SUMMIT INTERCONNECT

INSULECTRO

PCB 101 – How Boards are Manufactured

PCB Carolina 2022

Nino Hardin & Laura Martin

Presenters

Nino Hardin

Director of Sales - Summit

Nino Hardin is an industry leader with an extensive background in PCB Sales, Marketing and Business Development. As the new Director of Sales for Summit in Santa Ana, Nino focuses on enhancing the customer experience and growing sales across all Summit locations.

Mr. Hardin has been engaged in technical sales for over 10 years and has overseen sales of 50M+ in aerospace, defense, telecommunications, and semiconductor industries.

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Laura Martin

Director of Technology - Insulectro

Laura Martin specializes in PCB design for manufacturing and is responsible for educating customers on material properties and applications for a variety of products that range from medical devices to satellites.

Laura previously worked for Lockheed Martin for 15 years, initially in PCB manufacturing, then as a supervisor of mechanical engineering labs, and finally as the founder and leader of the producibility engineering department where she and her team reviewed all circuit board designs prior to release for manufacturing.

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Overview

Summit is the largest privately held PCB manufacturer in North America

- Eight North American-based facilities
- Multiple sites provide redundancy for customer risk mitigation
- Focused on providing the best customer experience with easy ordering and full transparency
- Broad range of PCB product capabilities
- Extensive quality certifications with continuous improvement processes

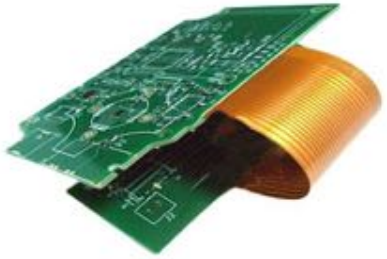
A total PCB solution from quick-turn prototype to volume production in a single manufacturing partner

A Complete Portfolio of PCB Products

Rigid

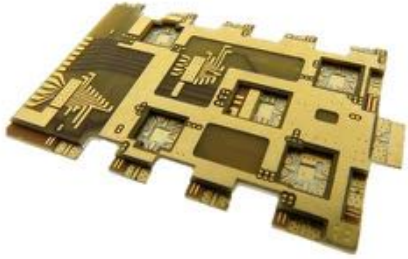
- High layer count
- Stacked microvias
- Complex miniature structures (i.e. blind/buried vias, via fill)
- Back drilling
- Multiple sequential lam
- Heat sinks
- Bonded, embedded coins
- Same-day turns available

Flex, Rigid-Flex



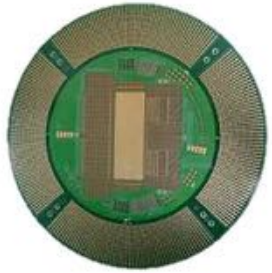
- Oversize, loose-leaf, bookbinder constructions
- Single-sided, double-sided, and multi-layer flex
- Adhesiveless and adhesive
- Stiffeners and connectors
- Laser ablation
- Thin flex laminates
- Flex assembly

RF / Microwave



- RF/digital hybrid designs
- Wide range of PTFE materials
- Mixed material stackups
- Plated cavities, edge plating
- Mode suppression/stitching
- Buried resistors
- Edge launch features

Semiconductor/ATE



- Reference, probe and load, and burn-in-boards
- High aspect ratio
- Low loss materials
- Bondable gold
- Tight tolerance drilling
- Ormet bonding
- Oversized panel options

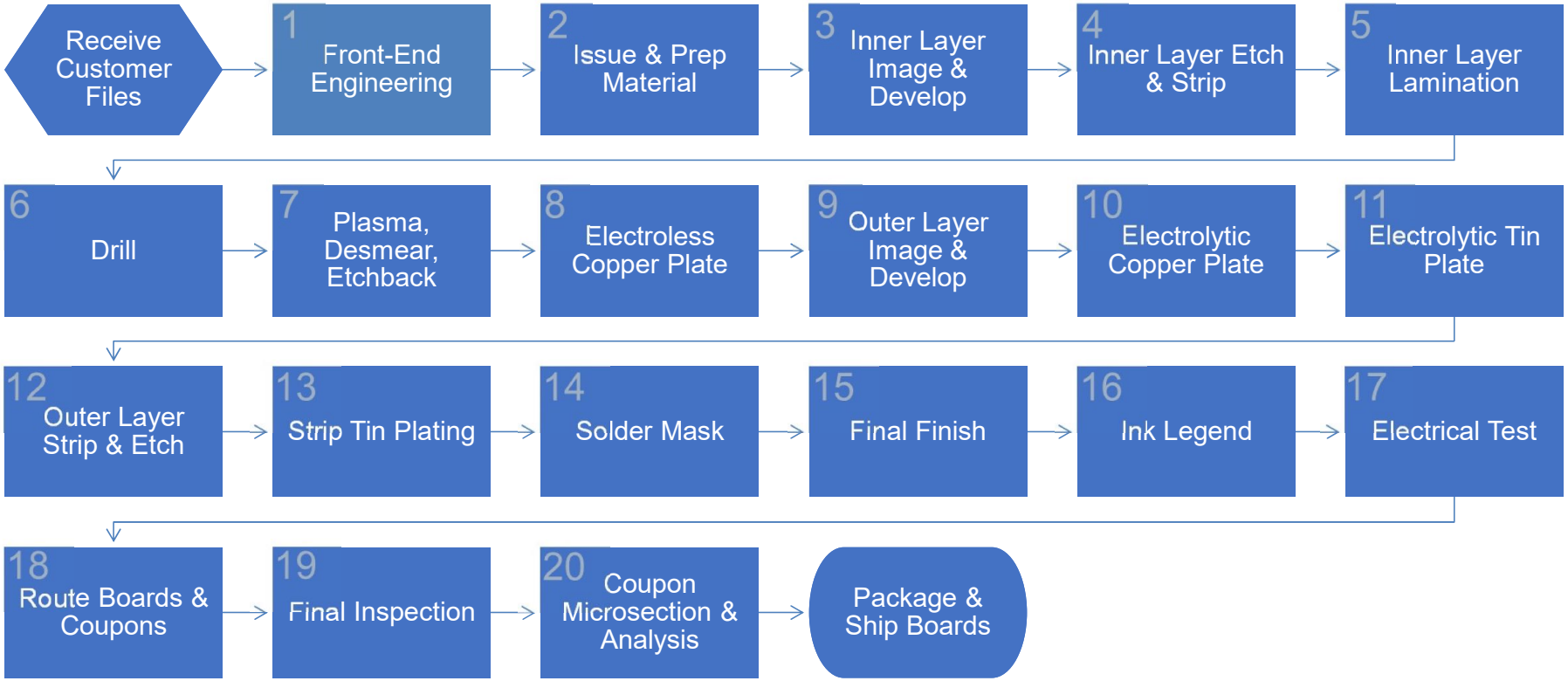
Insulectro is the largest distributor in North America of Electronic Materials for Printed Boards and Printed Electronics

- Rigid laminates and Prepregs
- Flex Laminates and Adhesive films
- Conductive Inks and Substrates and PSA's
- Process Chemistries for Imaging and Plating
- Z-Axis Interconnects
- PCB Equipment and Equipment Service
- Design Education

PumaFast

Large and dynamic inventory of electronic materials with many available the **same-day** from multiple branches across North America.

PCB Fabrication Process



Step 1: Front-End Engineering

The process of **converting** customer **design** files to **working** data.

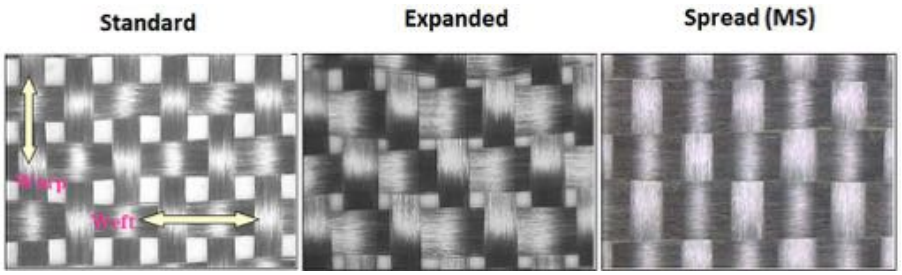
- Planning Steps
  - Review of all documentation
  - Create stack up and calculate impedance (if required)
  - Select material and panel size
  - Create manufacturing travelers
  - Release order to manufacturing floor
- CAM Steps
  - Input customer data
  - Perform net compare & DFM checks
  - Prepare data for manufacturing
  - Panelize
  - Output to production equipment

What is Core Material?

