Enablers for mmWave PCBs - Base Materials with High Electrical and Mechanical Reliability

2022, June 14

Manfred Huschka, Vice President
AGC Multi-Material General Division, RF Business Unit

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mmWave Laminate Technology Applications

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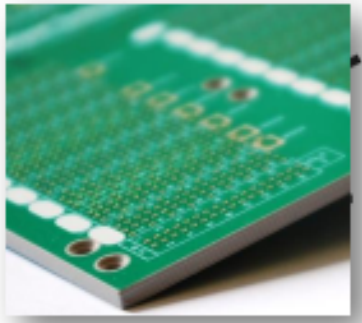
Vehicle-to-Vehicle (V2X) Communication Systems

Communications
5G wireless infrastructure

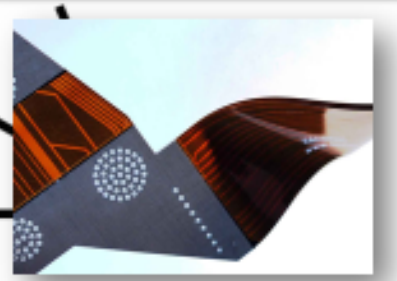
5G

Automotive
- Advanced Driver Assistance Systems (ADAS)
- Autonomous Cruise Control (ACC)
- High Temperature Reliability
- Keyless Entry
- Tire Pressure Monitoring (TPMS)
- Road Tolling
- Traffic Collision Avoidance Systems (TCAS)

Advances in one area rely on technological growth from other areas in the supply chain.



High Speed Data
- 56 GB data rates
- Internet of Things



Flex
- High-density interconnect
- High reliability connectors

Enablers for mmWave pcbs

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- Lowest dielectric loss of substrate
- Lowest moisture absorption of substrate
- Best copper insertion loss and lowest copper foil surface roughness

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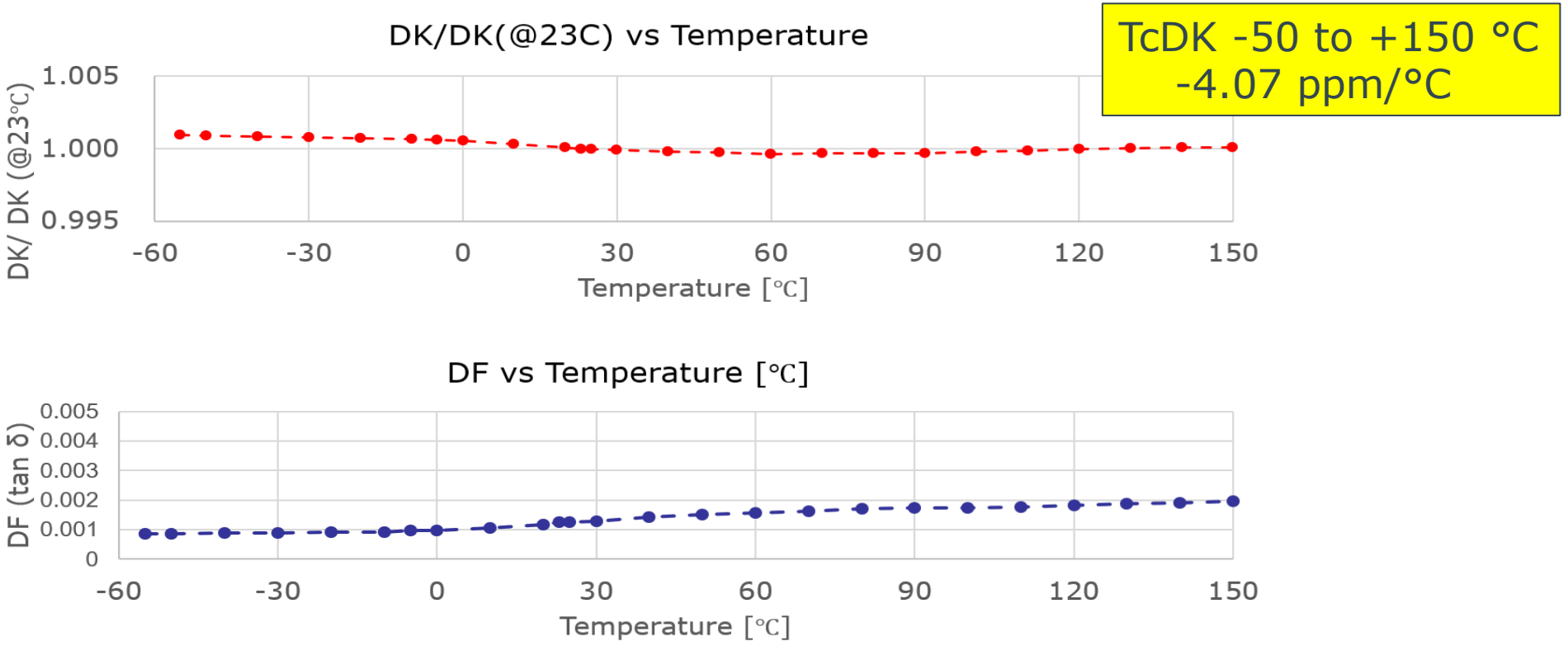
PTFE laminates have lowest dielectric loss of all pcb laminates



Stable DK and DF up to 110 GHz (e.g. NF-30)

