



# **ZEONIF™ XL-Series**

## **Advanced materials for High-Speed Circuit and Radio Frequency (RF) module Applications**

**Zeon Corporation Yuya Suzuki**

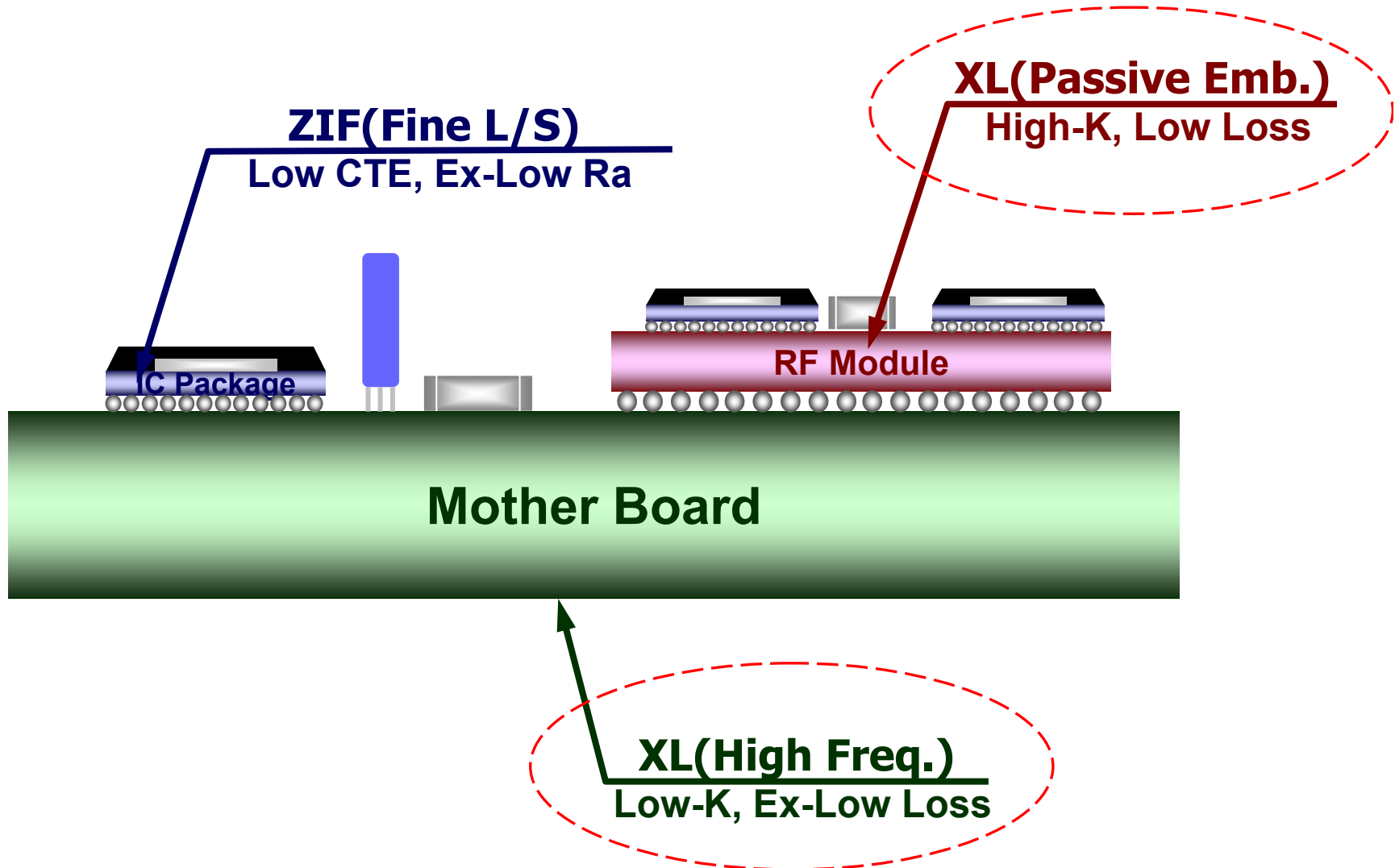
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  - High Reliability
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  - Miniaturized RF module using XL-high Dk

