



3D Packaging Synthetic Quartz Substrate and Interposer for High Frequency Applications

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Agenda

- Background
- Critical Interposer Properties
- Current Technology
- Substrate Comparisons
- Design and Testing
- Results
- Summary



Background



- Smaller and Thinner
- Higher Frequencies
- Increasing I/O Density
- I/O Vias and Trace metallization limited by positional accuracy and planarity
- Cost

Interposer Technology



GLASS PROPERTIES

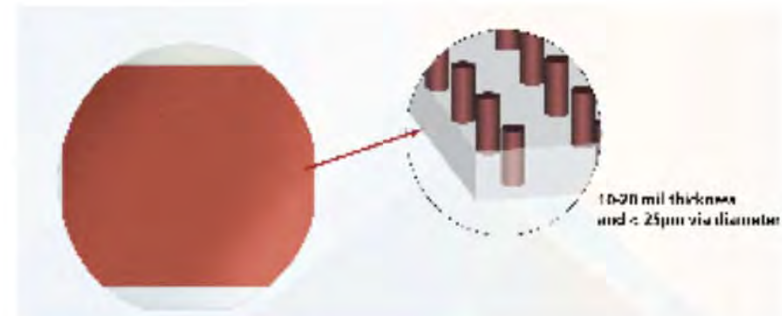
Glass Thickness: 0.3mm
Wafer Diameter: 150mm, 200mm, or 300mm
Surface Roughness: 60/40
High Volume Glass
Alkalai Free

TGV Interposer



TGV PROPERTIES

>50 μ m Diameter Vias
>130 μ m Via Pitch
TCE Matched Cu
Hermetic Vias
Low Cost Manufacturing
High Conductivity (1.6-1.9 m ohm / sq)



Critical Engineering Requirements



- Electrical and Physical Performance
 - Insertion Loss
 - Positional and Dimensional Accuracy
- Low Cost
 - Substrate
 - Metallization
 - Via Drilling
- High Volume Manufacturing

Markets



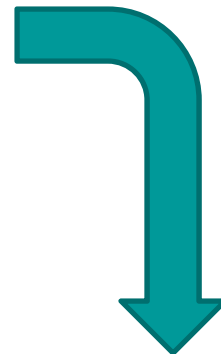
- High Performance CPU, ASICS and GPU's
- Wireless
- MEMS
- Display