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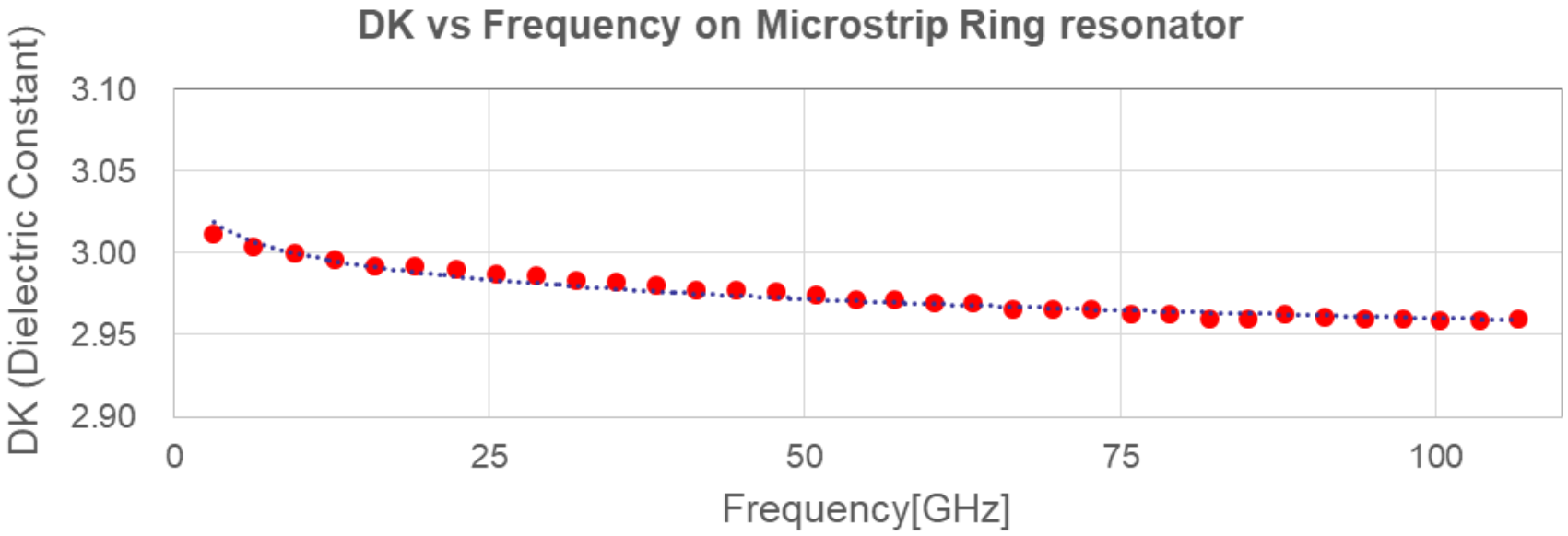

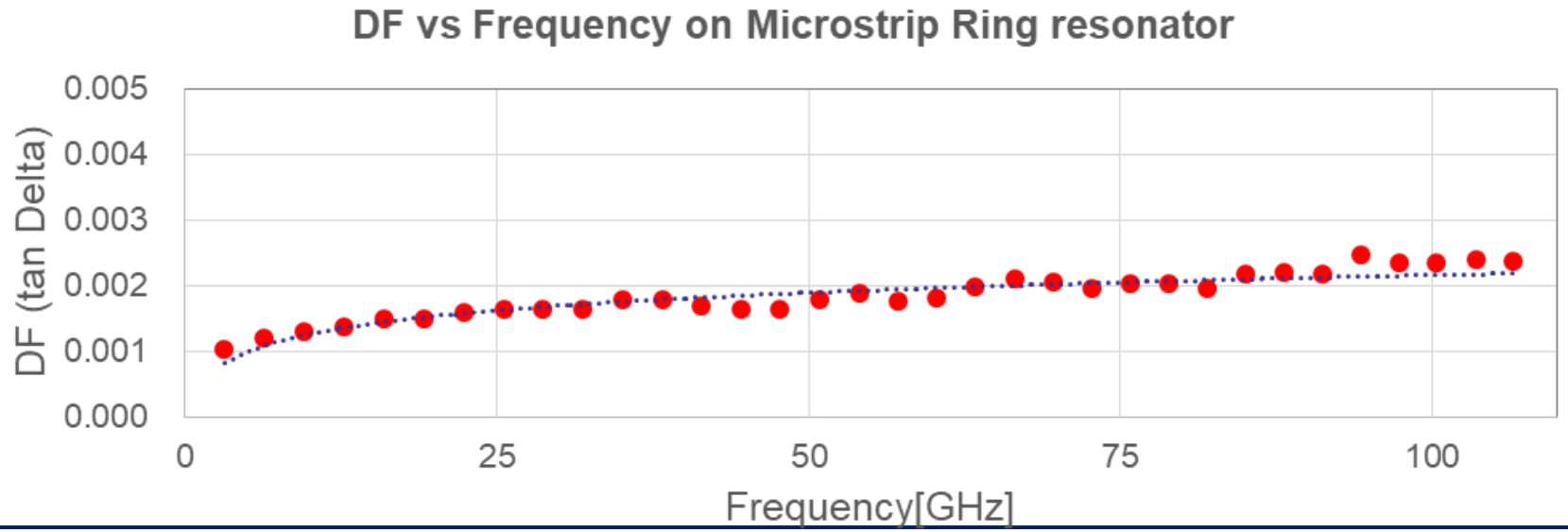

Thermoset resin laminates are almost there (e.g. MW4000M)

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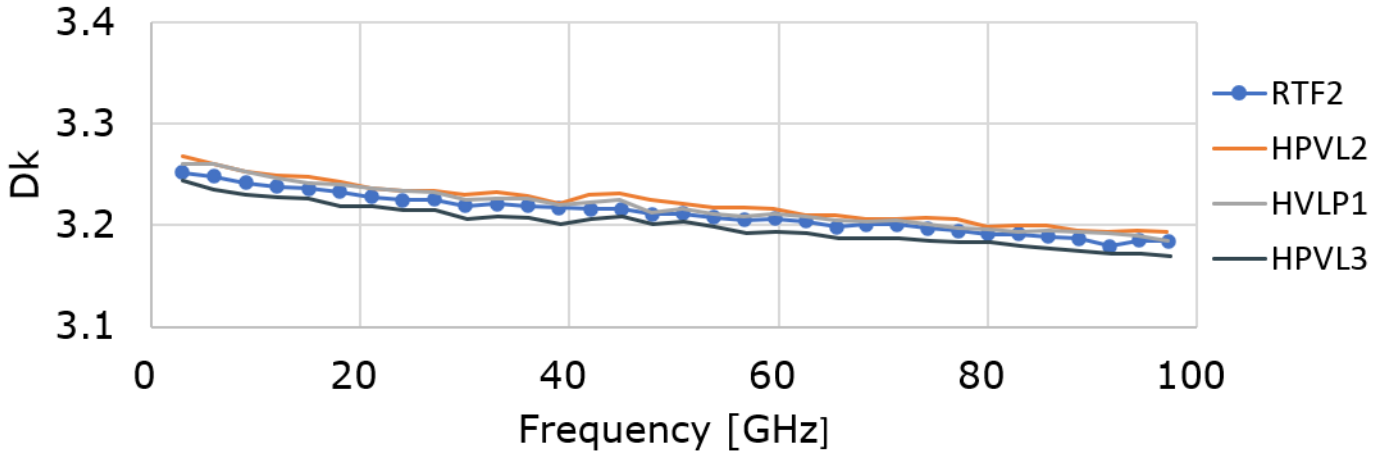

