# Radar Antenna Design Engineers Require Cost-Effective Solutions for Their Antenna PCBs

IWPC Workshop

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# AGC Global Operation for CCL business

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nelco

Joined AGC Group
on Dec 4th, 2018

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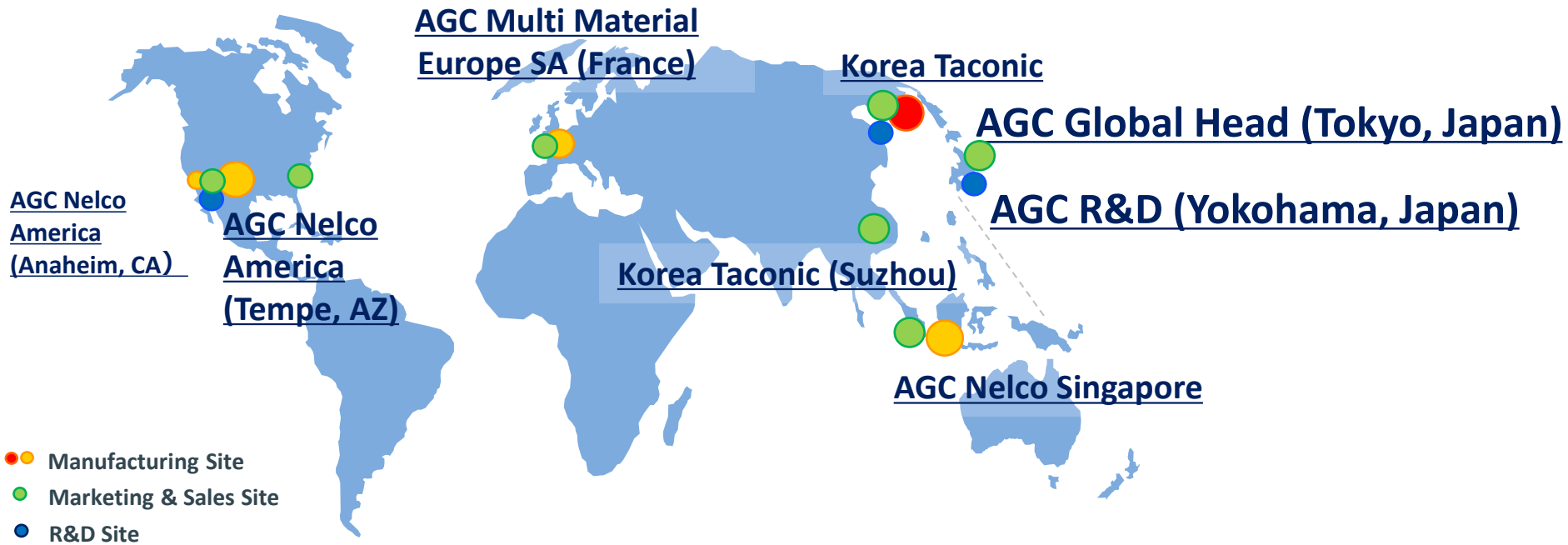
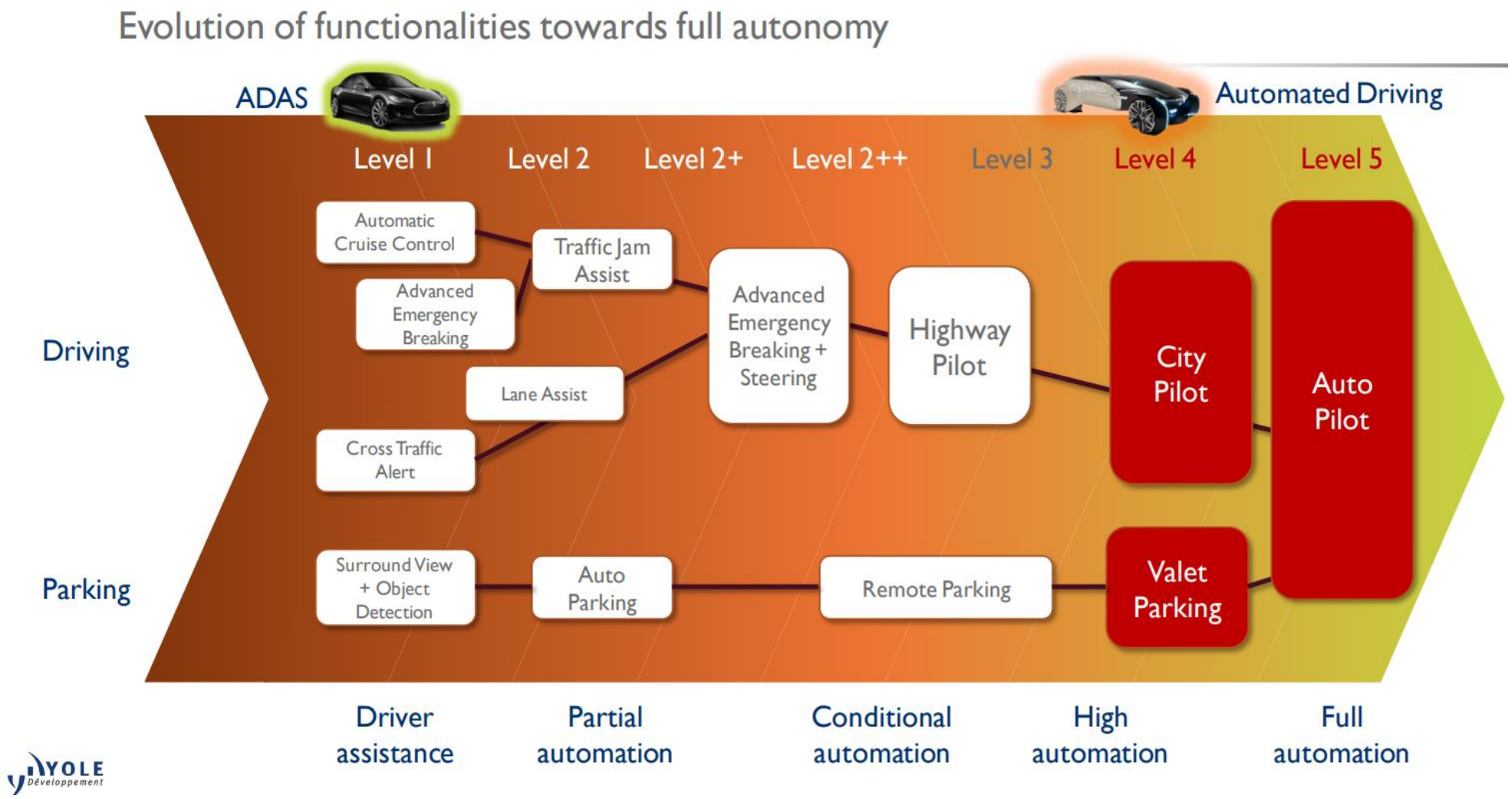
Joined AGC Group
on Jun 11th, 2019



