

TWENTIETH ANNUAL



TestConX™

March 3 - 6, 2019

Hilton Phoenix / Mesa Hotel
Mesa, Arizona

Archive

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Copper Laminate and Skew Mitigation

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Mesa, Arizona • March 3 - 6, 2019



Overview

- Fiber Weave Effect
 - What is Skew?
- Copper Roughness and the Effect on Loss



Copper Laminate and Skew Mitigation

2



PCB Materials: The Basics

- Start with rigid copper clad core.
- Circuits are formed in the copper.
- The PrePreg is the “glue” to stack these layers (AKA: B-Stage).
- Copper foil is used on the outer most layers.
- Everything is aligned and then laminated with heat and pressure.



Reinforced vs Unreinforced Laminates

- Unreinforced

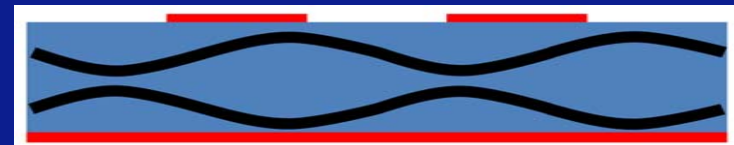


Thick (200 μm) - Niche
-Excellent performance/reliability
-Expensive to manufacture



Thin (50 μm) - Common
-Excellent performance/reliability
-Less expensive to manufacture

- Glass Reinforced

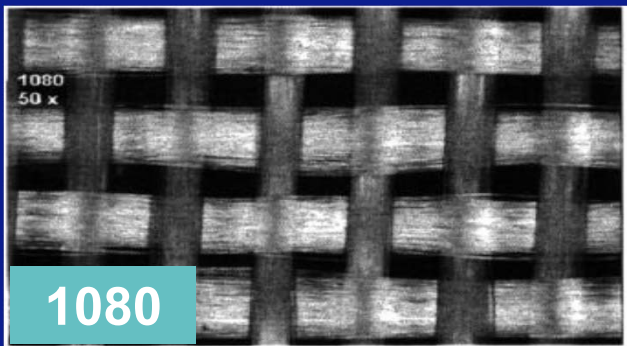
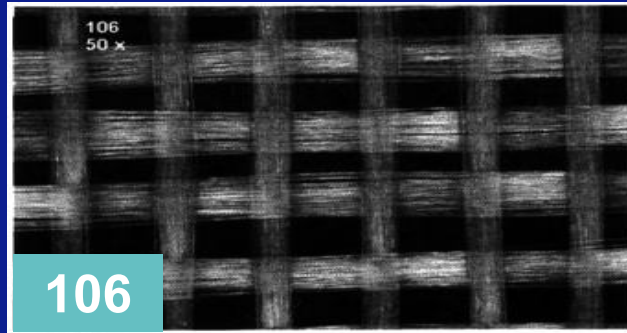


Thick (200 μm) - Common
-Excellent performance/reliability
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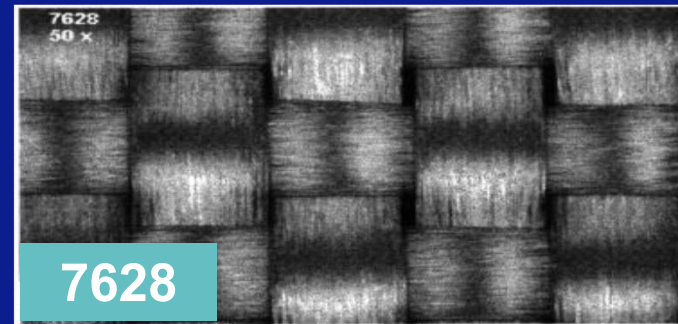


Thin (50 μm) – Less Common
-Less performance/reliability
CAF; Pad Cratering; Etch Defects
-Same or more expensive to manufacture

Why Glass Fabric?