Rigid Material

IPC-4101 & IPC-4103

- Laminate Cores – cured resin and glass fabric, and copper
- Prepreg Sheets – uncured resin and glass fabric



Copper Foil

IPC-4562

- Weight
  - 1/4 oz, 3/8 oz, 1/2 oz, 1 oz, etc.
- Type
  - Reverse Treated Foil (RTF)
  - Very Low Profile (VLP)
  - Rolled Annealed (RA)
  - Etc.

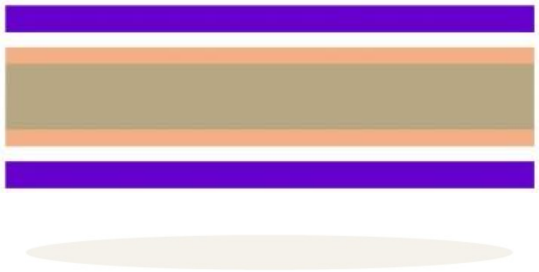
Step 2: Issue & Prep Material

- Core laminate is cleaned with an acid dip prior to photoresist process
- Prepreg sheets get tooled for lamination

Resin, glass, and copper substrate

a. Rigid core laminate

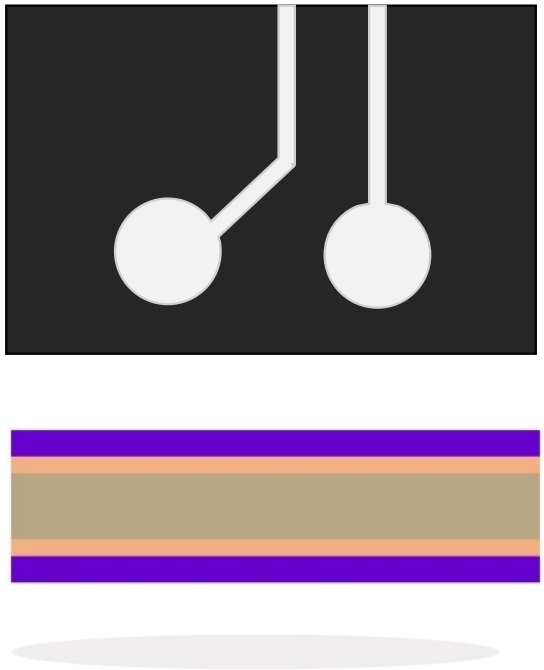
Substrate is coated with photo-imageable resist