# ADAS – The Evolution of Driving

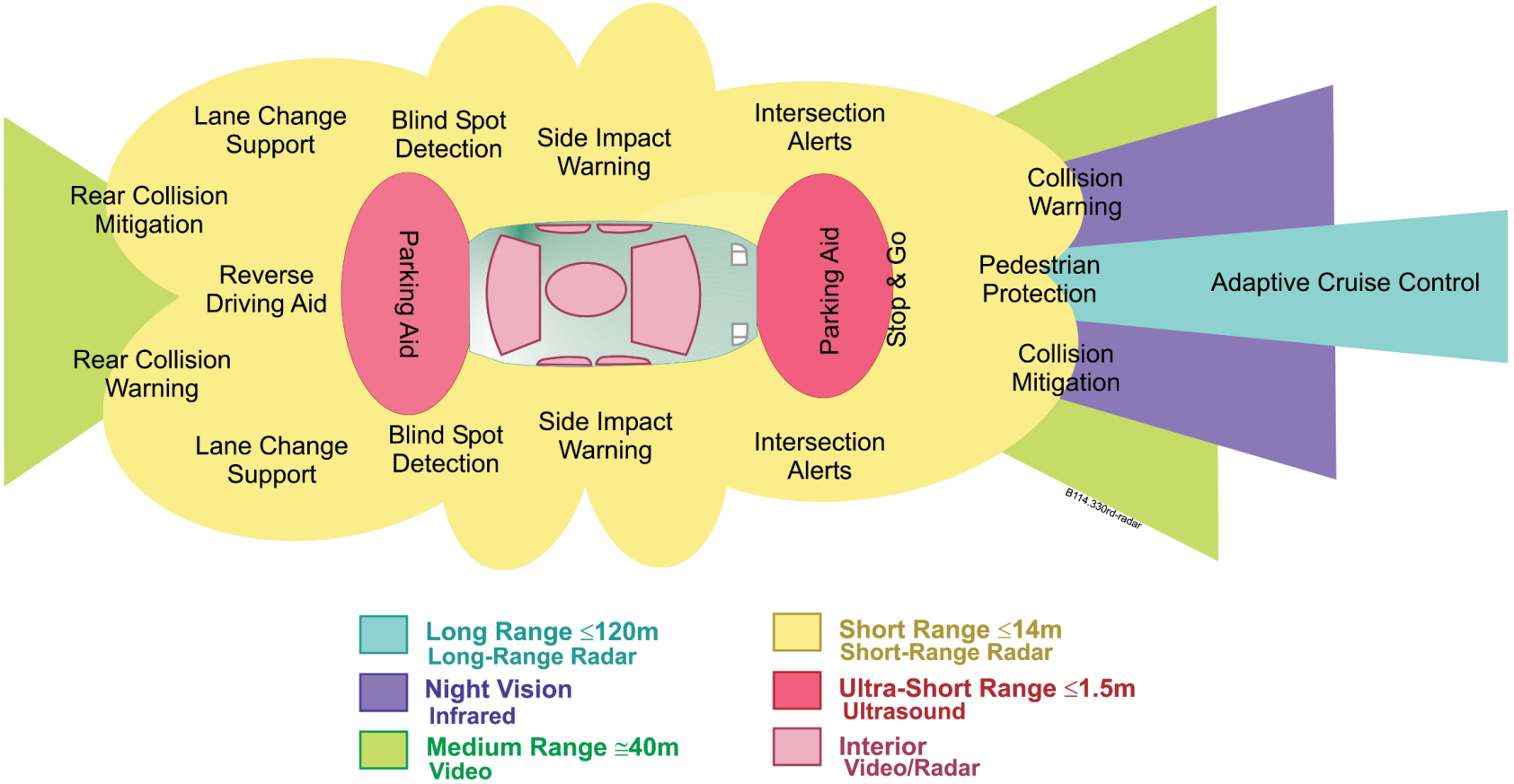



(courtesy of YOLE)

# ADAS Applications

- ADAS uses many kinds of sensors. Radar's specifications (detection distance, azimuth, relative speed, hight of object) are especially different depending on the functions.

-> Antenna design and materials need to be optimized depending on radar type.




(courtesy of PRISMARK)

# Product Roadmap for Car Radar Antenna Application

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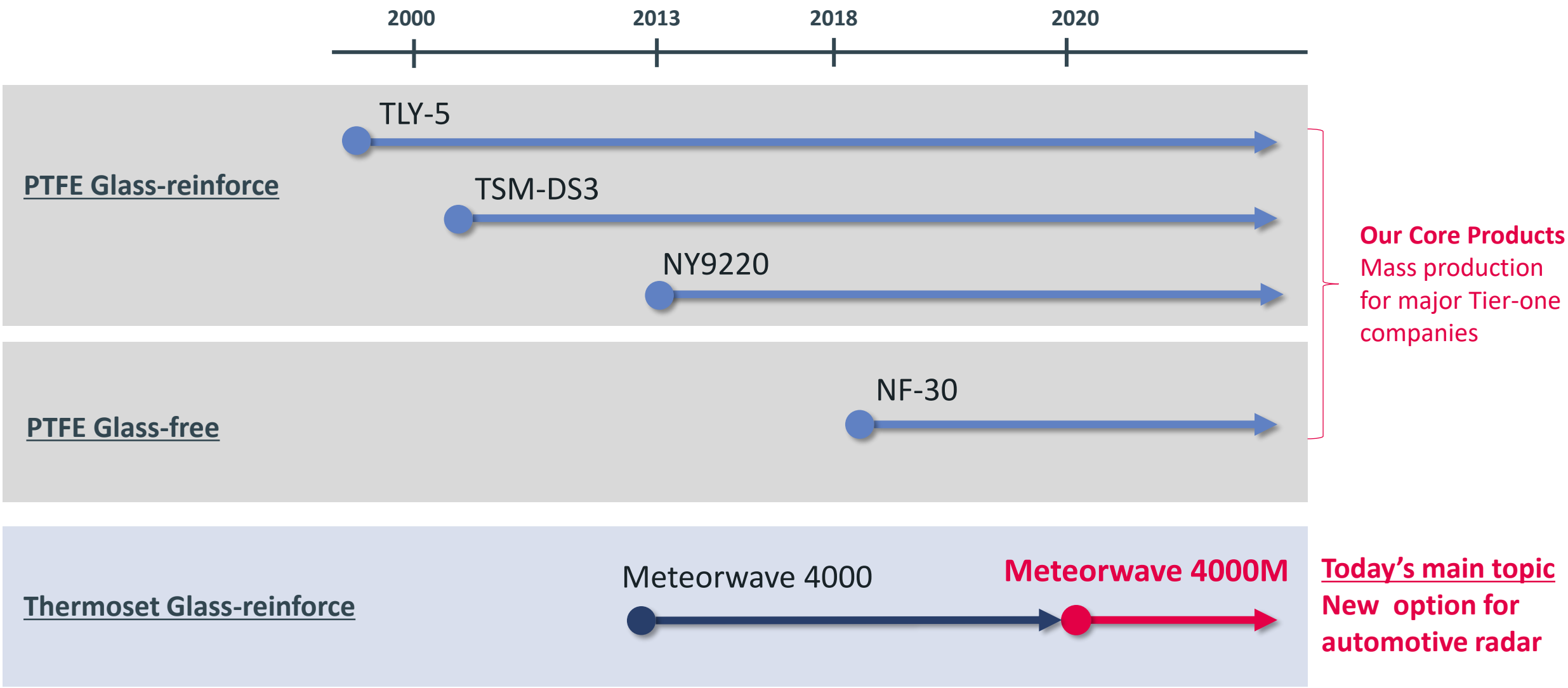

# Why Trend Toward Thermoset Materials for High Freq. Applications ?

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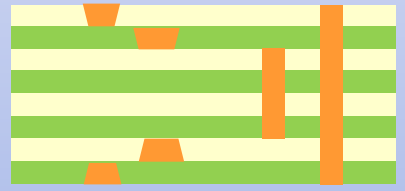
## Limitations using PTFE PCB

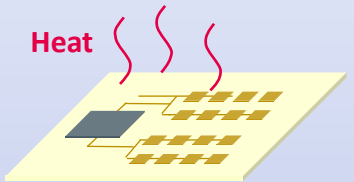
1. **Additional processing**
   - Plasma or tetraetch
     PTH/Smask/ML bonding
   - Need to avoid mechanical stress

2. **Limited options for homogeneous multilayers**

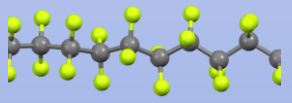


## Challenges for thermoset

1. **Thermally unstable**
   - Degradation by heat
   - Dk/Df vs temperature




2. **Higher loss**
   - PTFE CCL : Df < 0.001
   - Very Low loss thermoset CCL Df > 0.02



