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Archive

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Surface Finish Options for Spring Probe Applications

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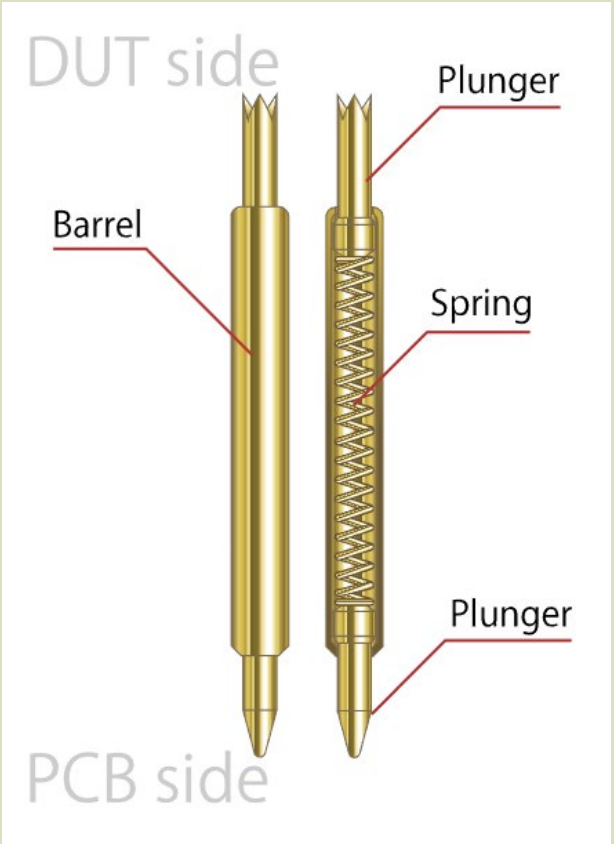
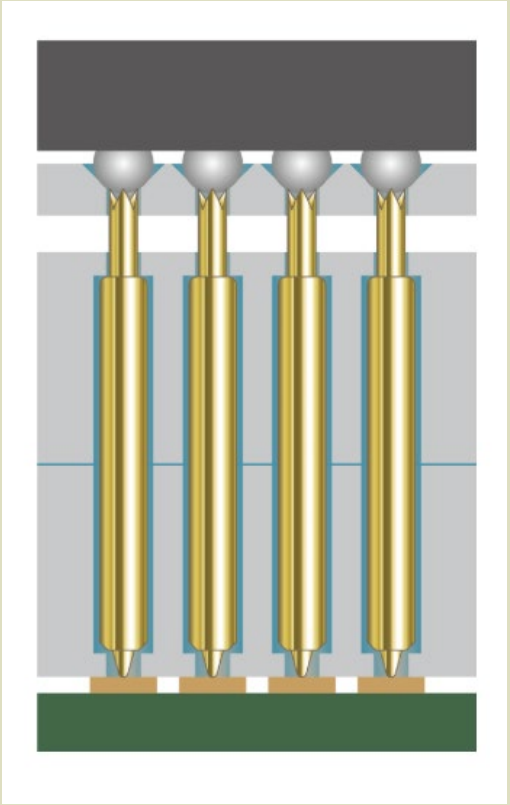
Spring Probe Introduction

- Spring probes are spring loaded electrical contacts used in the testing of ICs, substrates and PCBs. The inclusion of a spring enables a constant normal force on target surfaces that enables consistent electrical performance during testing.