Current Technology



Substrates

- Teflon/Ceramic
- FR4
- Alumina
- LTCC
- Silicon



Metallization

- Thin Film
- Copper foil
- Thick film copper

Substrate Sizes



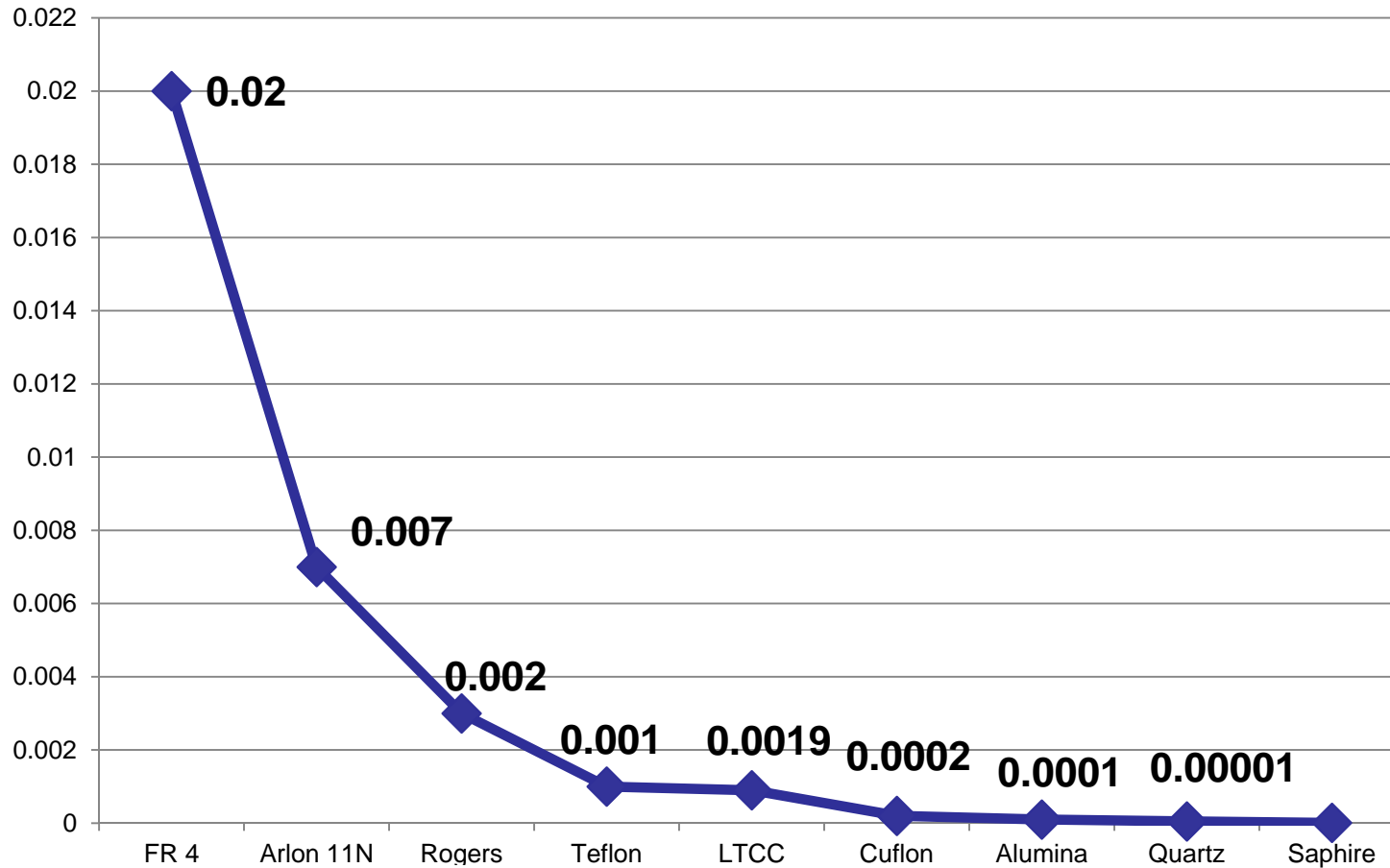
Substrate	Largest Format	Vias
LTCC	8 X 8 inch	Solid Plug
PCB	12 X 24 inch	Plate up
Alumina	8 X 8 inch	Plate up
Synthetic Quartz	8 inch dia	Solid Plug

