SEMICON® TAIWAN

# New Era of Panel Based Technology for Packaging, and Potential of Glass


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Electronics Company


AGC 旭硝子

CONNECT

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# Connecting the World

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# Connecting the World

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Smart Mobility

Green Energy /Environment

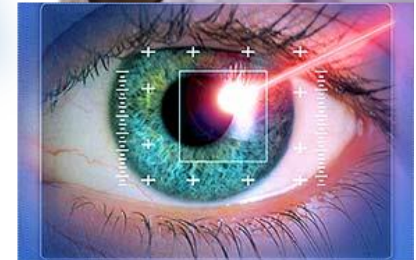
Smart Factory

BIG DATA

AI & IOT & SENSORS

Smart Mobile Devices
Wearable Devices
Wireless (5G)

Medical



Security/Biometrics

# Glass and Electronics

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Designing /Decorative material

Opening material

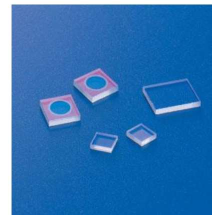
Laboratory glass

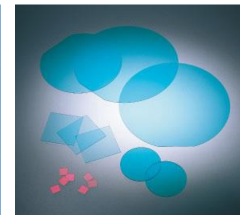
Display devices

Optical component

Human interface devices

*EDO KIRIKO*
*www.edokiriko.or.jp*





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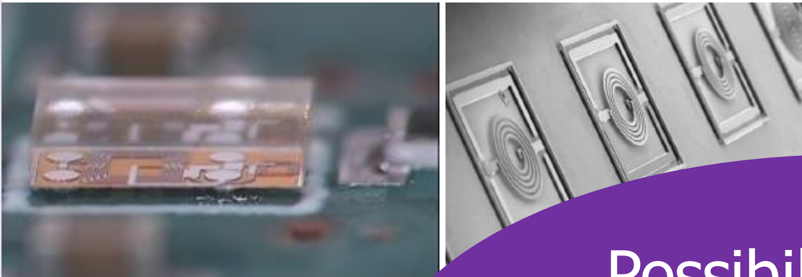
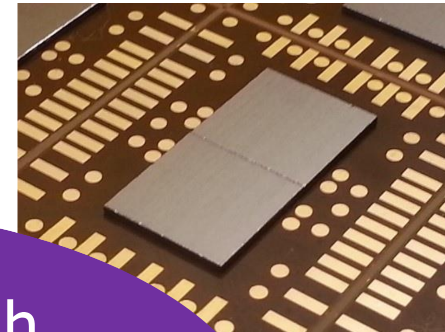
# Glass Benefit for Semiconductor Packaging

## High Resistivity and Electrically Low Insertion Loss



Glass Passive Device
Source: STmicroelectronics

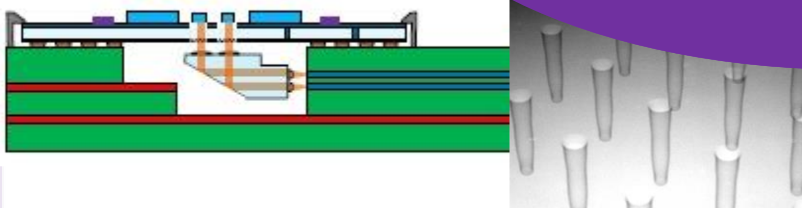
## Dimensional Stability



Demonstrator
ech

Possibility of high volume and low cost based on panel size manufacturing

## Transparency



Transceiver using TGV (Through Glass Vias)
Source: Fraunhofer IZM, GIT2015

FOPLP using Glass Carrier
Source: Sangyo Times

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# Transition to Panel Level Manufacturing

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# Keyword



FOWLP/FOPLP

TGV

# FOWLP/PLP R&D activities around the world

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Fraunhofer IZM's PLP Consortium

- Manufacturing line to transfer PLP technology to industry
- Focusing on Mold first approach

