Leading Edge Glass Interposer for High Frequency Application

Dai Nippon Printing co, ltd
Satoru Kuramochi Masaya Tanaka

Outline

1, Background

2, Concept of Glass Interposer

3, Results of Experiments

- 3-1 High frequency characteristics of TGV
- 3-2 Low loss dielectrics for RDL
- 3-3 Modeling high frequency transmission

4, Summary

Trend of Electronics Packaging

Cable Network

Server/Graphics card

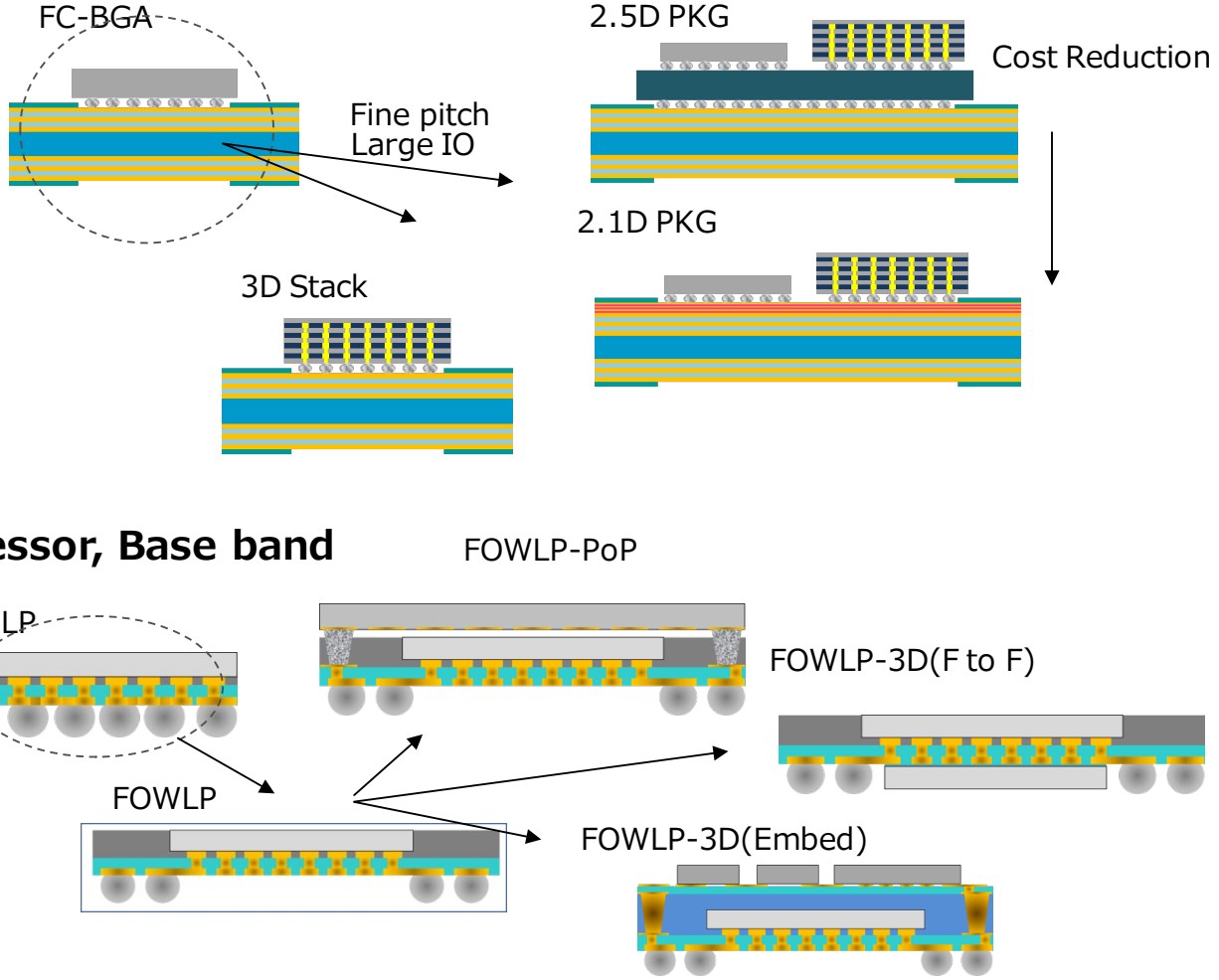
PC/Game/DTV

Tablet

Wireless Communication

Application processor, Base band

IOT Devices



Trend of 2.5D Packaging

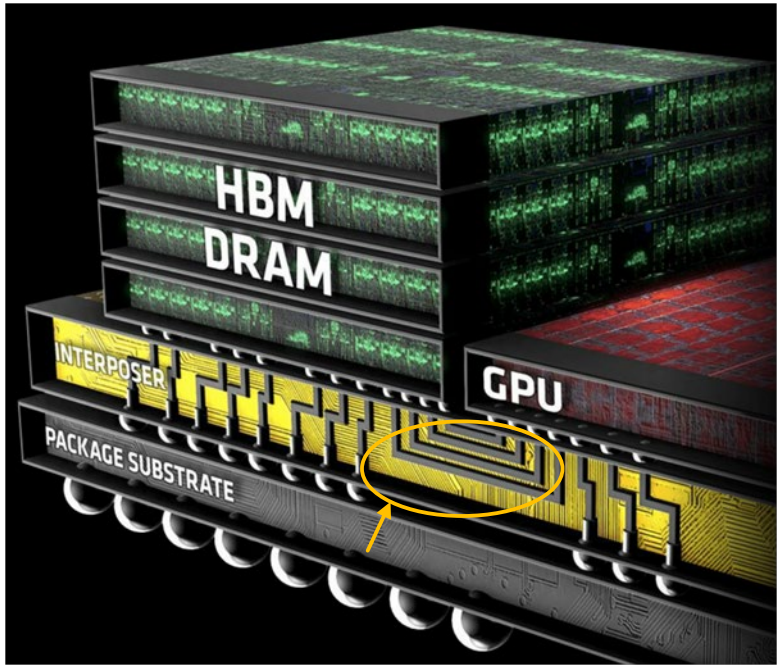
L/S will be downsizing for high density wiring.

Signal transmission speed will be also higher.

Trend of High speed Transmission Memory					
Memory	LP-DDR4	LP-DDR5	HBM	HBM2	HBM3
Wiring number [-]	(64)	(64)	1024	1024	>1024
Signal speed [Gbps]	3.2	6.4	1	2	>4
Transmission capacity [GB/s]	25.6	51.2	128	256	>512
L/S [um]	10/10	5/5	2/2	2/2	1/1

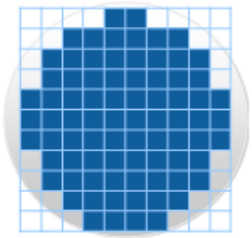
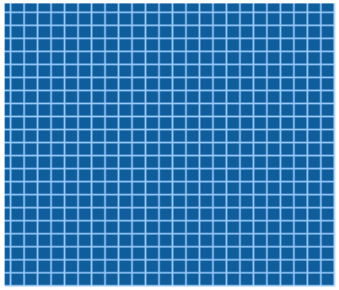
https://pc.watch.impress.co.jp/docs/news/event/1171755.html

https://pc.watch.impress.co.jp/docs/column/kaigai/752893.html



2015 Financial Day MAY6.2015

Motivation of Development

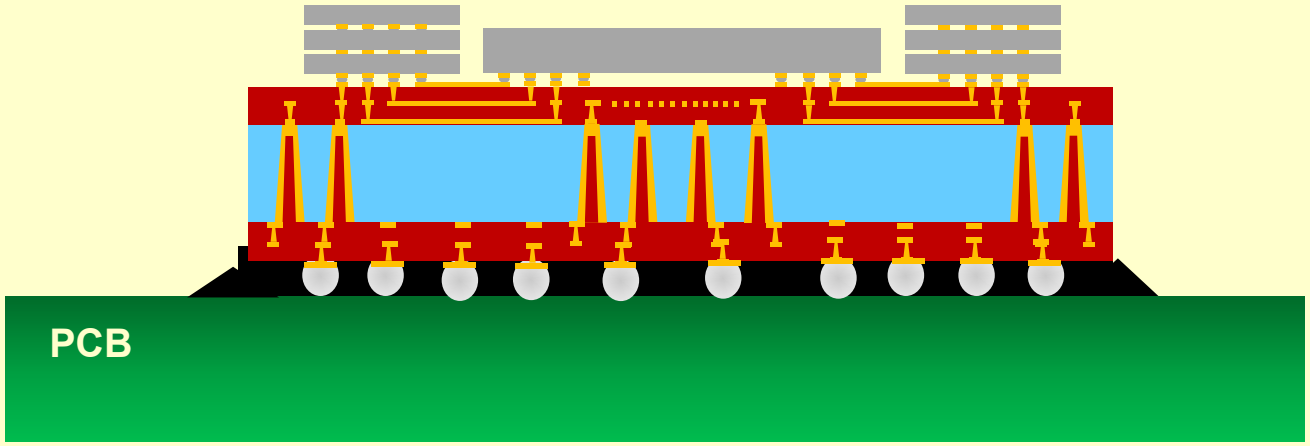
Technology	Si interposer	Glass interposer
Material	Si	Glass
Thickness	250-400μm	100-400μm
Hole	DRIE	FEDM
Metal	Cu	Cu
RDL	Cu-Polyimide Build-up	Cu-Polyimide Build-up
Dielectric	Polyimide	Polyimide
Size	200mm wafer - 300mm wafer	150mm-200mm wafer, 300mm×400mm-730x900mm Panel
Chip Number	47(30mm□) 	667 (30mm□) 