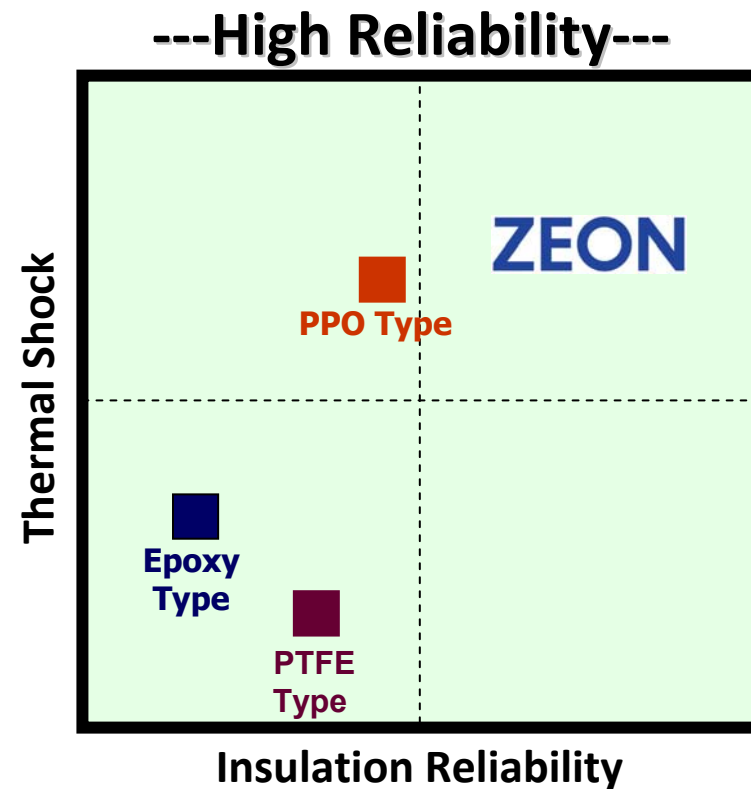
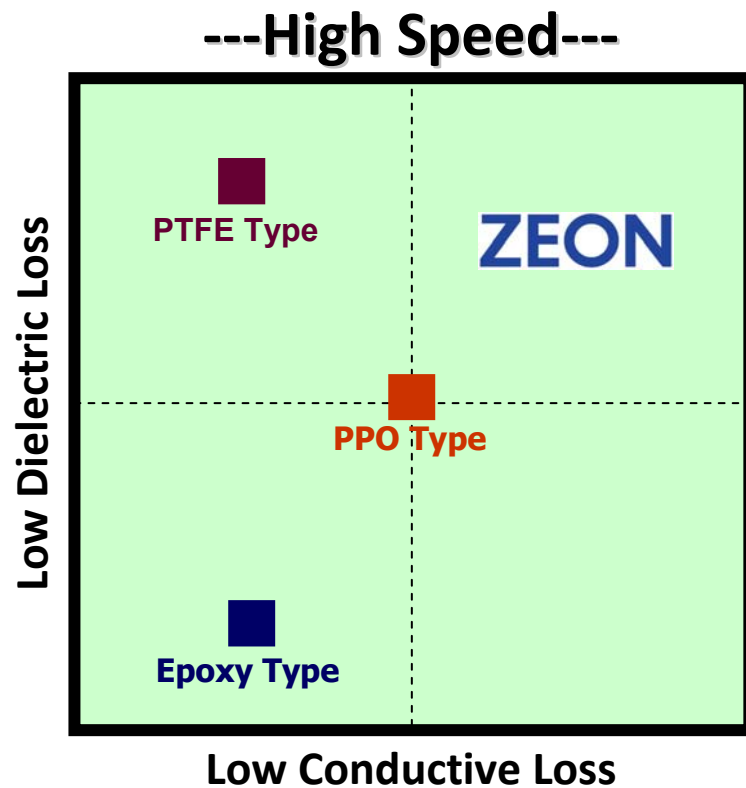
# **ZEONIF™ XL**

# Zeonif product portfolio Overview









# Design Concept of XL-Series

XL-Series contributes to achieve the High Speed/Freq. and high reliability substrate.



# General Properties of XL

Content	Unit	Zeon			Others		
		XL (halogen) <i>Low Dk halogen</i>	XL-HF <i>Low Dk halogen-free</i>	XL-200 <i>High Dk halogen-free</i>	Epoxy	PTFE	PPE
Dk(1GHz)	-	3.5	4.5	6.7	4.4	3.0	3.8
Df(1GHz)	-	0.001	0.001	0.003	0.018	0.0013	0.002
Tg(DMA 1Hz)	C	180	180	175	155	20	190
CTE <sub>z</sub> (<Tg)	ppm/C	50	45	40	65	-	45
CTE <sub>x-y</sub> (<Tg)		12	12	12	16		
Cu Foil Roughness	μm	 <150nm	 <150nm	 <150nm	 >>1μm	 >>1μm	 >1μm
Peel Strength (thickness 35 μm)	kN/m	1.1	0.8	0.7	1.4		0.8
Water abs.(23C*200HR)	%	0.06	0.08	0.08	0.2	-	0.15
Glass Cloth	-	E Glass	E Glass	E Glass	E Glass	E Glass	E Glass
Young's modulus	GPa	12	15	15	21		

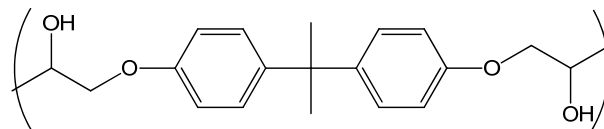
**Low loss and low moisture absorption material  
compatible to general packaging process**

# How to get low loss?

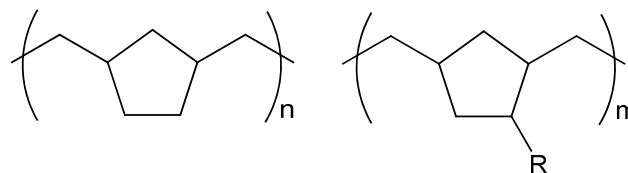
■ **Dielectric Loss** ■  
(Ld)

■ **Conductive Loss** ■  
(Lc)