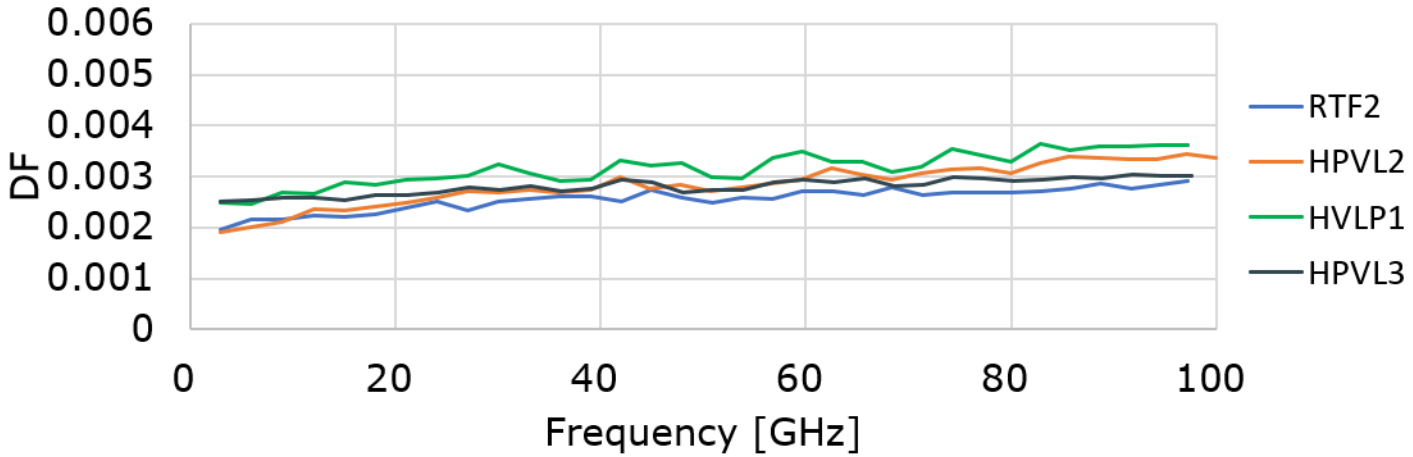

Enablers for mmWave pcbs

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- Lowest dielectric loss of substrate
- Lowest moisture absorption of substrate
- Best copper insertion loss and lowest copper foil surface roughness

Moisture Absorption of substrate materials

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- Unfilled PTFE laminates 0.03 – 0.03%
- Ceramic filled PTFE laminates 0.05 – 0.07%
- PPE/PPO laminates 0.11 – 0.19%

The higher the frequency …

- The more the insertion loss increases with increased moisture absorption of a laminate
- Whereas effective DK decreases

Laminates with lowest moisture absorption perform best!

Enablers for mmWave pcbs

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- Lowest dielectric loss of substrate
- Lowest moisture absorption of substrate
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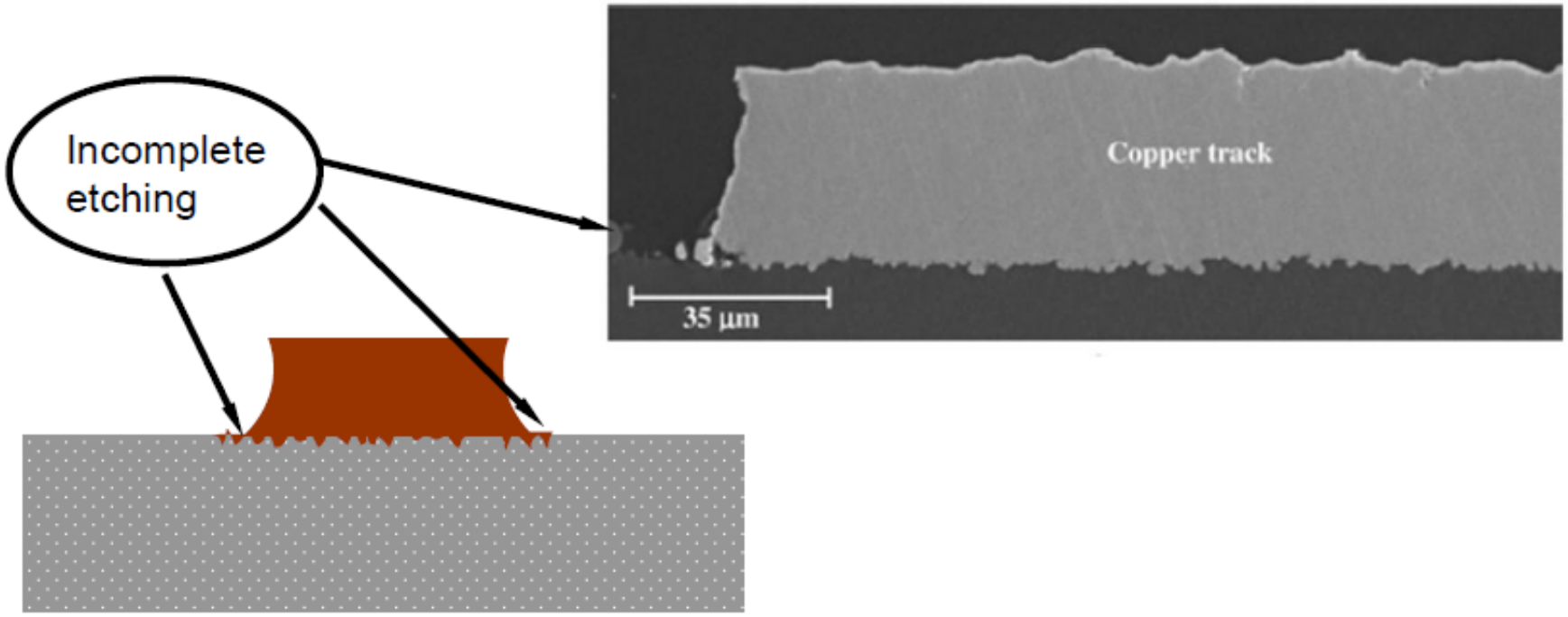
Copper Foil Technology becomes important