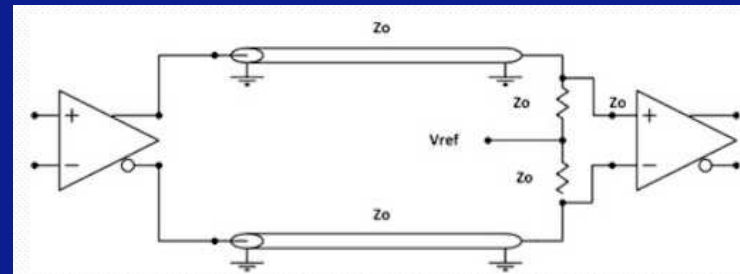
- In Fabrication
 - Supports B-Stage (prepreg)
 - Controls spacing
 - Cost



- In Use
 - Strength
 - Cost

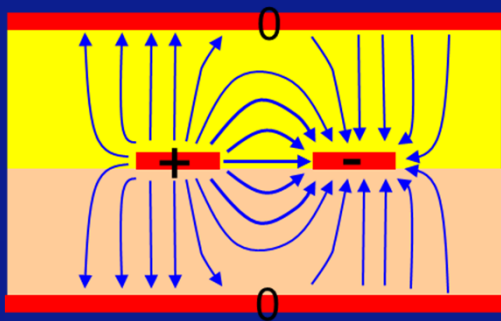
Skew

- Skew is the misalignment of two signal edges of a differential pair as they arrive at the terminals of the differential receiver.

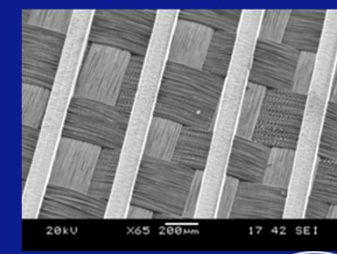
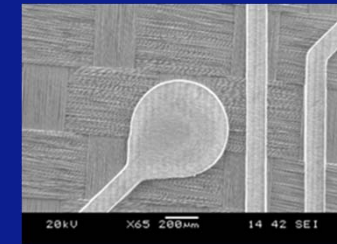
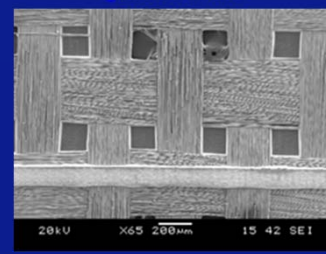
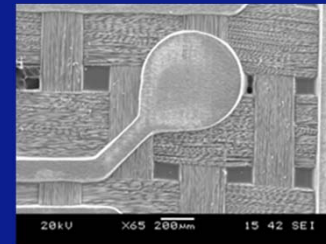
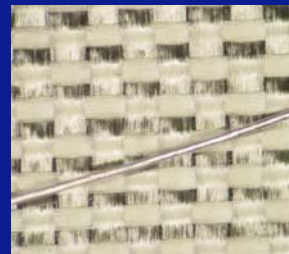


Spread Glass for Differential Pairs

- Reduces micro Dk effects
- Reduces signal skew
- Much better for cost and fabrication than rotating board on panel.