Si interposer can be integrated active and passive devices

Glass interposer potentially extend to fabricate large panel size

Concept of Glass Interposer

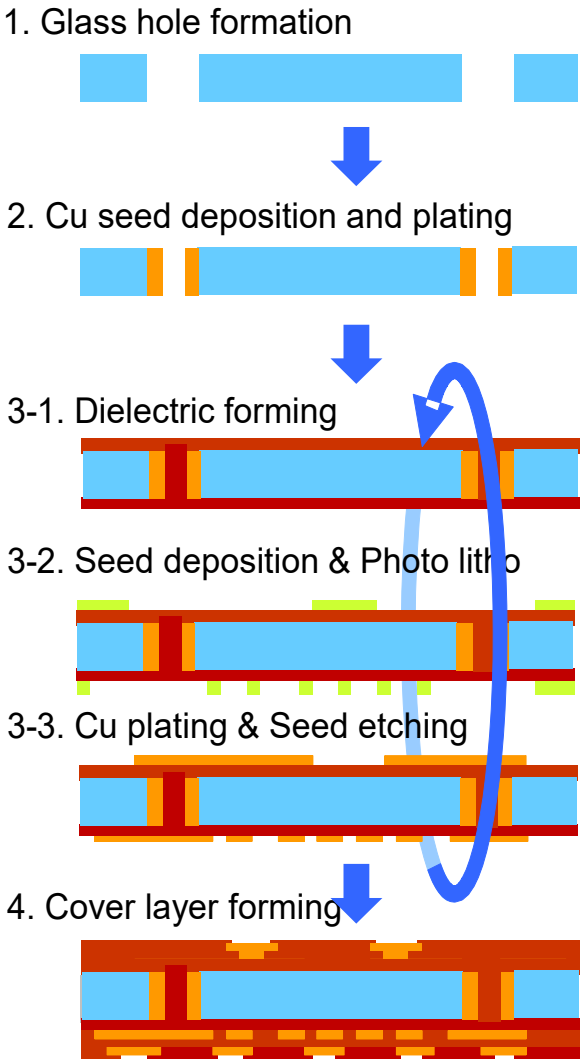
Glass Interposer



Target specification and feature

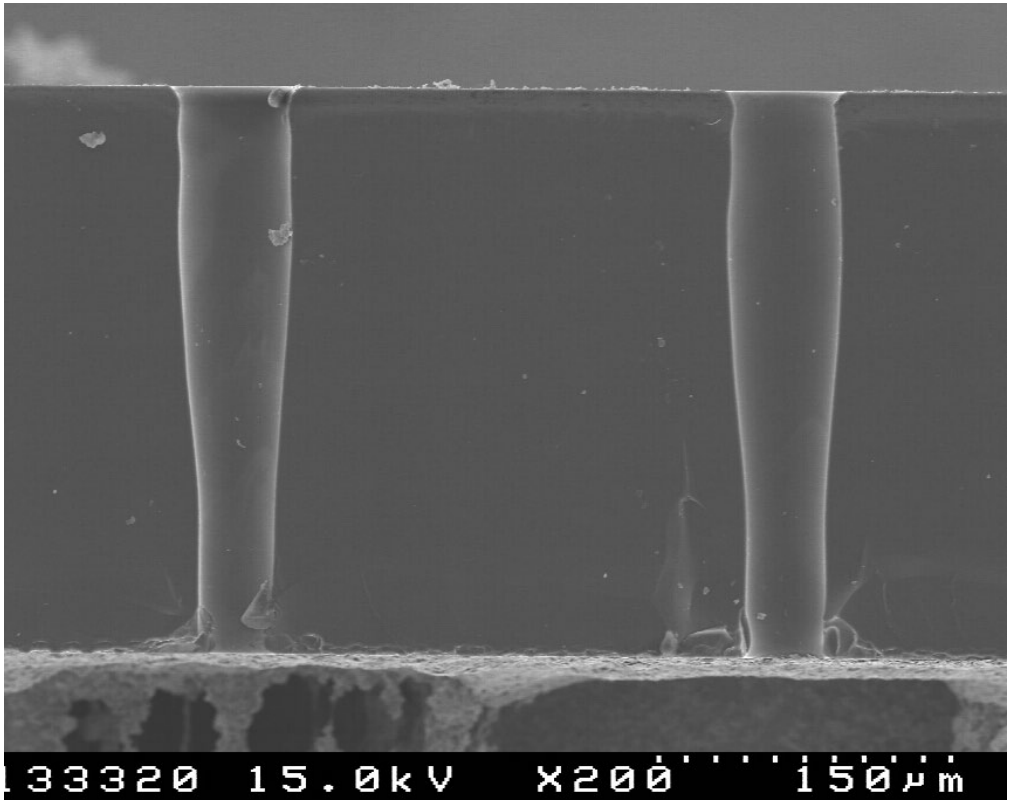
1. Fine pitch for wiring L/S=2/2um
2. Double side polymer laminate RDL
3. High frequency transmission characteristics
4. Interposer potentially extend to fabricate large panel size

Process flow



TGV formation

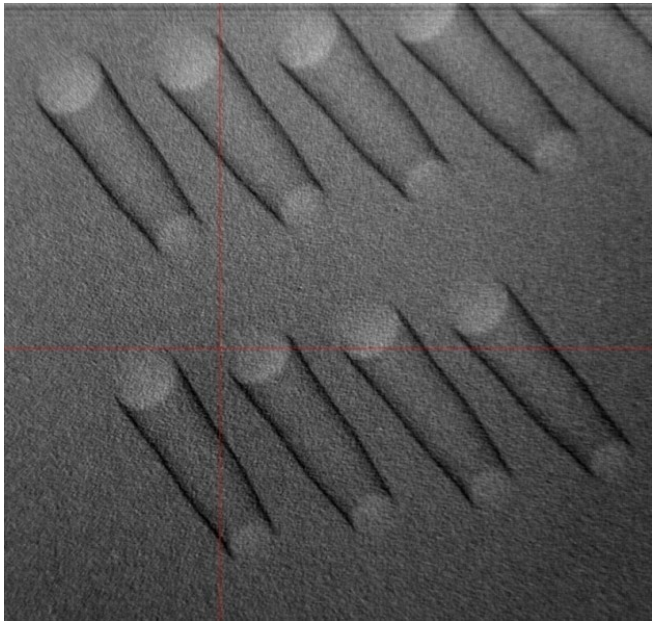
Focused Electrical Discharging Method (FEDM)



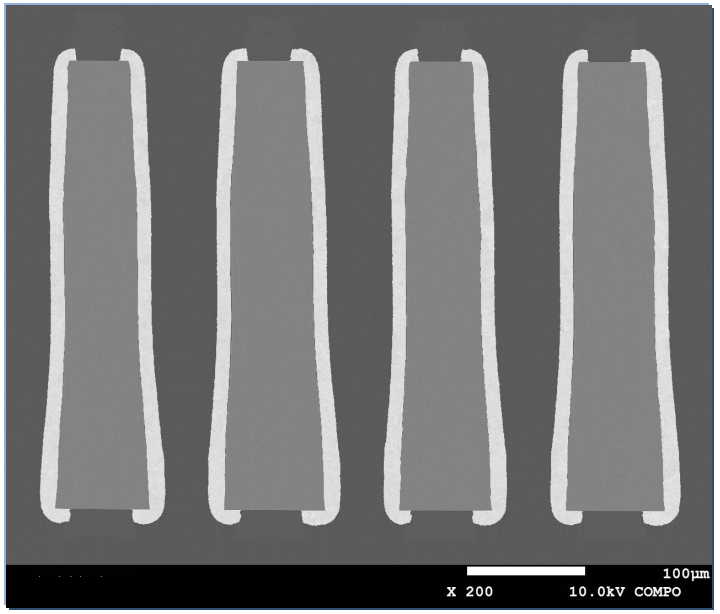
TGV side wall were smoothed because the glass locally heated and melted by high temperature

Conformal plating process

Seed layer deposition

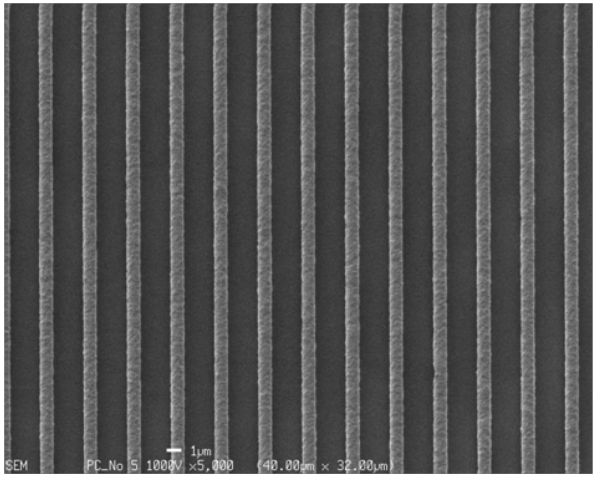


Conformal plating

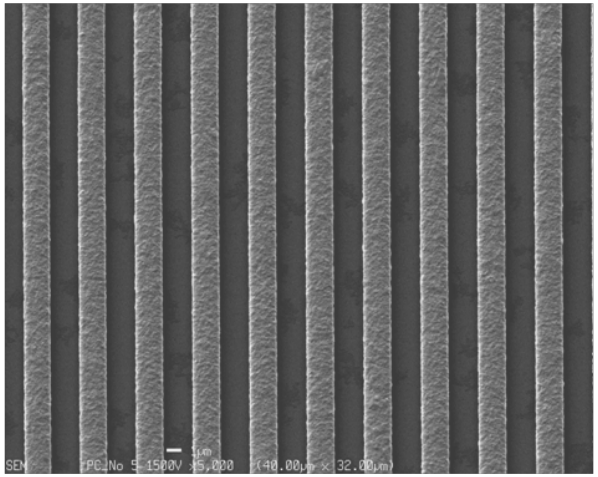


Conformal Cu via was successfully achieved by PVD and electroplating

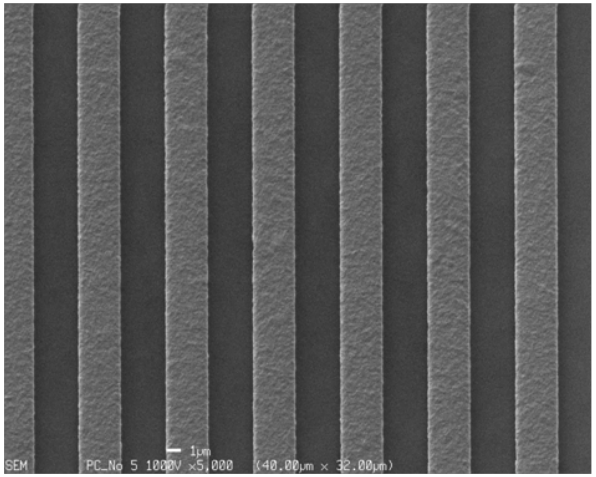
Fine Cu wiring fabricated by SAP(semi-additive process)