Placement → Accuracy → Molding → Lamination → Laser Drilling

| Placement | Accuracy | Molding | Lamination | Laser Drilling |
|---|---|---|---|---|
| Datacon evo2200/ ASM Siplace CA3 | Mahr OMS 600/ IMPEX proX3 | WL: Towa up to 8" PL: APIC up to 18"x24" incl. 12" WL | Lauffer/ Bürkle | Siemens Microbeam/ Schmoll Picodrill with HYPER RAPID 50 |

Mech. Drilling → Sputter → Cu Plating → Imaging → Etching

| Mech. Drilling | Sputter | Cu Plating | Imaging | Etching |
|---|---|---|---|---|
| Schmoll MX1 | CREAMET 600 CI 2 S3 | Ramgraber automatic plating line | Orbotech Paragon Ultra 200 | Schmid |

Source: Fraunhofer IZM

# FOWLP/PLP R&D activities around the world

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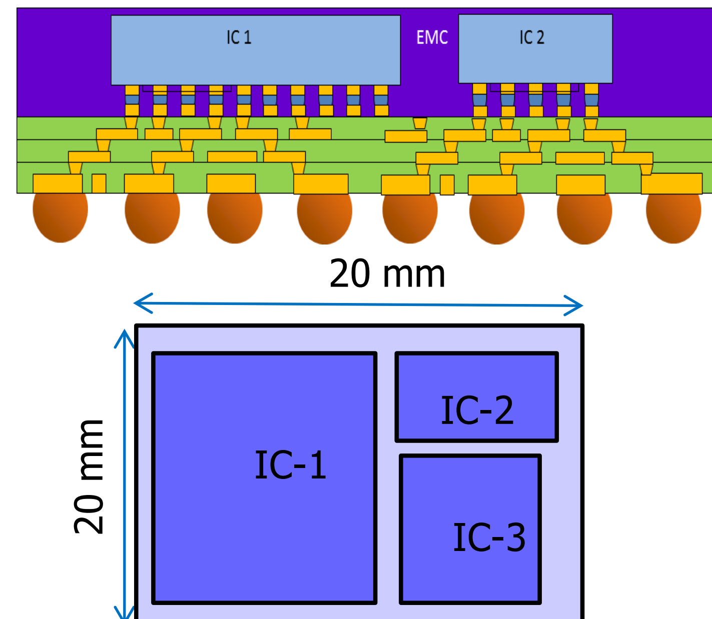
## A*STAR IME's FOPLP Consortium

Focusing on RDL first approach

Plan to establish complete panel line by 2017

- Development of complete packaging process flow with Gen-3 panel
- Qualifying tools and materials for panel-base Fan-out multi-chip packaging

| Package Specifications for Phase-1 | |
|---|---|
| Target App | Tablet, smart phones |
| Package | 20mm x20mm |
| Package thickness | 450um |
| # of I/O | 2400 |
| # of chips/Pkg | 3 |
| Panel size | 550 mm x 650 mm |
| RDL L/S | 2 layers, (10/10, 5/5 um) |
| Benefits | Higher throughput → lower cost |
| Challenges | Handling large panel |
| Reliability | MSL3, TCOB 1000 cycles |




Note: * Spec to be finalized with consortium members

Source: A*STAR IME, Modified by AGC

# Glass Carrier for FOWLP/PLP Manufacturing

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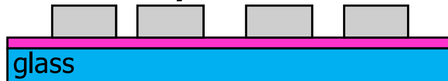
## Mold first

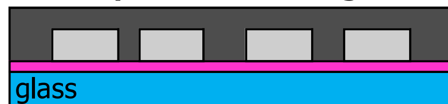
- Carrier for assembly and molding
- Temporary carrier for RDL processing (thin wafer handling, warpage compensation)