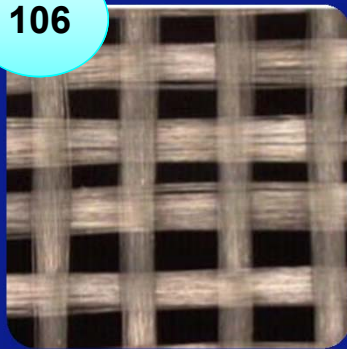


Differential Stripline



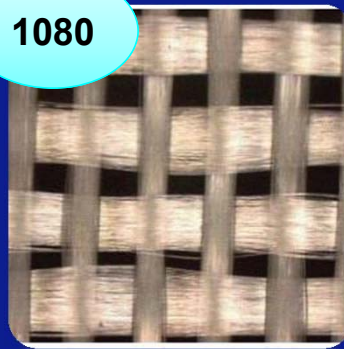
Fiber Glass Square Weave

106



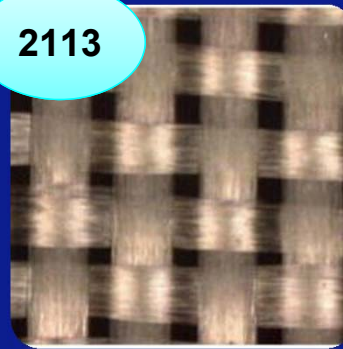
- About 2.0 mils
- Great for fill of heavy coppers.
- Not stable

1080



- About 2.5 mils
- Good for fill.

2113



- 3.0 to 3.5 mils
- Some fill properties
- Good stability

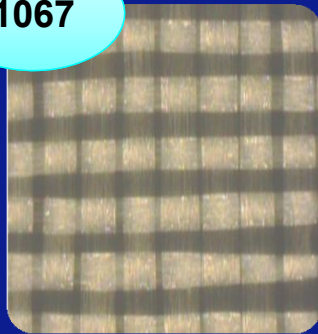
7628



- 7.0 to 8.0 mils
- Good for building thickness.
- Very Stable

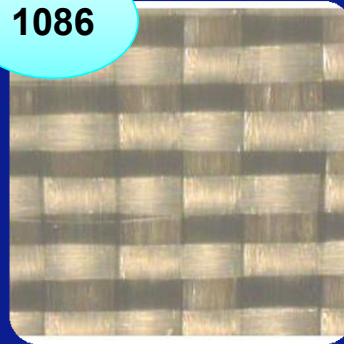
Fiber Glass Square Weave

1067



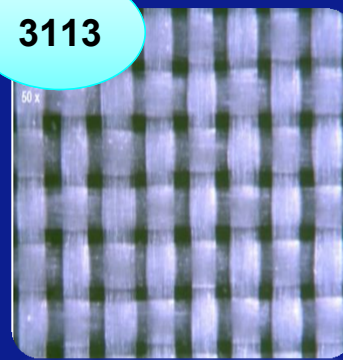
- About 2.0 mils
- Low skew

1086



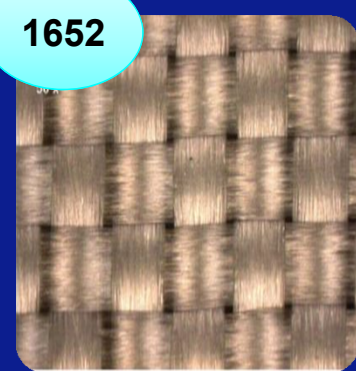
- About 3.0 mils
- Good for drilling

3113



- 3.0 to 3.5 mils
- Low Skew

1652



- 7.0 to 8.0 mils
- Low Skew

Example Dk/Df Charts

Glass Style	% Resin	Thick-ness (inch)	Dk	Df
1x 106	71.0	.0020	3.81	0.024
1x 1080	58.0	.0025	4.04	0.021
1x 2113	54.0	.0035	4.11	0.020
2x 1080	55.0	.0040	4.1	0.020
1x 7628	46.0	.0080	4.28	0.021

Glass Style	% Resin	Thick-ness (inch)	Dk	Df
1x 1067	66.5	.0020	3.05	0.0017
1x 1078	66.0	.0030	3.09	0.0018
1x 3313	58.5	.0040	3.07	0.0017
2x 1078	60.0	.0050	3.19	0.0021
2x 3313	58.5	.0080	3.24	0.0022

