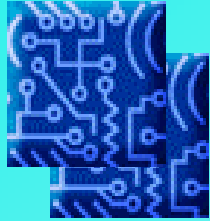


PWB Surface Finishes

SMTA Meeting Mar 16, 2005

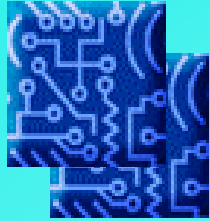
Luc Beauvillier
Holle Galyon
Matt Stevenson
Darren Hitchcock





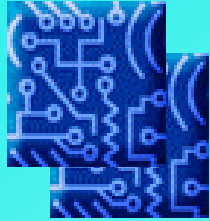
Purpose of the PWB *Surface Finish*

- Provide a solderable surface for component assembly
- Protect copper surface from oxidation
- Provide a surface appropriate for wear related parts



High Performance *Surface Finish*

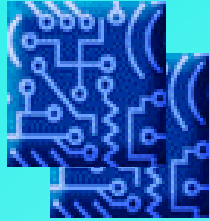
- Mixed Technology board designs
 - Solderable , SMT and Thru-hole
 - Wire Bondable
 - Contact Resistance
- Co-planar surfaces
- Compatibility with variety of fluxes & paste
- Cost effective
- Environment



Merix Offers . . .

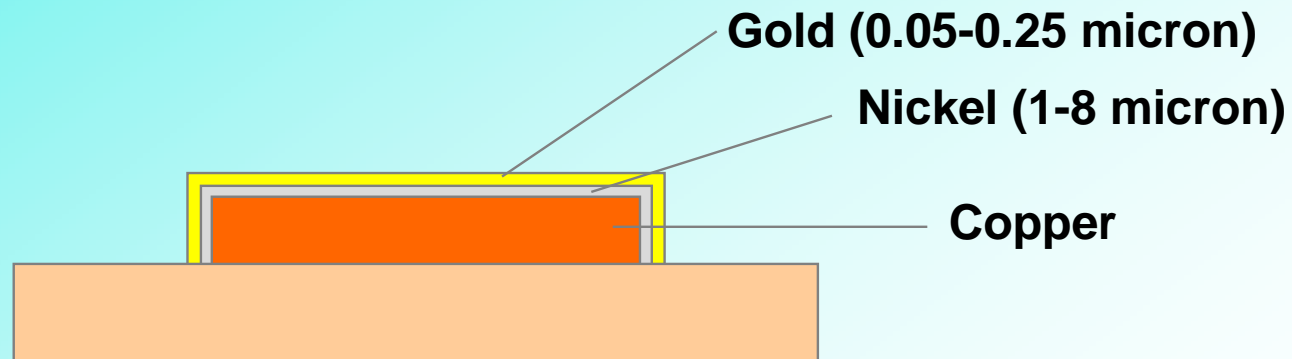
- Electroless Nickel - Immersion Gold
- Immersion Silver
- Hot Air Solder Level
- Organic Solderability Preservative
- Electrolytic Nickel - Hard Gold
- Electrolytic Nickel - Soft Gold

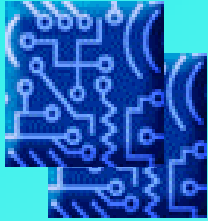




Electroless Nickel / Immersion Gold

A two layer, gold over nickel, metallic surface finish plated onto the copper base by means of a chemical deposition process.





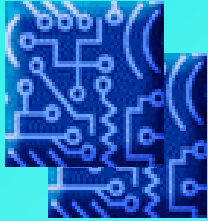
ENIG

Advantages

- Typical thickness: 3 to 8 μ inch gold over 150-250 μ inch nickel
- Excellent corrosion resistance
- Good for aluminum wire bonding
- Excellent flatness for fine-pitch technology
- Excellent solderability
- Excellent shelf life (12 mo)
- Good surface contrast
- Good contact resistance
- High Aspect Ratio capability