**Conventional**

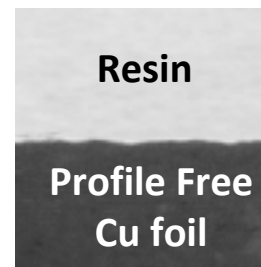


**XL-Series**



**Low Dk/Df**  
**Low water abs.**

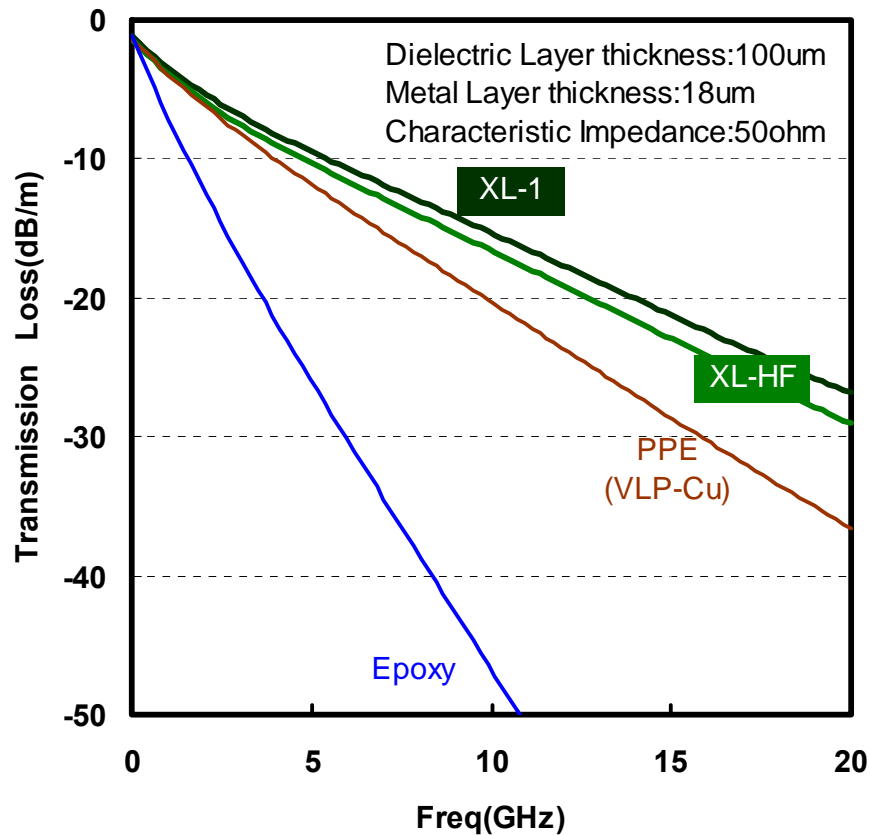
**Cross linking**  
**Adhesion**



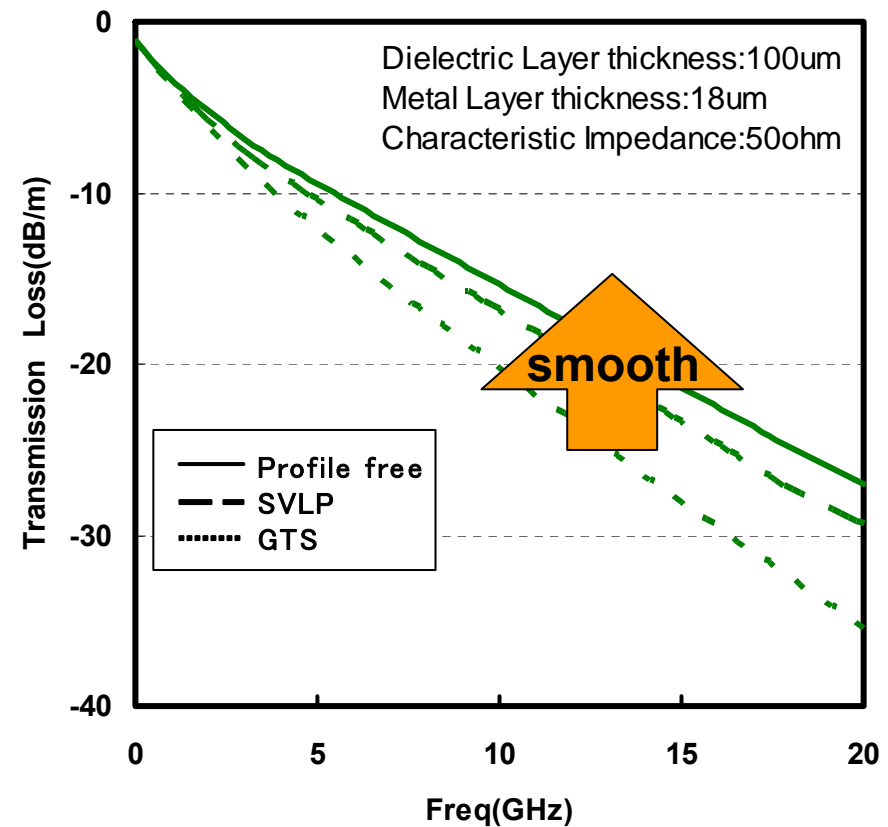
**COP (Cyclo-olefin Polymer) → Low Ld**  
**Profile free Cu foil → Low Lc**

# Transmission loss in micro strip line

Micro Strip Line



XL transmission & Cu roughness



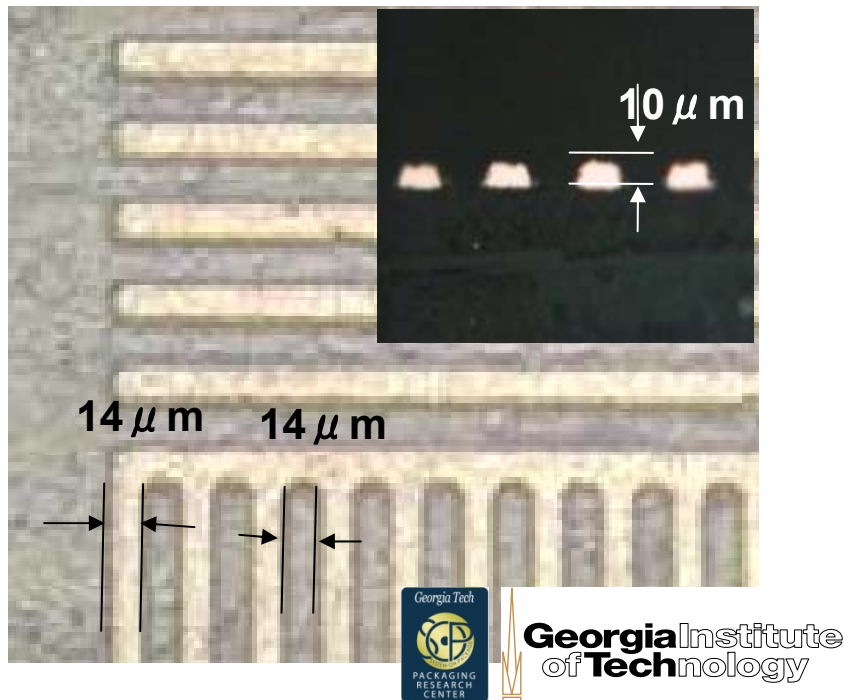
Extremely low transmission Loss due to low  $L_d$  &  $L_c$