b. Photoresist coat

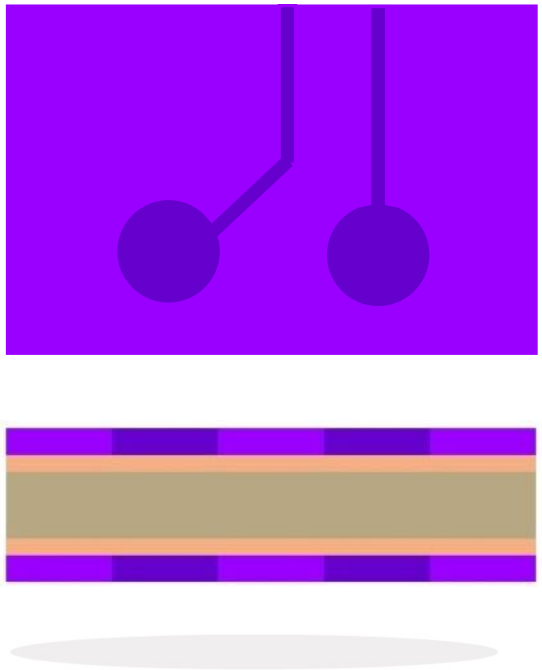
Step 3: Inner Layer Image & Develop

Circuit pattern is transferred to resist coated laminate by LDI



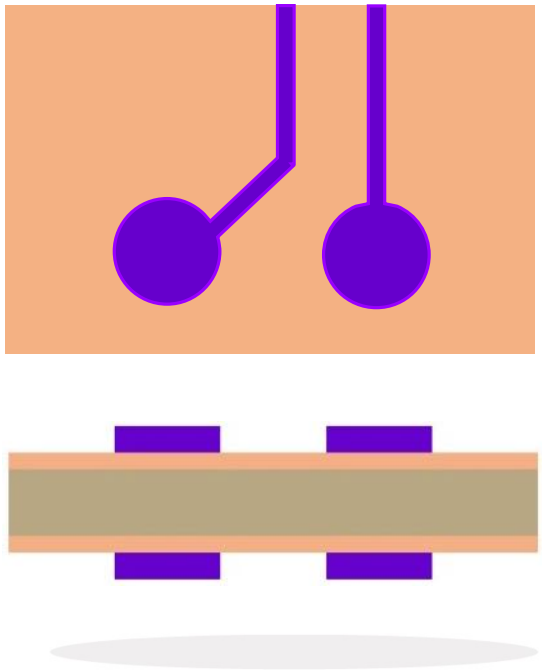
c. Image transfer

Pattern in resist is cured by the laser in previous step



d. Polymerized pattern in resist

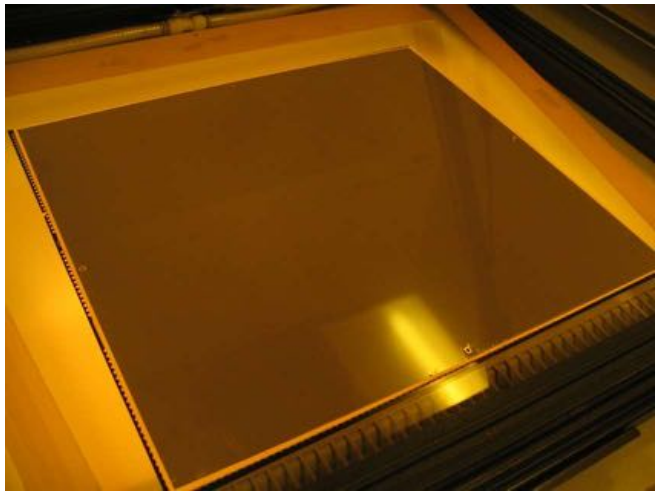
Uncured resist is dissolved away



e. Circuit pattern in resist

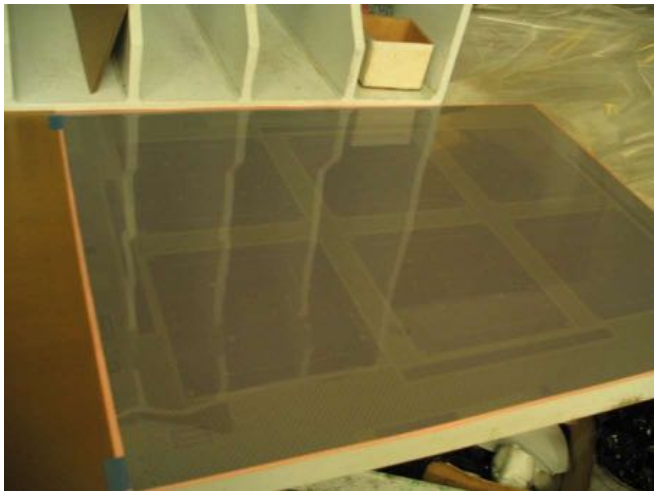
Laser Direct Image Equipment

Inner layer coated with resist



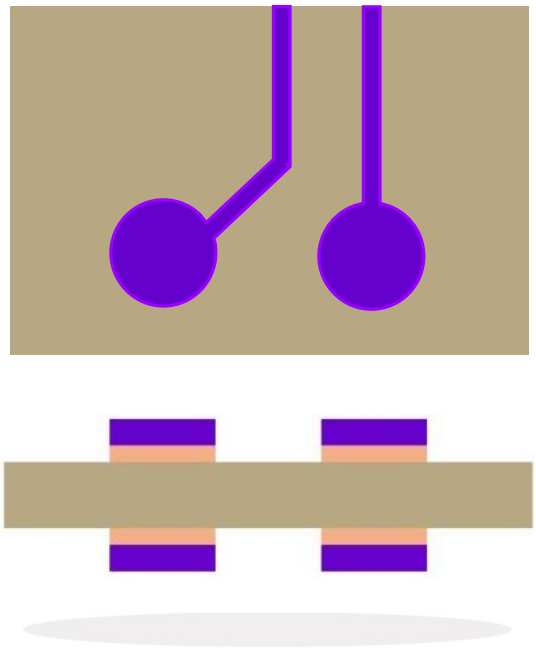
Laser Direct Image Machine

Inner layer image transferred



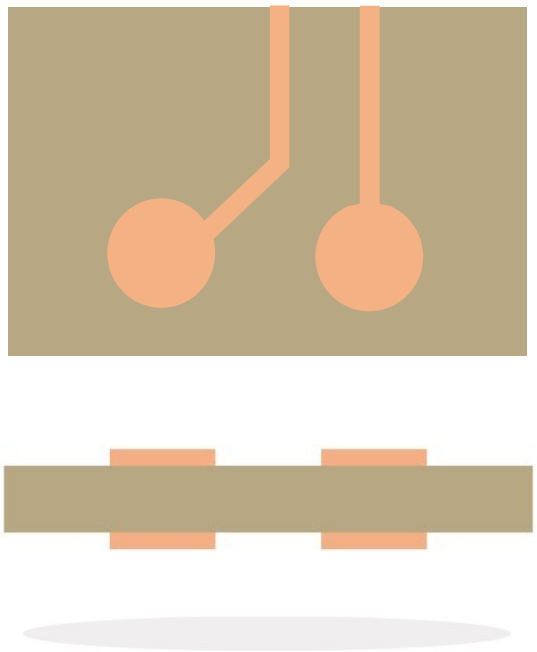
Step 4: Inner Layer Etch & Strip

Exposed copper is etched away down to the substrate



f. Etch copper

Resist is stripped and finished copper pattern remains



g. Final result

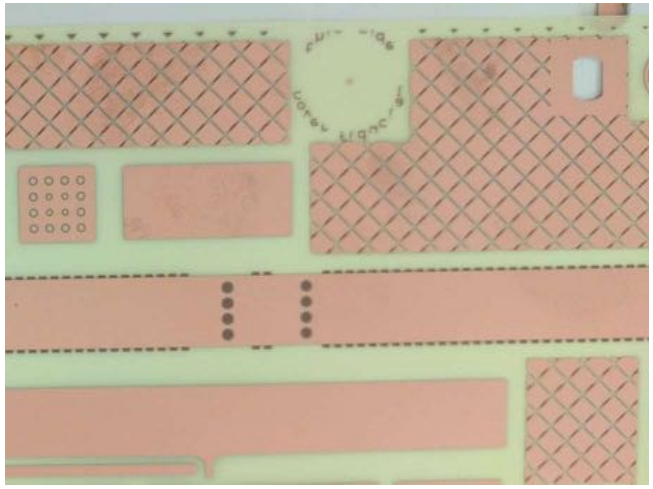
- Finished layers then get post-etch punched in preparation for the next process: Inner Layer Lamination

DES Line

Develop, Etch, Strip (DES) Line

Completed inner layer

Post-etch punch



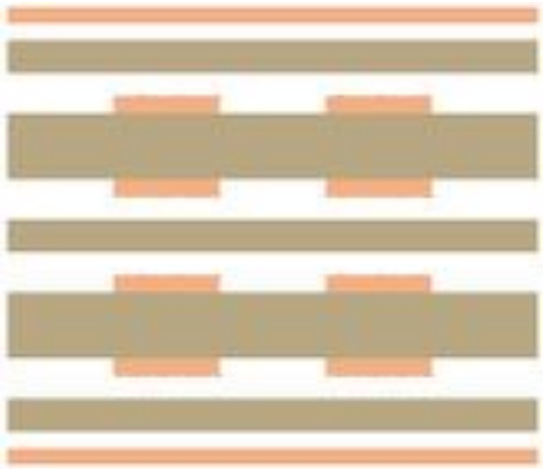
Automated Optical Inspection

Step 5: Inner Layer Lamination

Copper is roughened (by oxide) to promote adhesion for lamination

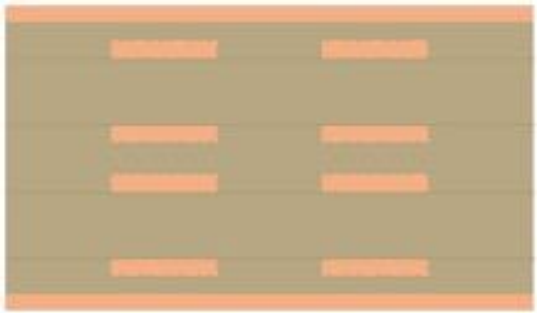
h. Roughened copper

Laminate, prepreg, and outer copper layers are stacked up for lamination



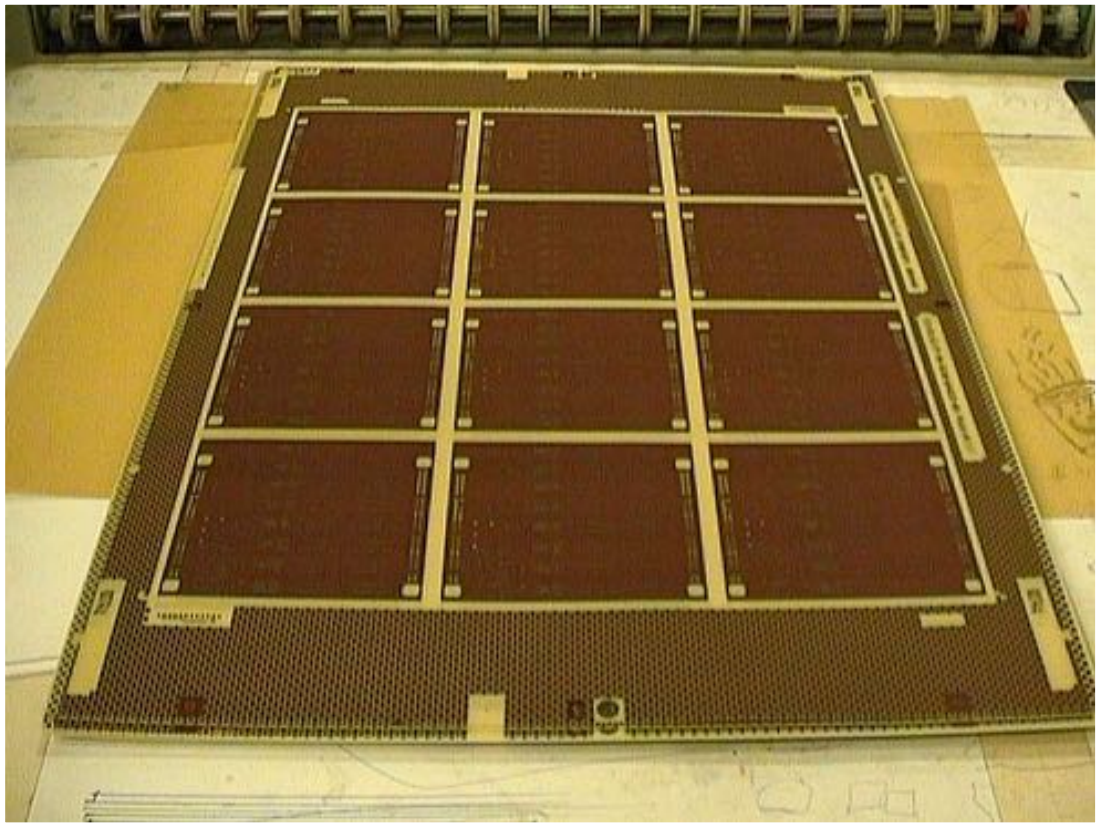
i. Materials stacked up

Final result (often referred to as a sub or panel)