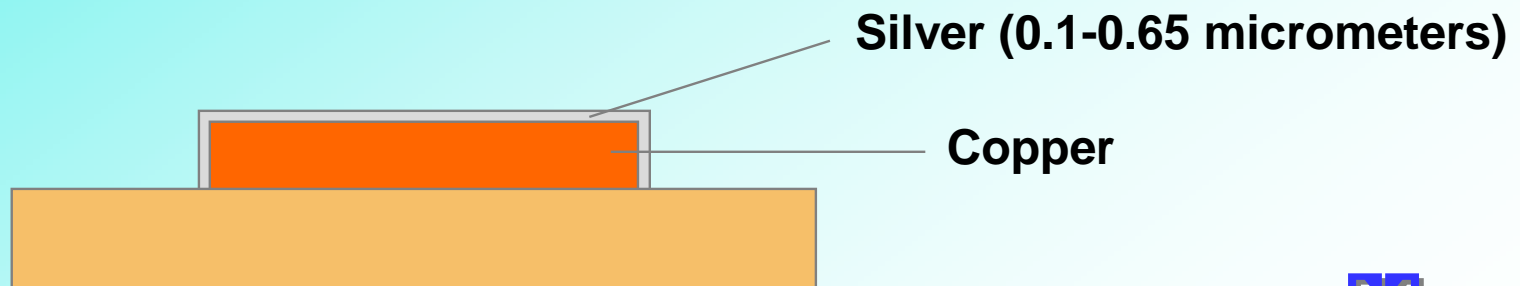
Disadvantages

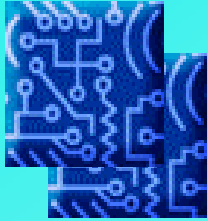
- Narrow process window
- Higher cost than HASL (1.5 to 2.0 times)
- Black pads: brittle solder joints
- Fatigue failures on large BGA packages
- Skip plate
- Extraneous nickel plating
- Soldermask compatibility with the nickel bath



Immersion Silver

A co-deposit of Silver and organics.





Immersion Silver

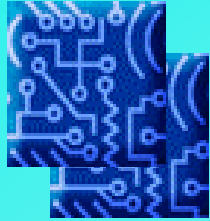
Advantages

- Typical coating thickness: 5 to 25 μ inch
- Very good alternative to HASL (lead free)
- Similar cost to HASL
- Excellent solderability, (comparable to solder)
- Excellent for fine pitch and BGA's technologies
- Holes capability over 10:1 aspect ratio
- Press fit connectors' capability
- Multiple heat cycles during assembly process
- Reworkable product (at fabricator)
- Selective gold compatible
- Good shelf life, 6 months to 12 months
- Conductive during PWB testing
- Low % Silver dissolved into solder joint

Disadvantages

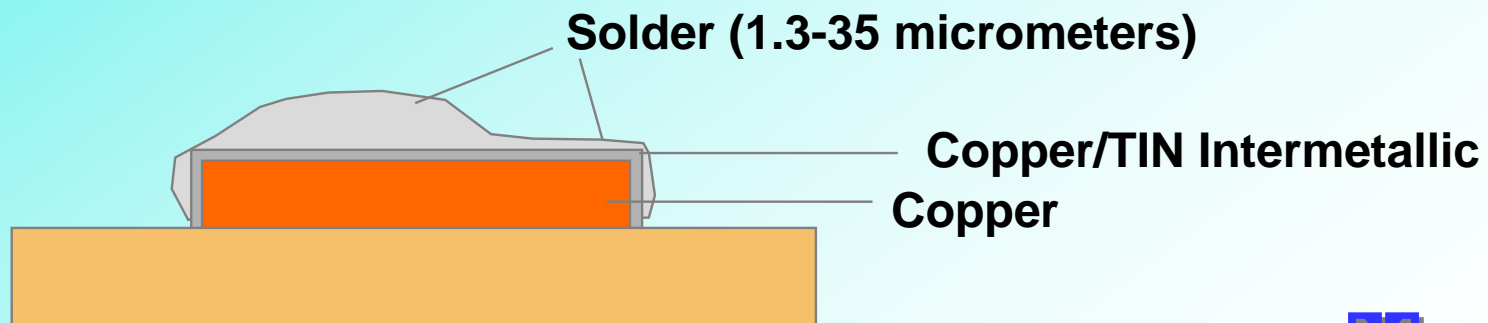
- No thermal cycle after Immersion Silver at the fabricator.
 - Vias cap: UV curable only
- Handling
- Some resistance from the OEM to use Immersion Ag with press fit connectors
- Micro-voids in the solder joints.
 - also found on other surface finishes
- Discoloration due to reaction with sulfur in the air. Does not impact solderability