Substrate Comparisons

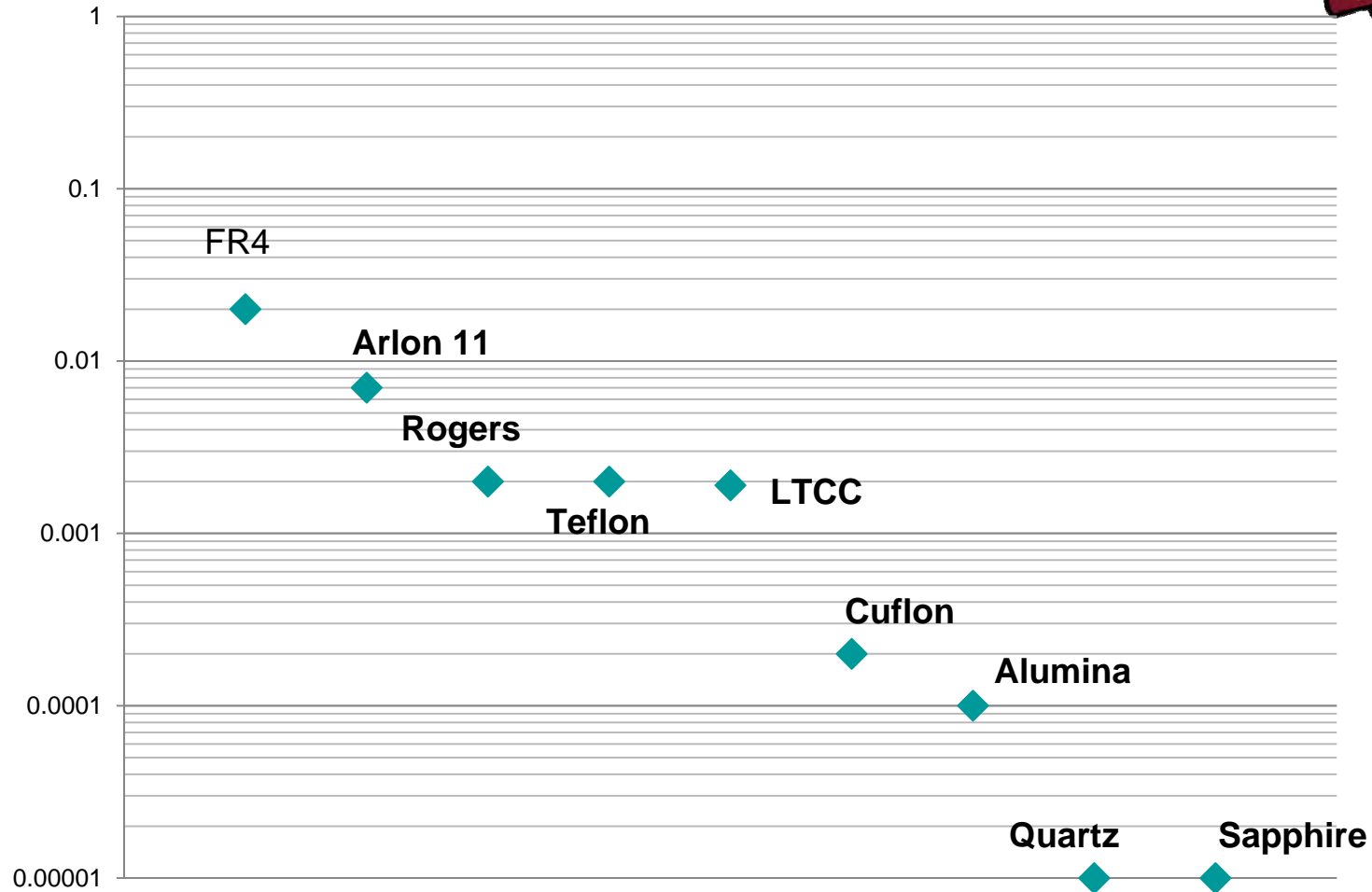


Material Type	Substrate	Dielectric Constant @18 GHz	Loss Tangent (10^{-4}) @18 GHz	Surface Roughness (Angstroms)
Ceramic/ Glass	Alumina	9.8	7	500-50000
	AQ	3.8	<1	10
	EN-A1	5.9	30	100-50000
	Soda Lime Glass	6.72	170	1000-50000
	Sapphire	11.5	<1	10-100
	LTCC	5-9	2-5	NA
PCB	PCB (ceramic/Teflon)	2.94	14	30000
	FR4	5-7	200-1000	2000-100000

Substrate Loss at 18 GHz



Substrate Loss at 18 GHz



Design and Testing

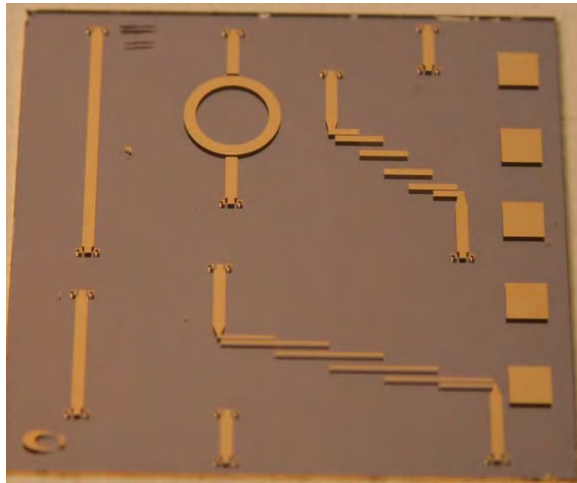


- Validation of substrate
 - LTCC
 - Alumina
 - Synthetic Quartz AQ
 - PTFE/Ceramic
- Test Circuit
 - Ring Resonator,
 - Co-Planar Waveguide
 - Edge Filters
- Metallization
 - Copper Metallization