***AGC Meteorwave 4000M – meeting the challenge!***

# Specification of Meteorwave 4000M

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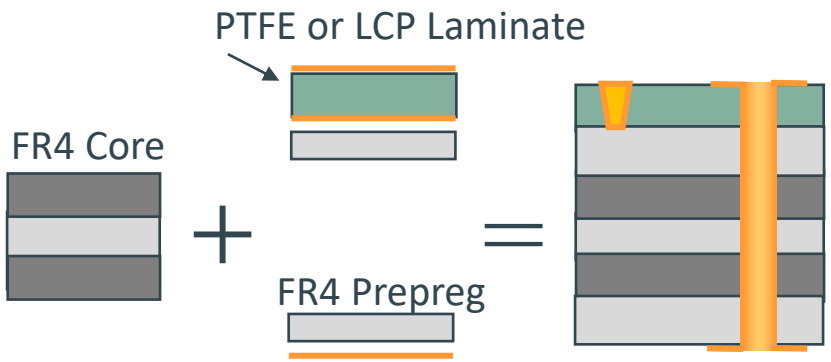
| Properties | Conditions | NF-30 (PTFE) | Meteorwave 4000M (Thermoset) | Unit |
|---|---|---|---|---|
| **Electrical Properties** | | | | |
| Dielectric Constant | @ 10 GHz | 3.0 | 3.2 | |
| | @ 77 GHz | 3.00 | 3.18 | |
| Dissipation Factor | @ 10 GHz | 0.0013 | 0.002 | |
| Insersion loss | @ 77GHz | -0.43 | -0.63 | dB/cm |
| **Thermal Properties** | | | | |
| Glass Transition Temperature (Tg) | DMA (Tan d Peak, tensile) | - | 200 | ˚C |
| Degradation Temperature | 5% wt. loss | 530 | 390 | ˚C |
| Time to delamination @ 300˚C | | >120 | >120 | minutes |
| **Mechanical Properties** | | | | |
| Peel Strength | 1/2 oz Cu (18μ) After Solder Float | 0.7 | 0.6 | N/mm |
| CTExy | -40 to + 125˚C | 11 / 15 | 18 /18 (1) | ppm/˚C |
| CTEz | 50˚C to Tg | 30 | 55 | ppm/˚C |
| **Chemical / Physical Properties** | | | | |
| Moisture Absorption | | 0.05 | 0.12 | wt. % |

(1)Resin Content 63%

# Improved Design Flexibility by Build-Up Process

- Sequential build-up process can decrease PCB area and the number of layers.
- Only thermoset resin system can be used for build-up process.

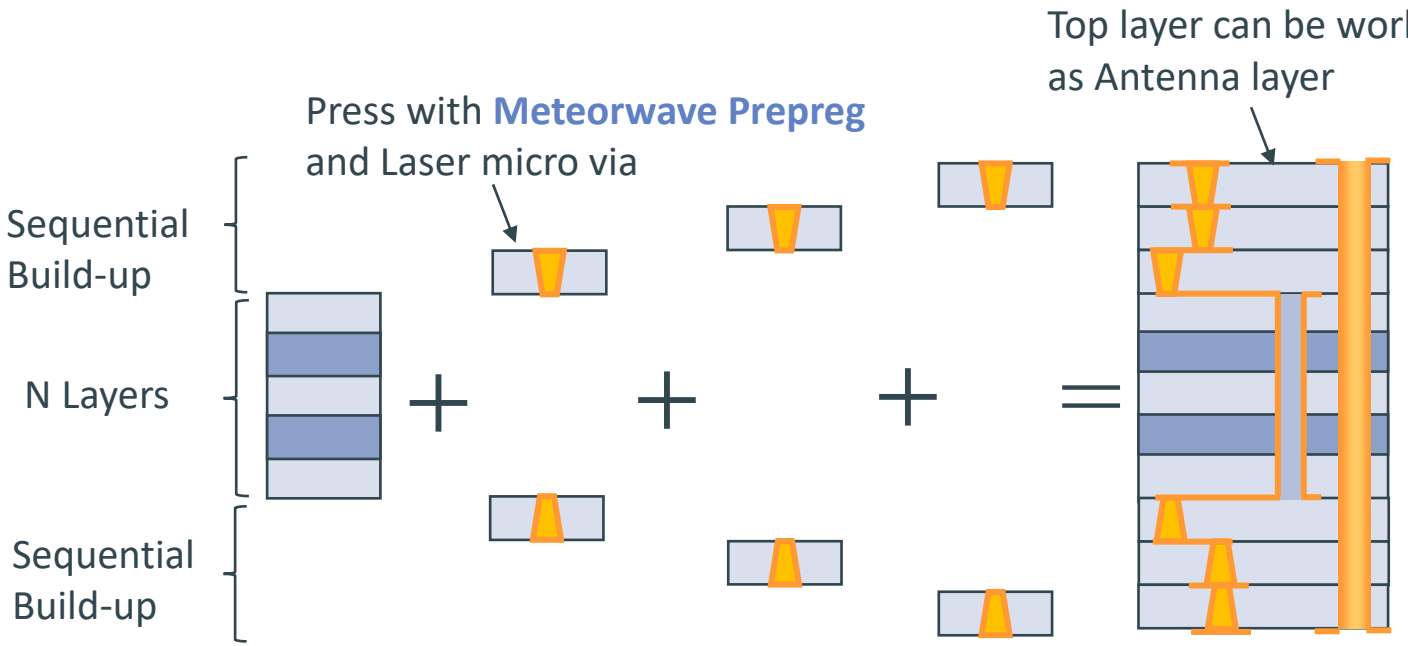
**Conventional hybrid antenna board**




**Applicable PCB material**

- Thermoplastic (PTFE) : NF30 etc.
- Thermoset : Meteorwave 4000M etc.

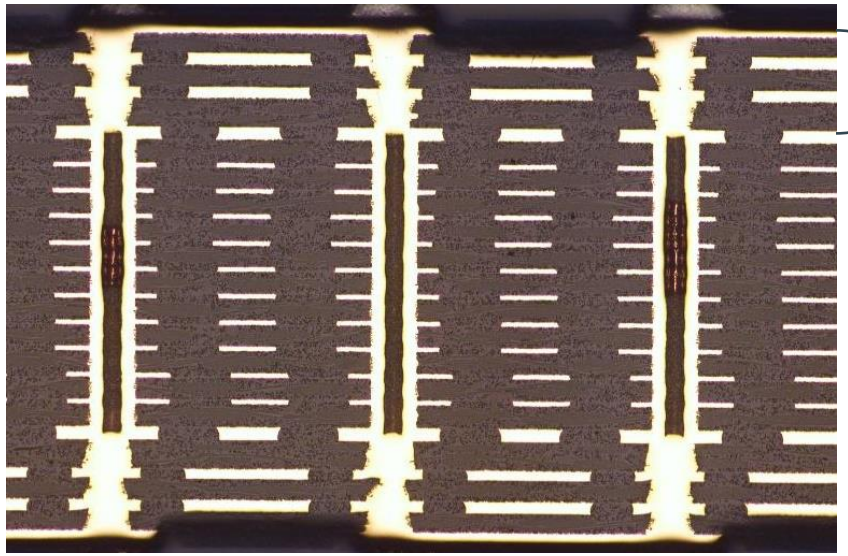
**Antenna board created by sequential build-up process**




**Applicable PCB material**

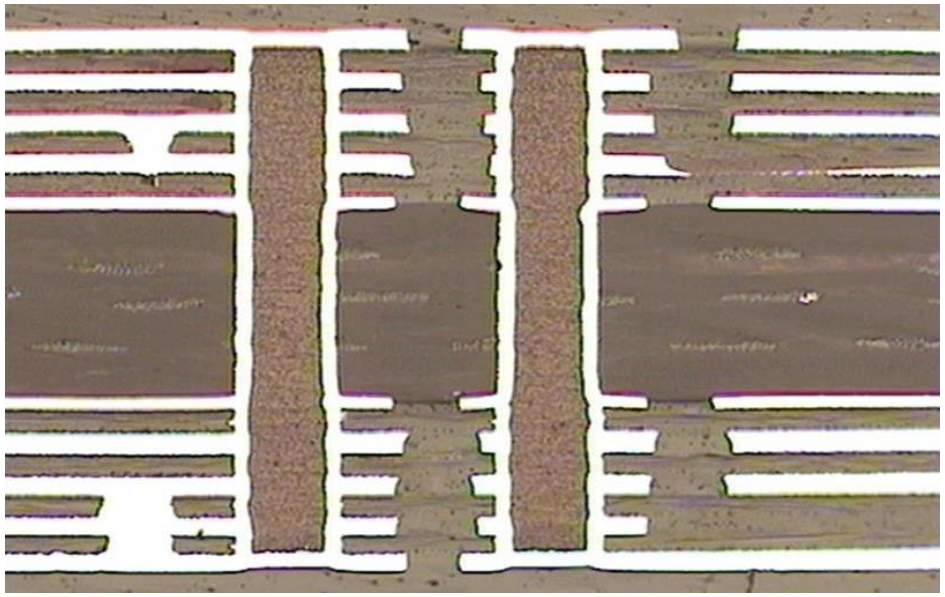
- Thermoset : Meteorwave 4000M etc.