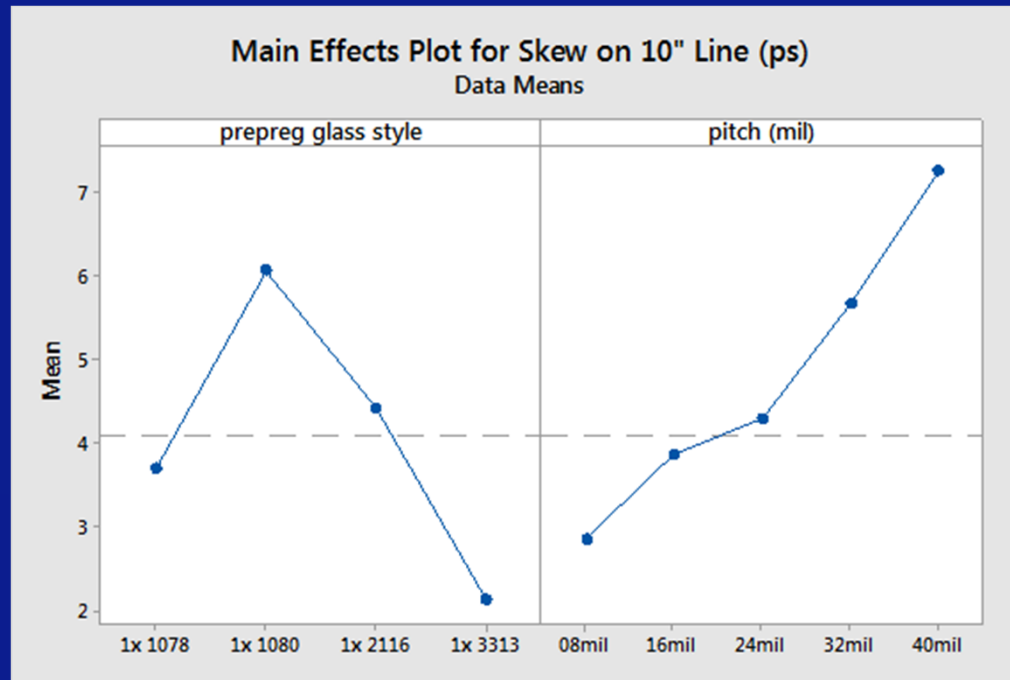


Copper Laminate and Skew Mitigation

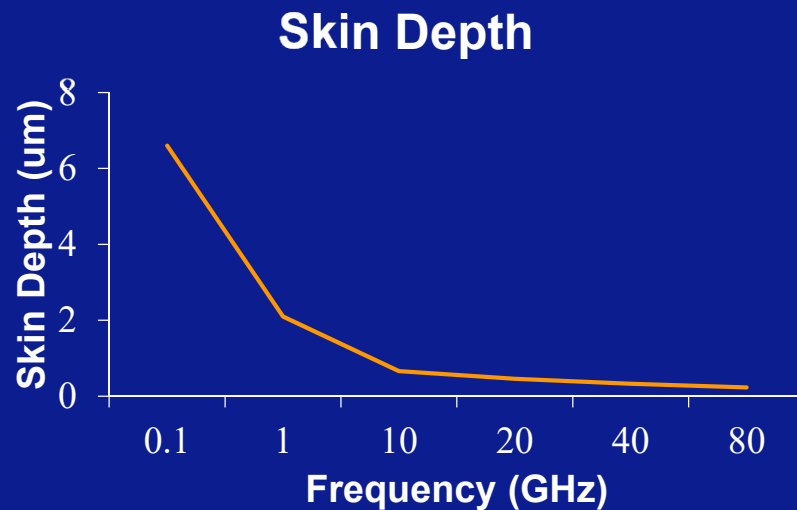
10



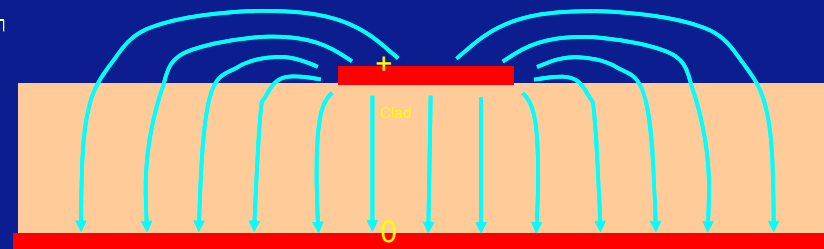
Test PCB Skew Data



Signal Integrity and Copper Roughness

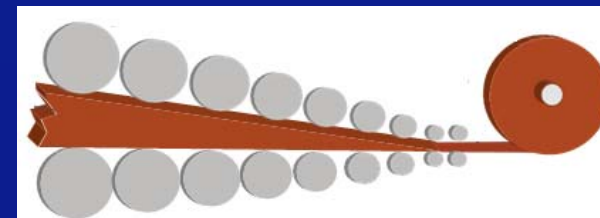
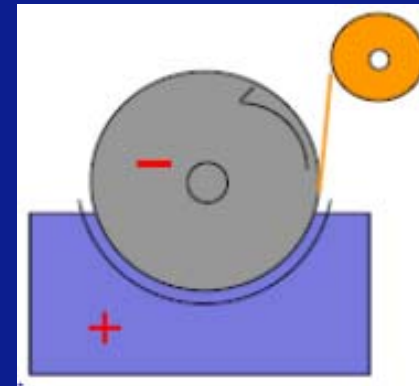


$$\delta = \sqrt{\frac{\rho}{\pi * f * \mu}}$$