# Fine line/space

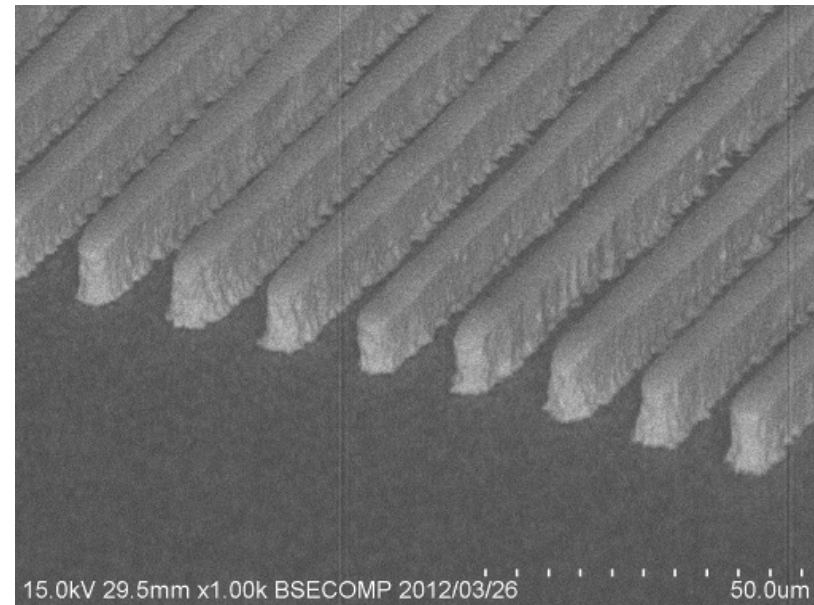
Subtractive process

L/S = 14/14



MSAP

L/S = 8/8



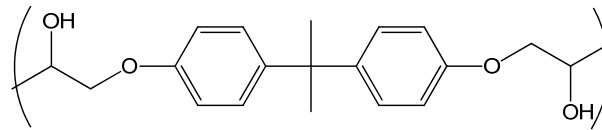
**Very fine line/space feasible because of profile-free surface**

# Low moisture absorption

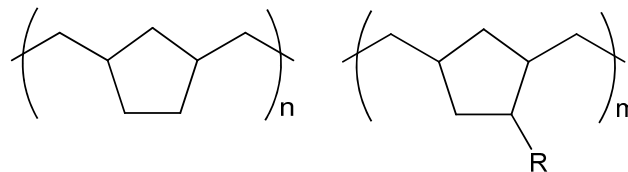
■ Dielectric Loss ■  
(Ld)

■ Conductive Loss ■  
(Lc)

**Conventional**

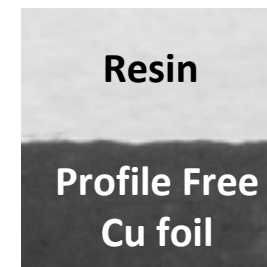


**XL-Series**



Low Dk/Df  
Low water abs.