Apply thermal release tape on carrier

Die assembly on carrier

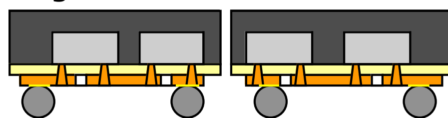


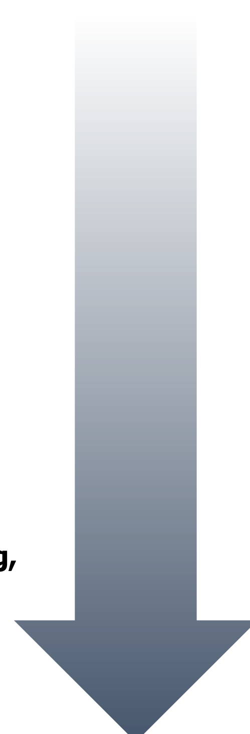

Wafer/panel overmolding




Carrier release

RDL (e.g. thin film, PCB based, ...), balling, singulation



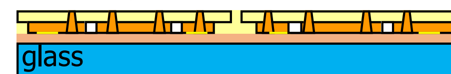


## RDL first

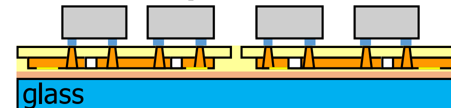
- Carrier for RDL build-up, assembly and molding

Apply release layer on carrier

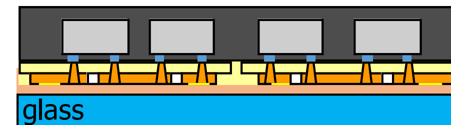
RDL (e.g. thin film, PCB based, ...)



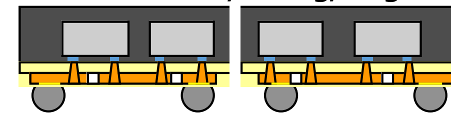

Die assembly on carrier




Wafer/panel overmolding




Carrier release, balling, singulation



Source: Fraunhofer IZM, Modified by AGC

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# Glass Lineup for FOWLP/FOPLP Carrier

| | 3~4 ppm/C | 4~5 ppm/C | 5~6 ppm/C | 6~7 ppm/C | 7~8 ppm/C | 8~9 ppm/C | 9~10 ppm/C | 10~11 ppm/C | 11~12 ppm/C |
|---|---|---|---|---|---|---|---|---|---|
| Alkali free | ■ | ■ | ■ | ■ | ■ | | | | |
| Alkali | | | | | ■ | ■ | ■ | | ■ |

Representative specification for 300mm glass carrier wafer

| | Specification | Note |
|---|---|---|
| TTV | ≦5μm | High spec : ≦1μm |
| Ra | ≦1.5nm | High spec : ≦0.5nm |
| Warpage | ≦100μm | High spec : ≦50μm |

# FOWLP Assembly & Molding with Glass Carrier

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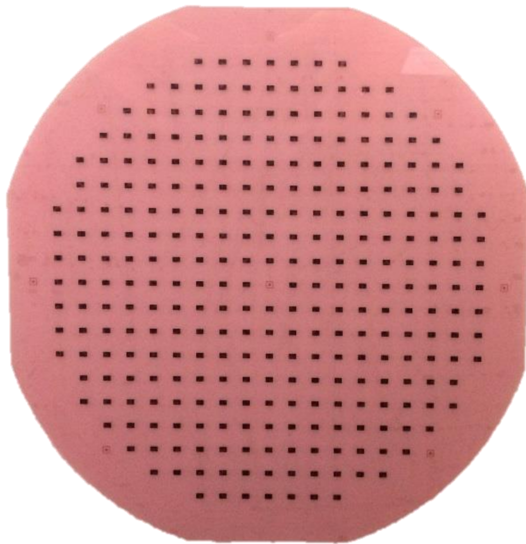
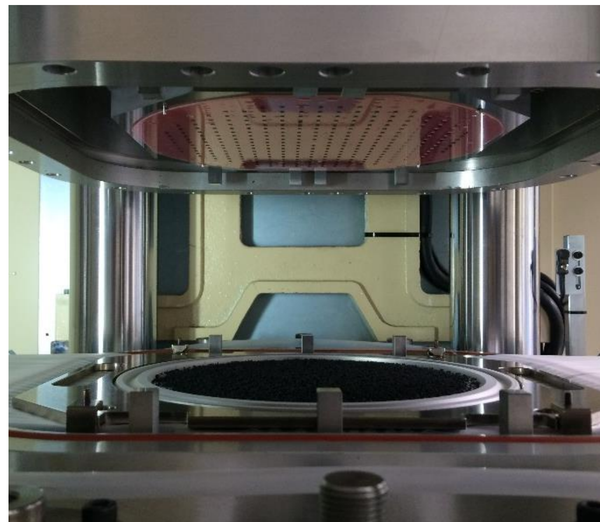
Fraunhofer IZM