Standard ED copper foil treatment



Copper Foil Technology becomes important

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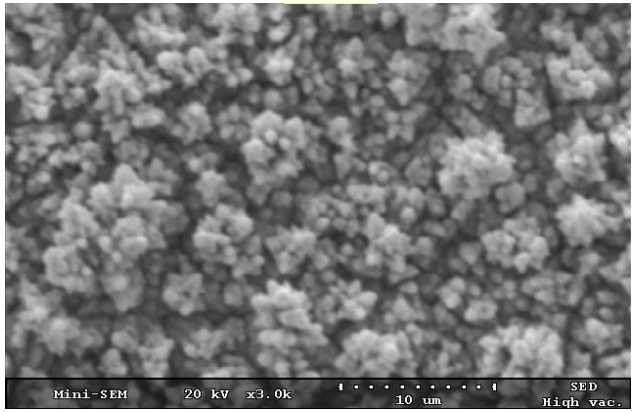
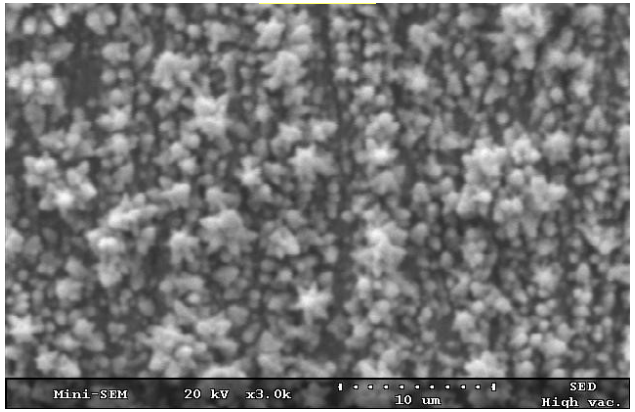
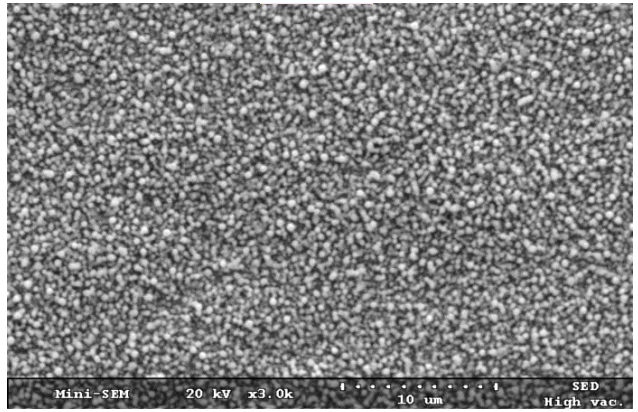
VLP copper foil