# Examples of PCB with Build-Up Layers



3 step
Build-up
Meteorwave

3 step
Build-up
Meteorwave



4 step
Build-up
Meteorwave

4 step
Build-up
Meteorwave

# Evaluation of Electric Performance

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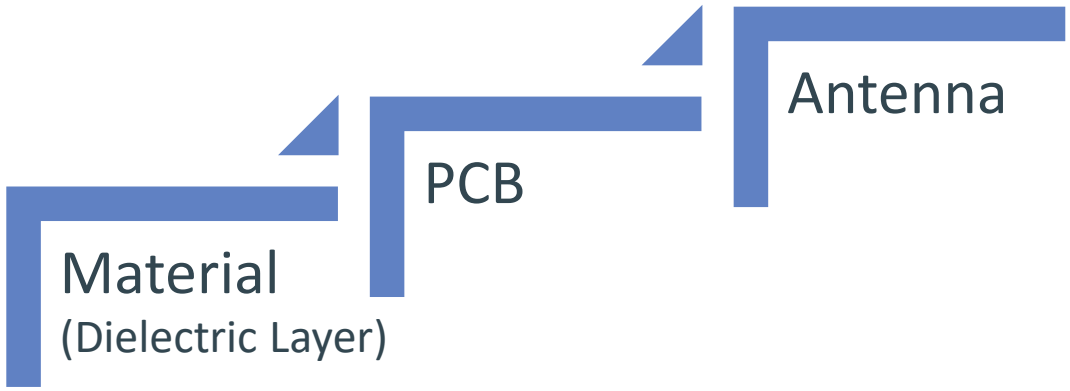
## Evaluation Condition

Need to show the stability under harsh environment

- High and Low Temperature
- High Humidity
- Long Term Aging (under high temperature)
- Before and After PCB process

etc…

## Evaluation Sample

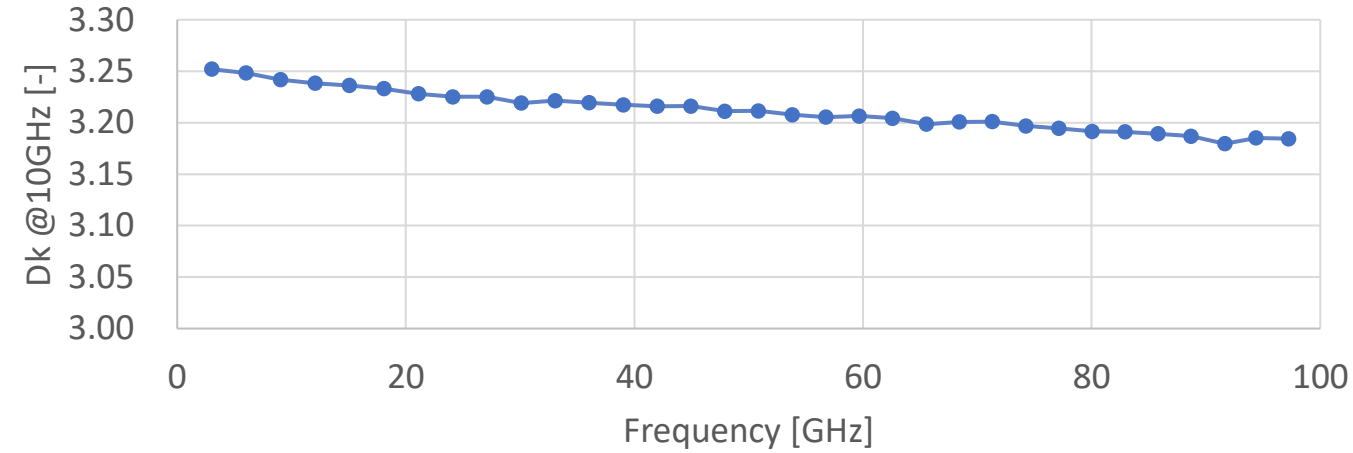


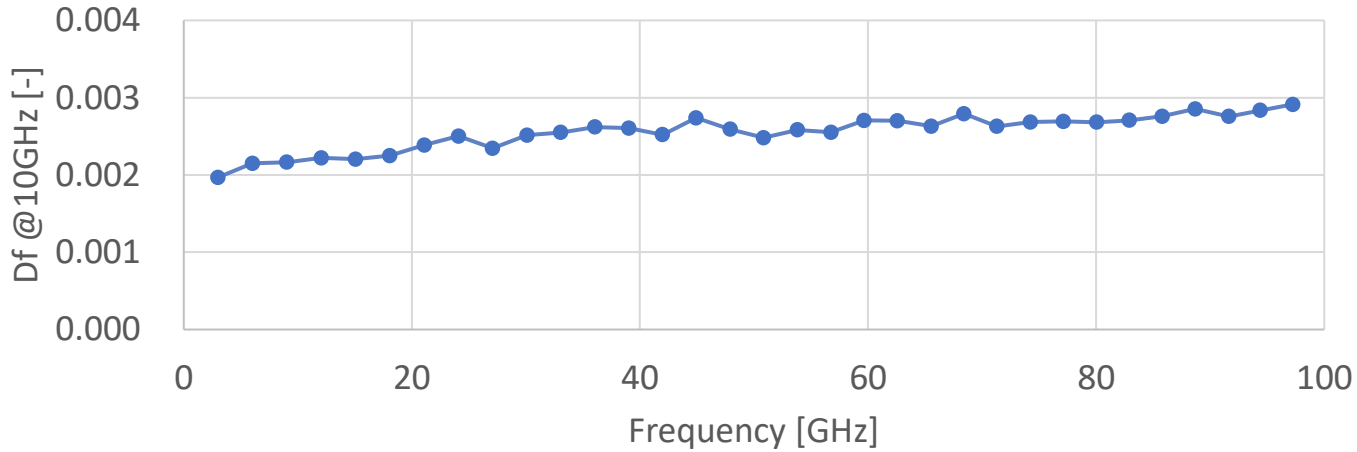
# MW4000M Dk/Df vs Frequency

- **Stable dielectric properties over a wide frequency range.**

**Micro strip line ring resonator method**

- 5mil (127um) thickness
- PCB coupon with ring resonator
- Room Temperature
- Frequency: 10-100GHz



