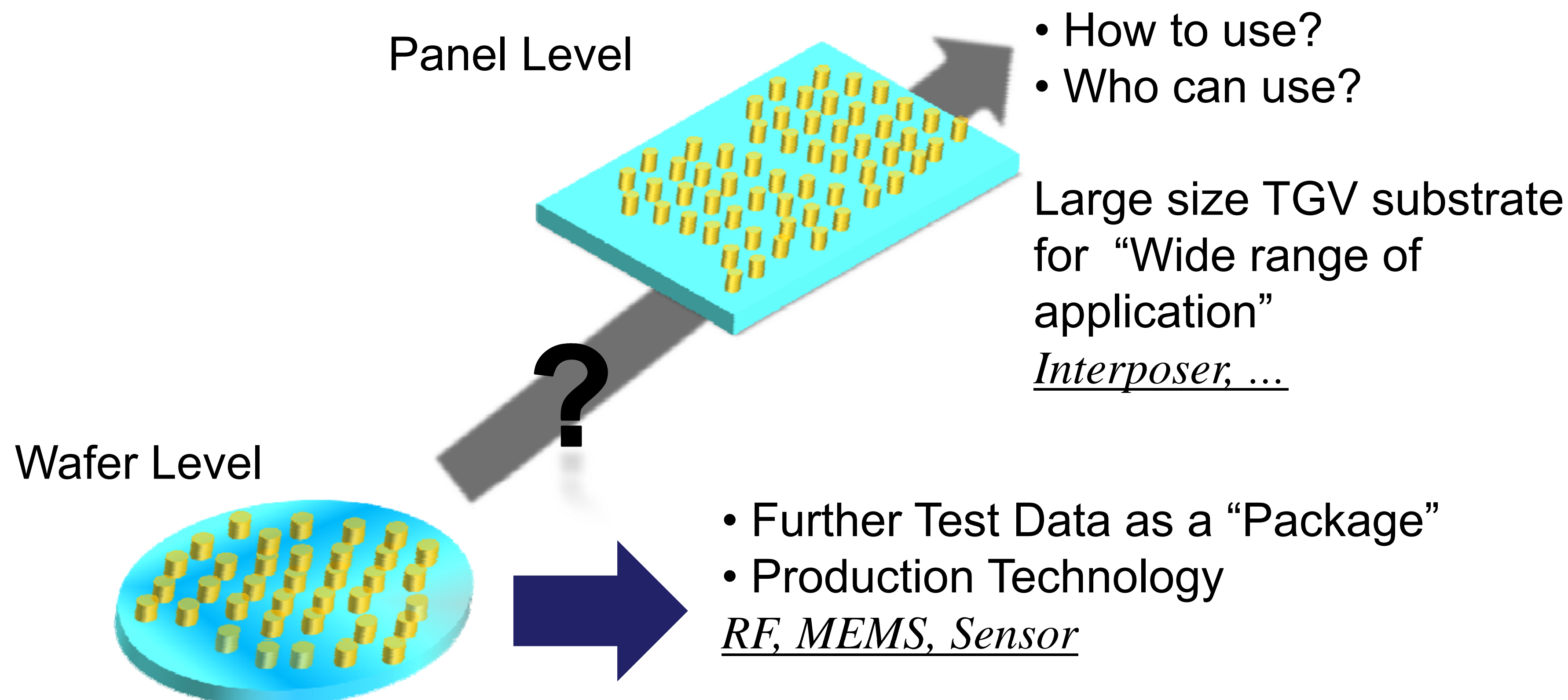
- Capability for 50um diameter via filling with 130um via pitch
- CTE matched Cu

	Demonstration result
Glass thickness	300um
Via pitch	200um
Via diameter	70um (top) 40um (bottom)
Metal via	Cu type



TOWARD TGV PANEL (FUTURE CHALLENGES)

Future Challenges



Roadmap for TGV Commercialization

Substrate Size: 500~ mm□ (upper) / 150 - 200 mm φ (lower)

TGV Diameter (Pitch): 20um (40um) (upper) / 40-70um (150um) (lower)

Technology Today
- 6 – 8 (12) inch glass wafer with through holes
- 300 ~ 500um thick glass wafer
- Metallization by partner (optional)
- Compatible with Wafer Level Process

TGV Wafer
- Better yield & productivity
- 6 – 8 (12) inch glass wafer with through holes
- Metallization (optional)
- Compatible with Wafer Level Process

RF, MEMS, Sensor and others

TGV Panel
- Panel base process: >500mm□
- 30~100um thin glass
- Pre/Post process harmonization is under development

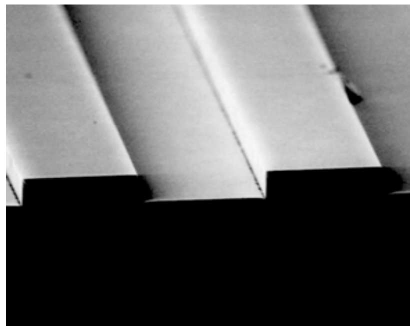
Interposer, other electronic devices

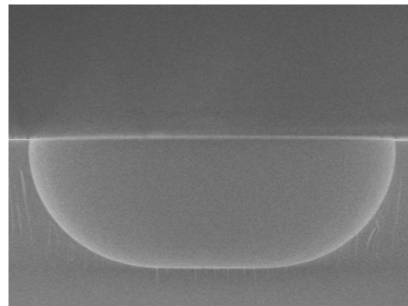
2014 | 2015 | 2016 | 2017

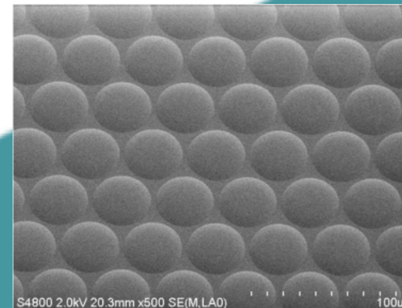
Message

- TGV Wafer:
  - Stepping into Individual Development from Basic Research
  - Needs further reliability test results.
- TGV Panel:
  - It can be the low cost solution for future interposer (needs infrastructure)
- TGV will create the Diverse Packaging not only for the interposer.

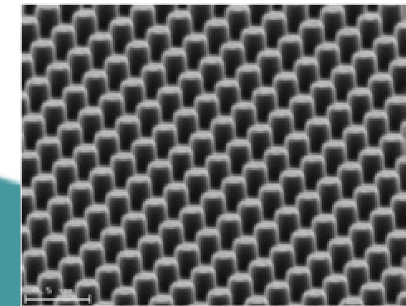
Nano/Micro Fabrication Technology Platform


Dry Etching


Wet Etching

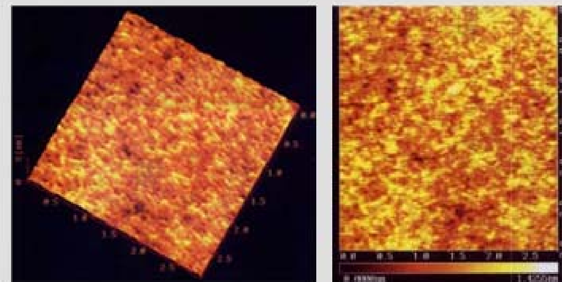


Glass Forming


Nano Imprint

Glass Drilling

ultra thin glass
(50um thick glass)


Super-polishing Ra ≦0.2 nm

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"Look Beyond"

AGC