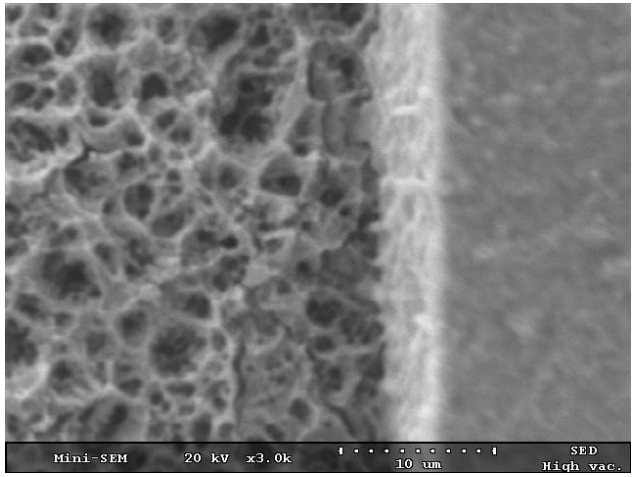
Reverse Treatment copper foil

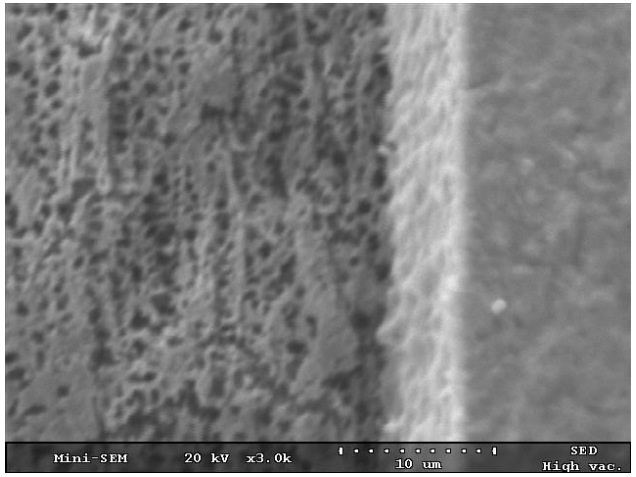


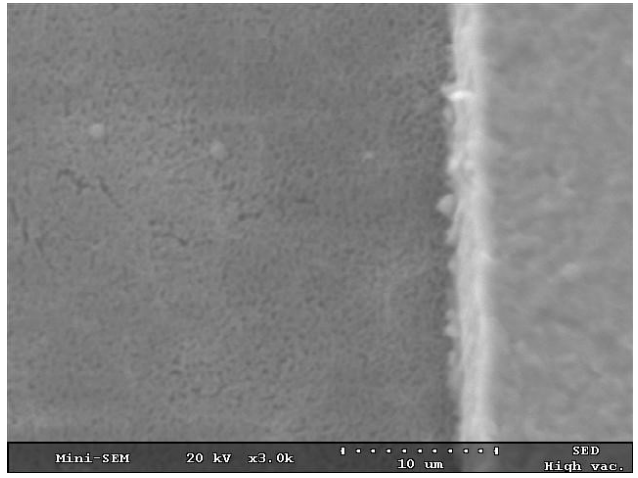
Ultra Low Profile copper foìl



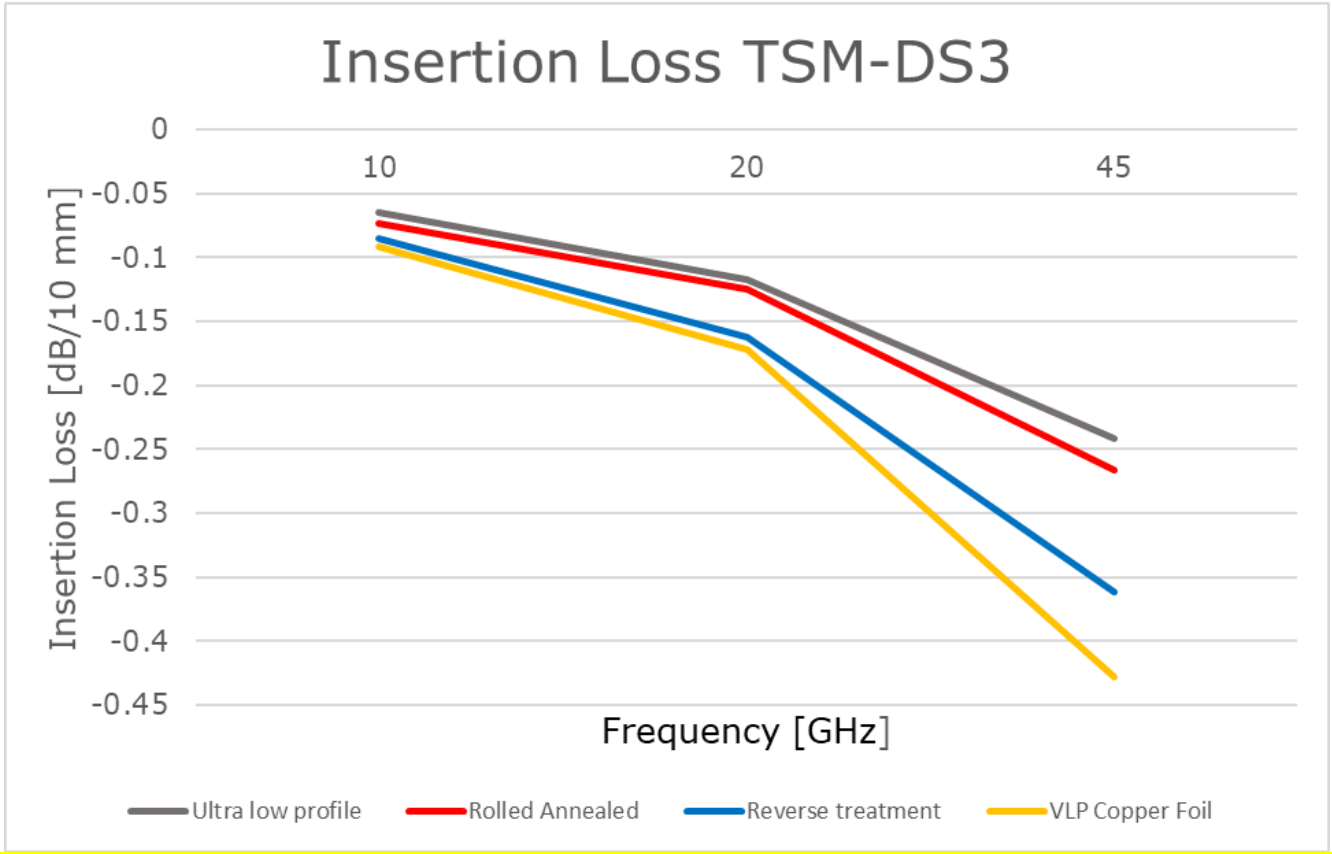
5 mil pattern / 5 mil space Circuitry on TSM-DS3-0100 @ x3000







Insertion Loss of Various Copper Types



The lower the copper foil treatment profile …

- The less treatment is embedded in the laminate surface and has to get etched out
- The steeper circuitry sidewalls are
- The better the insertion loss

Mechanical Reliability of PTFE based mmWave pcbs

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- Facts !

Peel Strength of Various Copper Types

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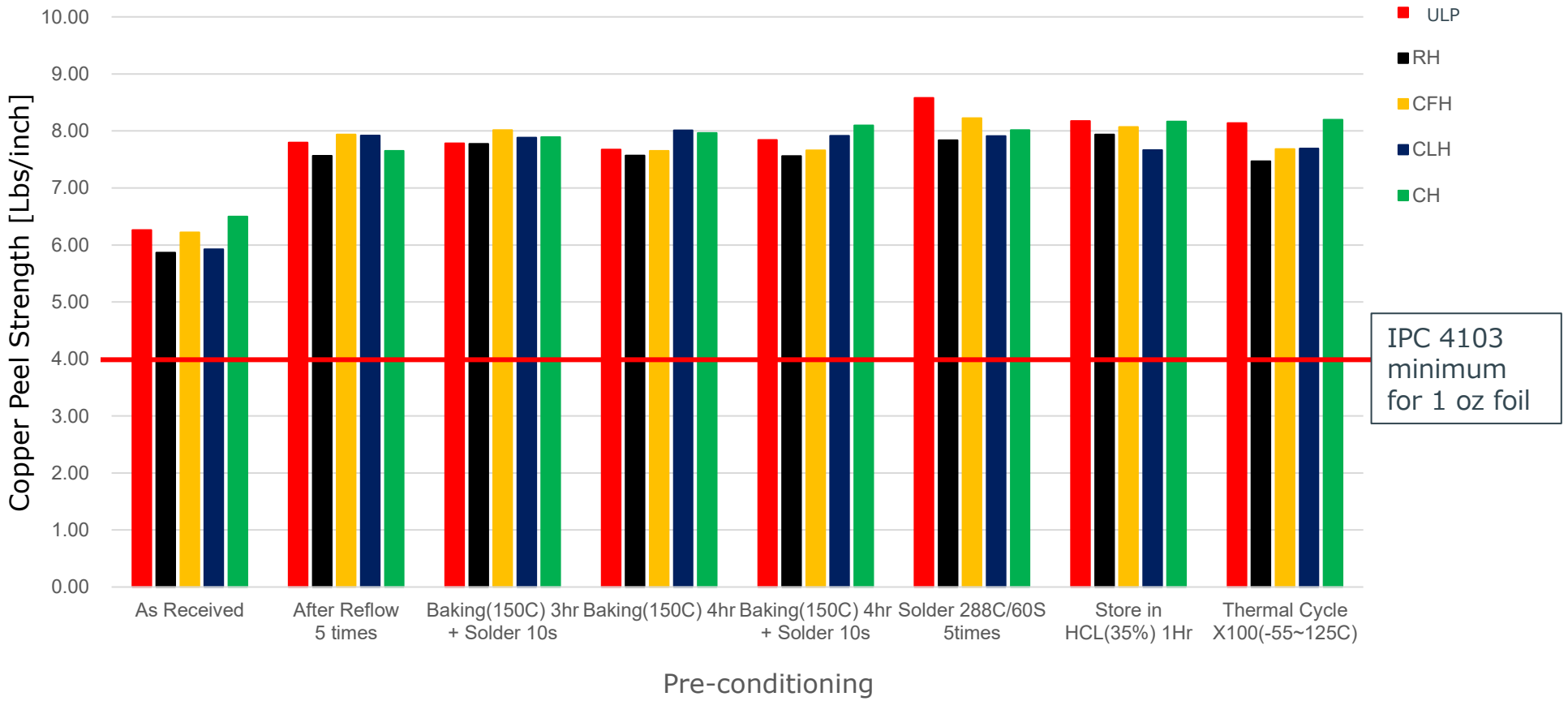
0.5 oz Peel Strength on TSM-DS3