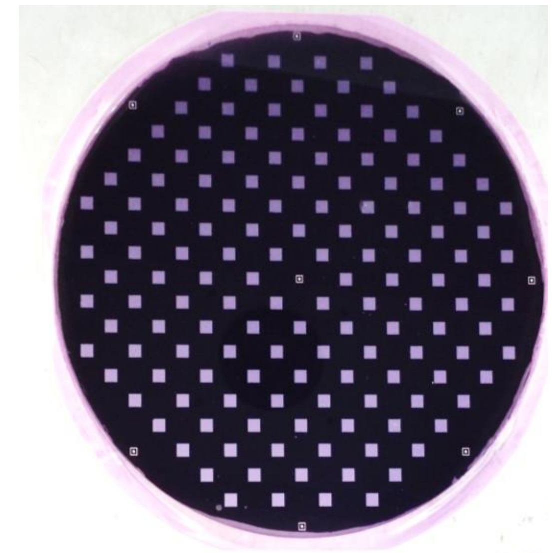
Panel Level Packaging CONSORTIUM



Assembled glass carrier with thermo-release tape



Compression molding of assembled glass carrier



Molded glass carrier before carrier release

Source: Fraunhofer IZM ,Modified by AGC

# Die Shift Test Result

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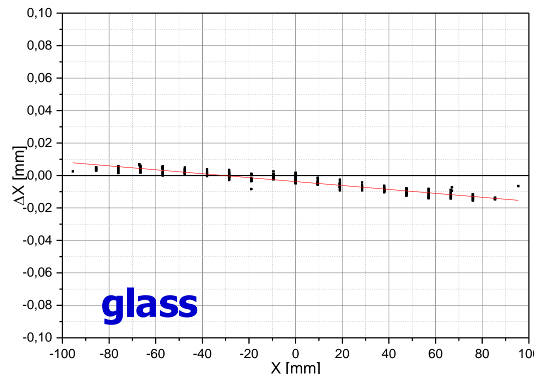
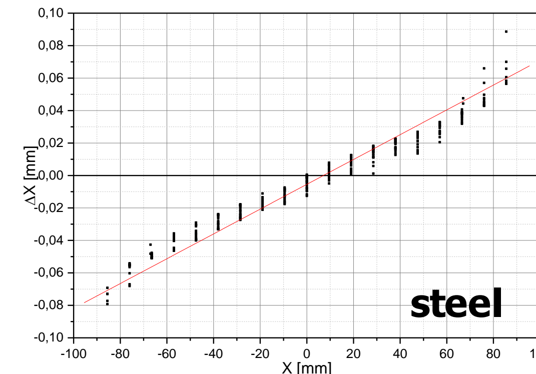
Fraunhofer IZM
Panel Level Packaging CONSORTIUM

Die Shift Factor Comparison on Wafer
between **Glass** (6,8 ppm/K by AGC ) and Steel (12 ppm/K)




| Carrier | X – Direction [mm/mm] | standard error | Y – Direction [mm/mm] | standard error |
|---|---|---|---|---|
| steel | $8{,}04 * 10^{-04}$ | $0{,}261 * 10^{-04}$ | $7{,}20 * 10^{-04}$ | $0{,}200 * 10^{-04}$ |
| glass | $0{,}87 * 10^{-04}$ | $0{,}213 * 10^{-04}$ | $0{,}65 * 10^{-04}$ | $0{,}167 * 10^{-04}$ |

**Die Shift Factor:**
Linear displacement of dies after molding (CTE EMC = ~8 ppm/K)
-> mainly due to CTE mismatch and chemical shrinkage of EMC.
⇒ Die shift on the glass carrier is much lower than on the steel carrier.
**Challenge: Robustness of glass carriers**