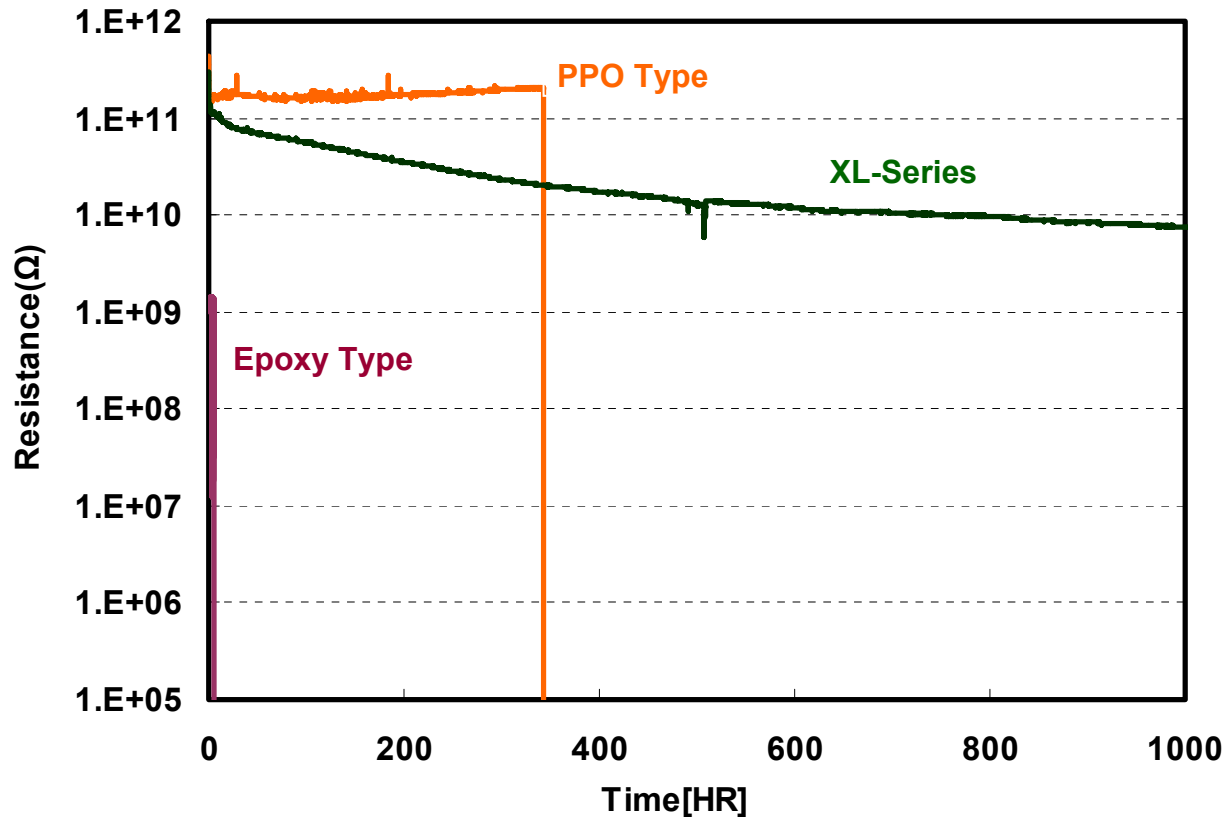
Cross linking  
Adhesion



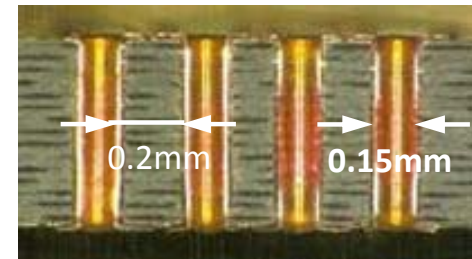
No polar group in main chain  
→ extremely low moisture uptake

# Insulation Resistance Test

**Test Condition: 130C\*85%RH\*100V**



**<Test Piece Info.>**



**<Test Sample>**

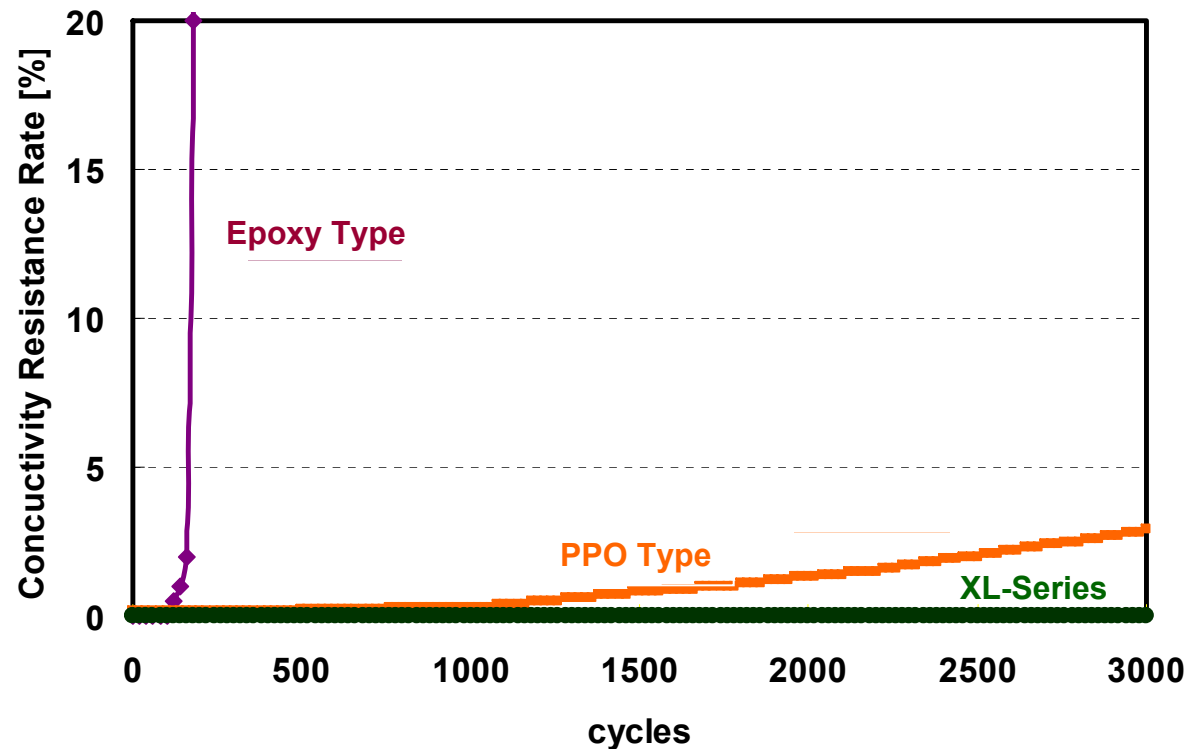
- Thickness ; 0.8mmt
- Hole number ; 20holes
- Land diameter ; 0.4mm

\*Pre-Condition:  
MSL 2A / 260 C(JESD22-A113)