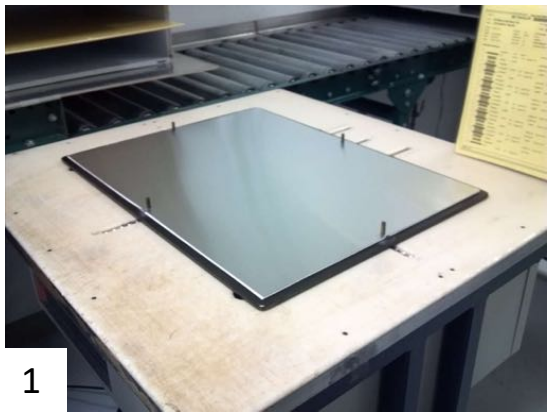


j. Laminated stackup

Inner Layer Surface Oxide



Lamination Layup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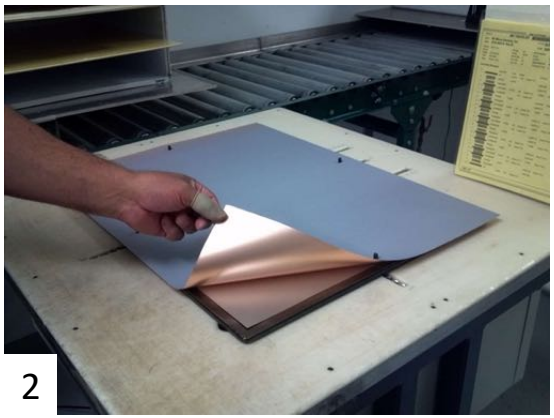
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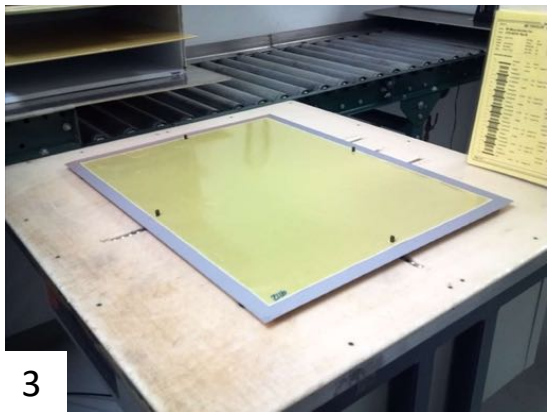
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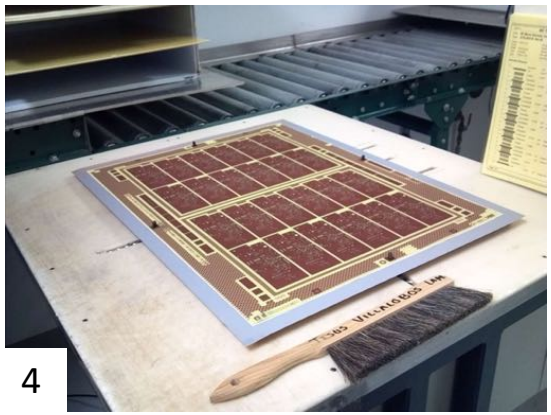
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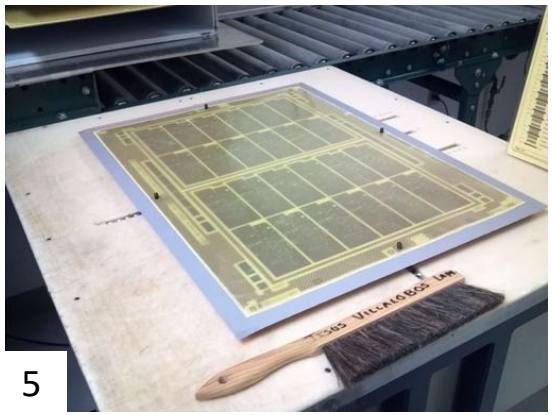
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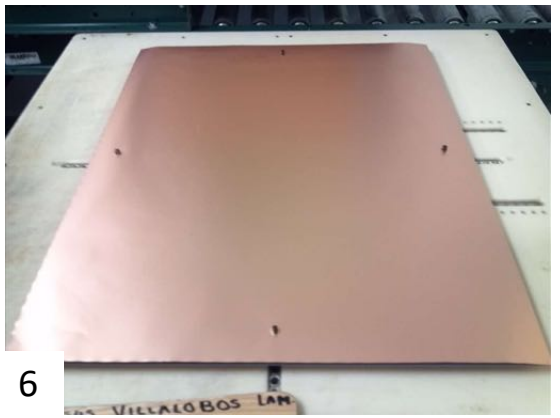
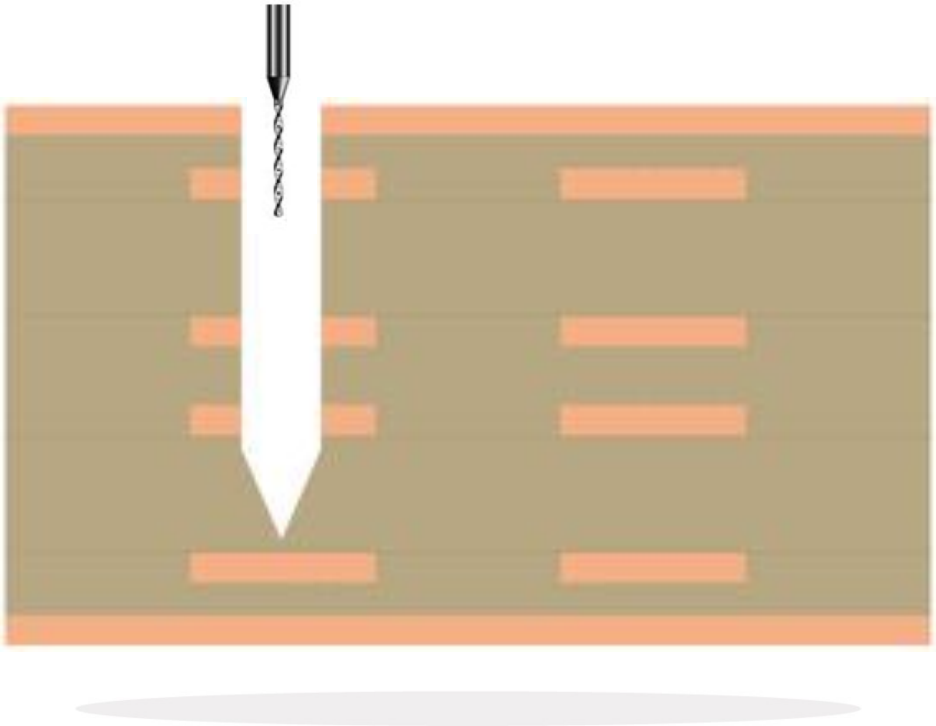

6

Lamination Press Machine

Step 6: Drill

- Prior to drilling, the panel is “flash routed” to remove resin squeeze-out from edges of panel
- An in-process coupon is “test” drilled and x-rayed to check registration prior to entire panel being drilled