Source: Fraunhofer IZM ,Modified by AGC

# FOPLP Warpage Test Results

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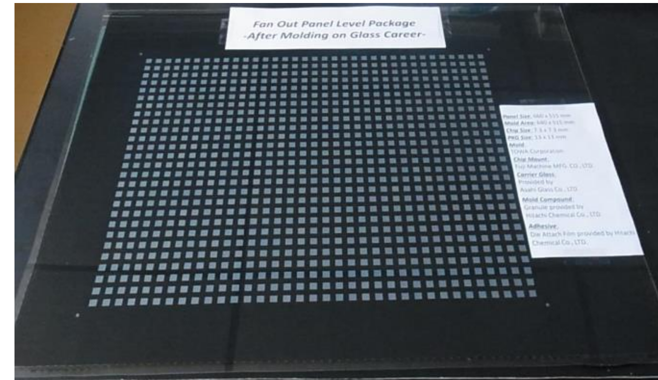
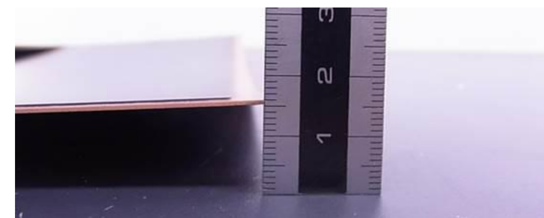
Hitachi Chemical

Panel size : 660 x 515 mm x 1 mmt
Die size : 7.3 x 7.3 mm (945 pieces)
Mold area : 640 x 495 mm x 0.4 mmt

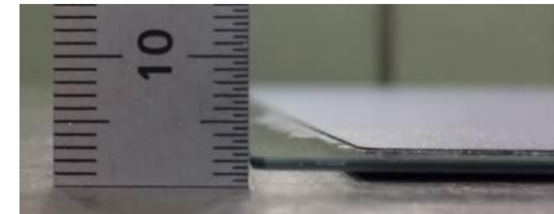
- Die Mount @ Fuji Machine Mfg.
- Compression mold @ TOWA
- Carrier : Glass (AGC)
- Organic substrate (Hitachi Chemical)



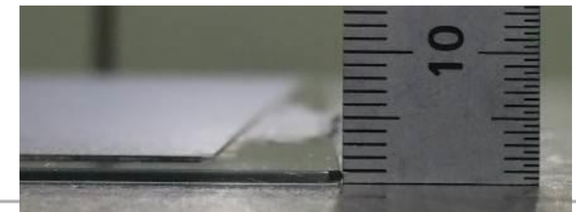

Warpage: 15mm
EMC: Film type (CTE: 8 ppm/C)
Carrier: Organic substrate (CTE: 6 ppm/C)




Warpage: 3.0mm
EMC: Film type (CTE: 7 ppm/C)
Carrier: Glass (CTE: 9.6 ppm/C)

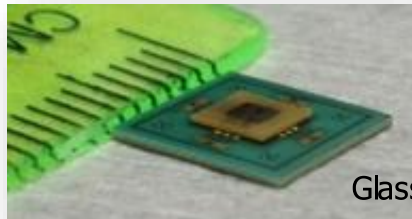



Warpage: -1.35mm
EMC: Granule type (CTE: 7 ppm/C)
Carrier: Glass (CTE: 8.3 ppm/C)