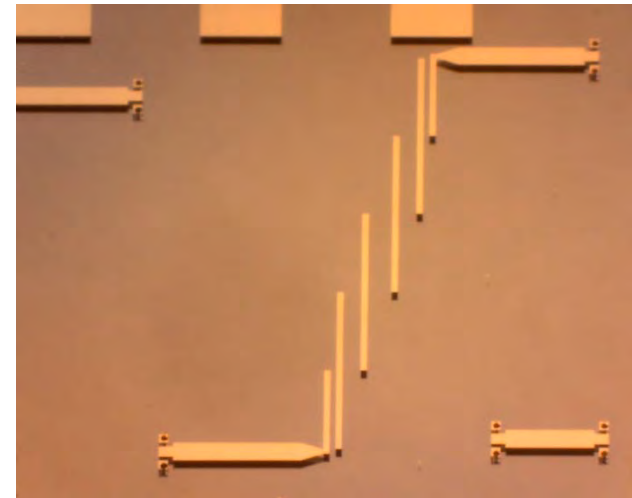
Design



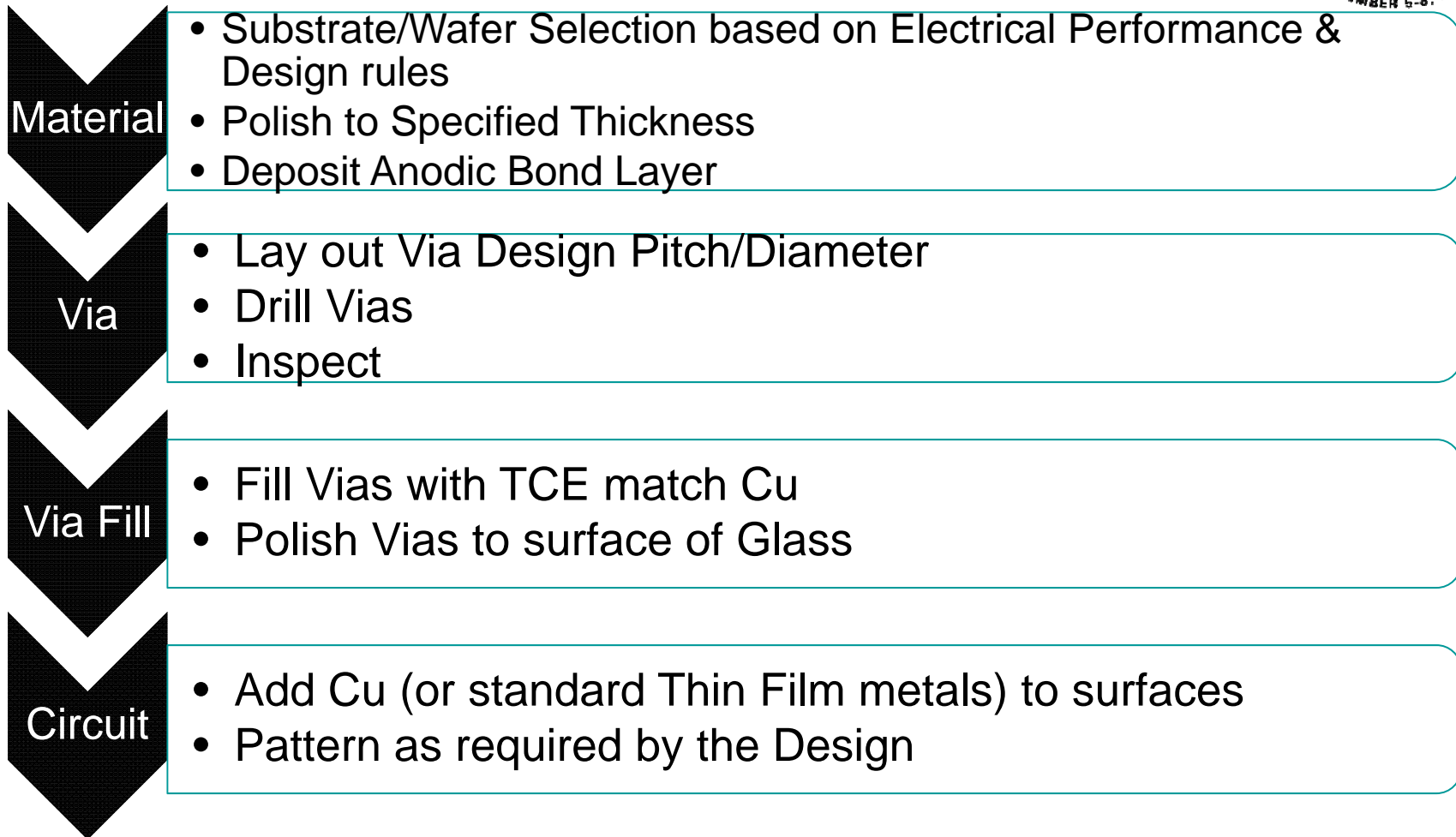
Four Materials were chosen
Synthetic Quartz, LTCC,
PCB(PTFE/Ceramic) and Alumina