L/S=1/2



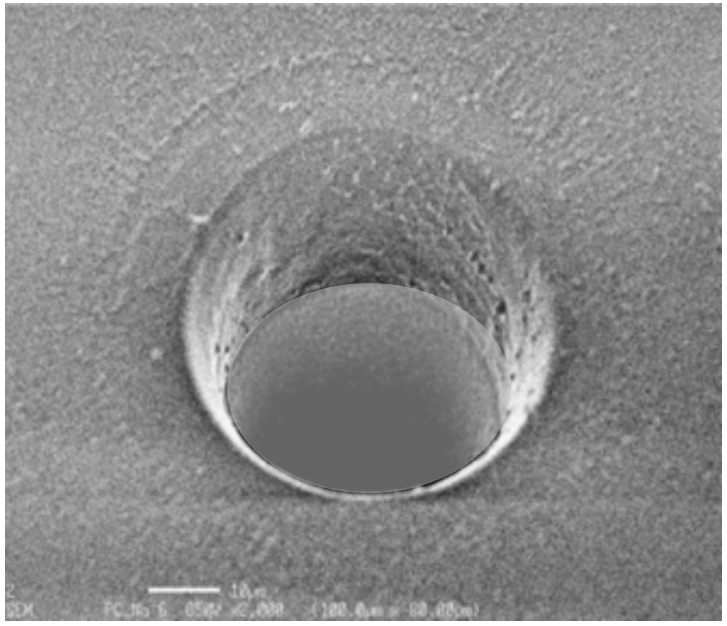
L/S=2/2

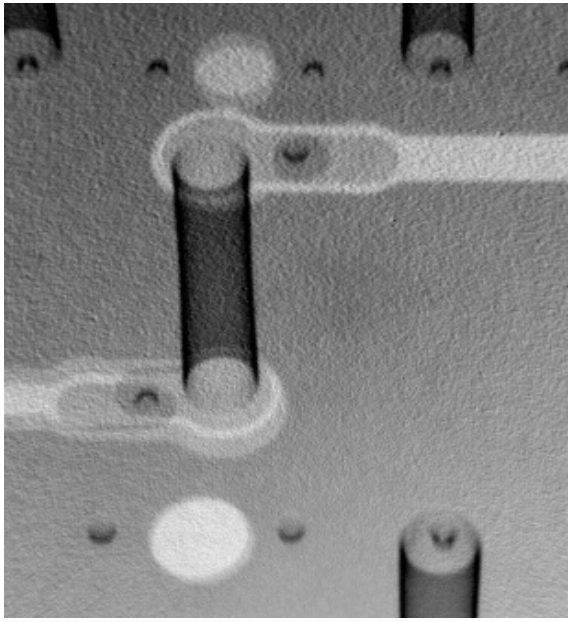


L/S=3/3

Micro Via formation

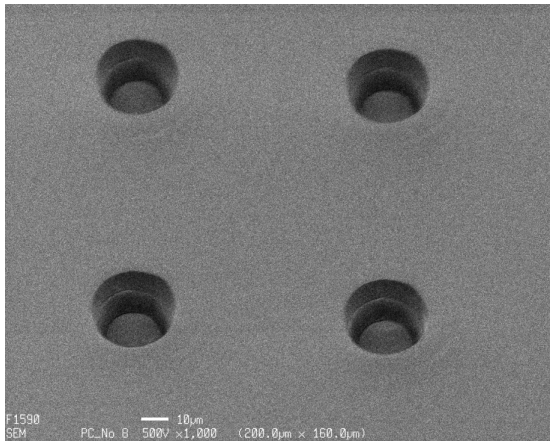
Top 26um
Bottom 20um



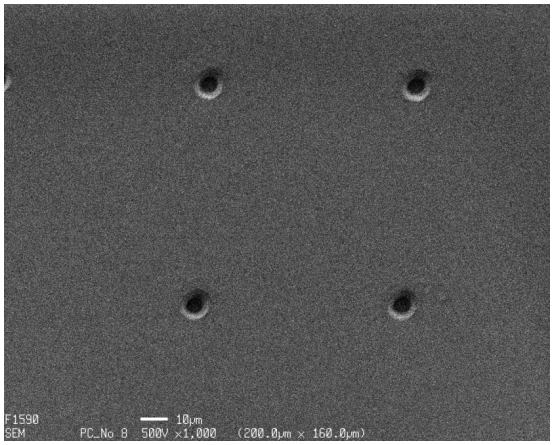


Micro Via formation

Top 26um
Bottom 20um



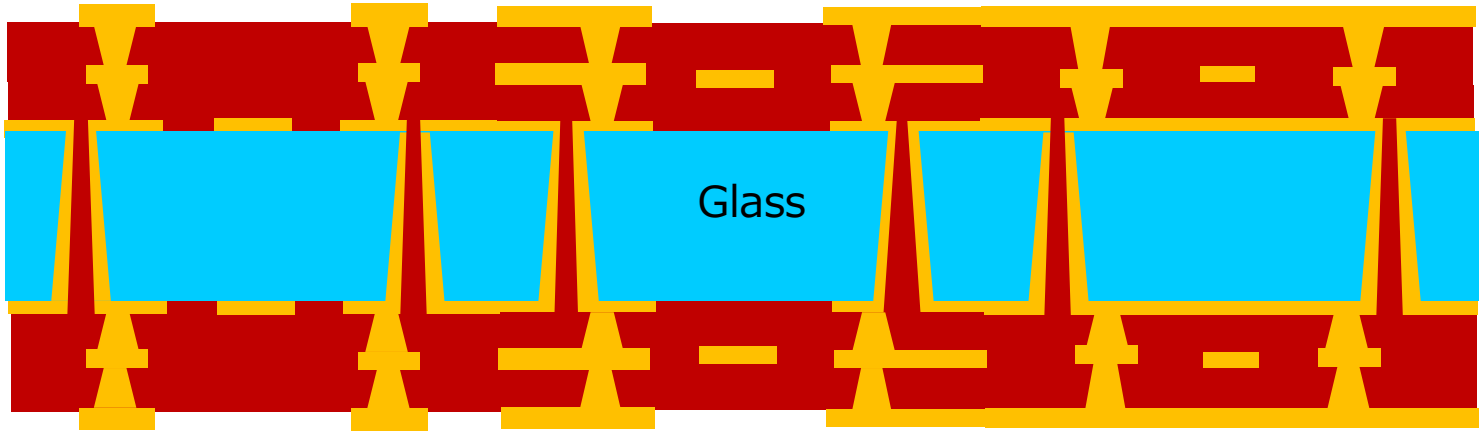
Top 8um
Bottom 5.5um

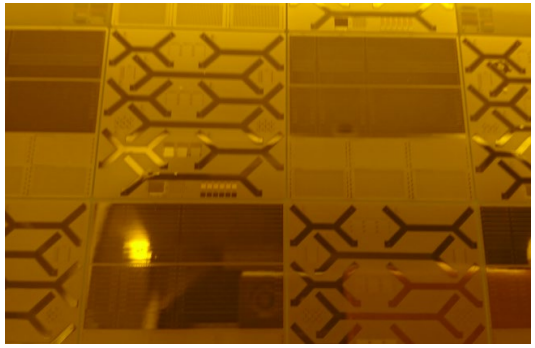


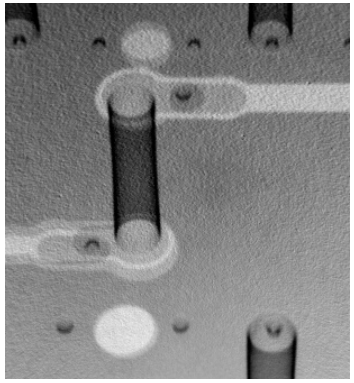
Demonstrate TEG

3 layer transmission line structure TEG

CPW L/S=30/17um CPW L/S=30/13um Strip L=20um

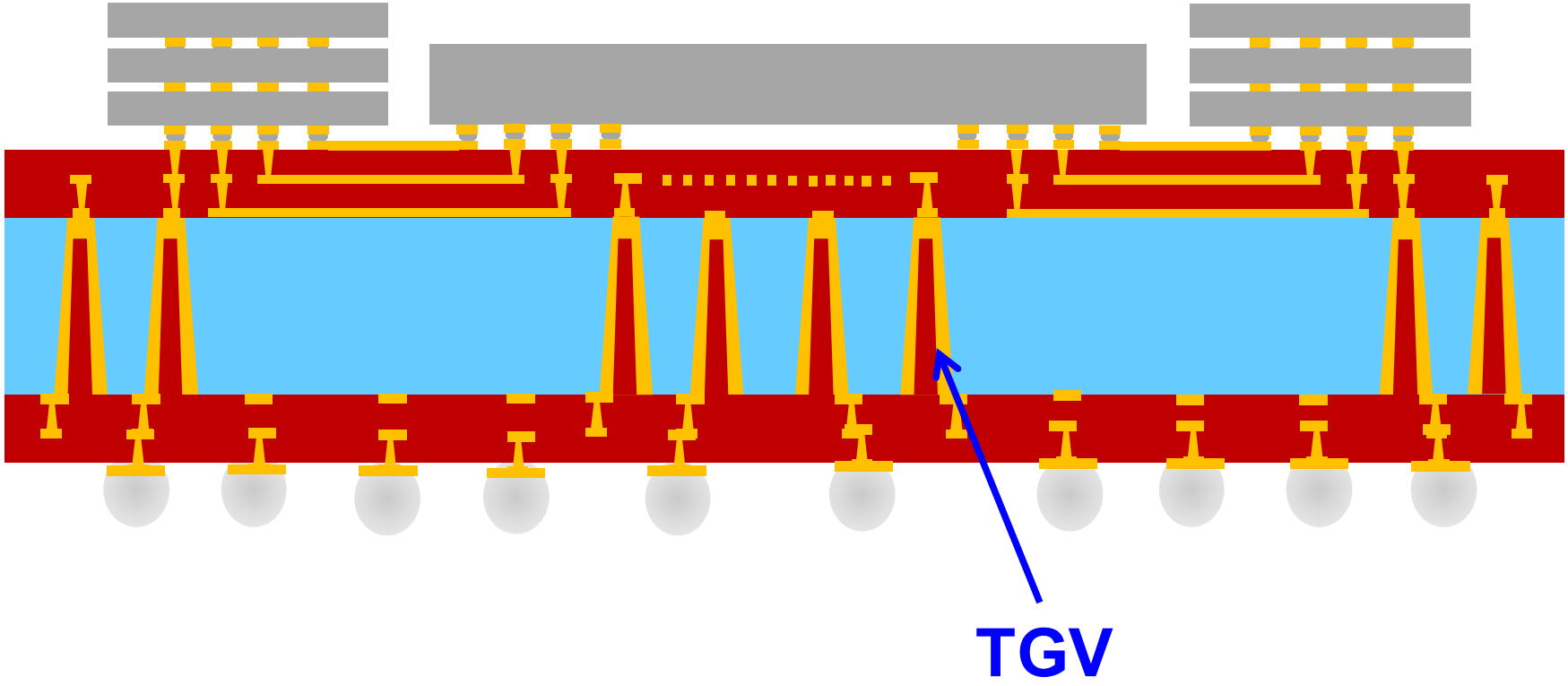






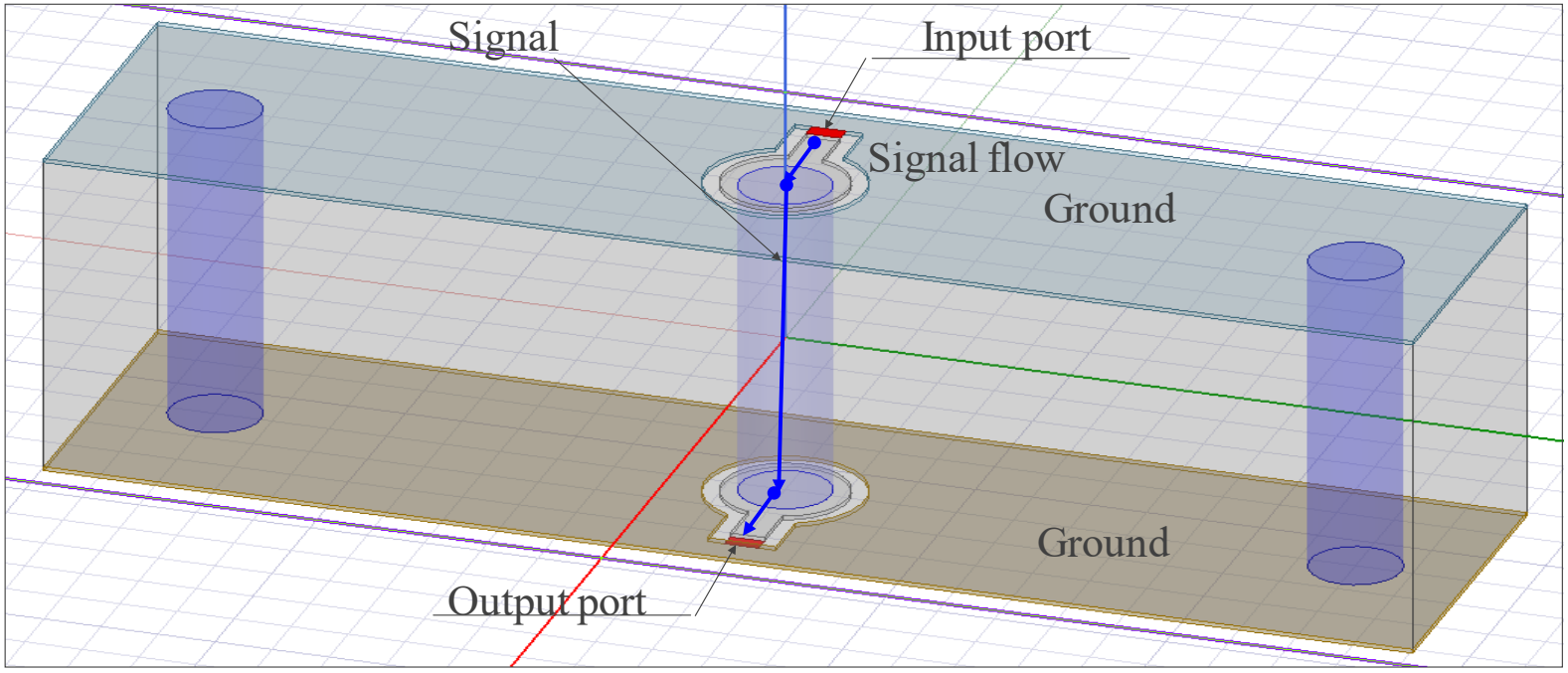
High frequency characteristics of TGV

2.1D Glass Interposer



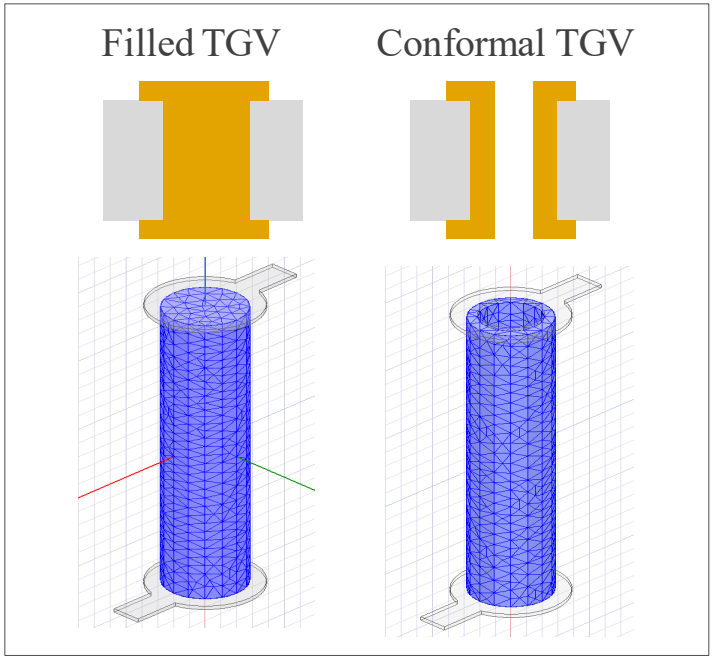
High frequency characteristics of TGV

[Simulation analysis setup:1]