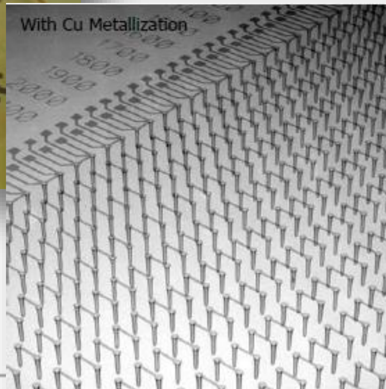



Source: Hitachi Chemical, Modified by AGC

# Lab to Fab, TGV is getting to launch



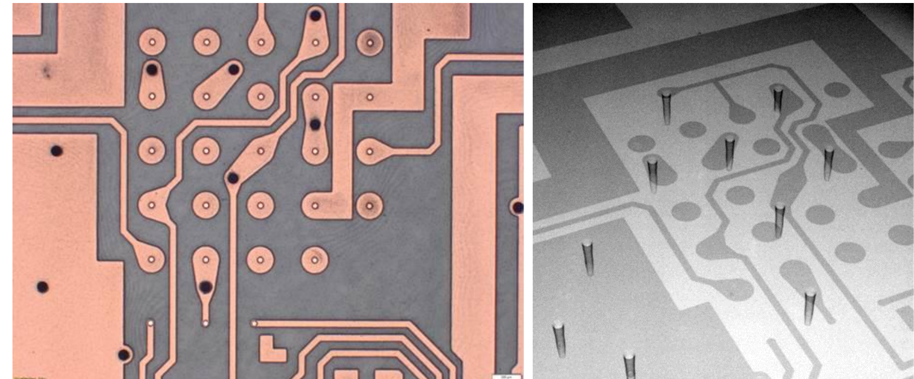
Glass IPD



Φ20um TGV metallization by industrial partners

Source: Tango Systems

RF application



# TGV is moving to panel size

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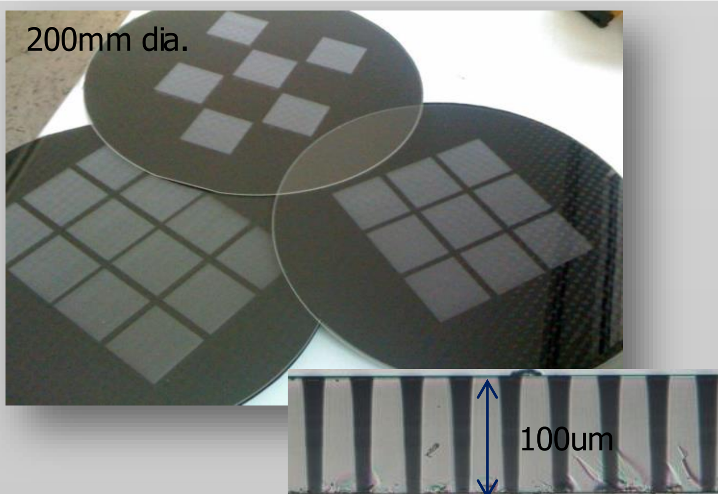
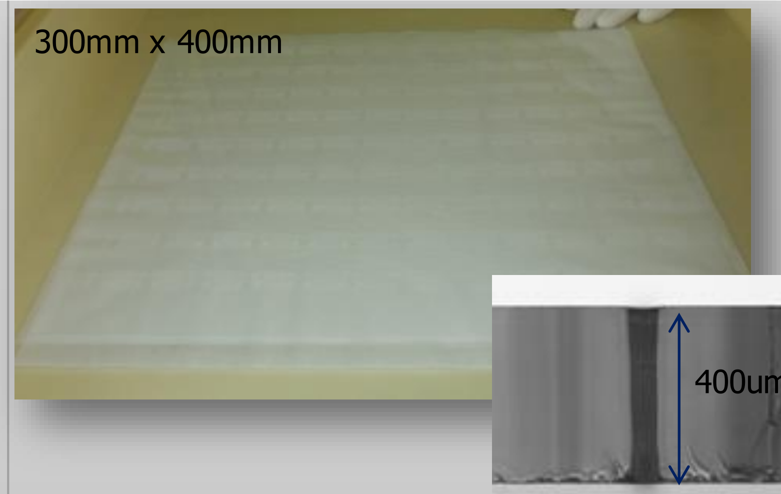
| | Wafer | Panel |
|---|---|---|
| |  |  |
| Size | 6inch, 8inch, 12inch | ~550mm x 650mm (Gen-3) |
| Thickness | 100~500um | 100~500um |
| Representative Hole Size | φ20~150um | φ65~150um |
| Hole Pitch | Minimum 2x Hole Diameter | Minimum 2x Hole Diameter |
| TGV Metallization | Cu conformal plating, Cu full-filled plating, and Cu paste filling | Cu conformal plating |