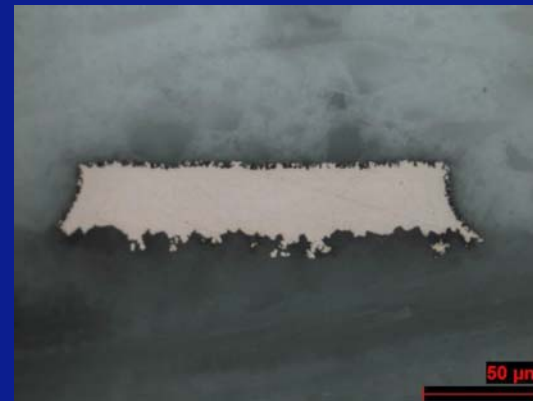
Types of Copper Foil

- Electrodeposited (ED)
 - Drumside Treated Foil (DSTF)
 - Reverse Treat Foil (RTF)
 - Very Low Profile (VLP)
- Rolled Annealed (RA)

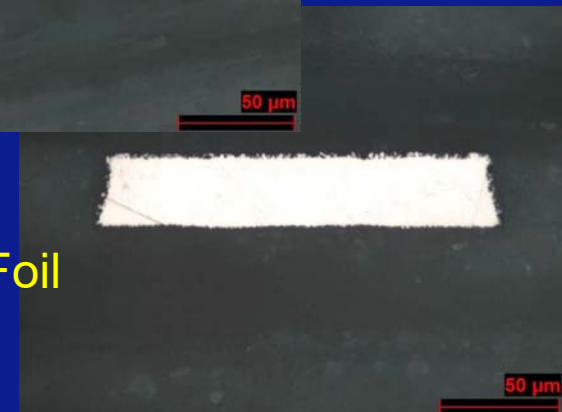


Copper Roughness

Copper Type	Rz
Standard	10 microns
RTF	7 microns
VLP	5 micron
VLP-2	2 micron
Ra	~2 micron