Peel Strengths of various severe pre-conditionings on TSM-DS3 – a highly ceramic filled PTFE laminate
In most cases cohesive fracture failure (= within dielectric layer)

Drilling and Plating is not Witchcraft

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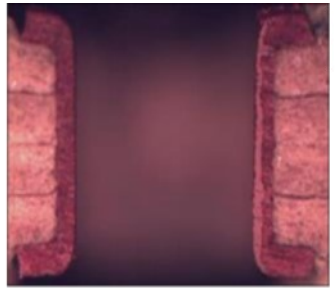
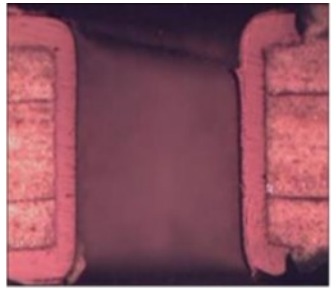
Plated vias in 20 and 60 mil NF-30

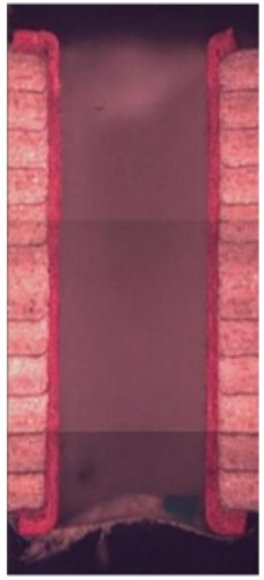
viewed from x and y direction

NF-30 20mil





NF-30 60mil



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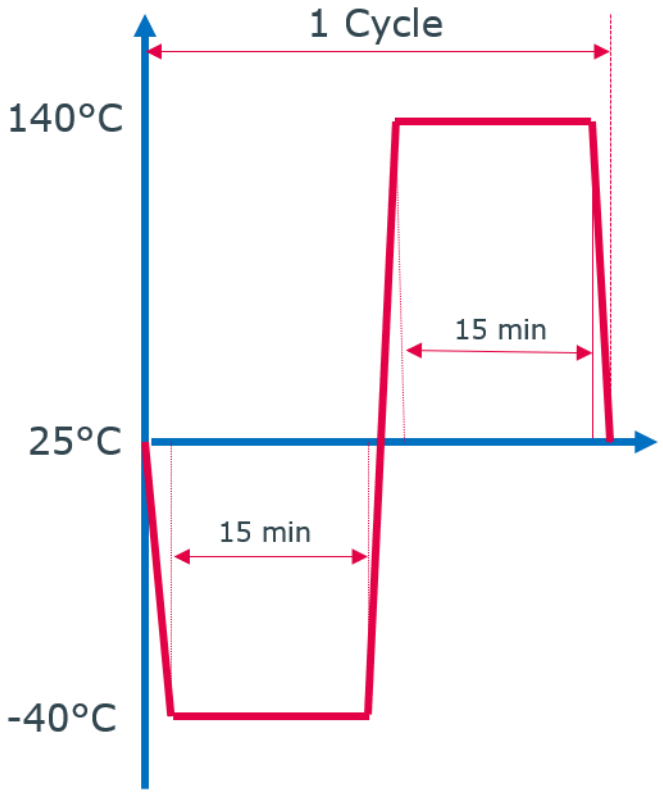
Thermal Cycling Test Condition

1,000 cycles
from -40°C (15 min) to + 140°C (15 min)