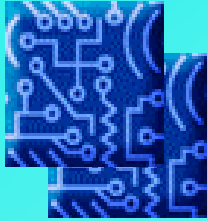




Hot Air Solder Leveling (HAL)

A molten solder immersion and hot air leveling (blasting) of surfaces and holes to provide a “pretinned” coating on exposed copper surfaces.





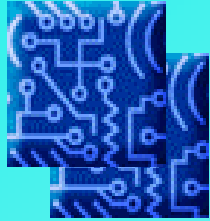
HASL

Advantages

- Typical coating thickness specifications:
 - 100 to 1 000 μ inch with an average of 150 to 300 μ inch on fine pitch
 - 40 to 1 000 μ inch on discrete pads average around 80 μ inch
 - coverage on large surface like ground plane (15 to 40 μ inch)
- Excellent solderability “Nothing solders better than solder”
- 20 mils pitch capability and depend upon the technology
- Board thickness up to 200 mils
- Panel size up to 24 x 28 inches
- One of the less expensive surface finish
- Good shelf life

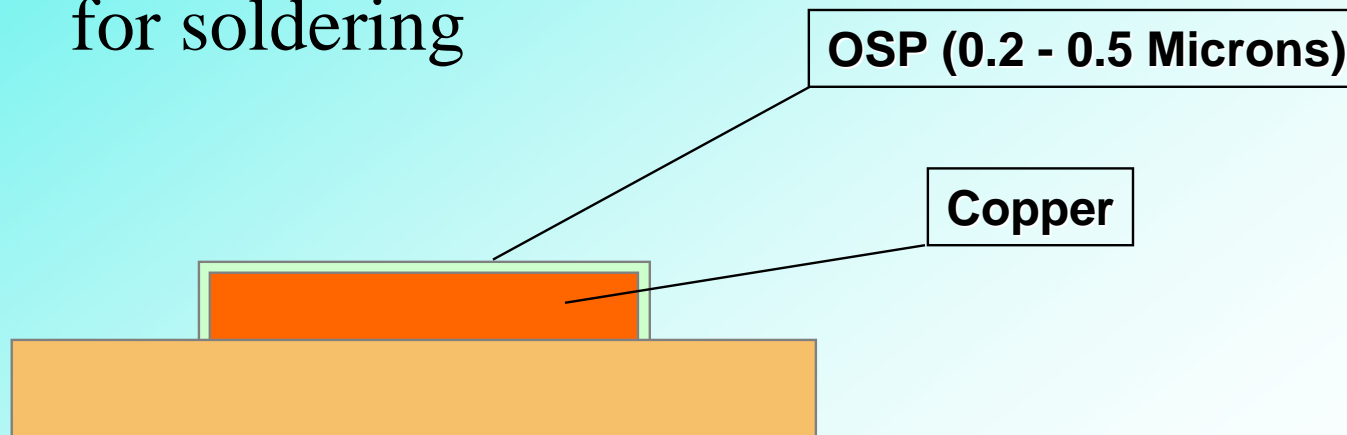
Disadvantages

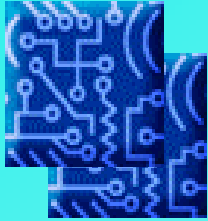
- Uniformity of the coating
- Thermal shock
- Limited capability on high density boards
- Limited capacity to clear vias holes. (> 6:1 aspect ratio)
- Difficulty to maintain hole size tolerance along plated edges
- Difficulty to process thin material
- Require a different drill selection. (Press fit connector dictate the drill)
- This process is very dependant of the board technology.
- Intermetallic layer grows with time and heat cycle.
- Use of Lead