# TGV contributes to miniaturized RF devices

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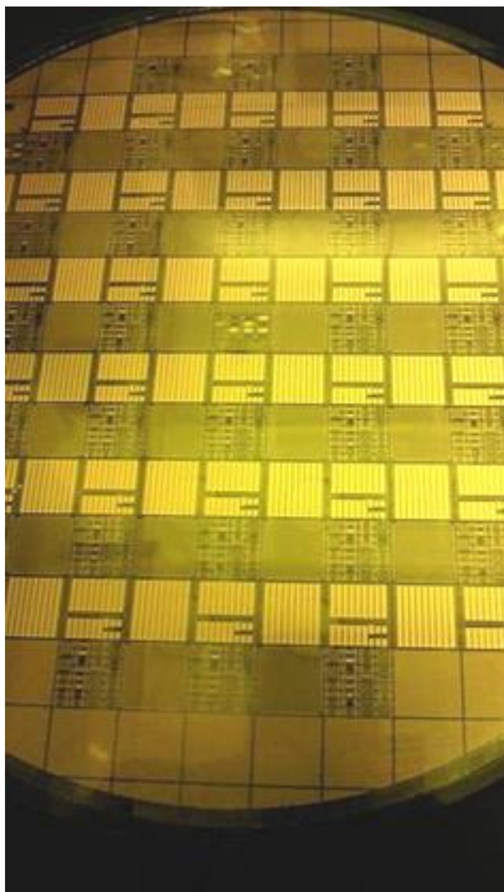
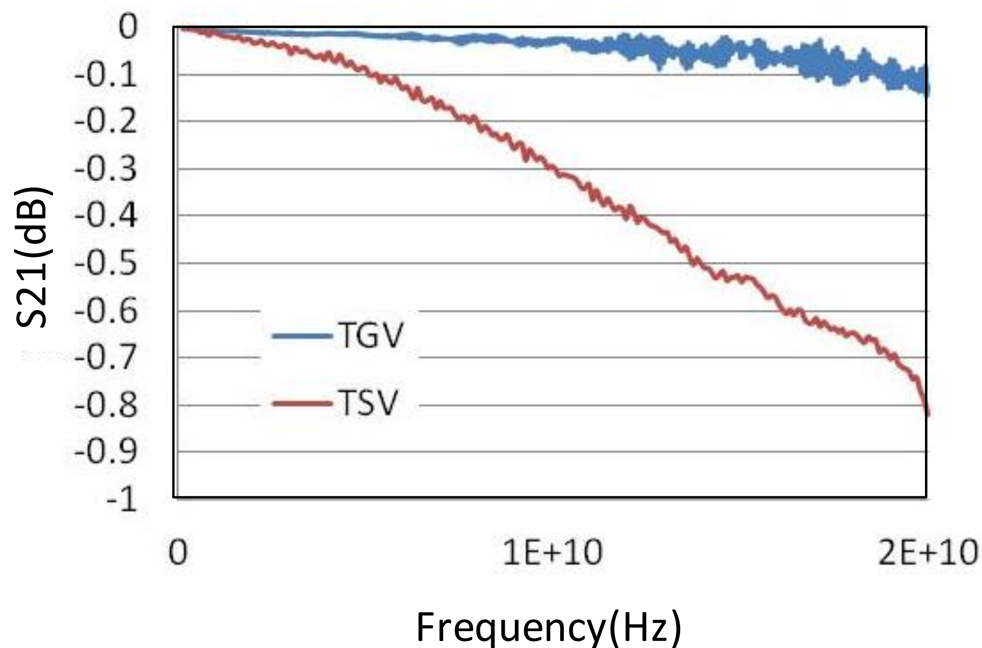
DNP






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

Source: Dai Nippon Printing

# Where Panel Technologies go

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# The necessity of panel technologies