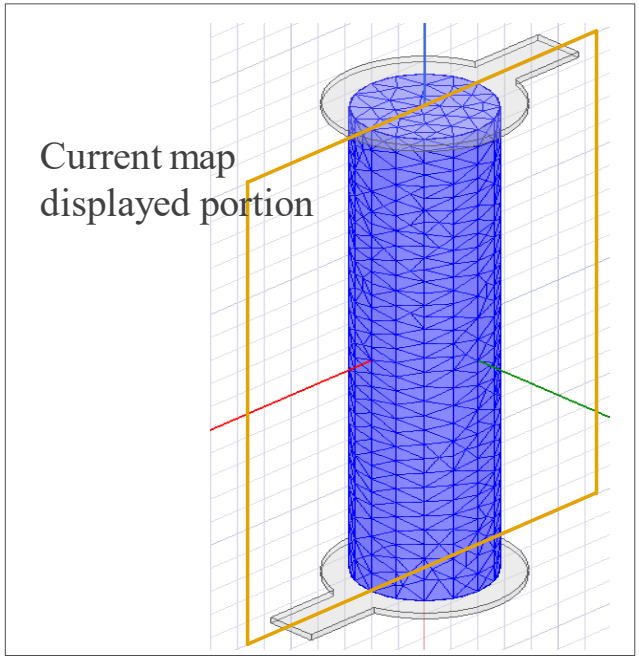


High frequency characteristics of TGV

TGV modeling detail



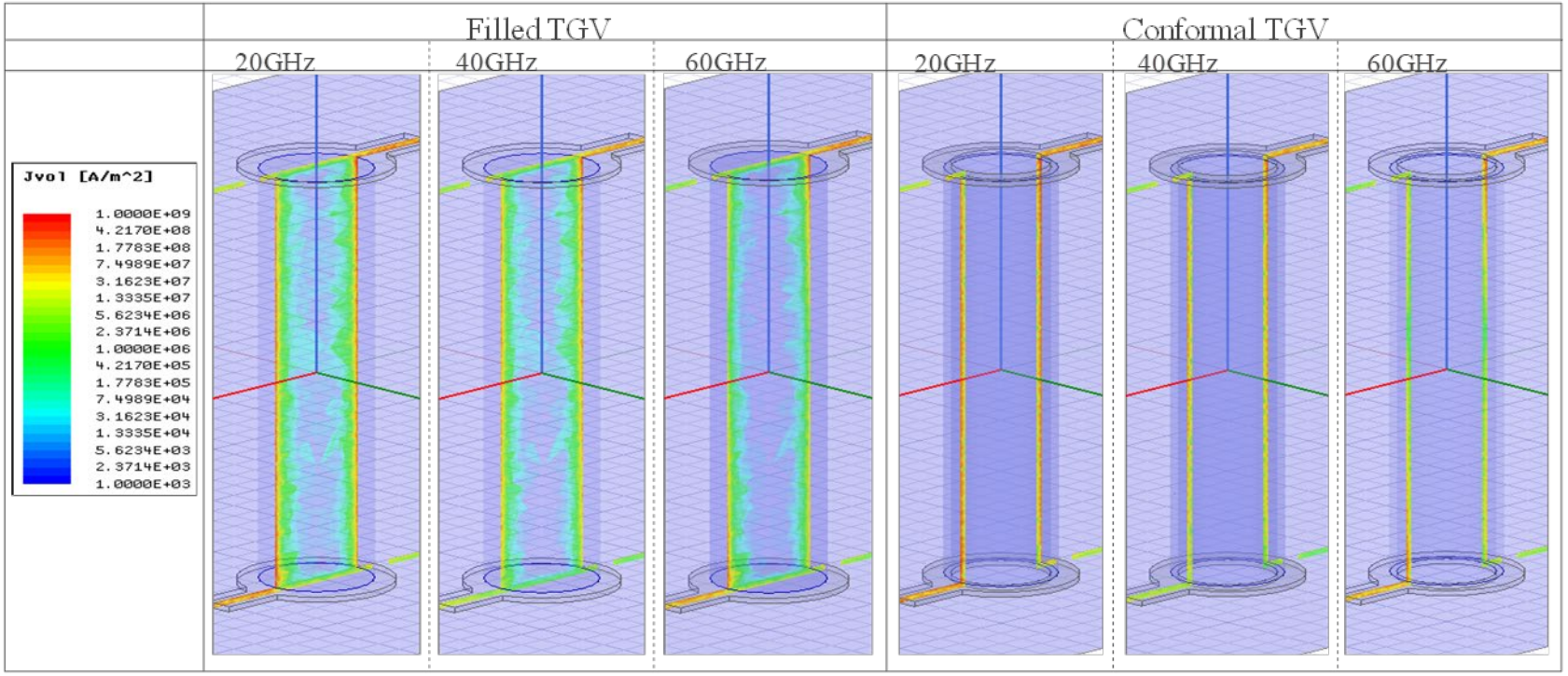
Mesh condition



Current map portion

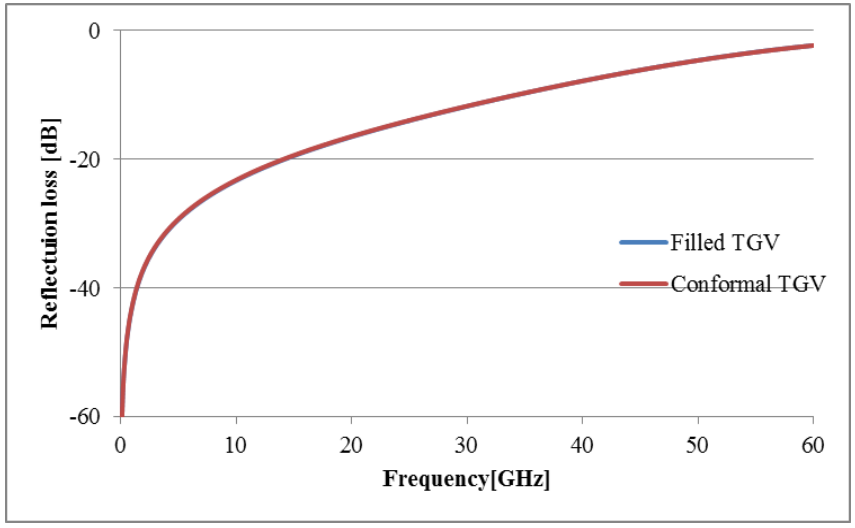
High frequency characteristics of TGV

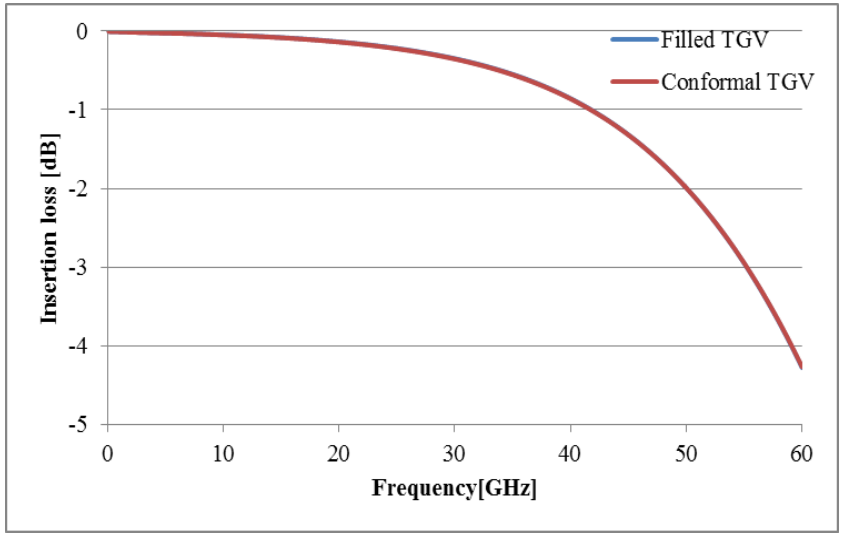
Simulation result of TGV



High frequency characteristics of TGV

S-parameter simulation result

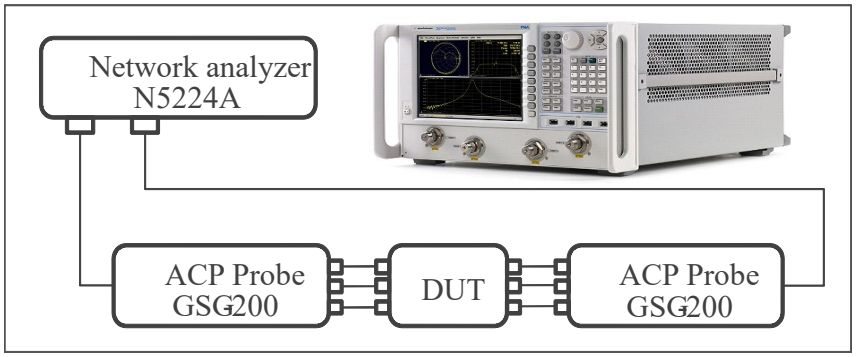




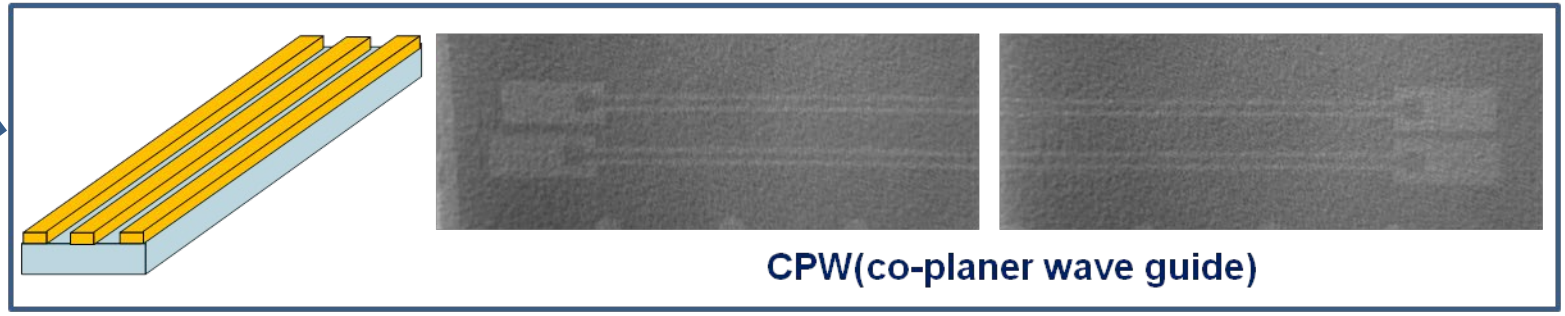
Each TGV model shows the almost same characteristics