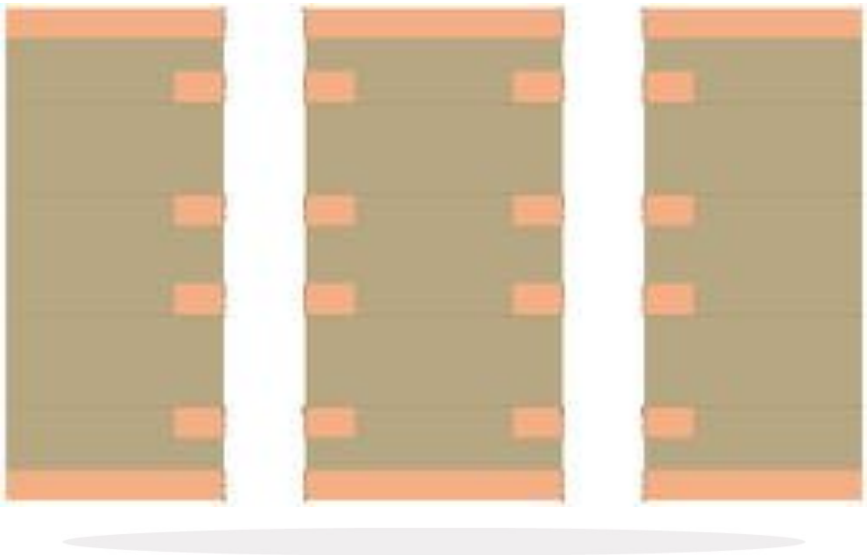
k. Drilling holes in laminated panel

Mechanical Drill

Mechanical Drill

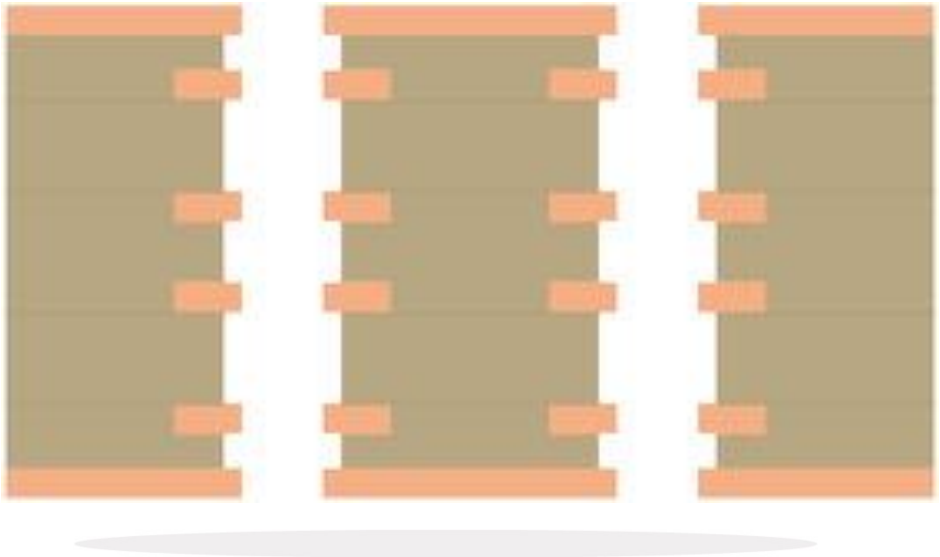
Step 7: Plasma, Desmear, Etchback

Drilled holes need to be prepared for electroless copper plating



l. Resin smear in holes after drill process

A series of steps is performed to desmear and etch back copper

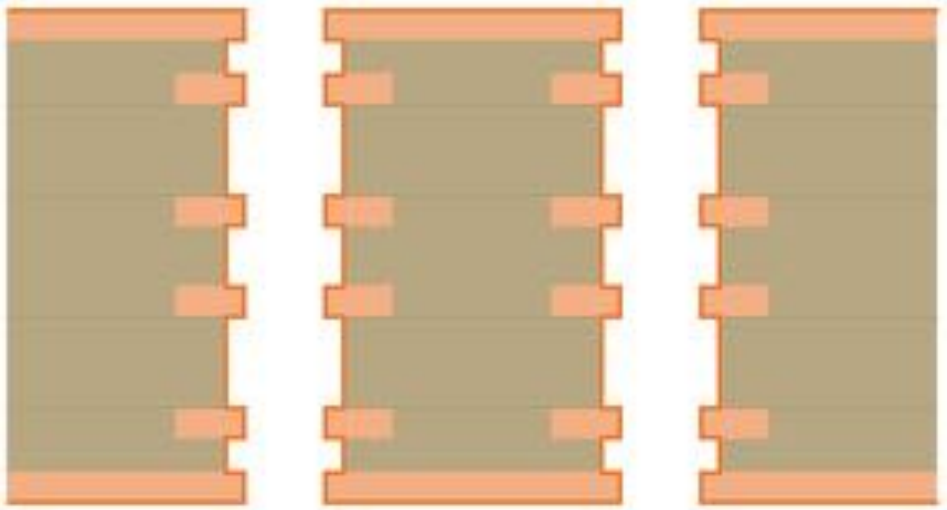


m. Cleaned and prepped holes, and etchback

Step 8: Electroless Copper Plate

- A conditioner charges side walls
- The palladium is attracted
- The reaction allows copper to start plating

Thin layer of electroless copper is chemically plated on non-conductive material

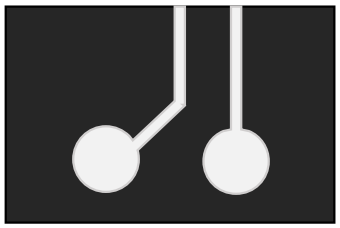


n. Electroless copper deposition

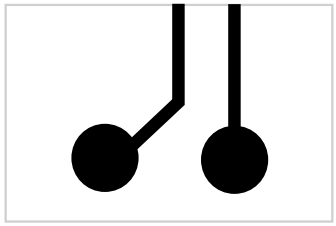
Hole Cleaning and Electroless Line

Step 9: Outer Layer Image & Develop

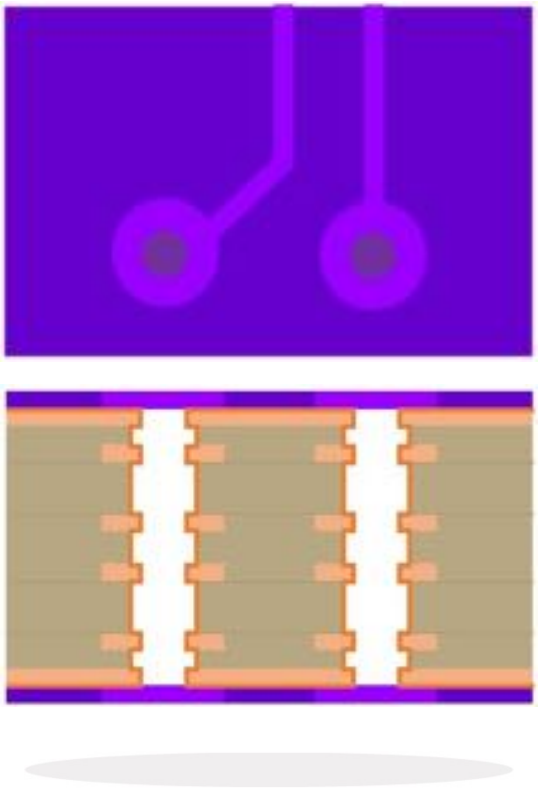
- Same process as inner layers, except the reverse image is polymerized now
- Panel is coated with photoresist and outer layer image is transferred by LDI
- Resist dissolves over pattern to be plated



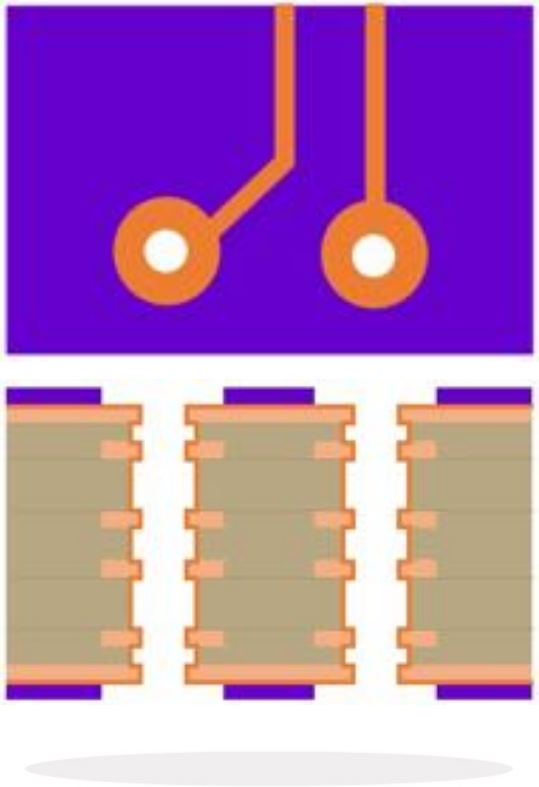
Inner layer image (negative)



Outer layer image (positive)