DUT Side



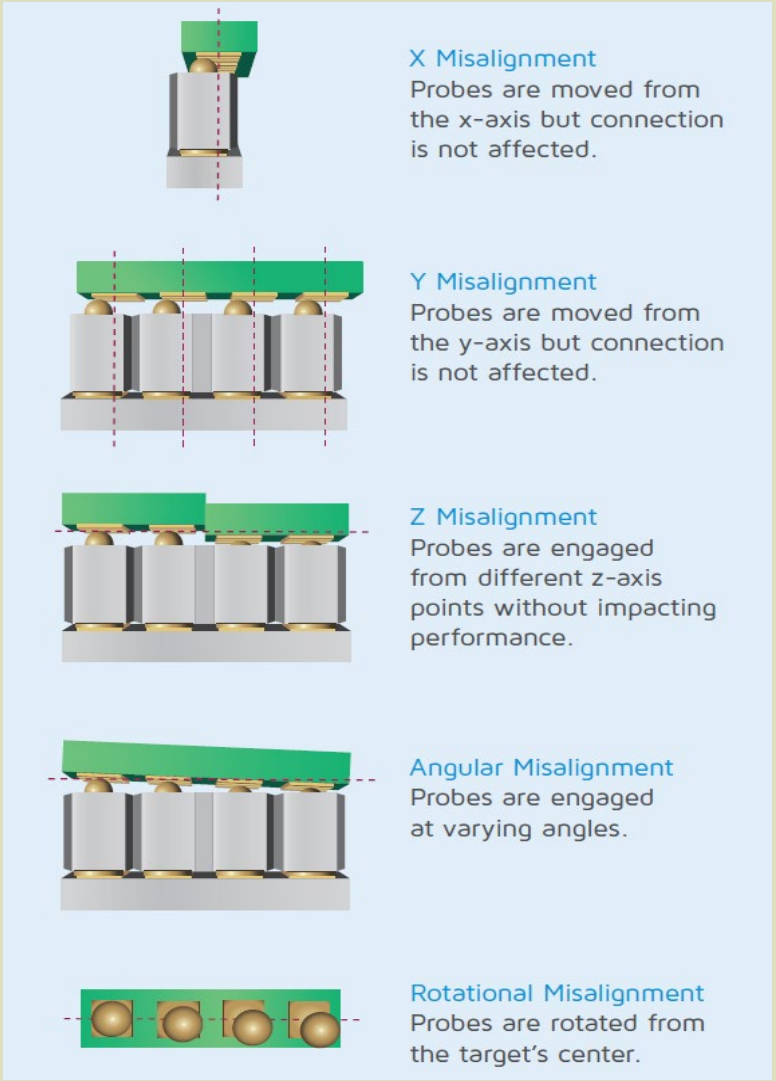
PCB Side

Spring Probe Introduction

- Common base materials for the components:
  - Brass
  - Bronze
  - Copper
  - Plated Nickel Silver and Gold
- All components are gold finished to ensure excellent electrical conductivity, durability, and corrosion protection throughout the life of the probe.

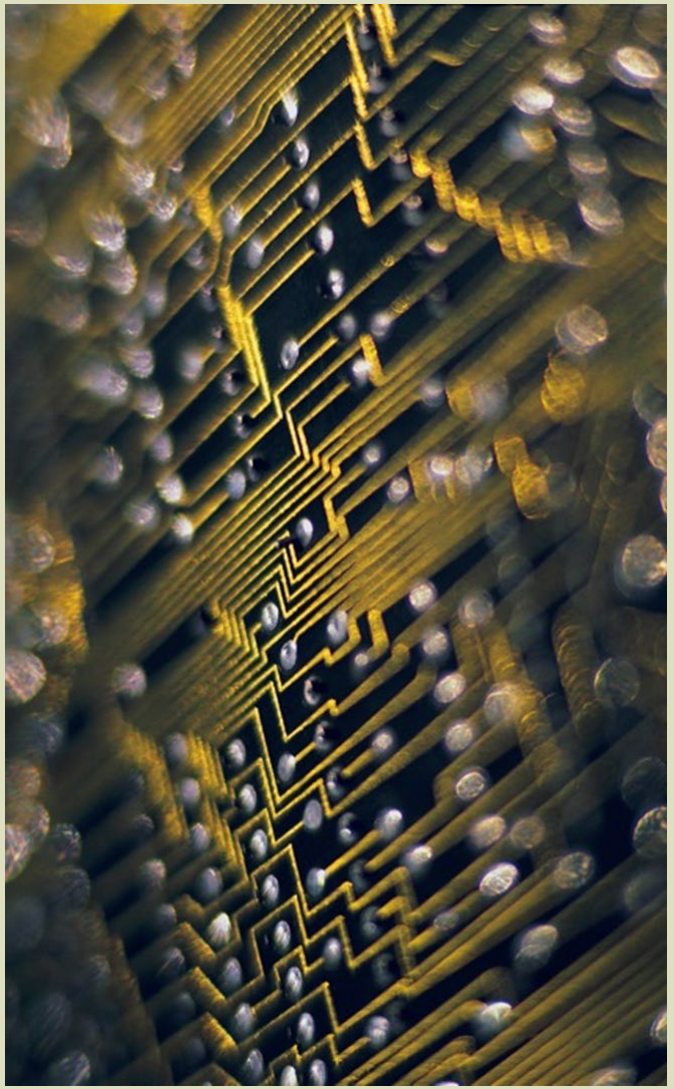
Spring Probe Challenges

- Features to consider:
  - Pitch
  - Type of package
  - Ground locations
  - Spring probe design
- Impact on electrical testing:
  - Alignment
  - Pad Damage
  - Impedance
  - Insertion Loss
  - Inductance