High frequency characteristics of TGV

S-parameter measurement setup

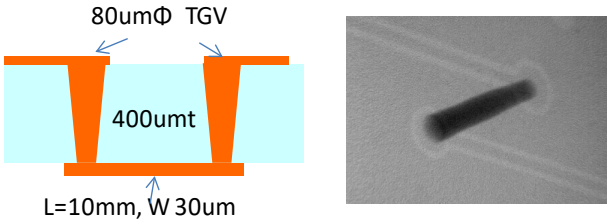


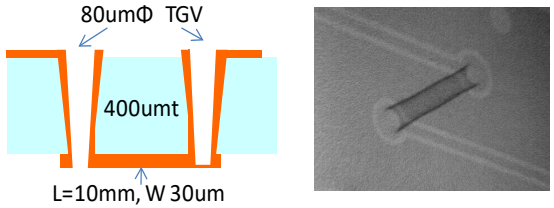
Compare Measurement Data



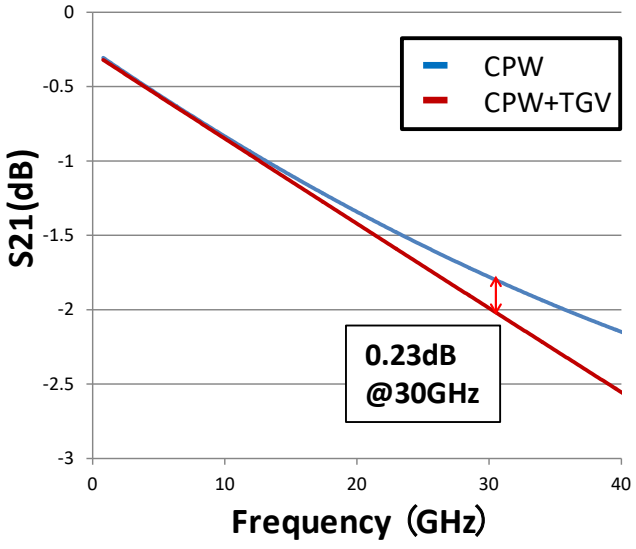
High frequency characteristics of TGV

Measurement result of TGV

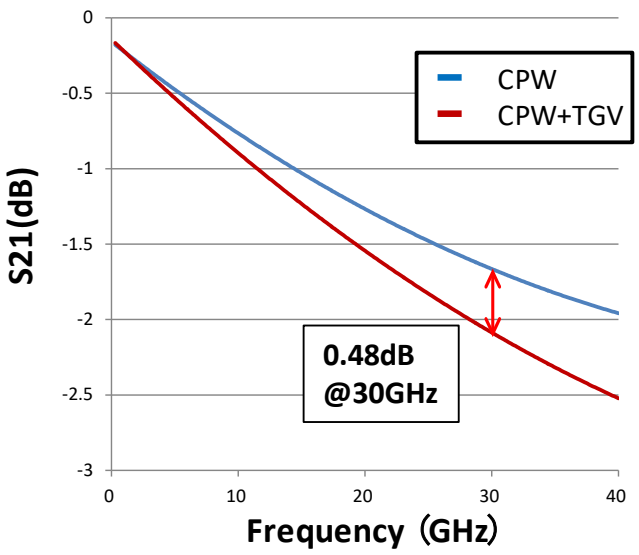




Filled Type



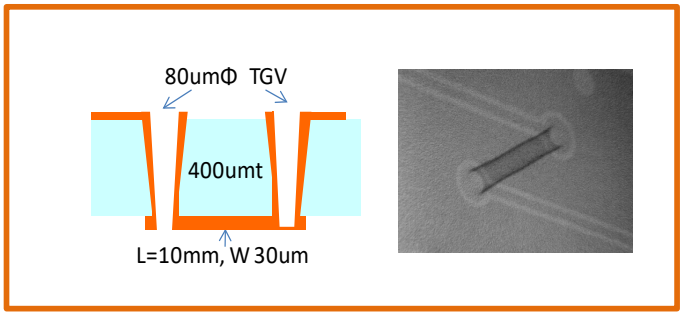
Conformal Type



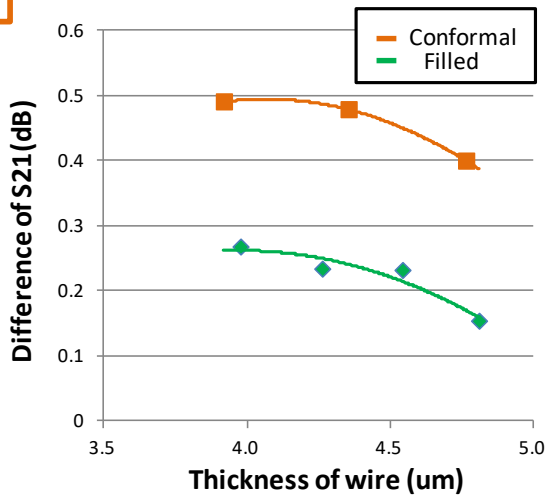
Simulation result indicate there are no difference of Filled and conformal.

There are difference on real measurement

High frequency characteristics of TGV



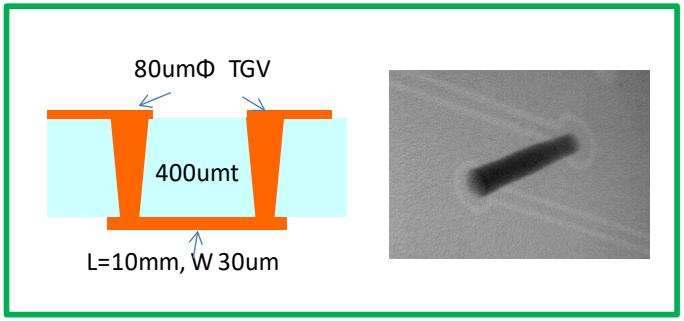
Trace thickness are larger, differential loss are smaller



Simulation result indicate there are no difference of TGV itself.

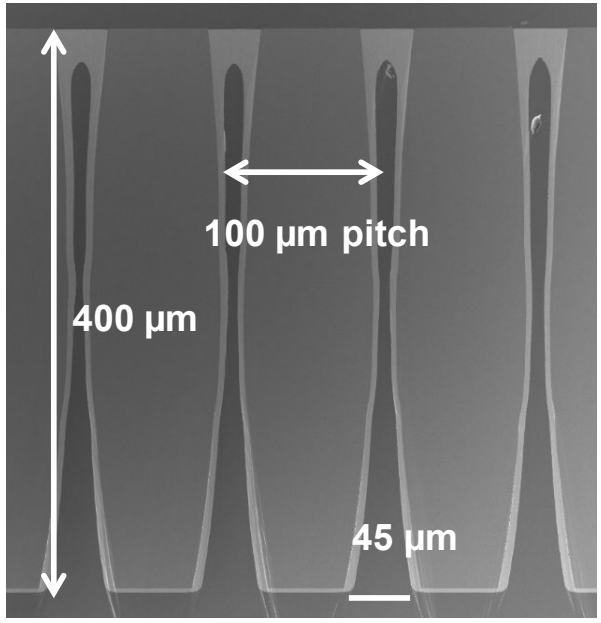
Differential of Filled type must be independent trace thickness

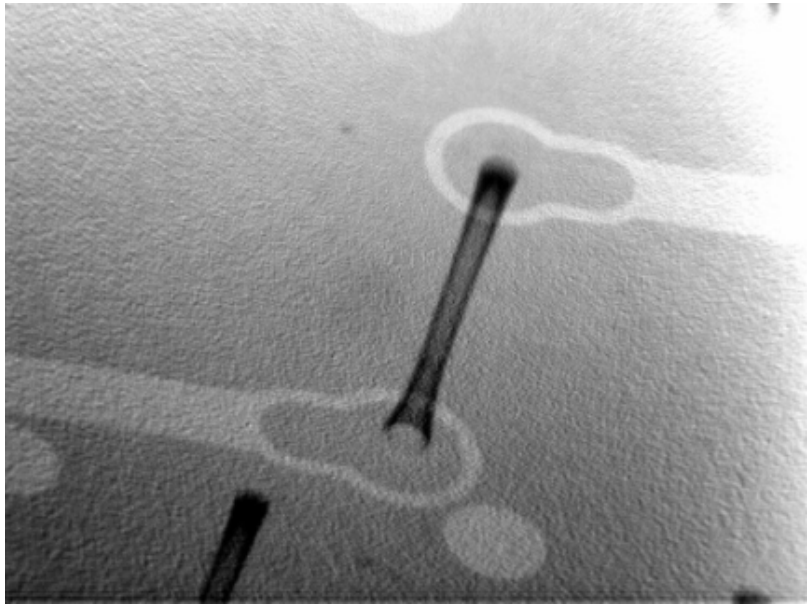
Differential relate reflection on the joint of CPW and TGV



High frequency characteristics of TGV

Fine pitch partial fill Type

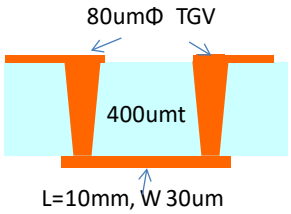


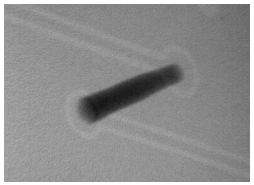


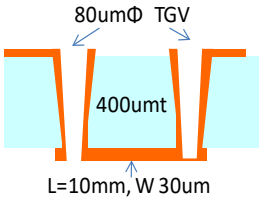
Upper flat surface enable to fabricate ultra fine wiring.