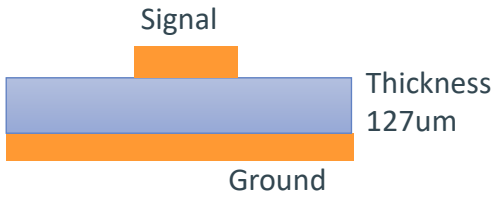



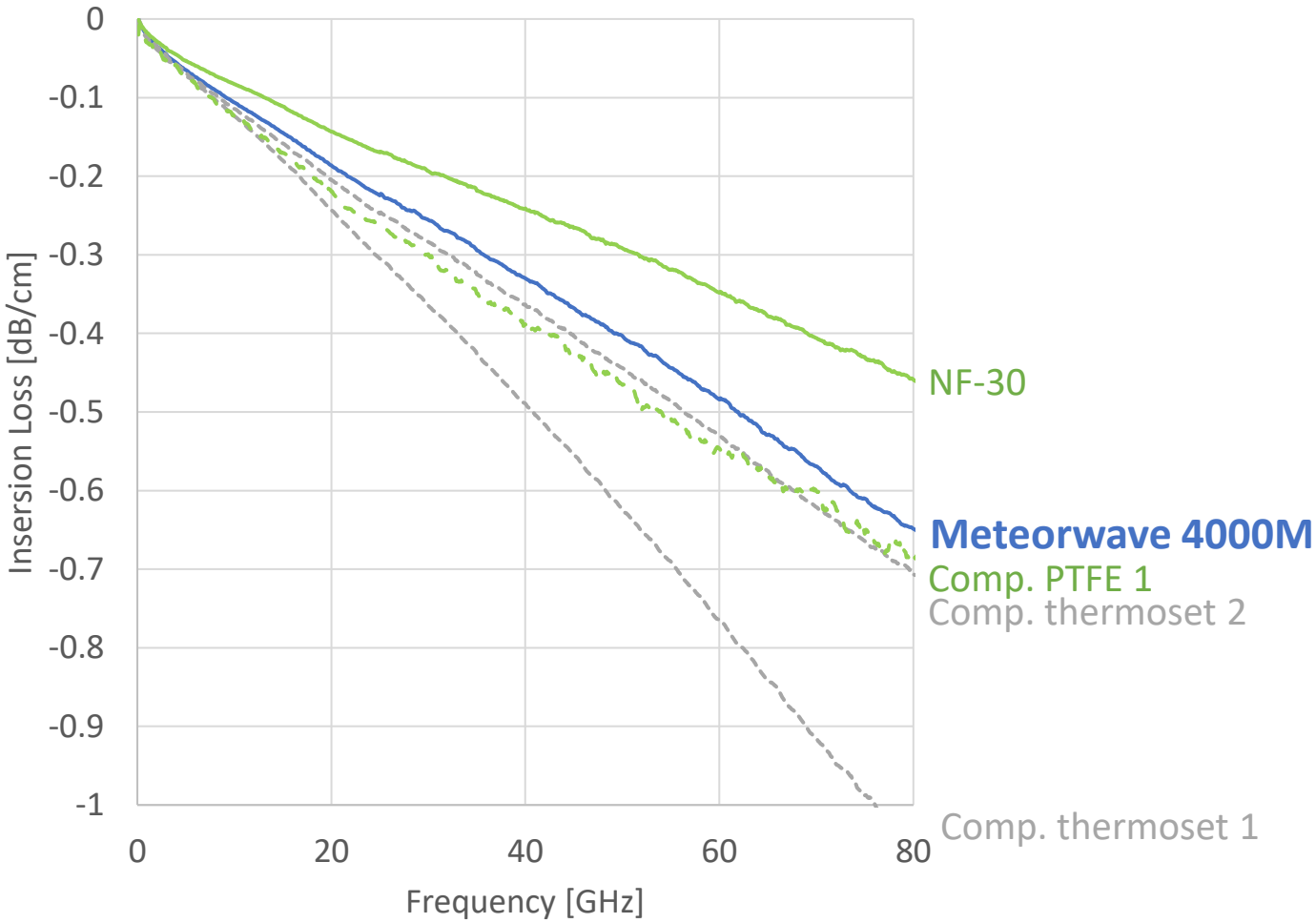
# MW4000M Insertion Loss

- **The Lowest insertion loss among thermoset materials for radar application.**
- **Low insertion loss competitive to PTFE laminate**

**Micro strip line method**

- 5mil (127um) thickness
- Two-length micro strip line (8inch-2inch)



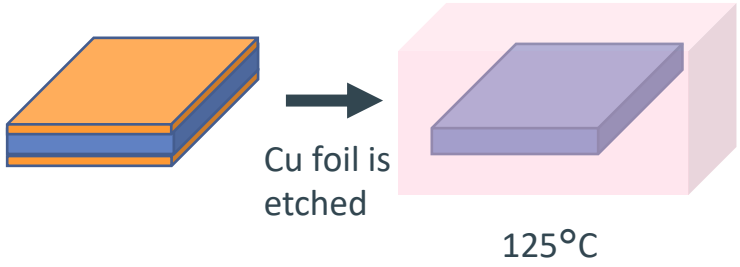



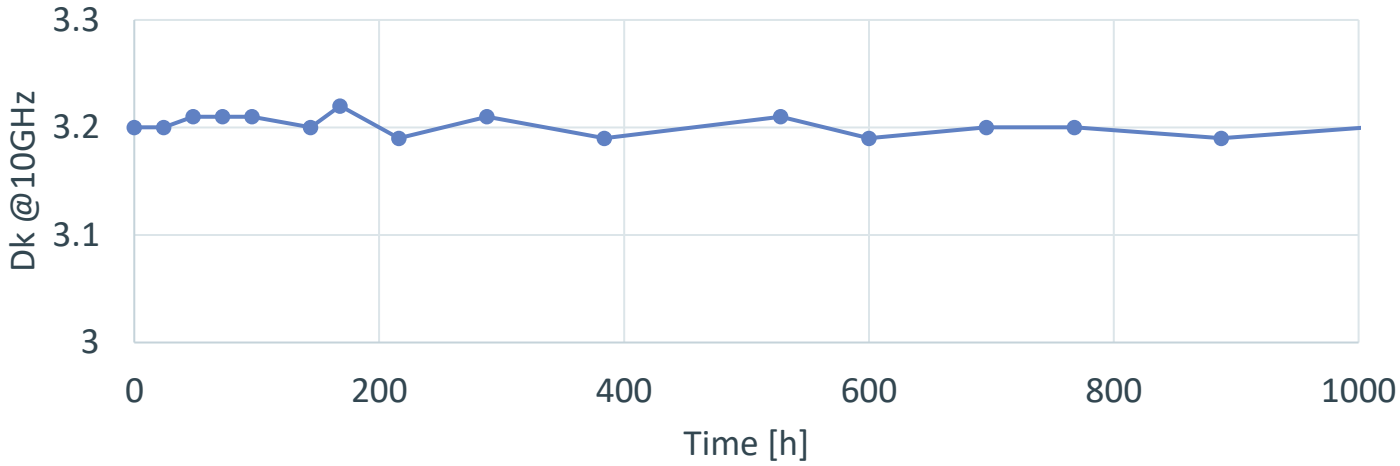
# MW4000M Aging Resistance at 125 °C / Material

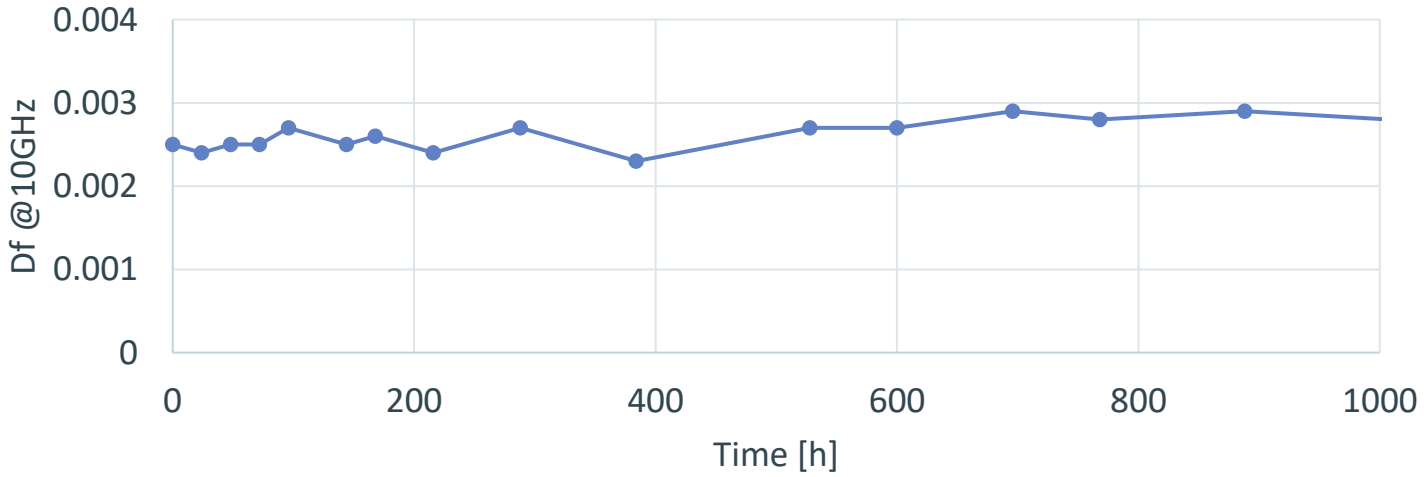
- **Stable dielectric properties under aging at 125°C.**

**Split Post Dielectric Resonator (SPDR) method**

- 5mil (127um) thickness
- Copper foil was etched
- Temperature: 125°C
- Frequency:10GHz



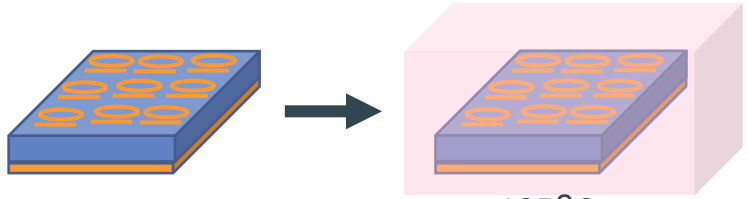



# MW4000M Aging Resistance at 125 °C / PCB level

- **Stable Dk and Insertion loss under aging at 125°C.**

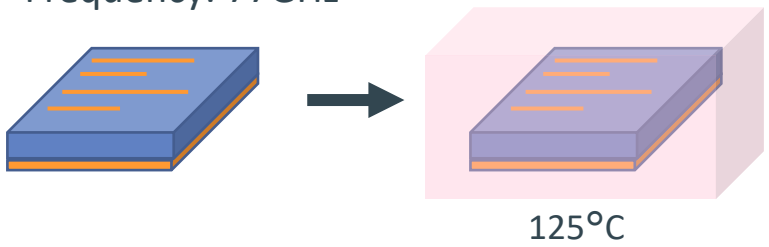
**Micro strip line ring resonator method**