Organic Solderability Preservative (OSP)

- A water based organic compound that selectively bonds with copper to provide an organometallic layer that protects the copper for soldering





OSP

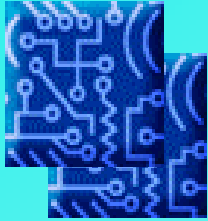
Advantages

- Typical coating thickness: 8 μ inch to 20 μ inch
- Major advantage of OSP: Gold doesn't need to be protected
- The least expensive surface finish
- Reworkable
- Shelf life (12 months)
- New OSP formulations are now available for lead free applications

Disadvantages

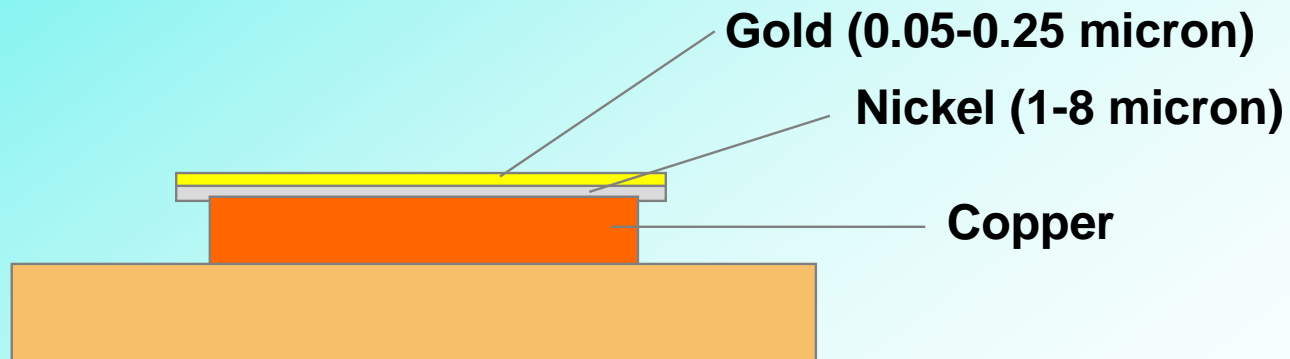
- Difficult or impossible to inspect the final product
 - Skip plating
 - Residue on copper
 - Coating thickness
- Difficult to soldermask via cap
- Electrical test need to take place prior to coating
- Solder may not wet to corners of large SMT pads.
 - still good solder joint

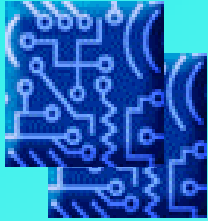




Electrolytic Nickel / *Electrolytic Gold*

A two layer, gold over nickel, metallic surface finish plated onto the copper base by means of a electrolytic deposition process.





NICKEL / HARD GOLD

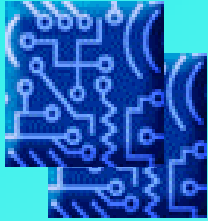
Advantages

- Gold connectors:
 - Typical thickness: 30 to 50 μ inch minimum gold (99.7%) over 150 μ inch minimum nickel
- Solderable surface:
 - Typical thickness: 5 to 15 μ inch gold (99.7%) over 150 μ inch minimum nickel
- Excellent corrosion resistance
- 130 to 220 Knoop hardness
- Excellent wear resistance, best for surface rotary switches, on-off contacts, and edge connectors
- Excellent shelf life

Disadvantages

Solderable surface

- Gold Distribution
- Throwing power in the holes
- The copper is exposed on the sides of the traces
- Porosity
- Difficulty to measure the true line width
- Soldermask adhesion on gold



NICKEL / SOFT GOLD

Advantages

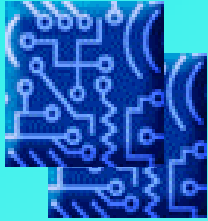
- Typical thickness: minimum 30 μ inch gold (99.9%) over 200 μ inch nickel minimum
 - A minimum of 200 μ inch nickel is required to stop the copper to migrate into the gold
- Aluminum or gold-wire bonding
- Excellent corrosion resistance
- Good for pressure contacts
- Less than 90 Knoop hardness
- Fair wear resistance
- Excellent shelf life