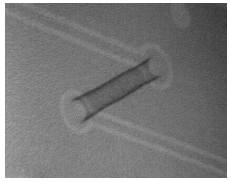
High frequency characteristics of TGV

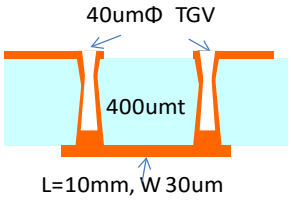
Measurement result of TGV

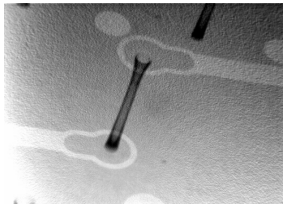




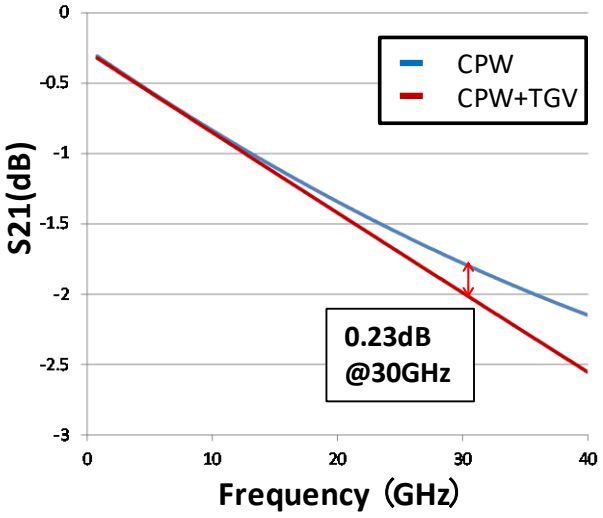




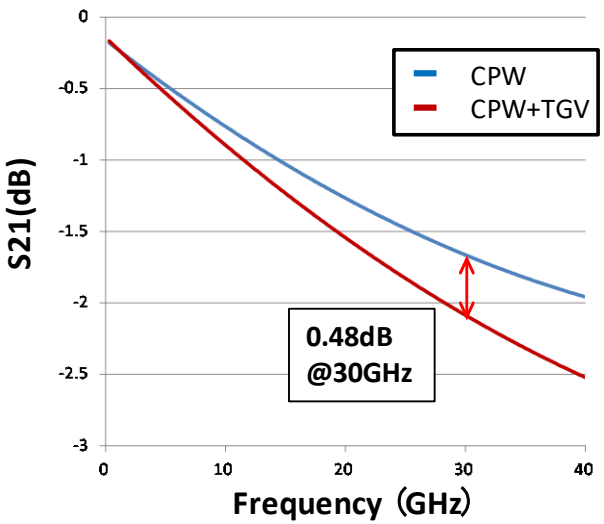




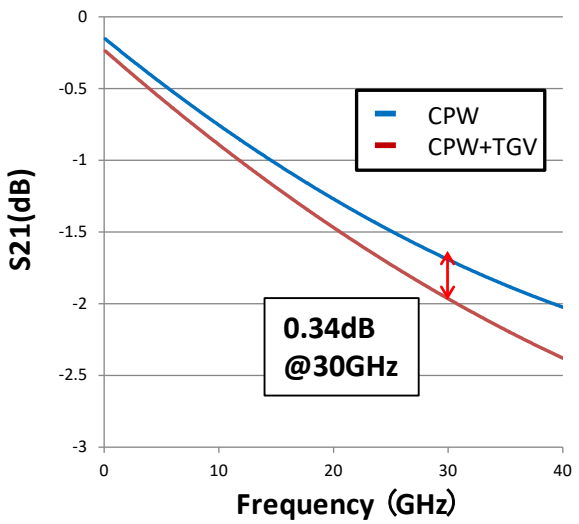
Filled Type



Conformal Type



Partial fill Type

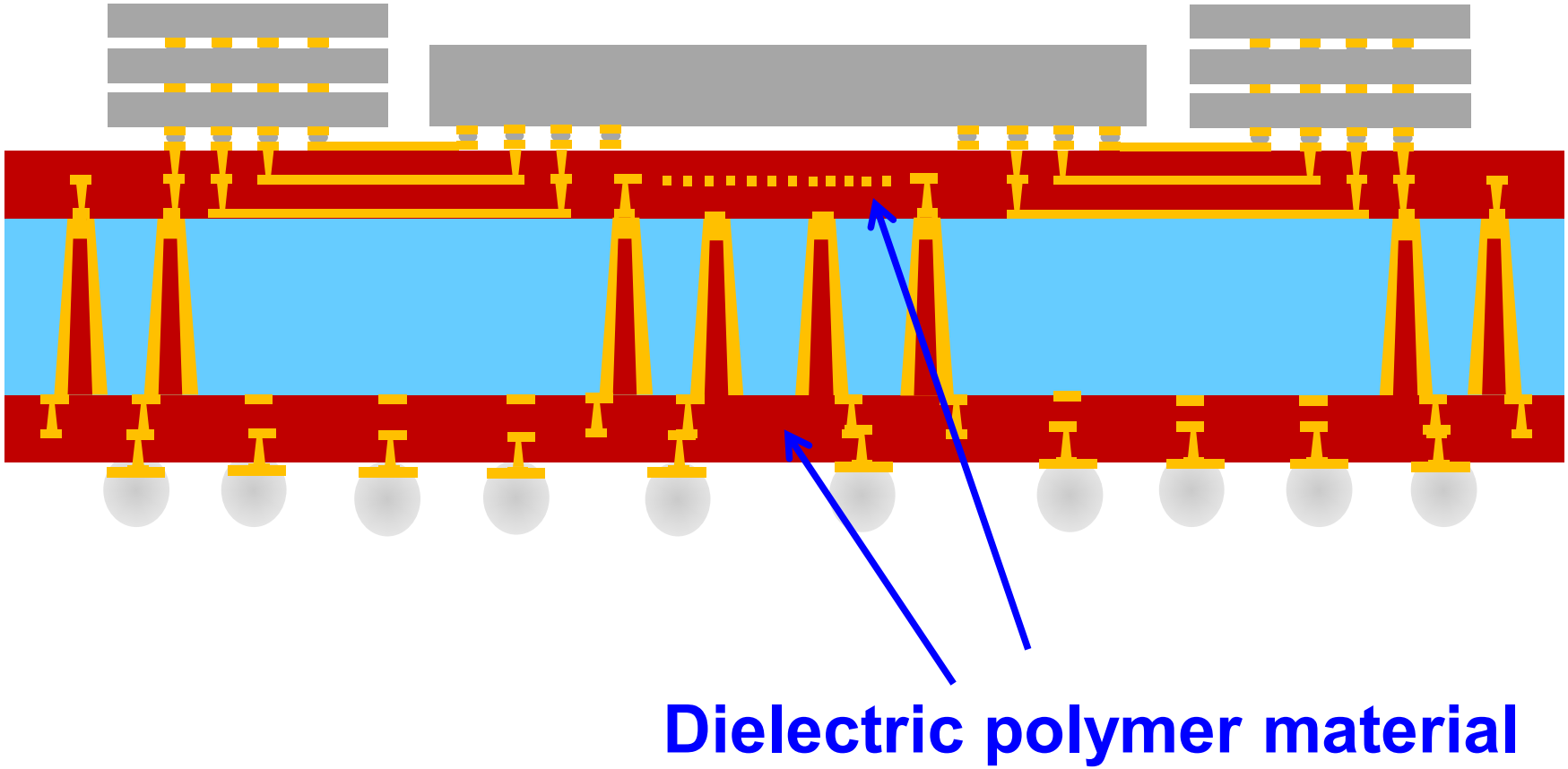


Filled Type < Partial fill Type < Conformal Type

There are difference, but loss are very lower than surface wiring loss.

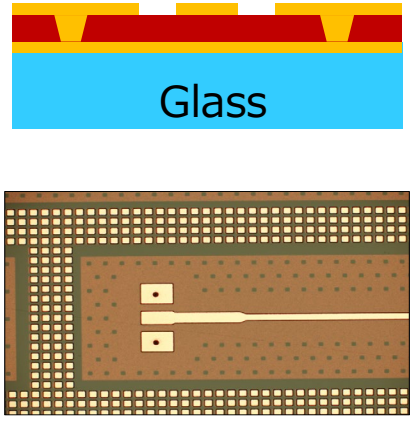
Low loss dielectrics for RDL

2.1D Glass Interposer



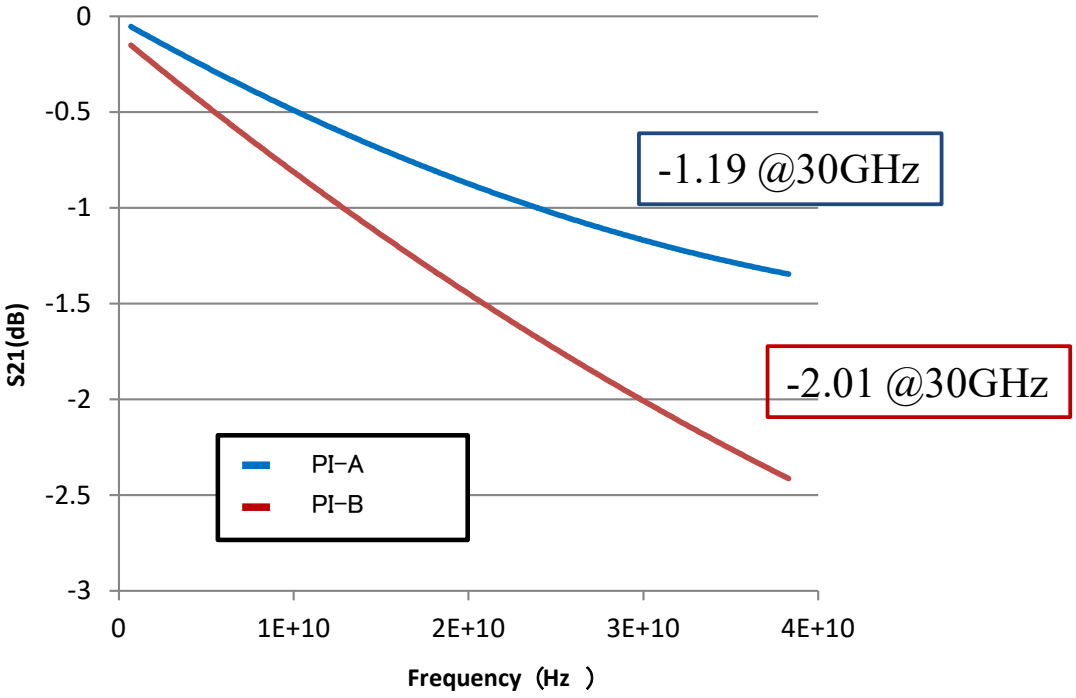
Low loss dielectrics for RDL

	Dielectric polymer	Er	Tanδ
PI-A	Low loss polymer	3.0	0.005 @10GHz
PI-B	Conventional Polymer	3.4	0.03 @10GHz



Micro strip line structure

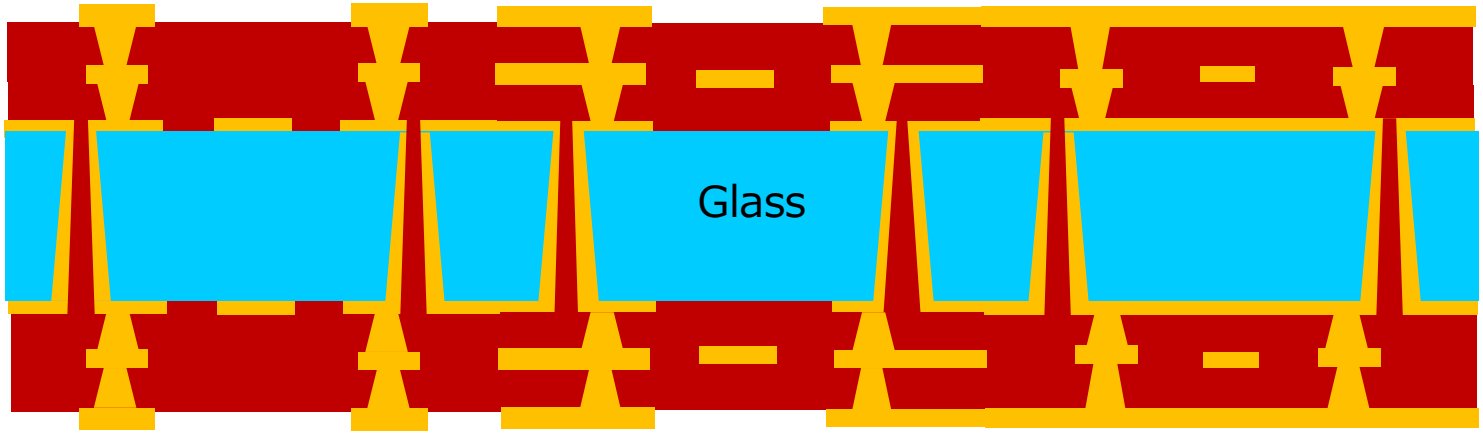
W=60um L=10mm

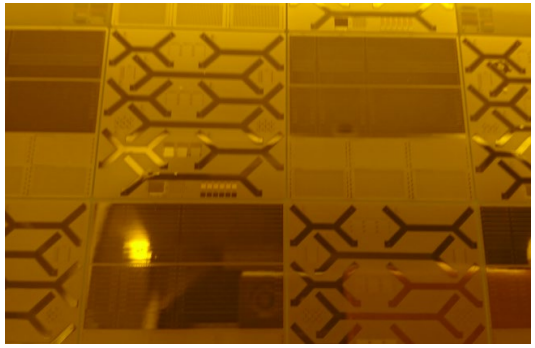


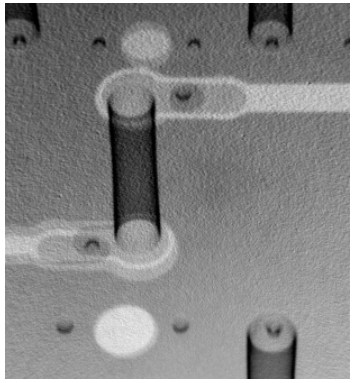
Low loss dielectrics for RDL

Demonstration of 3 layer transmission line structure TEG

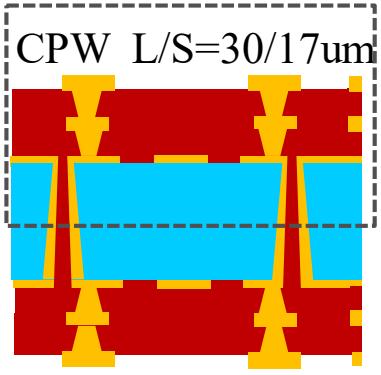
CPW L/S=30/17um CPW L/S=30/13um Strip L=20um