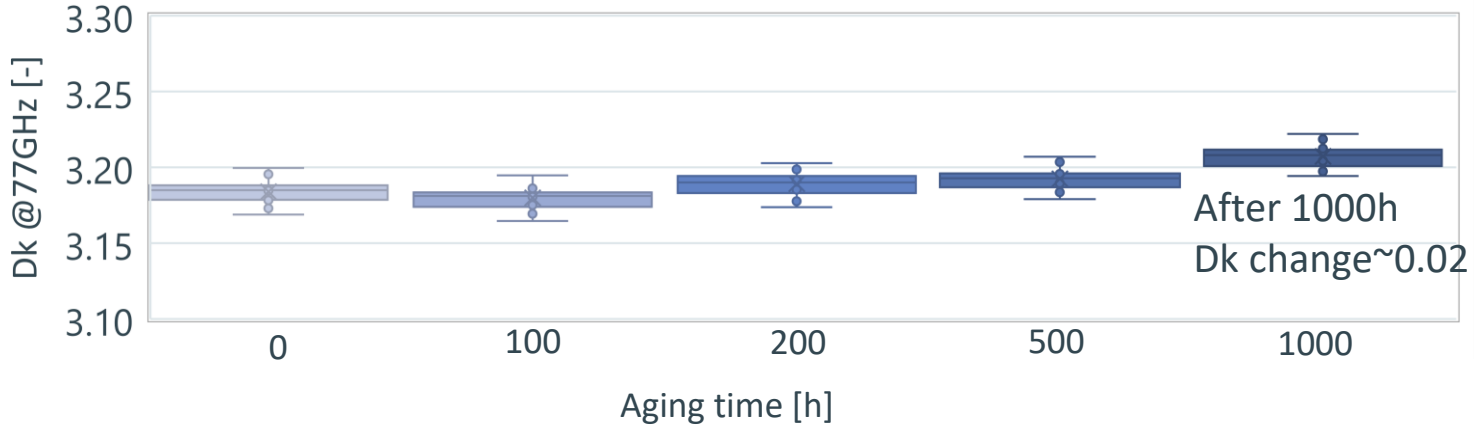
- 5mil (127um) thickness
- PCB coupon with ring resonator
- Temperature: 125°C
- Frequency: 77GHz

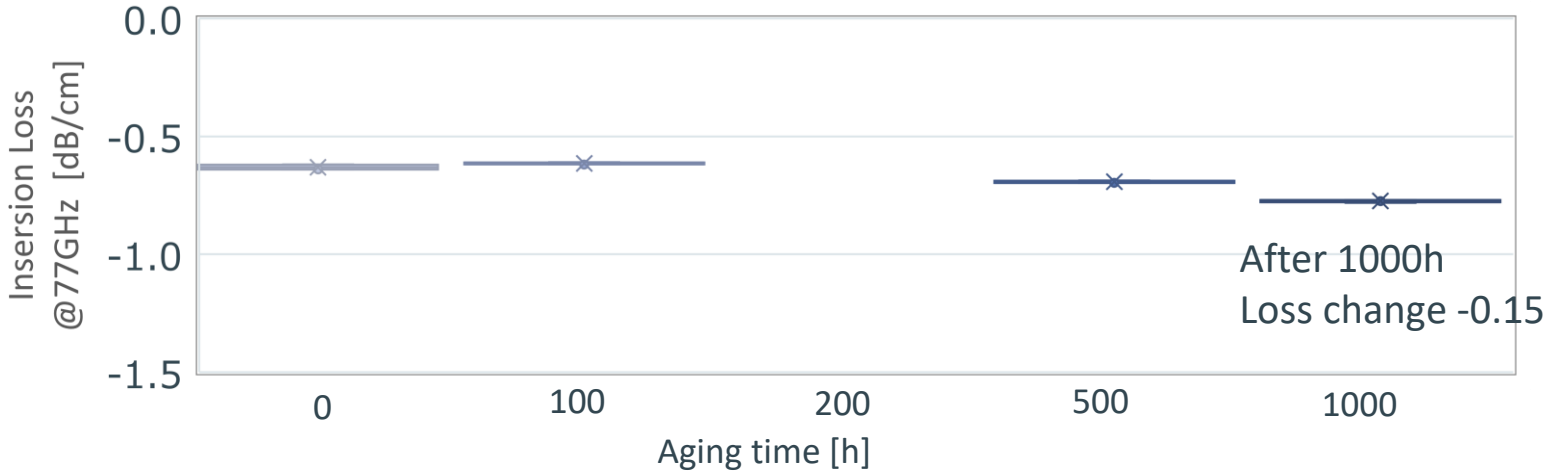



**Micro strip line method**

- 5mil (127um) thickness
- Two-length micro strip line (8inch-2inch)
- Temperature: 125°C
- Frequency: 77GHz