Test Vehicle Design:
Ring Resonator
CPW
Edge Filer



Fabrication

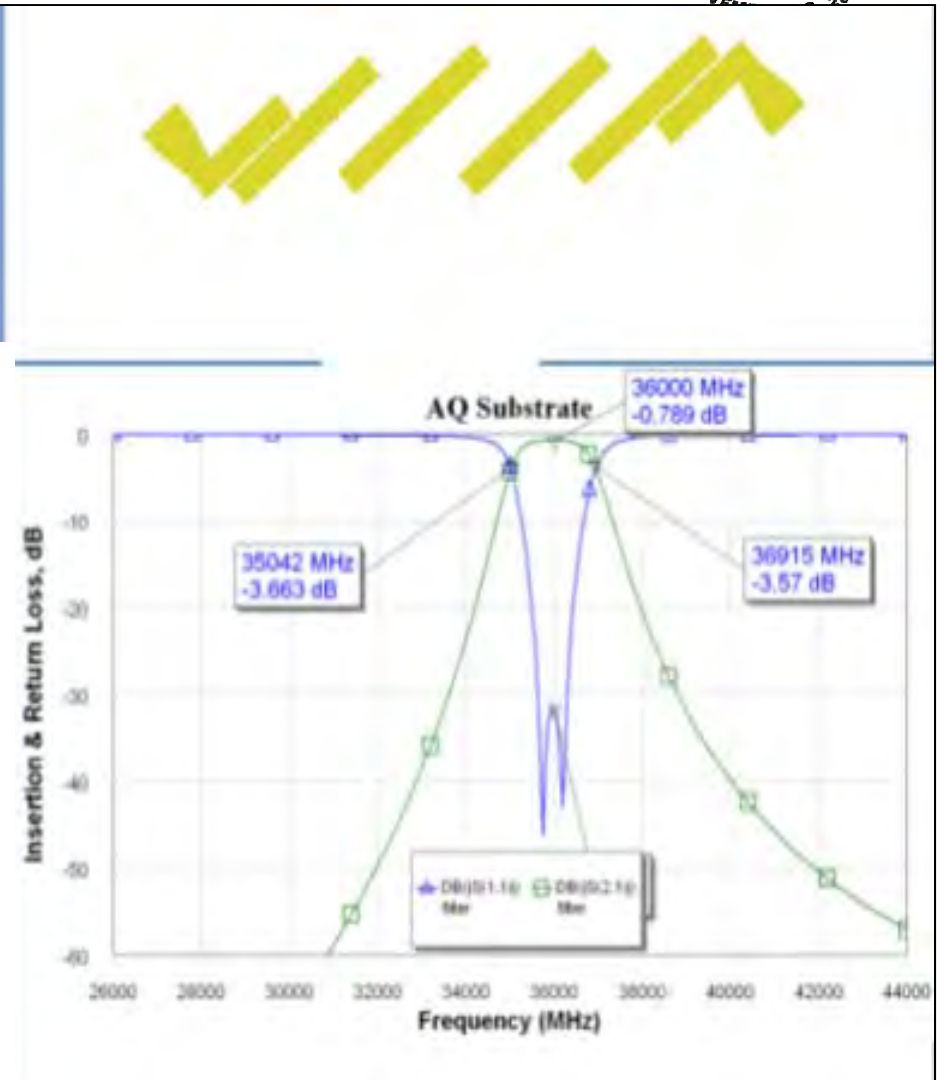
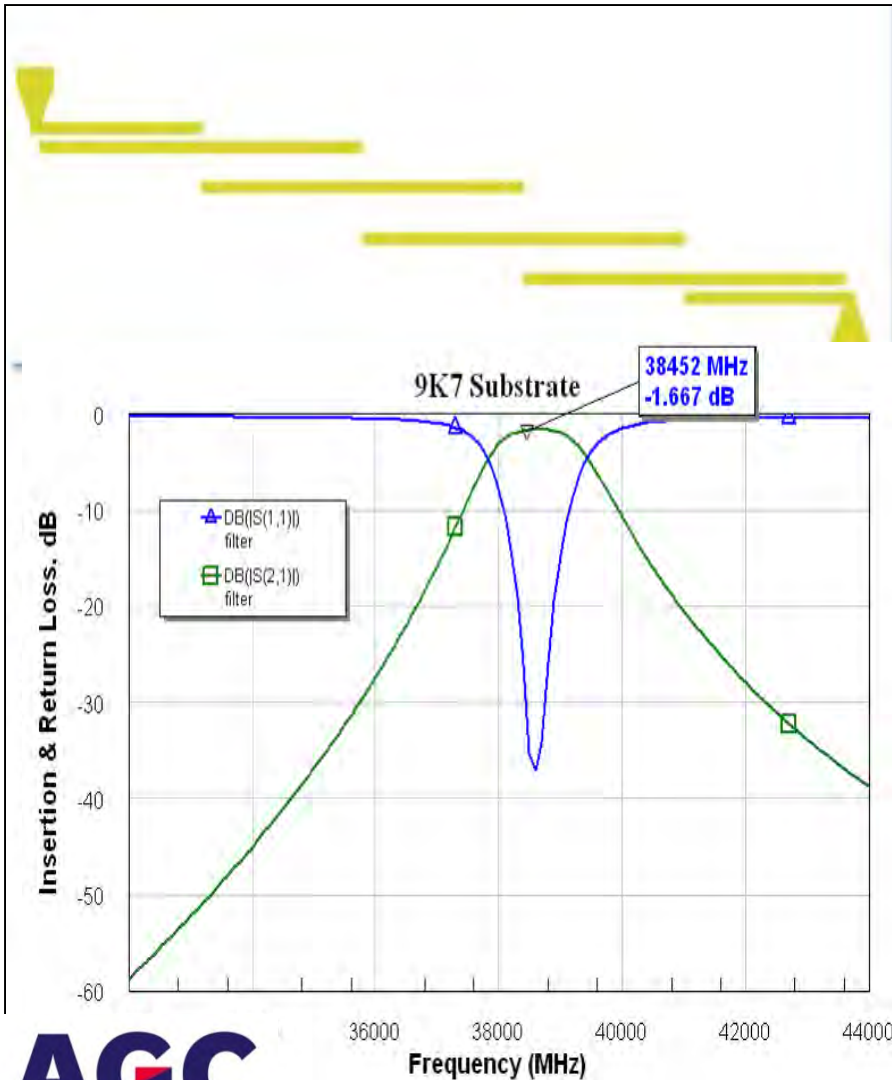


Results



- Filter Result at
 - 36 GHz
- Loss tangent results
 - Bandwidth
 - Insertion Loss

Test Results



Test Result Summary



Material	Frequency	Insertion Loss	Band Width %
Synthetic Quartz	36 GHz	-0.789 dB	7.9%
LTCC	36 GHz	-1.747 dB	8.1%
PCB (PTFE/Ceramic)	36 GHz	-3.91 dB	8.1%
Alumina	36 GHz	-1.55 dB	8.1%

Summary



- Low Loss Synthetic Quartz has better loss performance than Alumina, PCB and LTCC at 36 GHz.
- High Precision Vias down to 50 micron and 130 can be done.
- High Conductivity Copper thickfilm
- Solid Plug Vias