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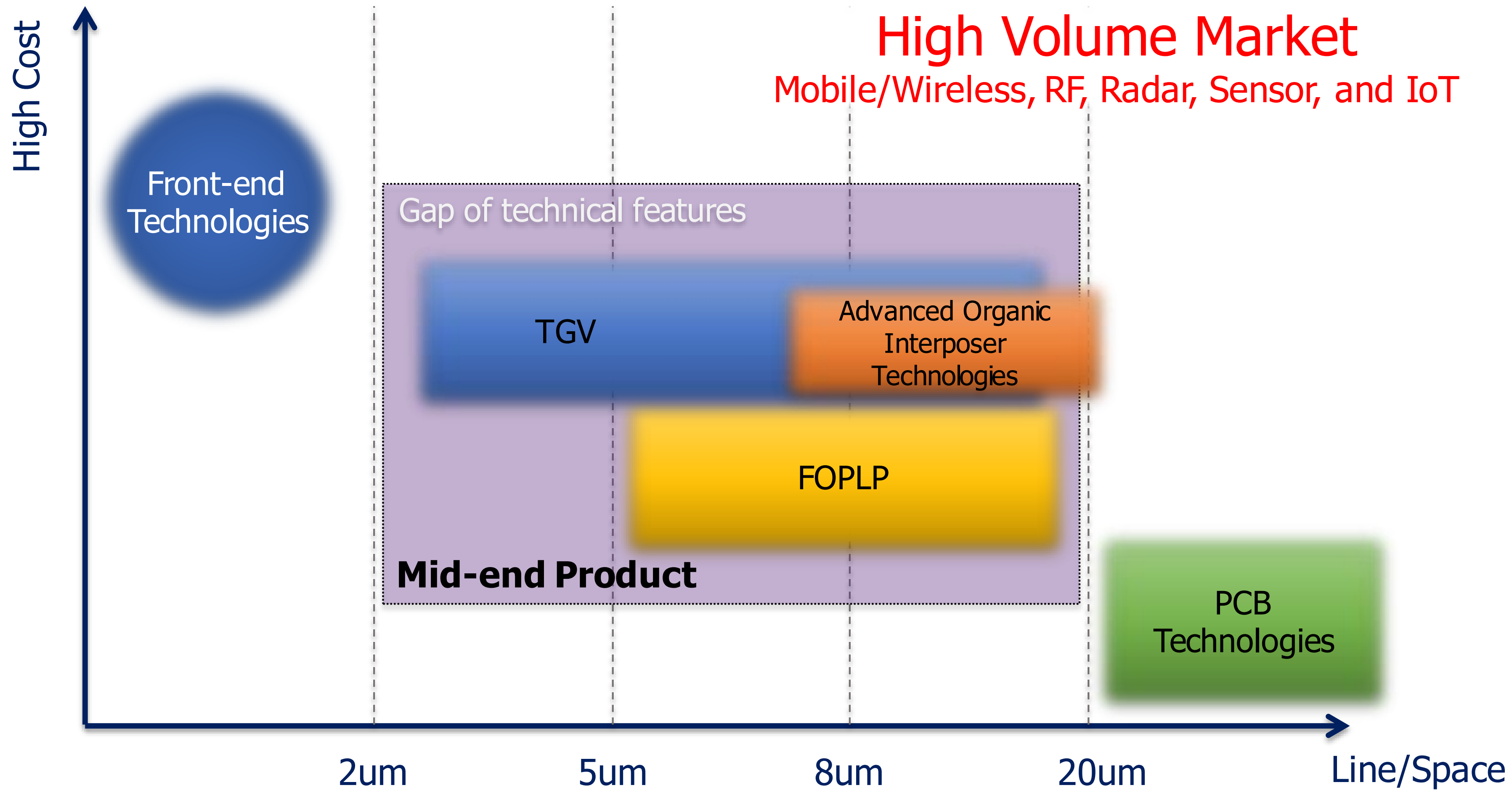

# Summary

- R&D consortium for FOPLP using large glass carrier is taking off. Glass panel is a good candidate as carrier material because of flat surface and an availability of different CTE.

- TGV is moving to panel size up to Gen-3 from wafer size. RF is a possible application based on better material properties (low insertion loss) of glass.

- Panel technologies will be an important to realize high volume manufacturing for mid-end products in a future connected world.

"Look Beyond"

Glass is only the Beginning.

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