Spring Probe Challenges

- With the increased density of interconnects and frequencies of signals, the requirements and capabilities of electrical testing is critical to maintaining quality and producing good parts.
- However, while design features of spring probes are very important, they are not the sole contributor to RF performance.
    - The final finish chosen also has an impact on electrical performance for different applications which will be discussed.



Electrolytic Nickel & Gold

- A common final finish that targets an electrolytic deposition of 100-200 µ” of nickel, and 20-50 µ” of gold.
- The process is simple compared to other options.

Advantages

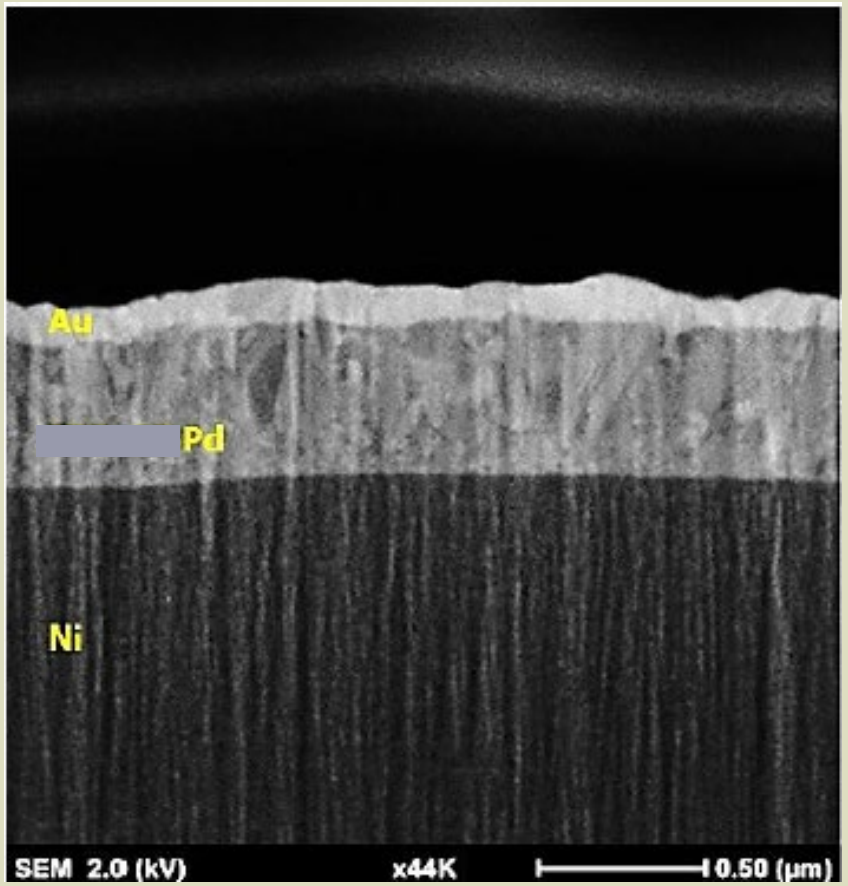
› Produces a hard, durable surface
› Long shelf life

Disadvantages

› Very expensive
› Thickness uniformity challenges

ENEPIG

- Another common final finish comprised of electroless nickel, electroless palladium, and immersion gold.
- The electroless nickel deposit is a Ni-P alloy where the %P in the deposit can be tuned through chemical parameters.
- The electroless palladium can either deposit a pure Pd or a Pd-P alloy.
- A flat or round probe tip will likely provide adequate electrical connection without damaging the surface finish.