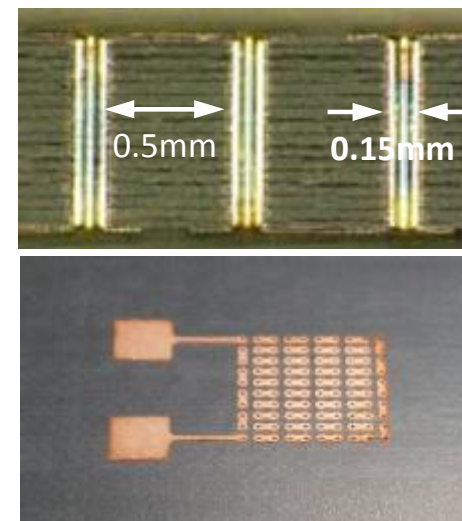
**High resistance up to 1000HR.**

# Thermal Shock Reliability

Test Condition: -65C\*30min~150C\*30min



<Test Piece Info.>



<Test Sample>

- Thickness ; 0.8mmt
- Hole number ; 100holes
- Land diameter ; 0.45mm

\*Pre-Condition  
MSL 2A / 260 C(JESD22-A113)

High resistance even under sever condition

# Processability of XL

## 【 Press & Drilling 】

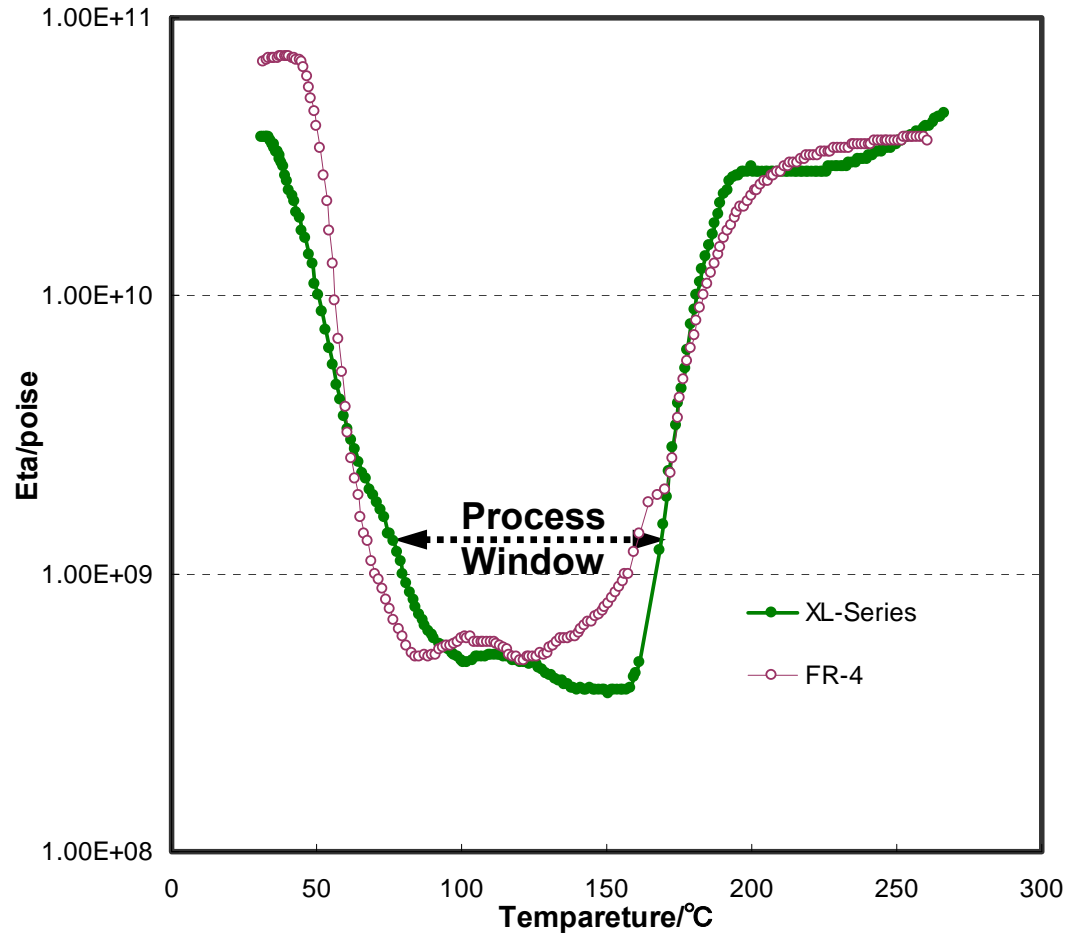
Process	Condition	FR-4	XL-Series
Lamination	Temp.	160C	190C
	Pressure	2.5MPa(363psi)	3MPa(435psi)
	Time	50min	30min
Drilling (0.3mm $\phi$ )	Chip Load	20um/rev	20um/rev
	Speed	120~160krpm	120~160krpm

## 【 Desmear 】

Process	Comp.	FR-4	XL-Series
Swell	Securigant P/ NaOH aq.	60C*5min	60C*5min
Rinse	Deionized water	R.T*20s(3)	R.T*20s(3)
Micro etch	Compact CP/ NaOH aq.	80C*10min	80C*10min
Rinse	Deionized water	R.T*60C(3)	R.T*60C(3)
Reduction	Securigant P500 98%H2SO4 aq.	40C*5min	40C*5min
Rinse	Deionized water	R.T*20s(3)	R.T*20s(3)
Dry	Air	150C*30min	150C*30min

**FR-4 process compatible**

# Lamination property



**Good resin flowability almost same as FR-4**

# Summary of XL

## 1. Extremely low dissipation factor(Df)

- minimizes dielectric loss( $Q_L$ ) of a circuit
- achieves high frequency transmission