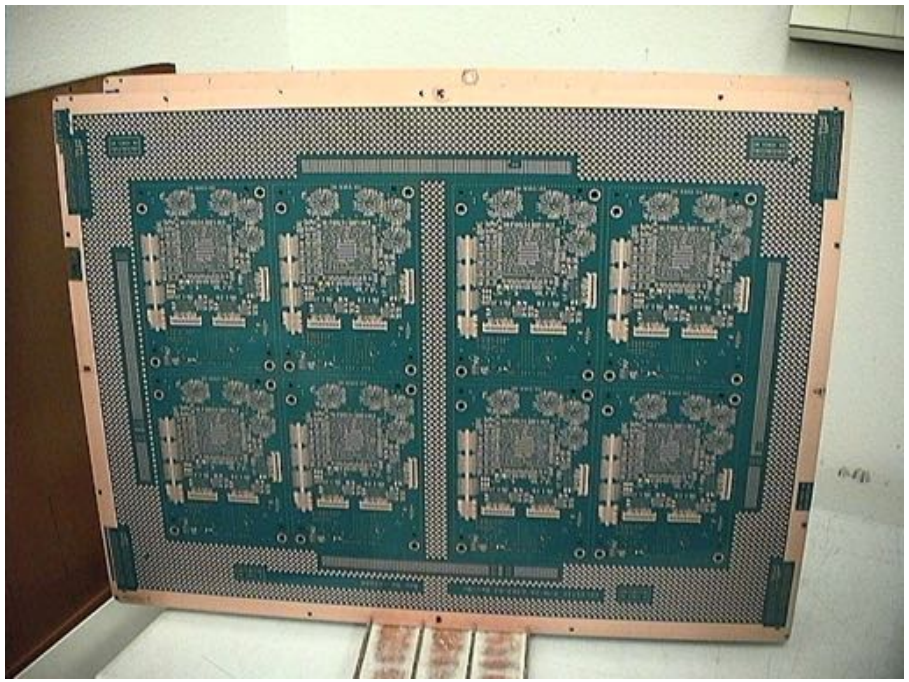


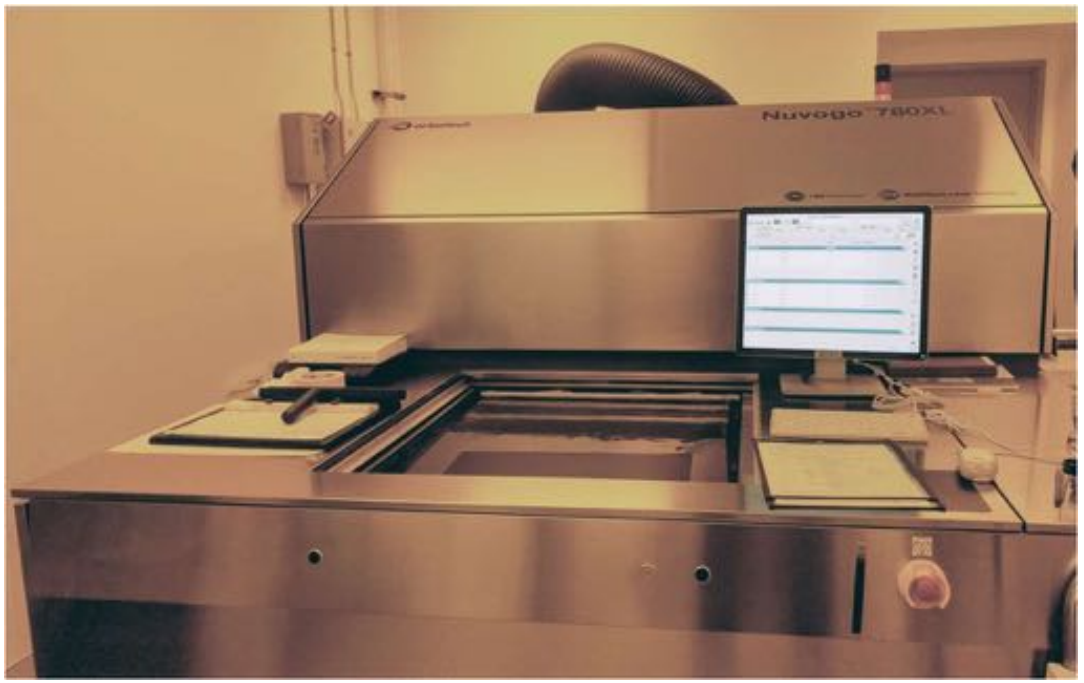
o. Panel coated in photoresist



p. Outer layer image transferred

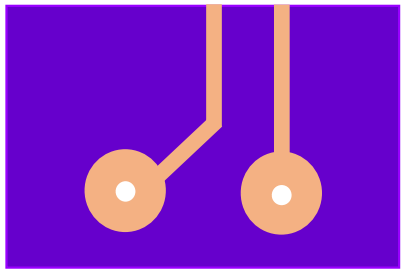
Outer Layer Image



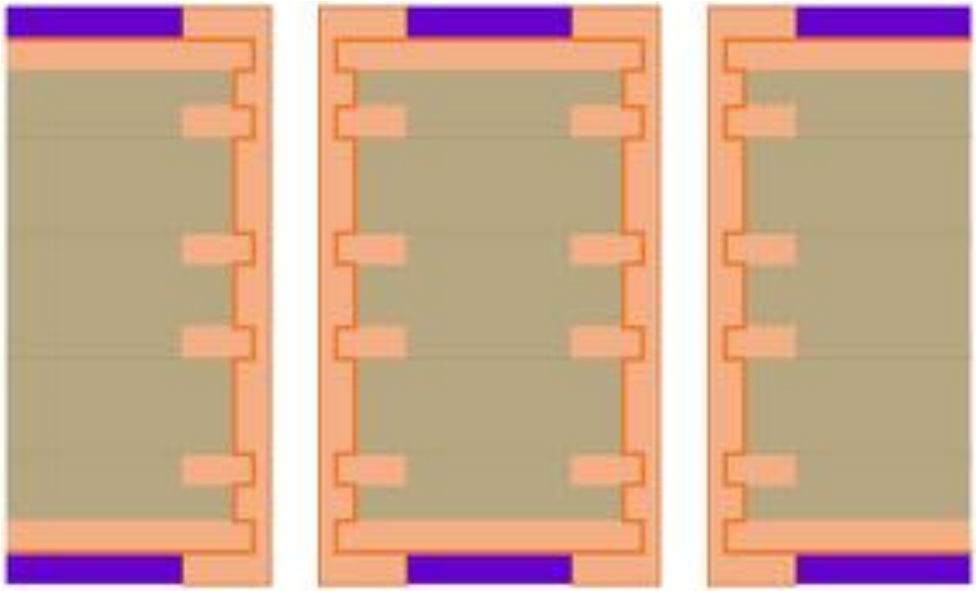


Step 10: Electrolytic Copper Plate

- Electricity can now be used to plate surfaces made conductive from the electroless plating step



Copper is electrically plated until hole wall thickness requirements are met



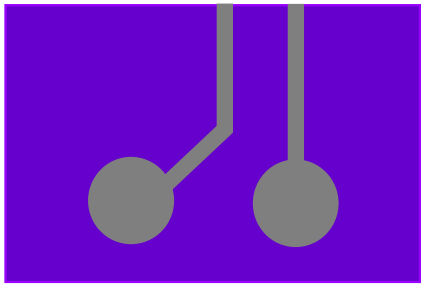
q. Resist-free area is plated with electrolytic copper

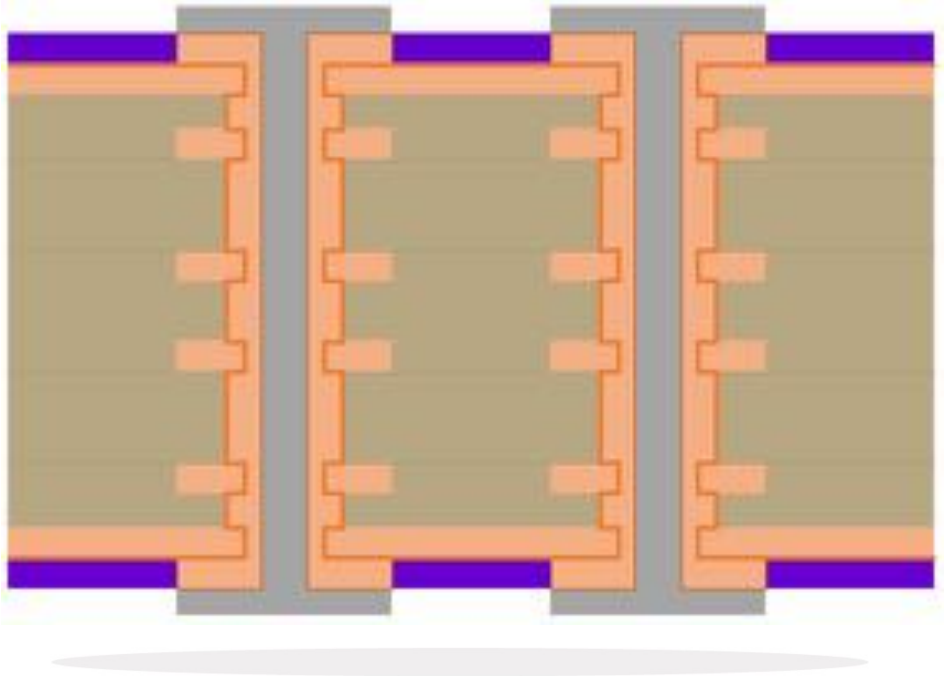
Electrolytic Plating Line

Step 11: Electrolytic Tin Plate

- Similar to photoresist, the plated tin protects the copper and can withstand the resist strip chemicals