ENEPIG

Common Target Thickness (IPC-4556B):

- 118 - 236 µ” Ni-P
- 2 - 12 µ” Pd/Pd-P
- 1.6 - 3.9 µ” Au

Advantages

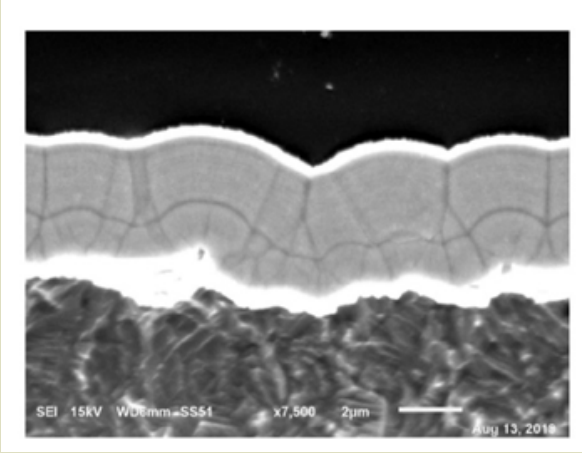
- Excellent coplanarity
- Long shelf life
- Universally Accepted

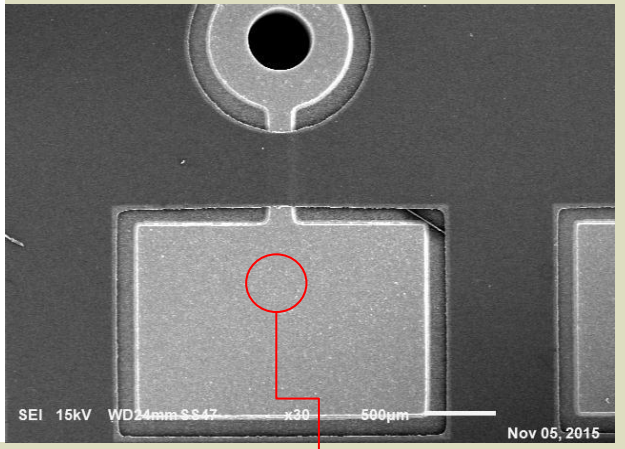
Disadvantages

- Not reworkable
- Signal loss (Rf)
- More complex process

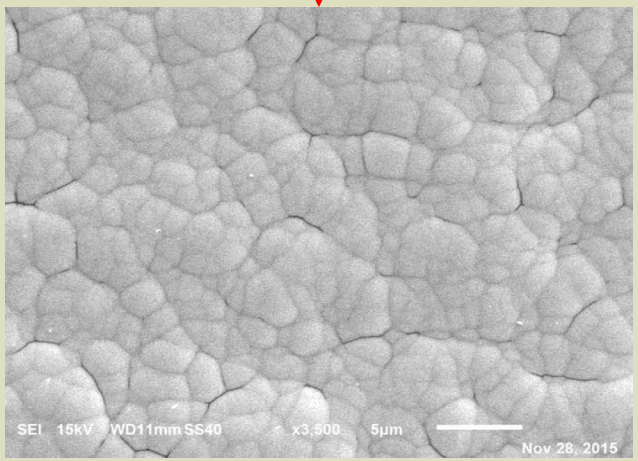
ENEPIG – Nickel Deposit

- Mid-Phosphorus Nickel:
  - 6-9% Phosphorus
  - Gives skip and corrosion resistance
  - Excellent stability and resolution



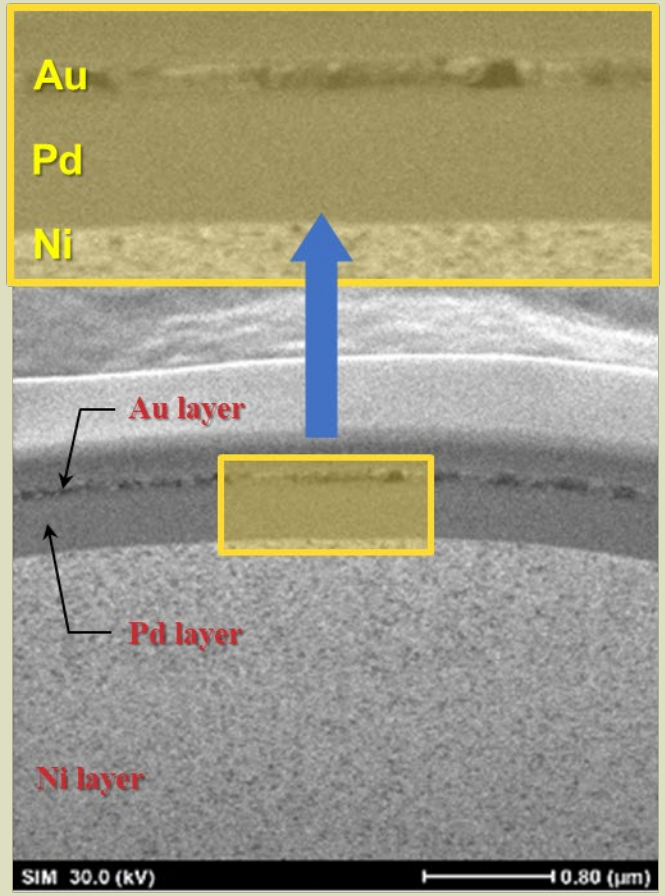


- High-Phosphorus Nickel:
  - 7.5-10% Phosphorus
  - Improved tolerance to contamination
  - Enhanced skip and corrosion resistance