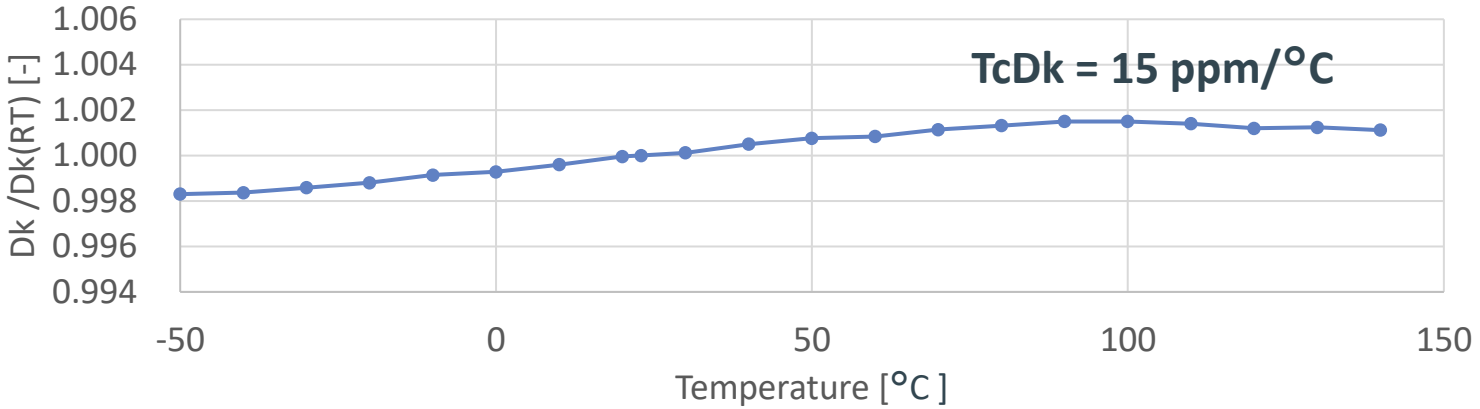



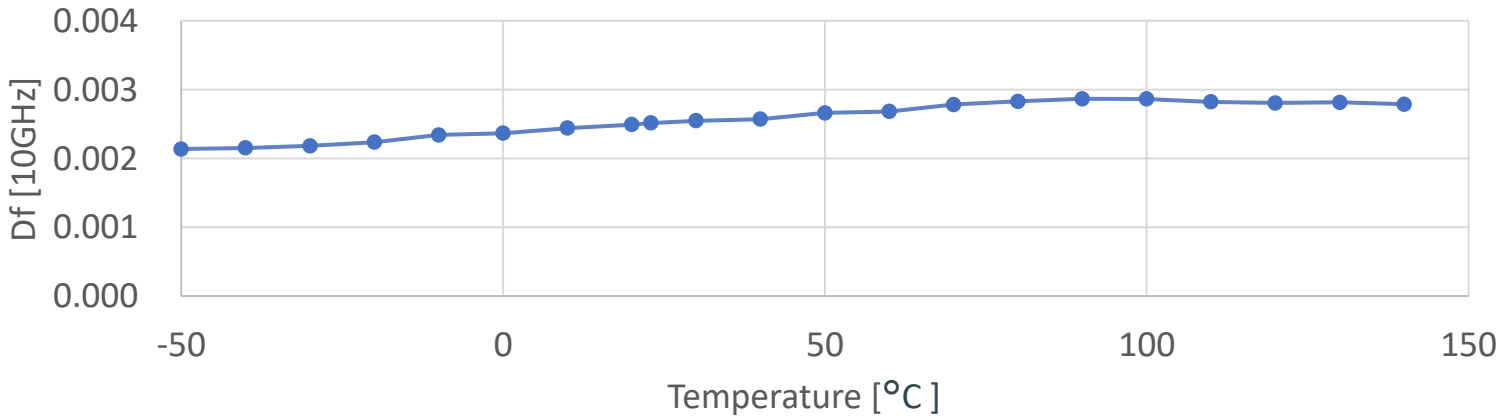



# MW4000M Dk/Df vs Temperature

- **Stable dielectric performance over a wide temperature range.**

**<u>Clamped stripline method</u>**
**(IPC-TM-650.2.5.5.5C)**
- Temperature -50 ~ 140°C
- Frequency:10GHz

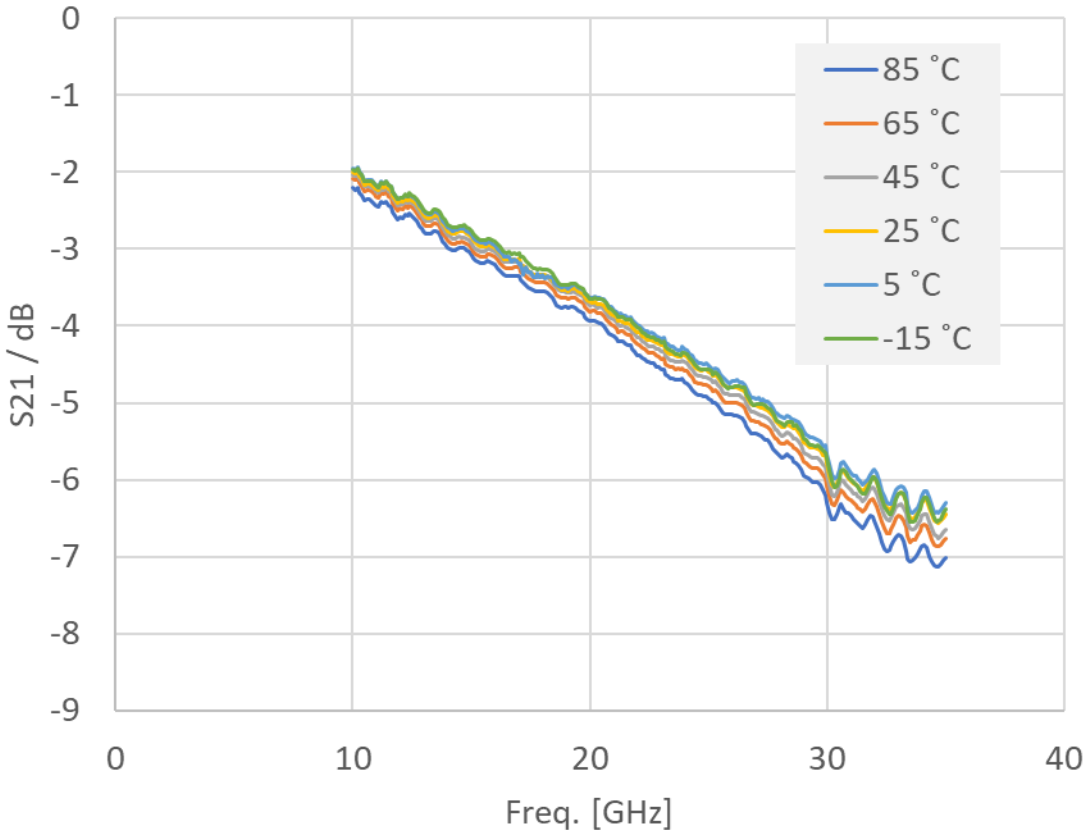


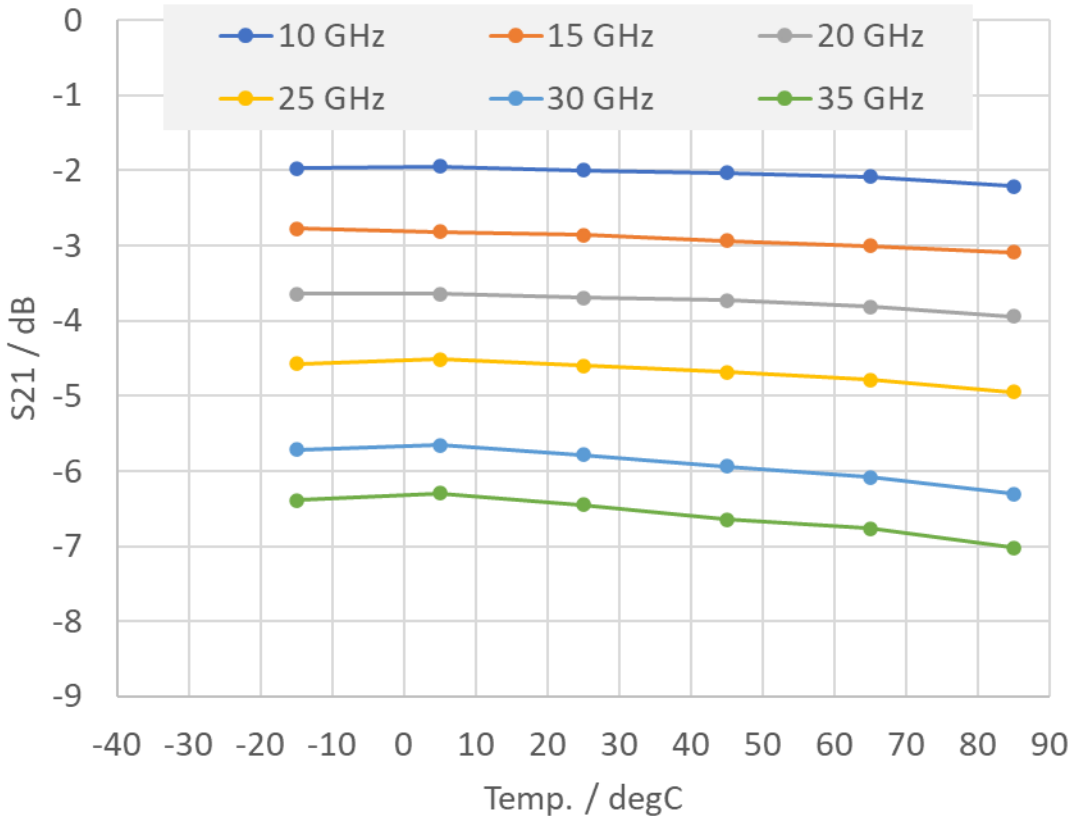



# MW4000M Insertion Loss vs Temperature

- **Stable insertion loss over a wide temperature range.**

**Micro strip line method**



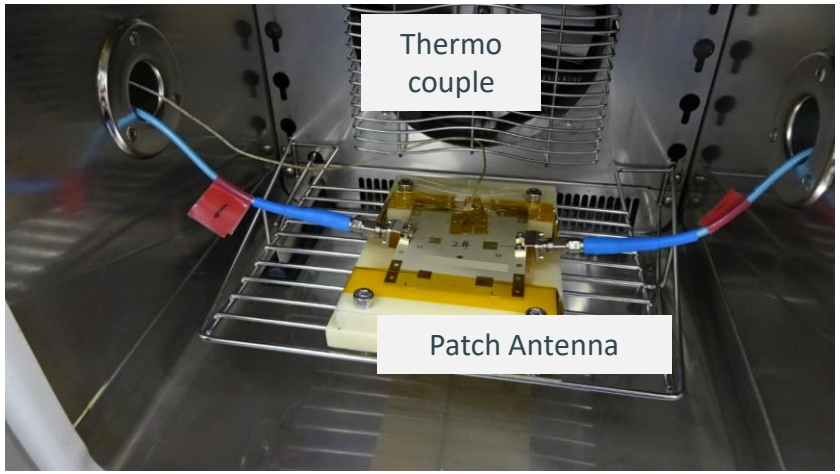



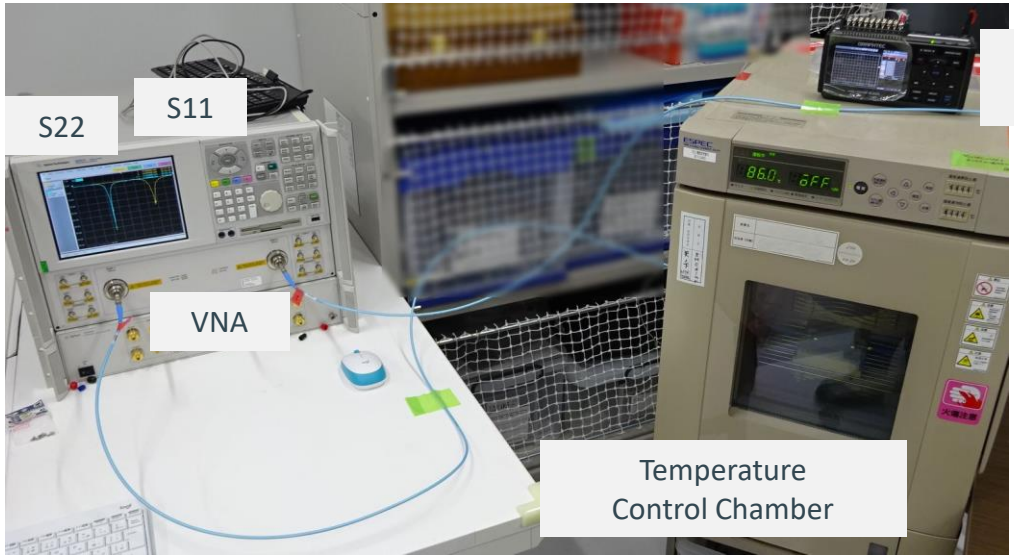
# MW4000M Antenna Performance vs Temperature