Thermal Reliability in a Multilayer PCB

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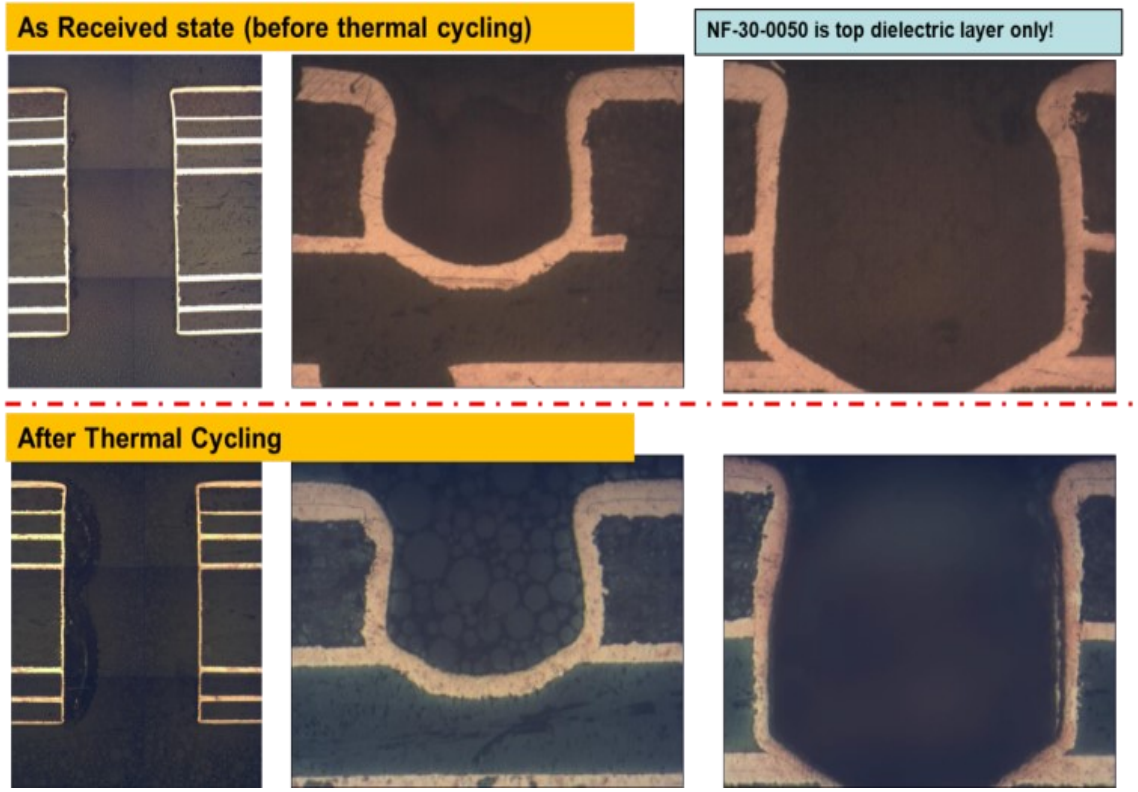
NF-30 hybrid multilayer before and after thermal cycling

1,000 cycles from -40°C to + 140°C



Thermal Reliability in a Multilayer PCB

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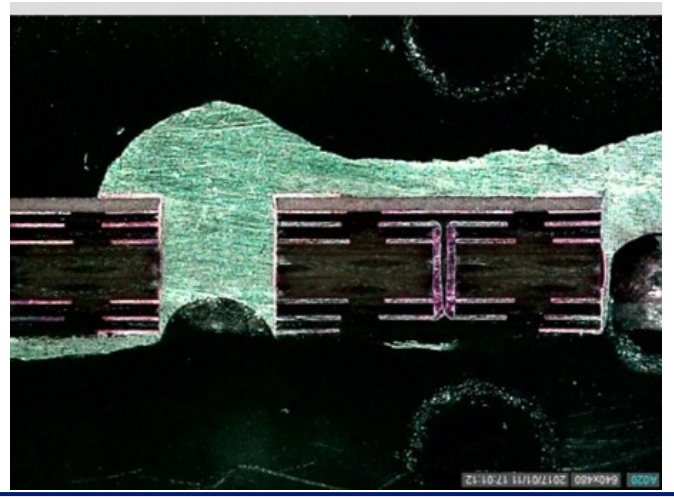
Solder Float Test: 30 minutes (!!!) at 288℃

as received

after 30 minutes!!

Solder Float Test: 50 x 288 °C solder float (10 s)



TSM-DS3 and *fast*Rise™ FR-27/FR-28 Prepregs

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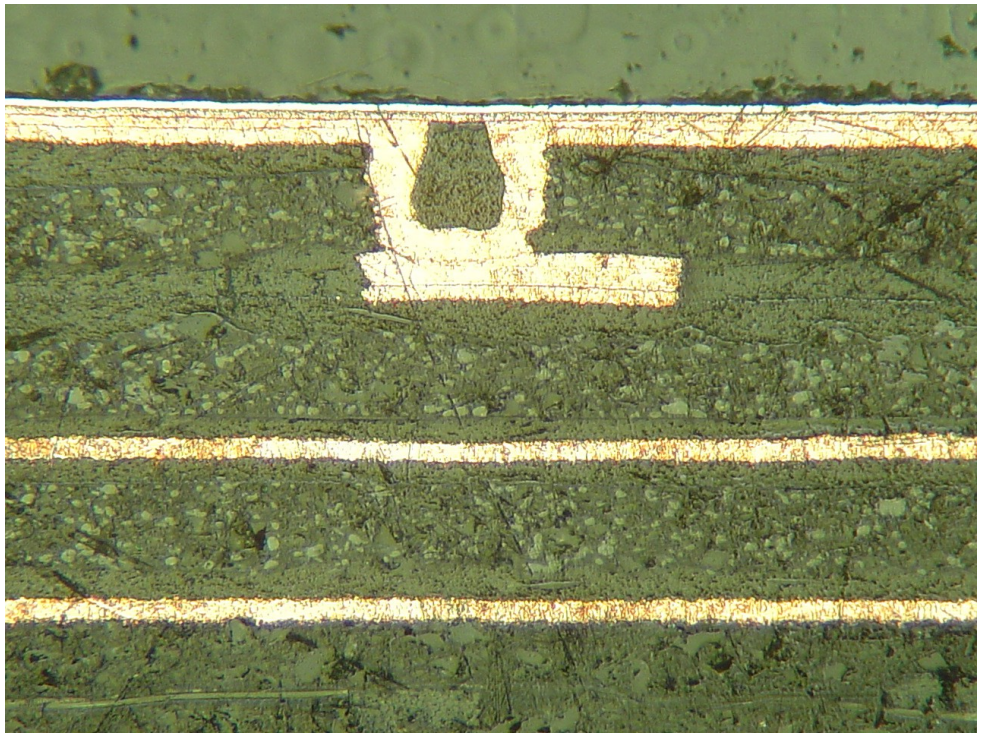