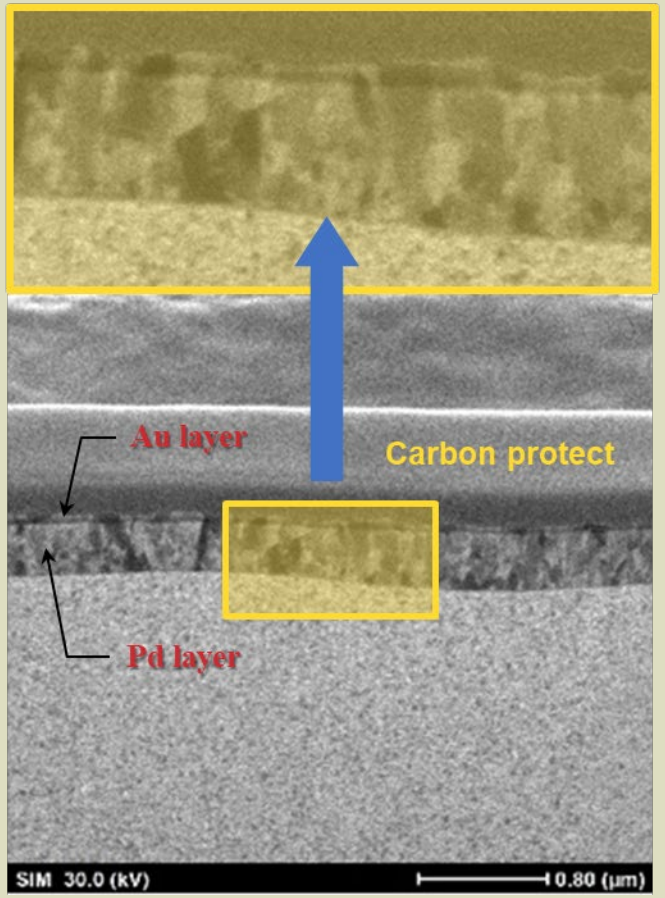


ENEPIG – Pd Deposit

Pd-P Deposit



Pure Pd Deposit



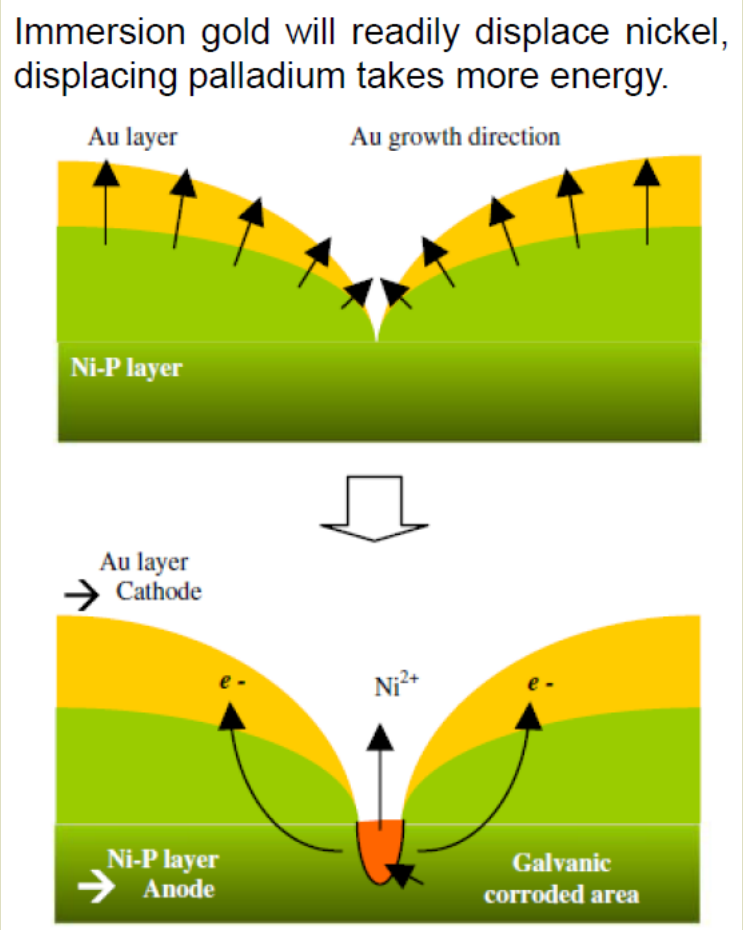
The Pd-P deposit is amorphous in nature; the pure Pd deposit is crystalline.