Disadvantages

Solderable surface

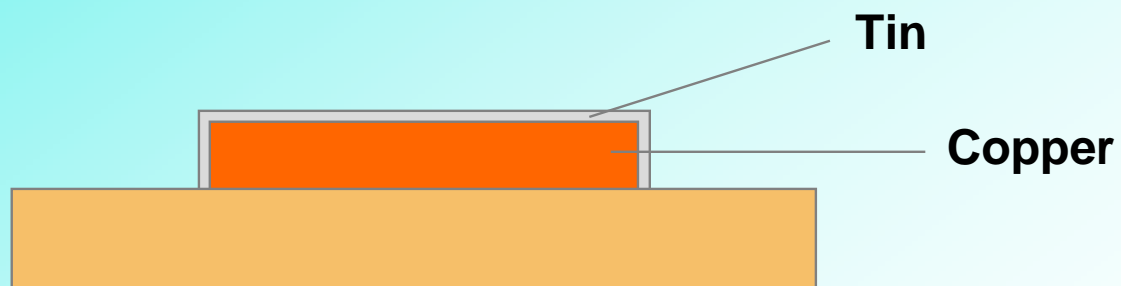
- Gold Distribution
- Throwing power in the holes
- The copper is exposed on the sides of the traces
- Porosity
- Difficulty to measure the true line width
- Soldermask adhesion on gold

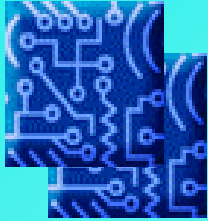




Immersion Tin

A co-deposit of Tin and organics.





IMMERSION TIN

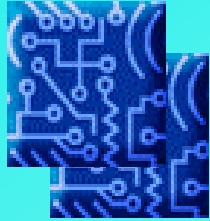
Advantages

- Back Plane
- Press fit connectors Technology
- Reworkable

Disadvantages

- Soldermask compatibility
- Thiourea (TU)
- High temperature of the Tin bath
- Process control: Solderability Test (Tin porosity)
- Intermetallic Growth
- Solderability goes down significantly with each reflow cycle
- Unable to analyze chemistry directly
 - solderability test (6-8 hr test)
- Not installed at Merix

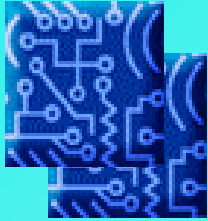




Lead-Free Assembly, PWB Surface Finish Developments

- Lead Free compatible OSP's
 - Enthone 106 HT designed for Lead Free reflow profiles (currently in testing at Merix)
 - Drop in alternative to 106 AX for Merix and CMS
 - Survive extra reflow cycle in a tin/lead assembly environment
 - Easy process to control.
- UIC Immersion Silver
 - Investigating to reduce / eliminate tarnishing
 - Testing planned





Selective Plating

| | HASL | OSP ENTEK 106AX or HT | ENIG | Electrolytic Nickel Gold | Immersion Silver | Immersion Tin | Plated Tin/Lead (unfused) |
|--------------------------|------|-----------------------|-------------------------|---|---|---|--------------------------------|
| HASL | | No | No | Yes if the design can be taped | No | N/A | N/A |
| OSP ENTEK 106AX or HT | | | Under engineering (R&D) | Yes | No | No | Yes if the design can be taped |
| ENIG | | | | Under engineering (R&D) | Under engineering (R&D) | Under engineering (R&D) | Under engineering (R&D) |
| Electrolytic Nickel Gold | | | | Yes Two different thicknesses in different areas | Yes if the design can be taped and meet design criteria | Yes if the design can be taped and meet design criteria | Yes if meet design criteria |
| Immersion Silver | | | | | | No | Yes if the design can be taped |
| Immersion Tin | | | | | | | N/A |

Design Criteria: Ten mils minimum line width between the two different metals (in overlap area)

Fifty mils minimum spacing required between features of two different metal when connected together by a trace