**Patch antenna return loss**

- Temperature: 15 ~ 85°C
- Frequency: 16~32 GHz

Coupon for patch antenna return loss measurement



# Antenna Performance / Resonant Frequency Shift vs Temp.

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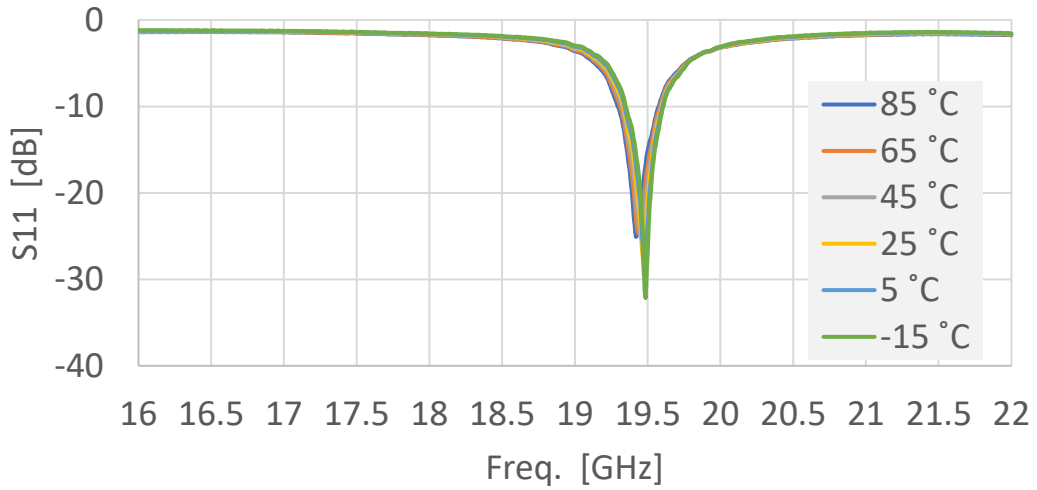
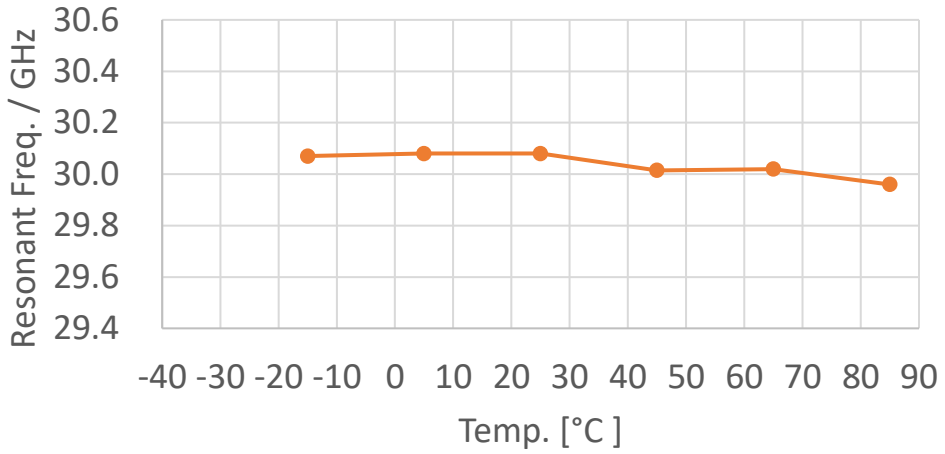
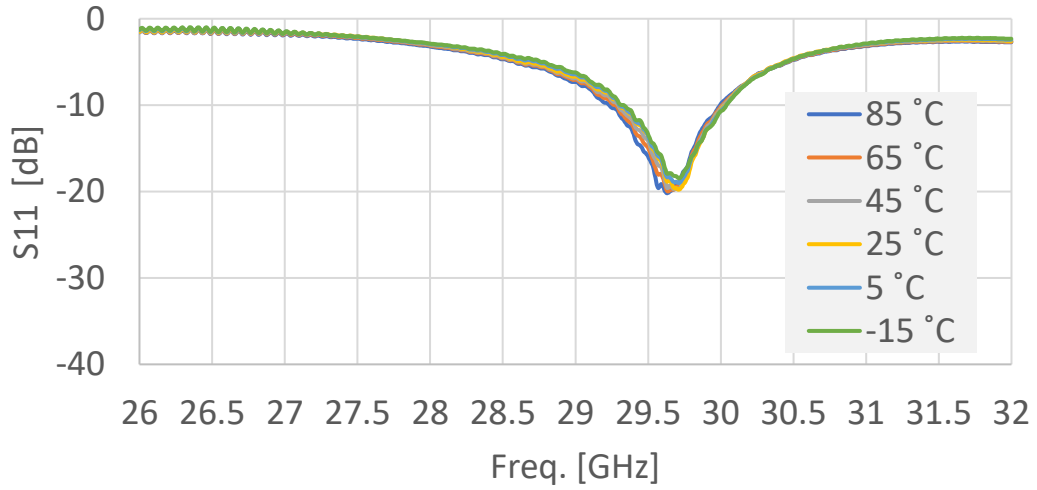
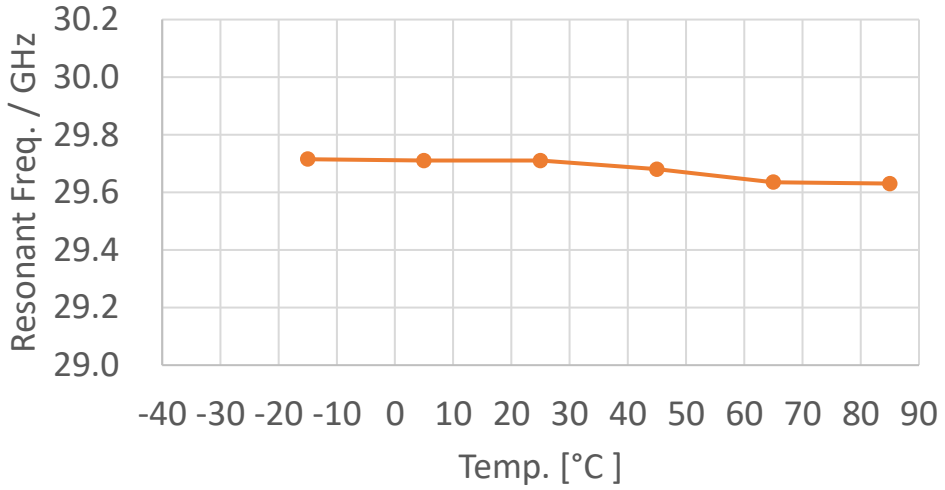
- **Stable Resonant Frequency over a wide temperature range.**



# Summary

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## Benefits of MW4000M

**Good Process Ability**

- Simple and easy PCB process
  - Processing same as FR4
  - Good compatibility with FR4 in hybrid construction.
  - Vast manufacturing experience by many PCB makers.
- Availability of Multiple Lamination

**Stable Electric Performance**

- Low insertion loss competitive to PTFE laminate
- High aging resistance (both of material and PCB level)
- Low temperature dependence (both of material and antenna level)

**Good reliability**

- Robust thermal performances.
- Compatible with lead free assembly.
- Good thermal cycling properties

# END

You can contact me at any time

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