## 2. Profile free conductive layer

- zeronizes conductive loss( $Q_C$ ) delivered from Ra/Rz
- realizes fine line spacing with subtractive process

## 3. Low moisture absorption

- reduces resistance change under humidity test

## 4. Good processability

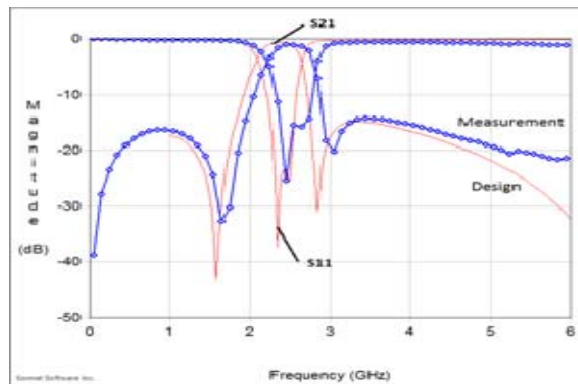
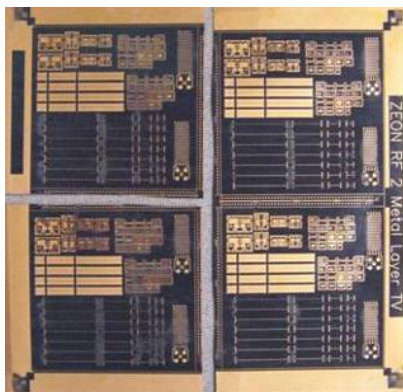
- provides multilayer PCB with conventinal process

# **Joint work at GT-PRC**

## **RF module with XL-200 (high Dk)**



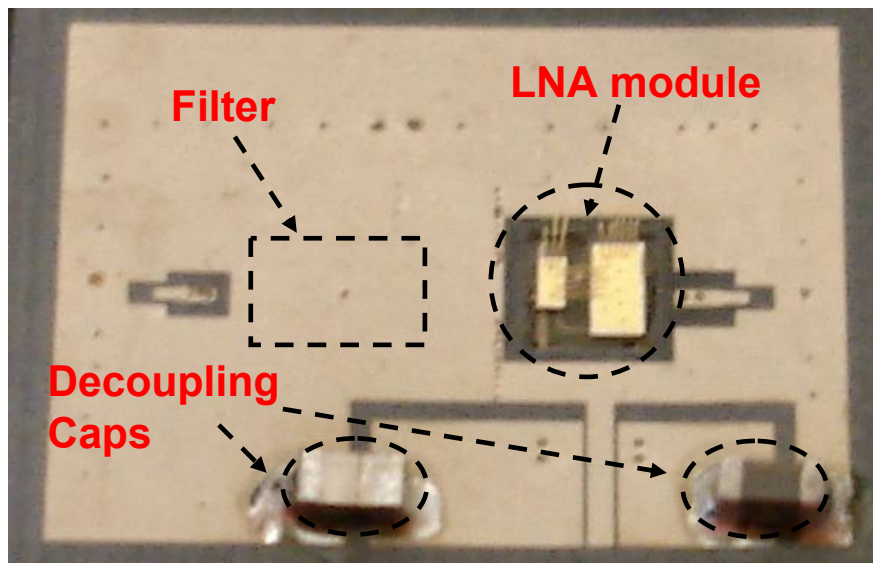
# Miniaturization of embedded filter



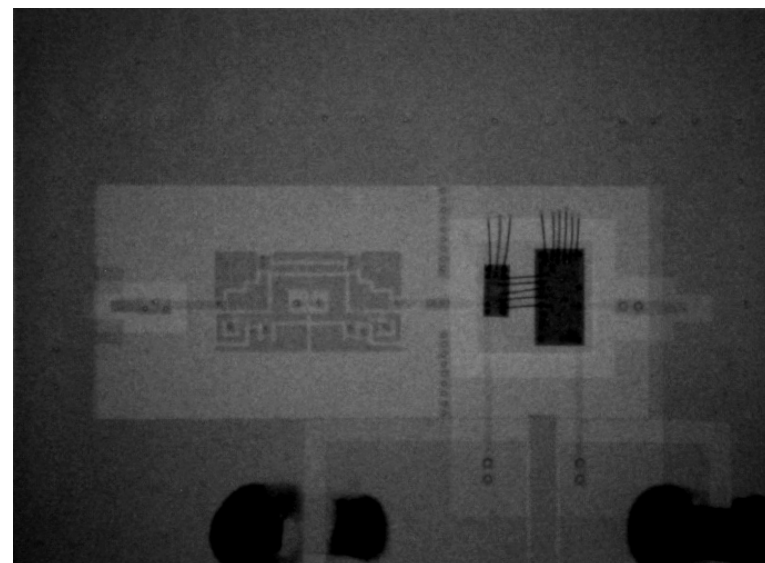
Material	Volume (mm <sup>3</sup> )	Insertion Loss (dB)	Number of Layers	Dk	Df
FR-4	1.32 (2.2x3x0.2)	2.1	4	3	0.004
LTCC	2.72 (2.2x1.4x0.9)	1.7	4	7.8	0.001
LCP	12	1.6	4	2.9	0.002
BT	2.38 (2x1.7x0.7)	2.2	8	-	0.02
XL-200	<b>0.85</b> (3.5x4.6x0.05)	<b>1.08</b>	<b>2</b>	6.5	0.003