The Pd-P deposit is harder than the pure Pd deposit giving Pd-P a slight advantage in terms of minimizing pad damage during testing.

ENEPIG – Gold Deposition Mechanism

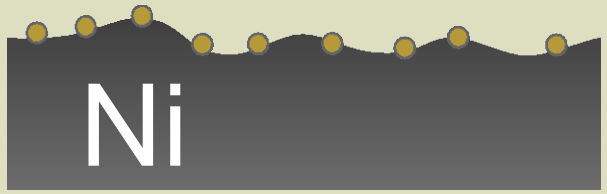
Reduction-assisted Immersion Gold - RAIG

RAI gold is a mixed reaction bath. Both immersion and autocatalytic reactions start simultaneously. As the substrate becomes less accessible, the immersion reaction will diminish, and the autocatalytic reaction will dominate. Non-aggressive; will not produce substrate corrosion. Capable of depositing 4 – 6 units of gold in a single step.

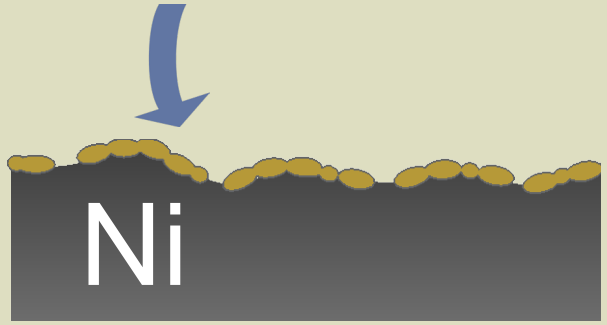


ENEPIG – Gold Deposition Mechanism

Standard Displacement Gold

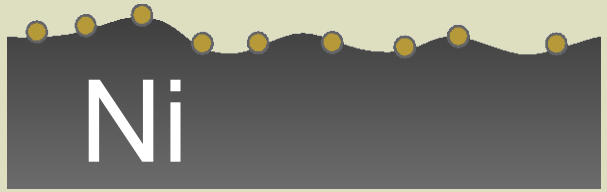


Displacement reaction occurs on Nickel surface.



Continuously, Gold film grows up by displacement reaction.

Mixed Reaction Gold



Displacement reaction occurs on Nickel surface at first.

Auto-catalytic reaction starts after Gold partially covers the Nickel surface.

Future Alternative Finish - EPIG

- A final finish comprised of electroless palladium and immersion gold.
- Target Thickness (No IPC Specification):
  - 5 - 40 µ” Pd
  - 2 - 10 µ” Au