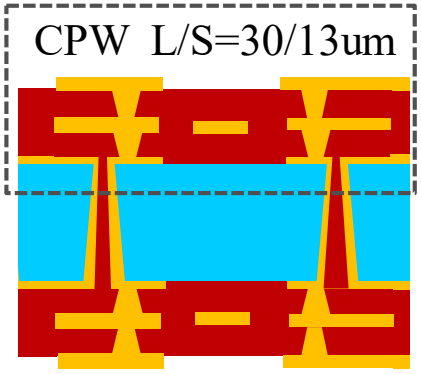


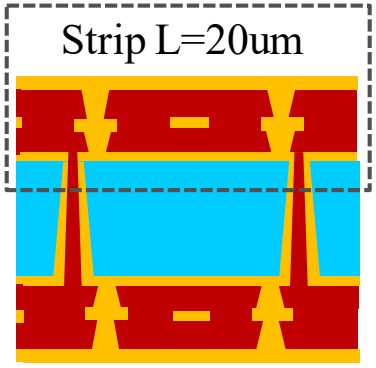


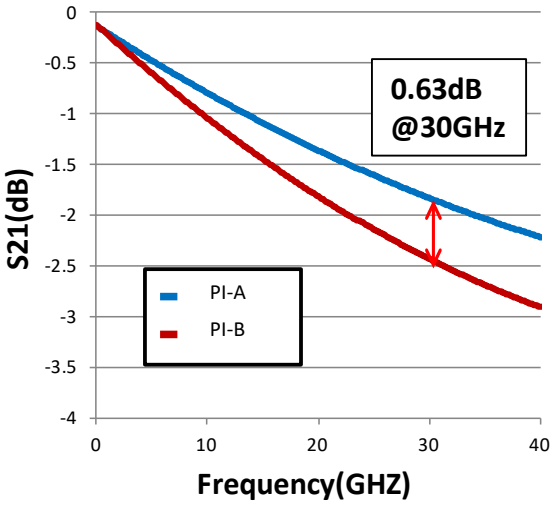


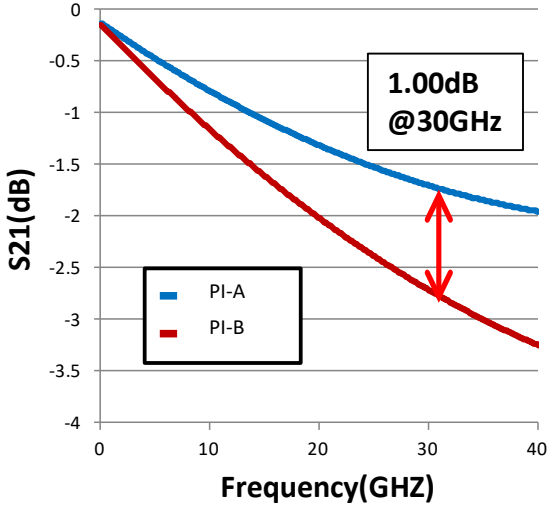
Low loss dielectrics for RDL

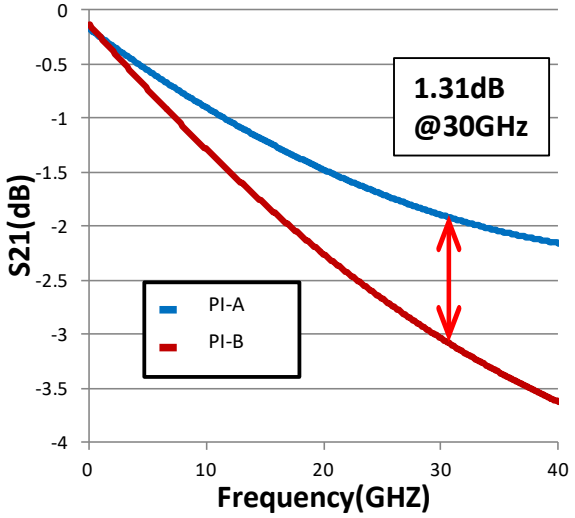








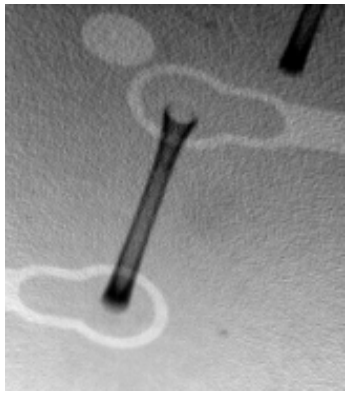


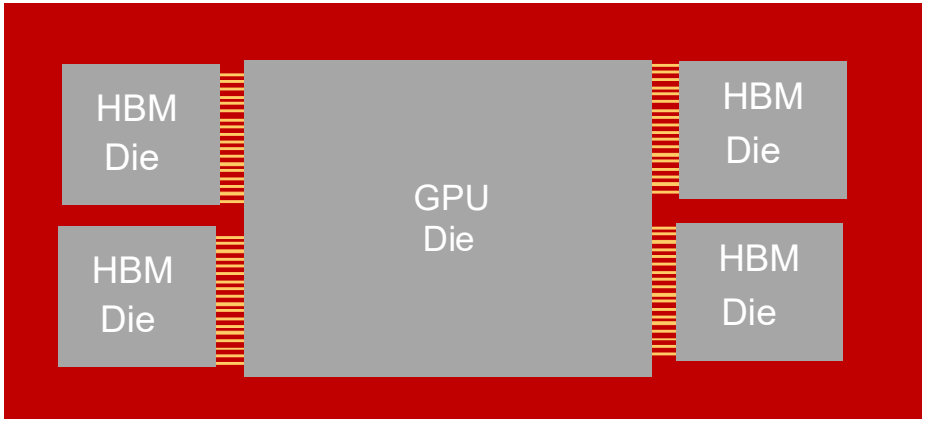


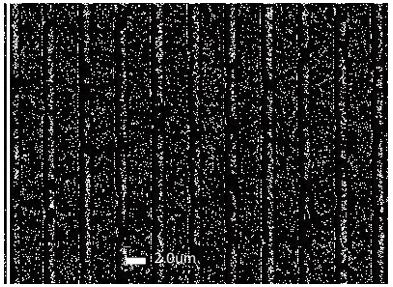
CPW on Glass makes small differential

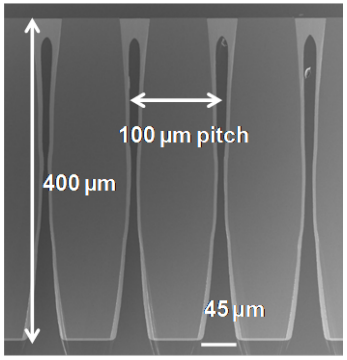
Modeling high frequency transmission

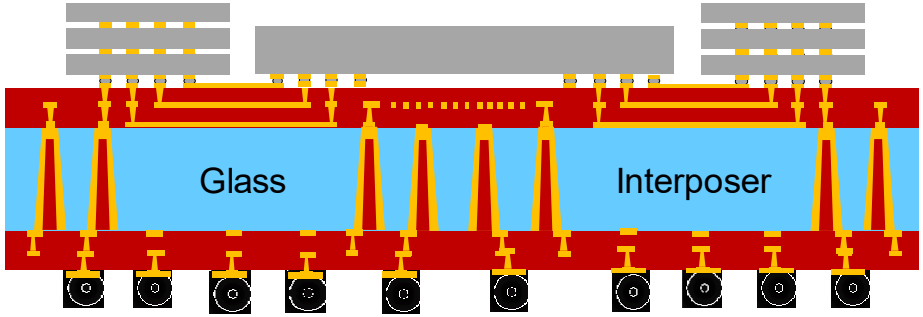
2.1D Glass Interposer

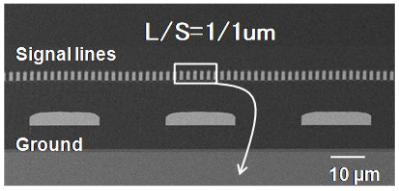


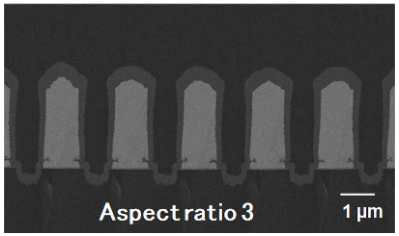




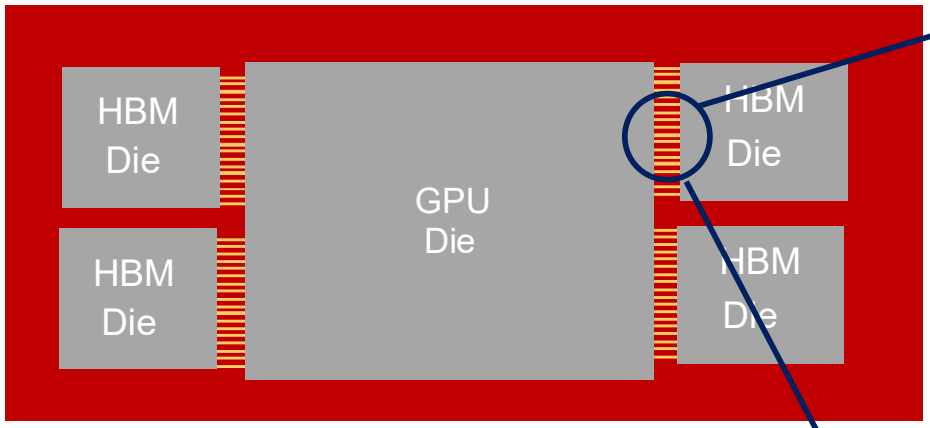


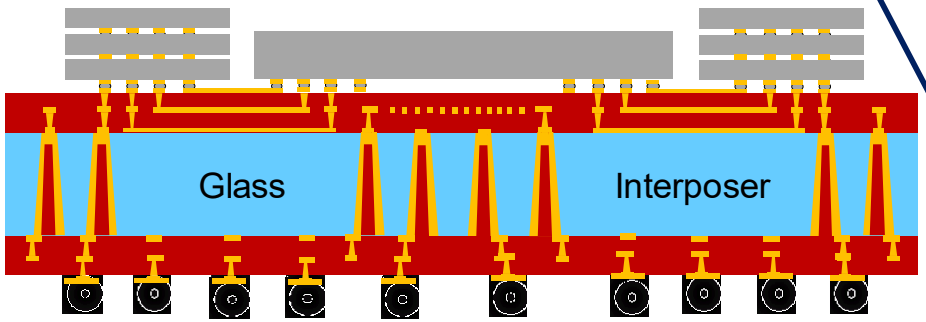




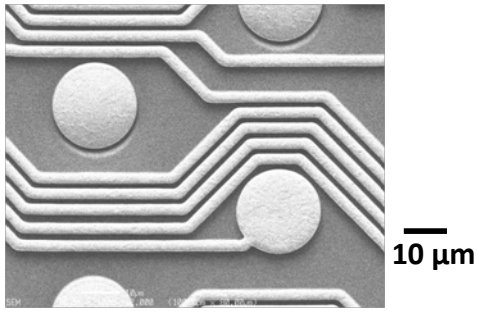


Modeling high frequency transmission

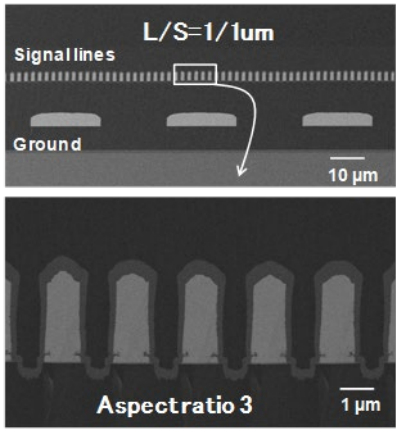




Limitation distribution
Length pad to pad >5mm



Limitation cross section area of fine wiring



L/S smaller than 2/2

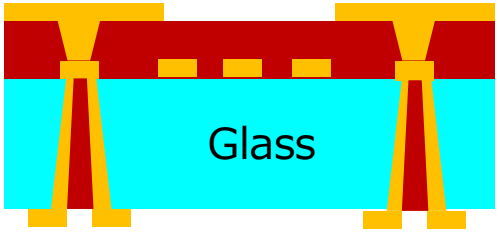
Length>5mm

→ **Conductive loss will be large** → **Need low loss dielectric structure**

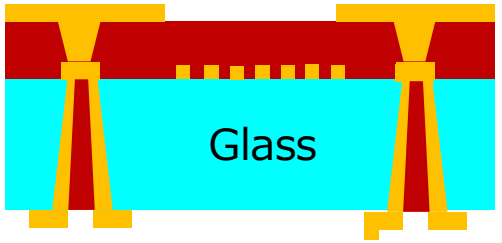
Modeling high frequency transmission

Impact of dielectric material

L/S=30/15um



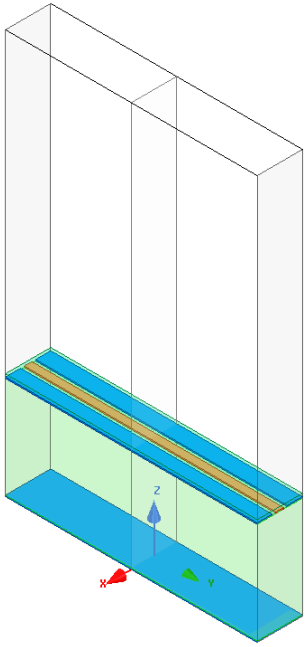
L/S=2/2um



L/S=2/2um,