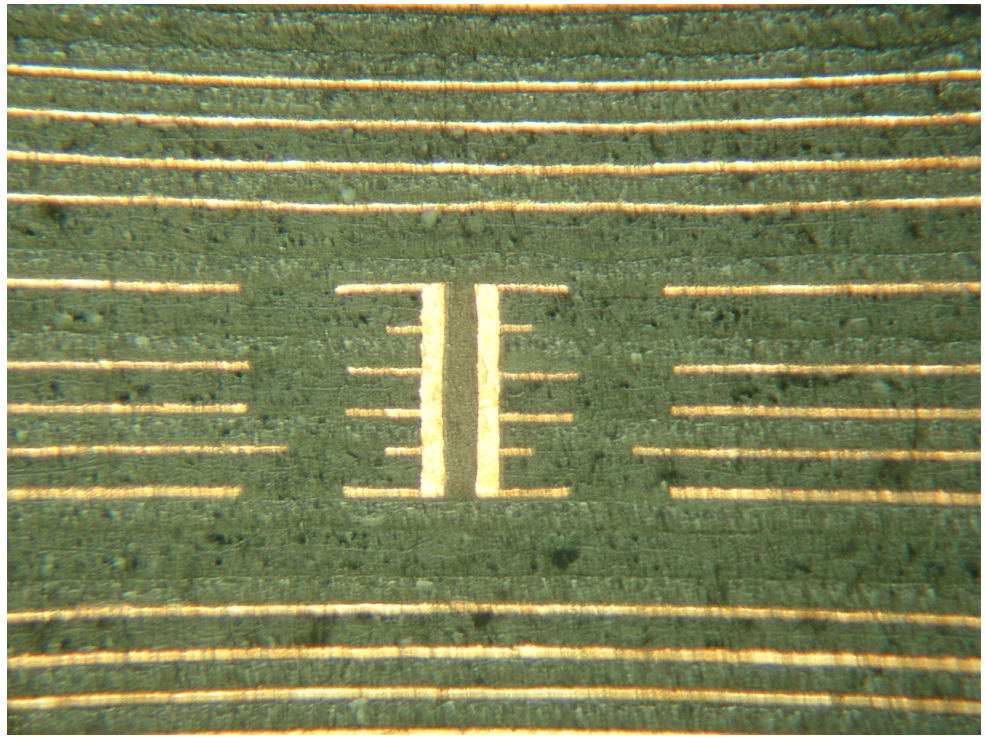

High Dimensional Stability Over Many Layers

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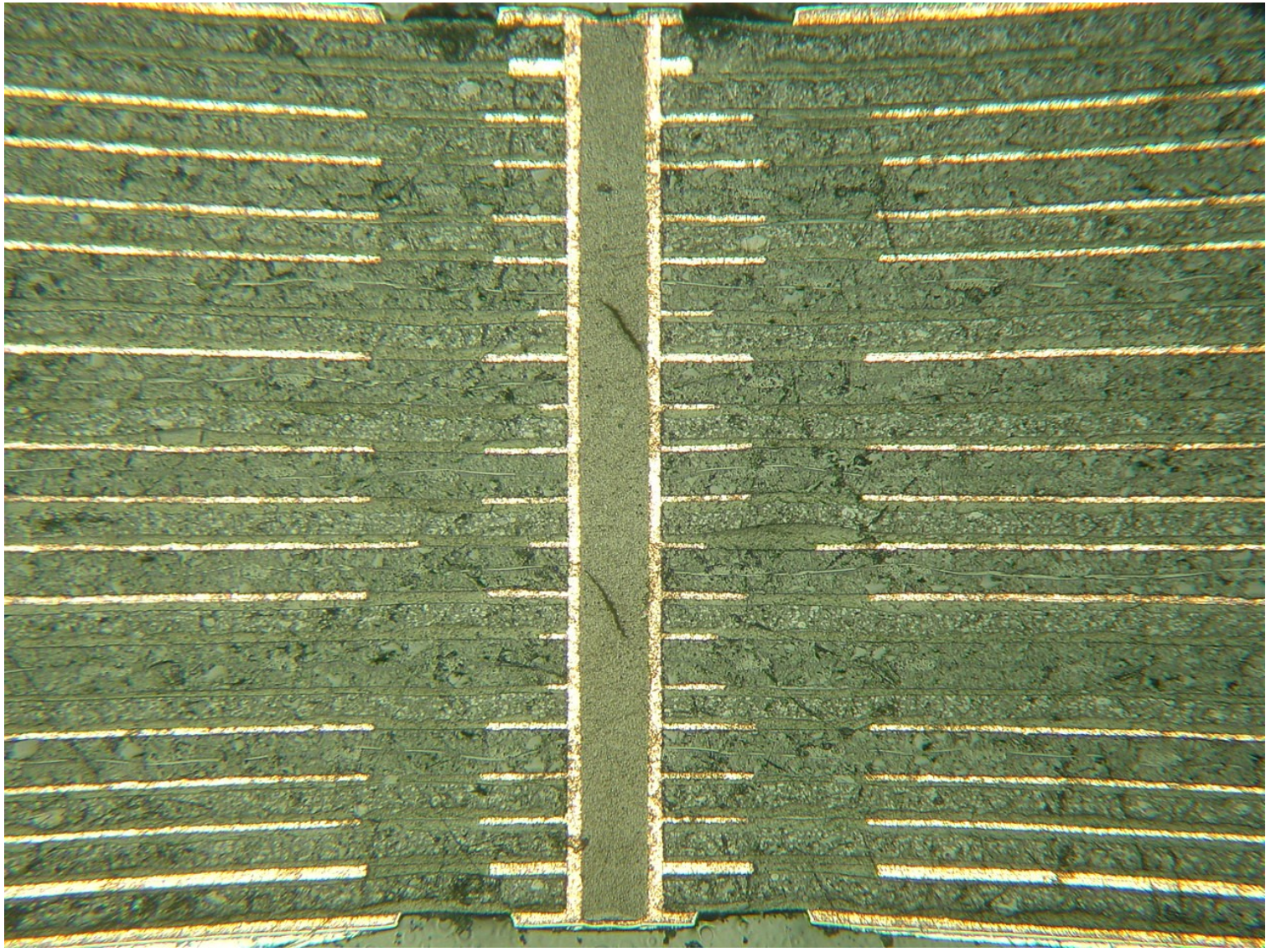

High Electrical and Mechanical Reliability

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You now have valuable substrate information, allowing you to choose the most suitable substrate for your design(s), irrespective of the actual frequency

You can contact me at any time

manfred.huschka@agc.com

Manfred Huschka, Vice President
AGC Multi-Material General Division
RF Business Unit