Advantages

› Excellent coplanarity
› Good shelf life
› Good signal integrity

Disadvantages

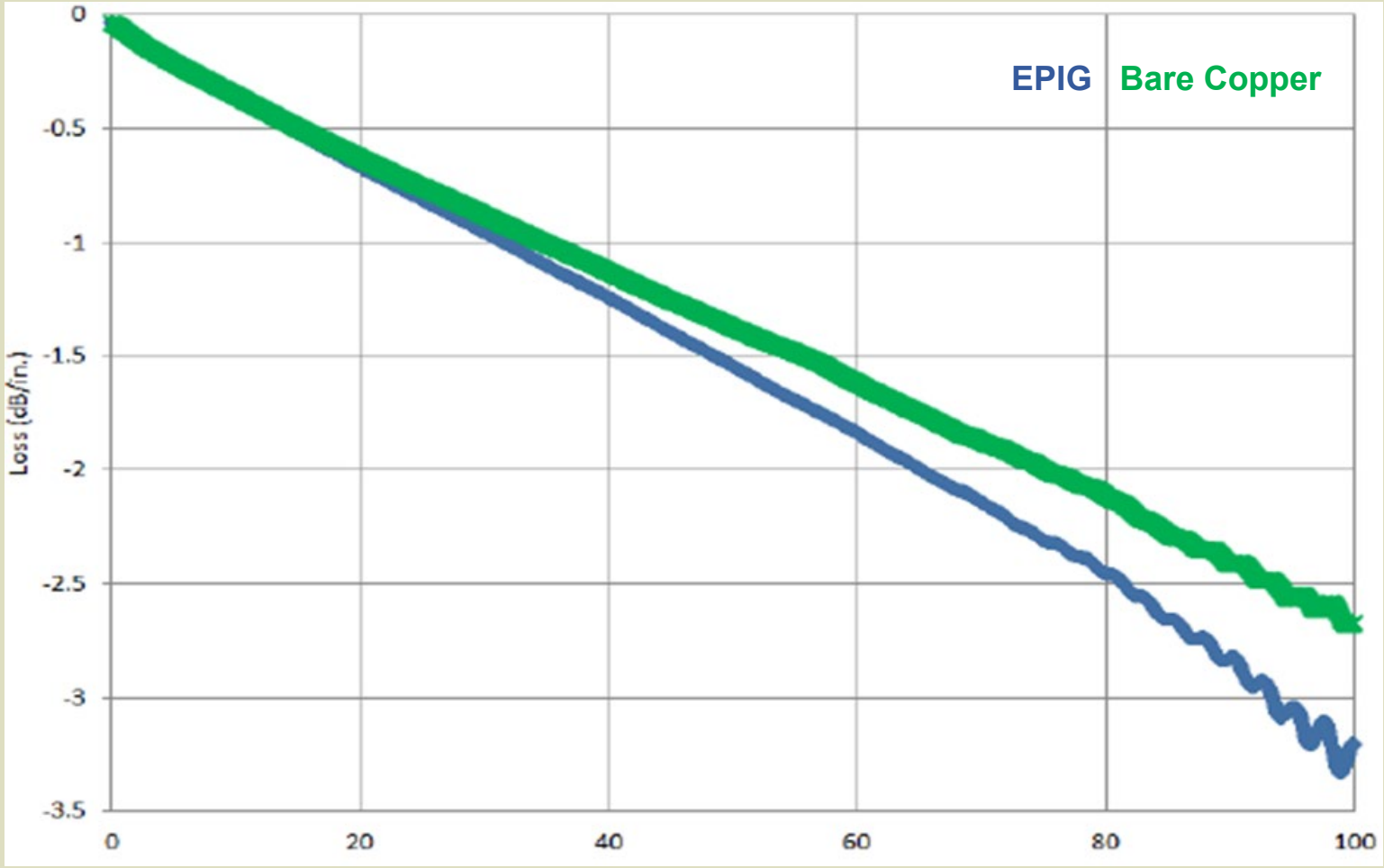
› Not reworkable
› Complex process
› No universal acceptance

EPIG – Insertion Loss

Rogers Corporation: EPIG Insertion Loss Evaluation

Microstrip insertion loss, differential length method using 5 mil thick low loss material with smooth copper.

"Insertion Loss Performance Differences due to Plated Finish and Different Circuit Structures" – John Coonrod, Rogers Corporation, IPC Apex, 2019



Future Alternative Finish - IGEPIG

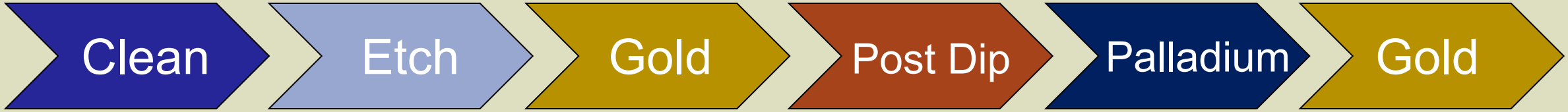
- A final finish comprised of immersion gold, electroless palladium, and immersion gold.

- The finish is not universally accepted but has shown promising results in lowering insertion loss compared to ENEPIG.

Future Alternative Finish - IGEPIG

Target Thickness (No IPC Specification):

- 2 - 3 µ” Au
- 1.5 - 4 µ” Pd
- 0.5 – 1.0 µ” Au



Advantages

- Excellent coplanarity
- Economical
- Good signal integrity
- Good shelf life

Disadvantages

- More complicated process
- No universal acceptance

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