Small and high performance filter due to low loss and high Dk

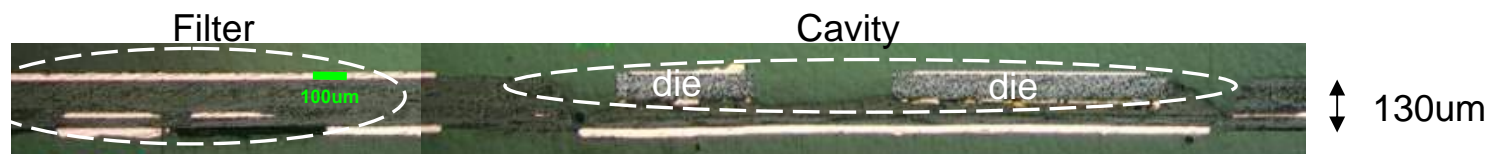
# Receiver Module Fabrication



Top view of assembled module



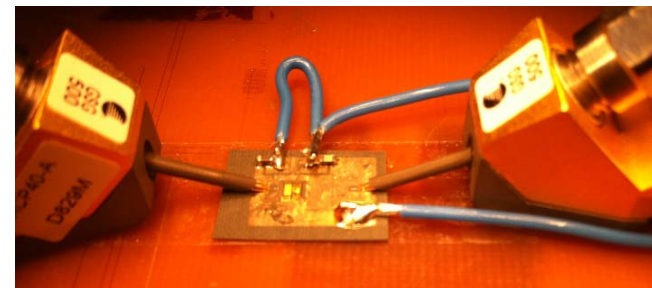
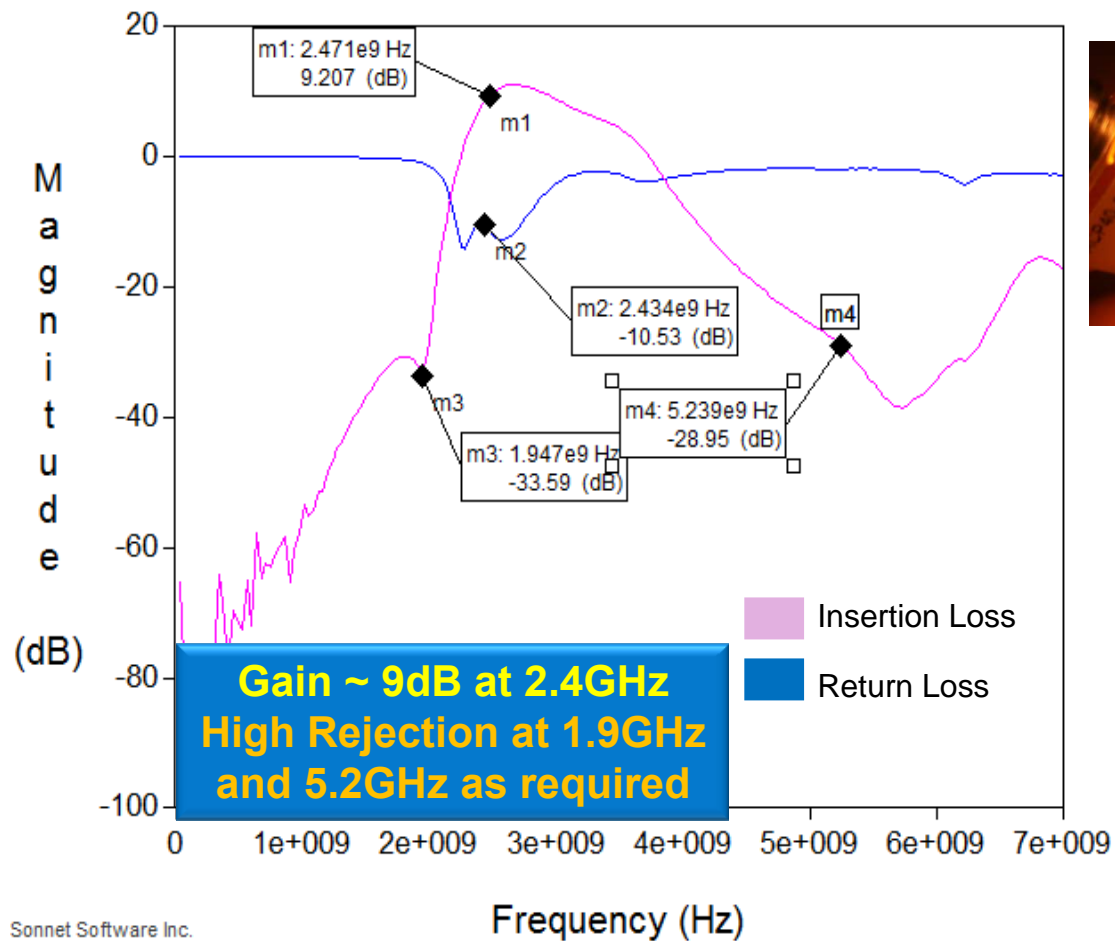
X-ray image of module



Cross-section of module

**World's thinnest 130um receiver module**

# Receiver Module Response



- SOLT Calibration
- GSG 500um RF probes
- Supply: 3.3V, 14mA
- Vector Network Analyzer

**Demonstration of 130um thin RF module with specification satisfied**

# Summary

Super-thin WLAN RF Receiver with embedded passives and chip-last embedded GaAs Actives has been demonstrated with XL-200 (high Dk)

- Reduced form factor
  - 130um World's thinnest 3D organic module
  - 5-10X volume reduction
- High RF performance
  - Gain: 9.2 dB
  - Out-of-band rejection: 34 dB
- Embedded passive substrate testability for selective site die embedding

# Your Zeon contacts

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