Tin is plated over exposed copper and acts as a resist for the next process

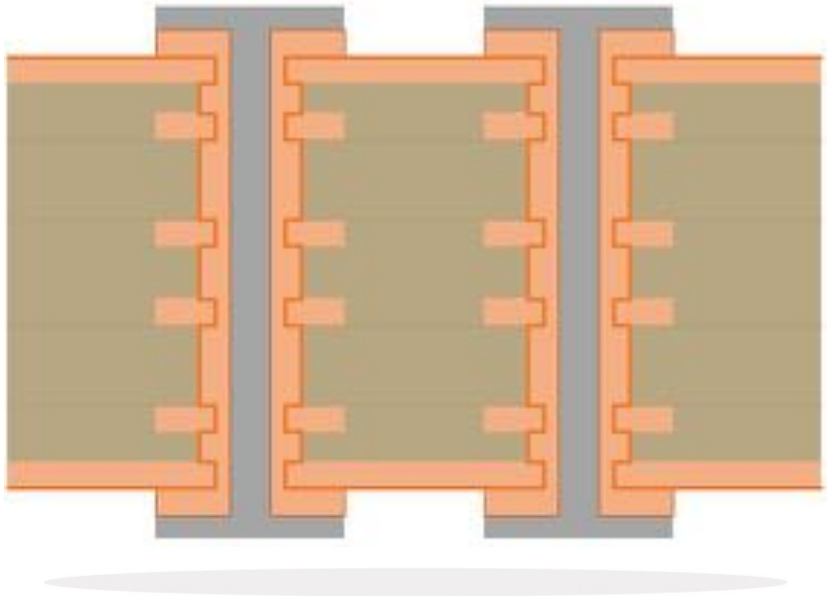




r. Tin “resist” plating

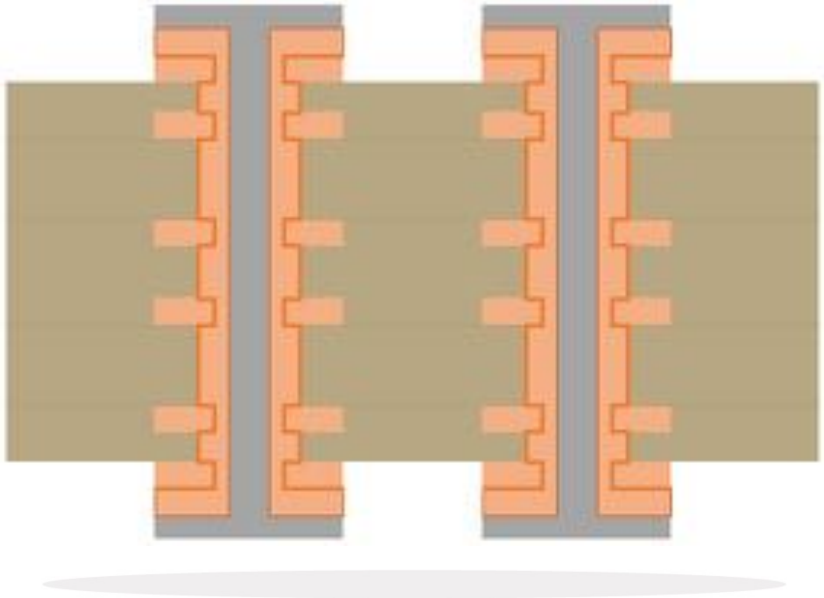
Step 12: Outer Layer Strip & Etch

The photoresist is stripped away, and remaining copper is exposed



s. Stripped resist

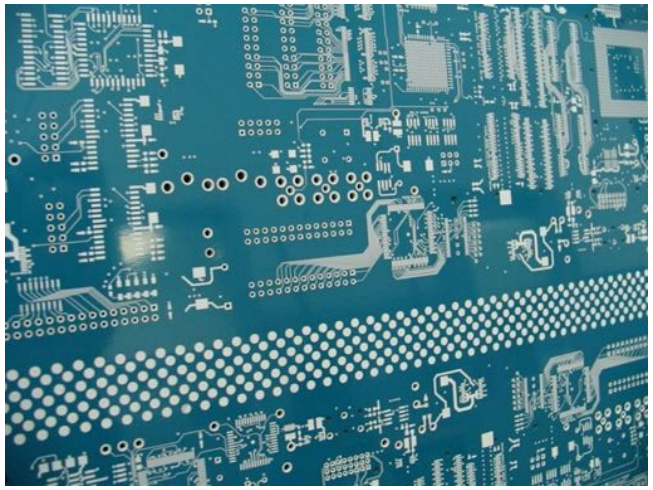
Remaining exposed copper is etched away down to substrate