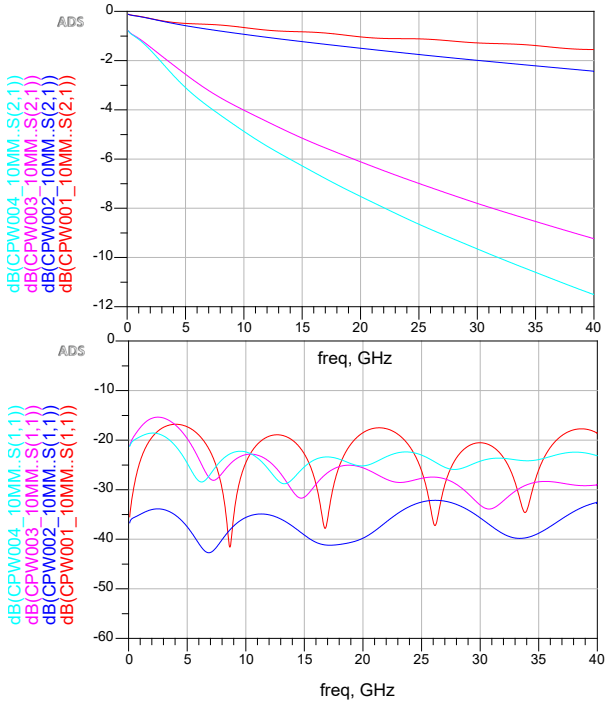
10Gbps 10㎜ length

model(001)

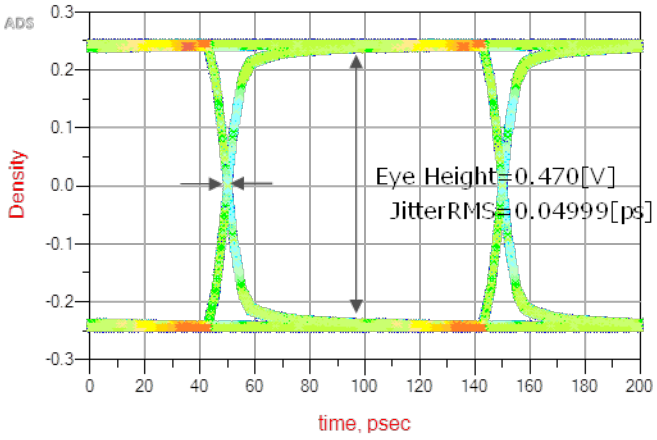


2.5D simulation

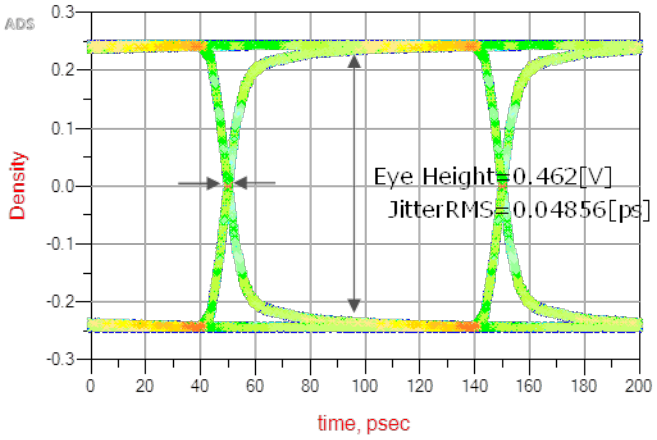
Wiring length 10mm port



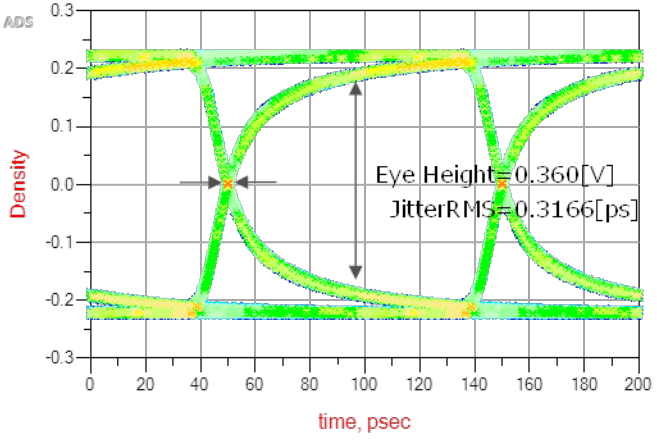
Modeling high frequency transmission



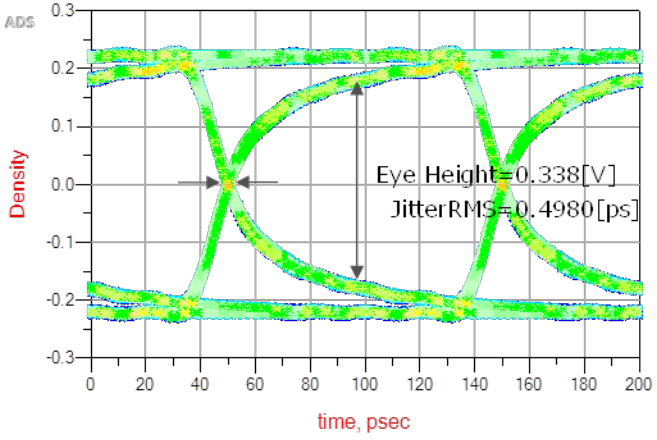
L/S=30/15 CPW PI-A



L/S=30/15 CPW PI-B

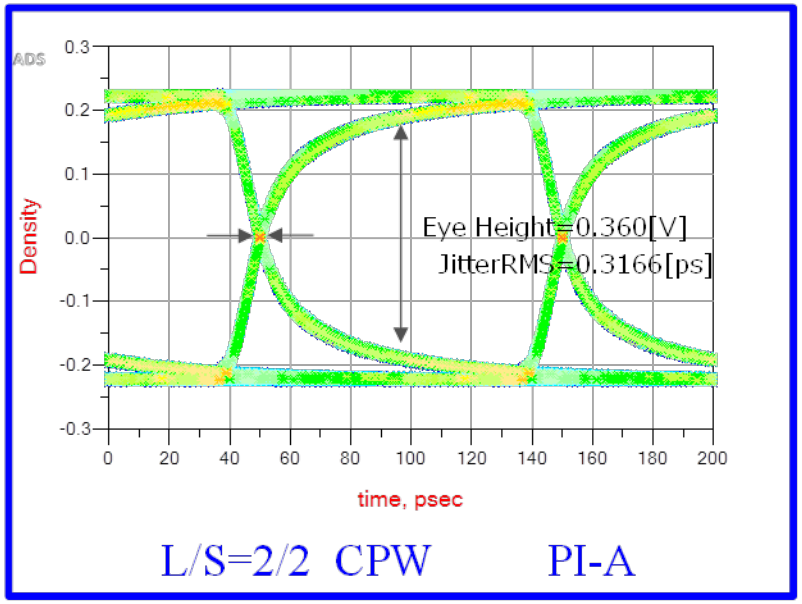


L/S=2/2 CPW PI-A

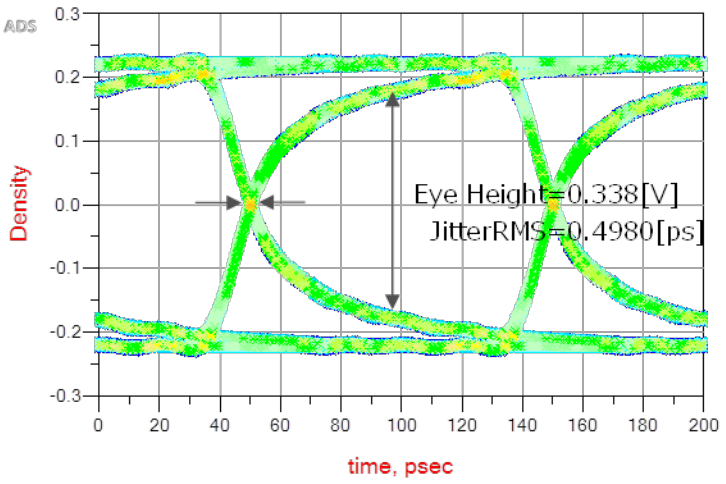


L/S=2/2 CPW PI-B

Modeling high frequency transmission



L/S=2/2 CPW PI-A



L/S=2/2 CPW PI-B

Model	Eye height(V)	Rising time(psec)
L/S=2/2 CPW tanδ=0.005 dielectrics	0.360	45.6
L/S=2/2 CPW tanδ=0.03 dielectrics	0.338	57.3

Summary

Interposers with TGV interconnects was demonstrated with fine pitch through via.

Three types of Cu plating method with through via have excellent transmission properties. The new types of partial filling TGV perform low loss and fine pitch configuration.

Low loss dielectrics synthesized and measured for high frequency transmission characteristics on the 3layer transmission line.

High speed transmission characteristics for 2.1D interposer modeled with eye diagram.

Excellent transmission obtained on fine pitch trace area using Low loss dielectric polymer.

Thank you for attention