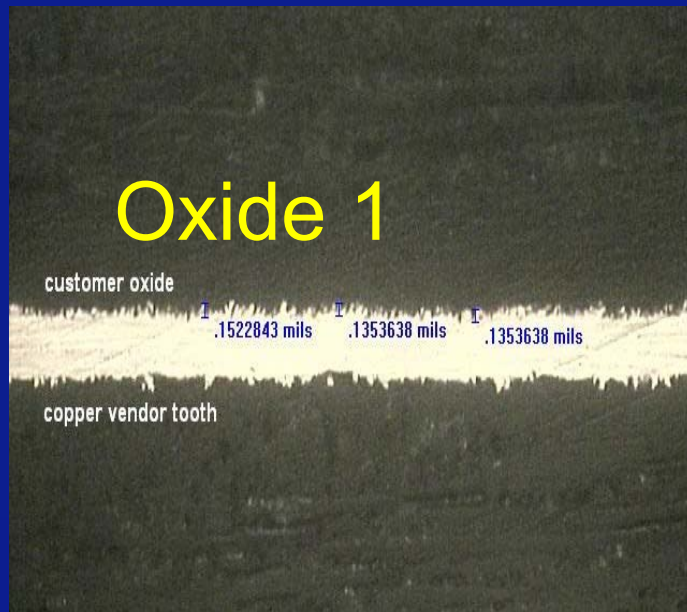


Std 1oz Foil

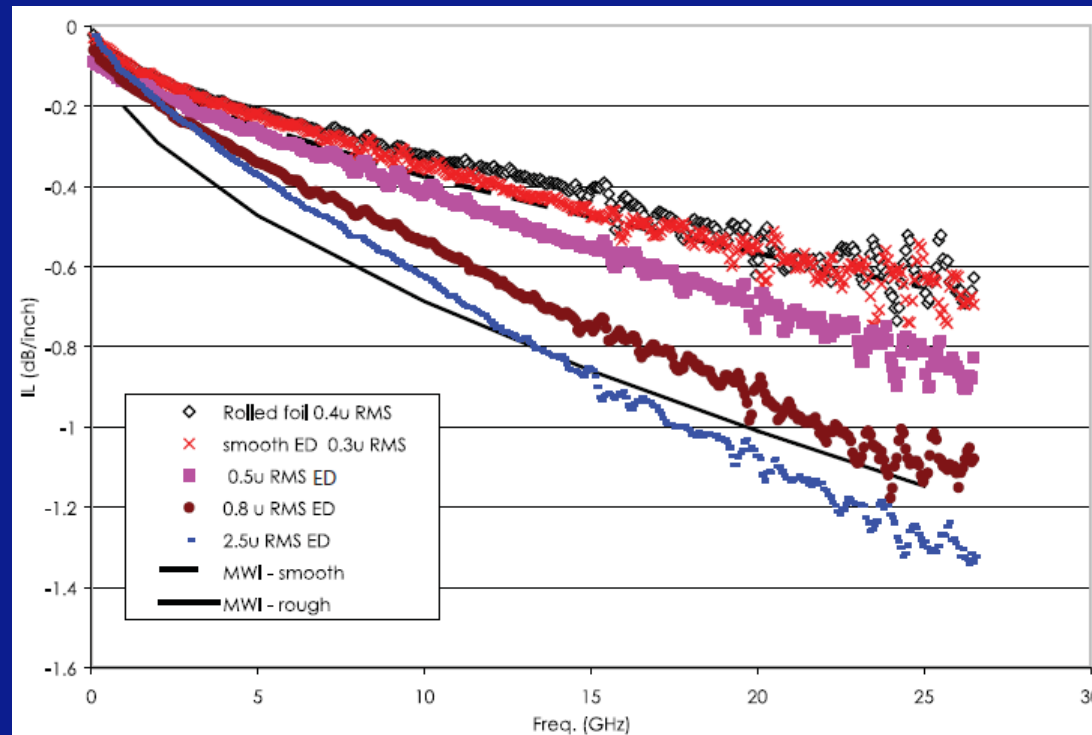


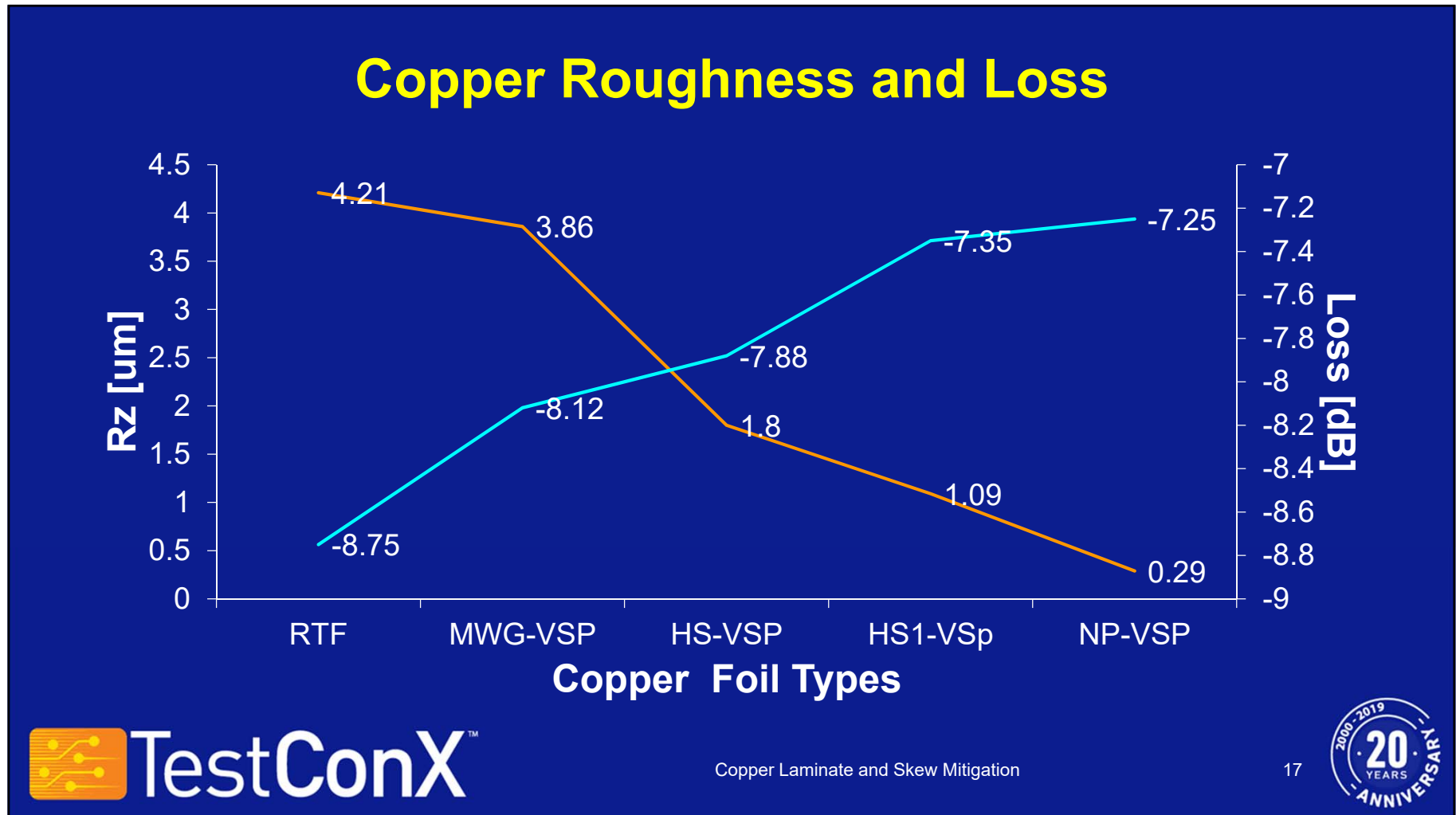
VLP-2 1oz Foil

Core Surface treatments



Loss and Copper Foil Types





Conclusion

- Glass reinforced dielectrics can be used in higher frequency applications if utilizing spread weaves.
- Copper roughness should be considered when considering frequencies >2 GHz.