t. Etched copper

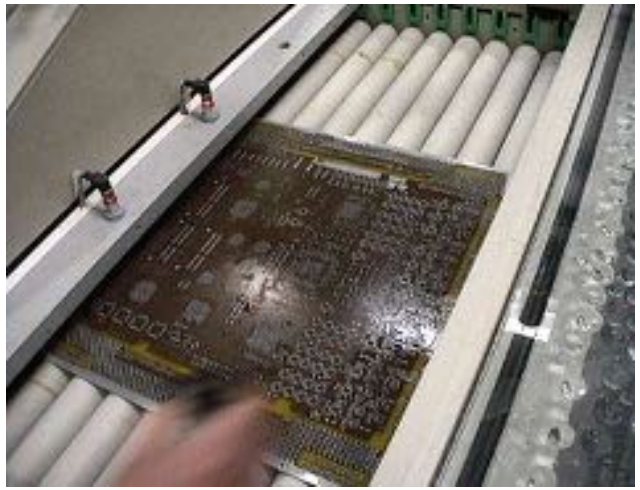
Tin Plate, Strip, and Etch

Tin plate with resist



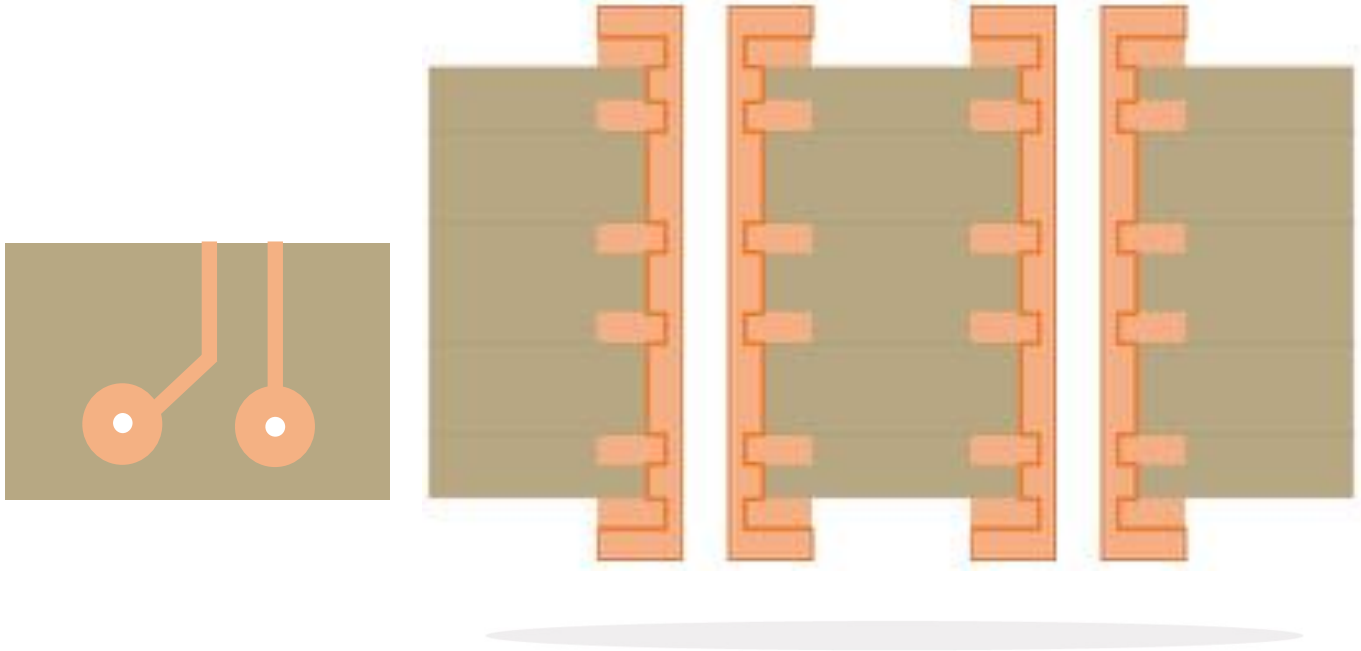
Resist stripped

Etched copper



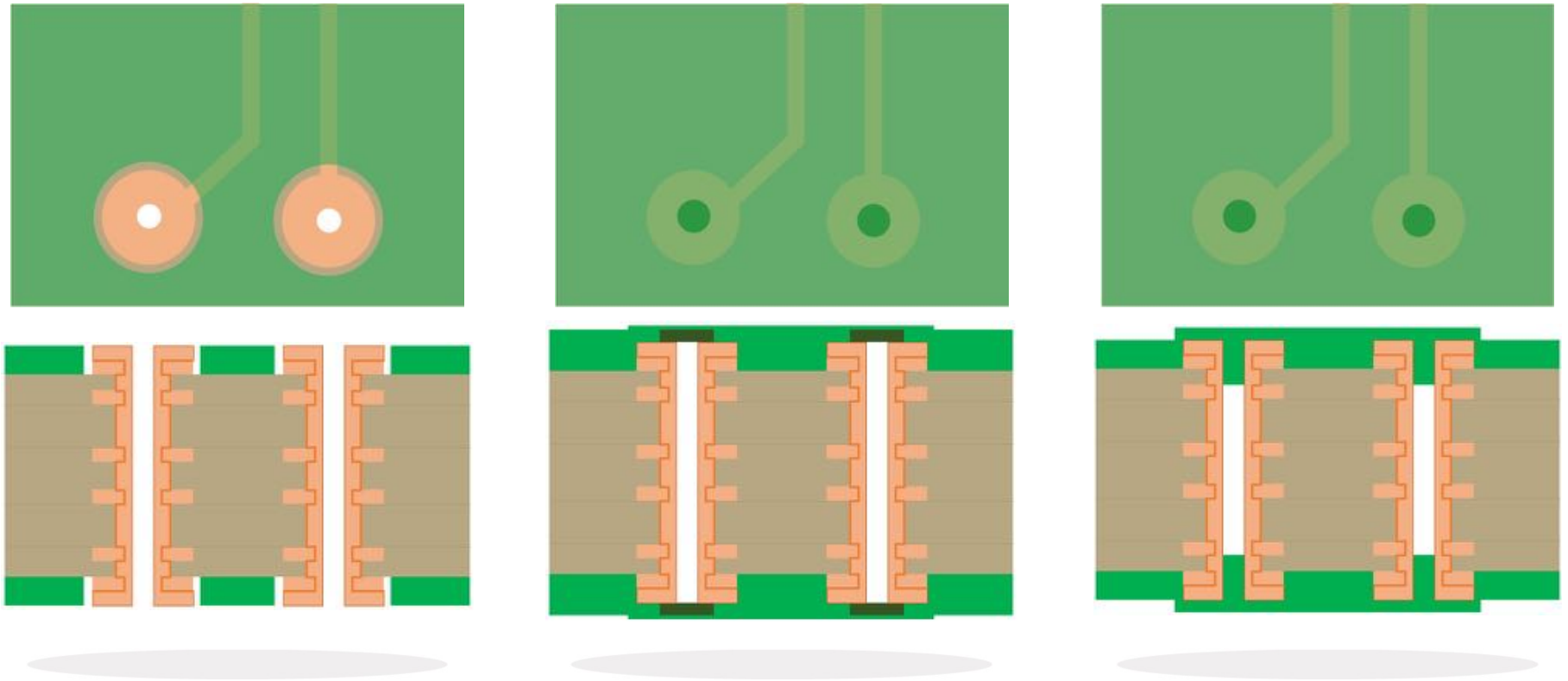
Step 13: Strip Tin Plating

Tin “resist” is stripped from panel, revealing final circuit pattern



u. Final step of outer layer image transfer

Step 14: Solder Mask



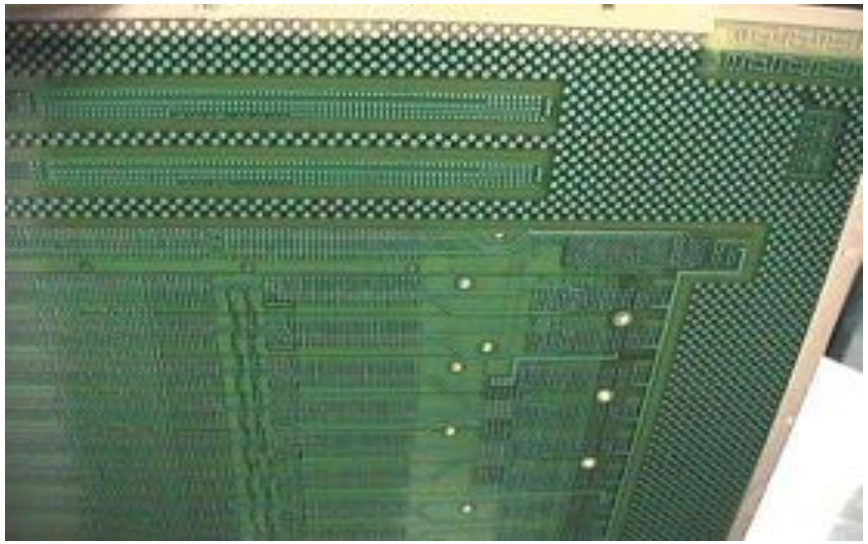
a. Solder mask

b. Solder mask with dry film tent

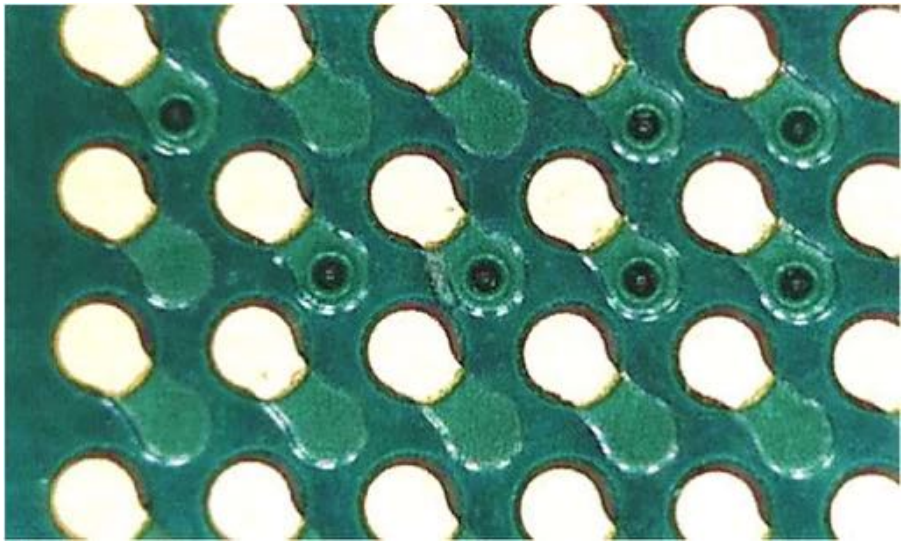
c. Solder mask plugging

Solder Mask

Panel coated with solder mask



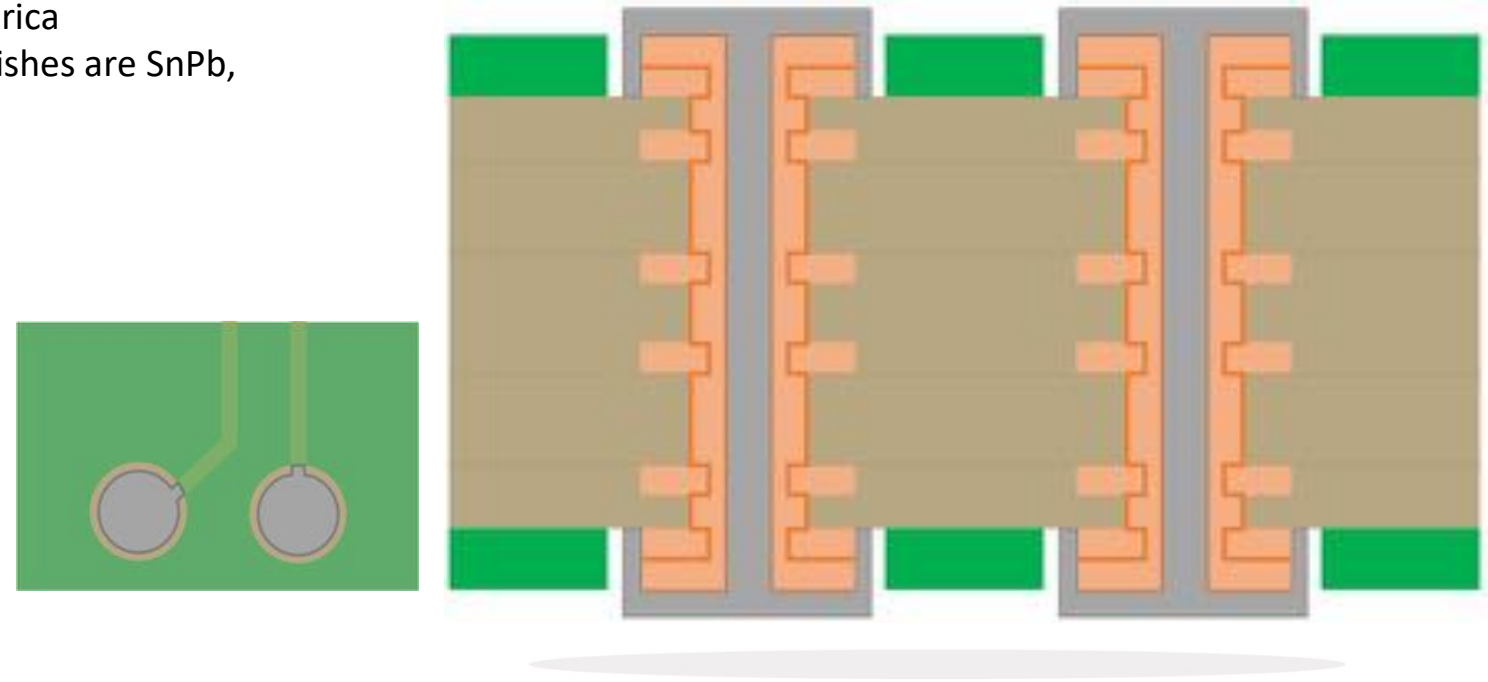
Close-up of exposed copper and covered vias



Step 15: Electrolytic Final Finish Plate

- Electroless Nickel, Immersion Gold (ENIG) is the most used final finish used in North America
- Other common finishes are SnPb, HASL, ENEPIG, etc.

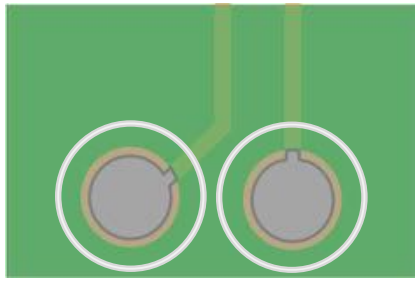
Final finish is applied to exposed copper to protect it from corrosion



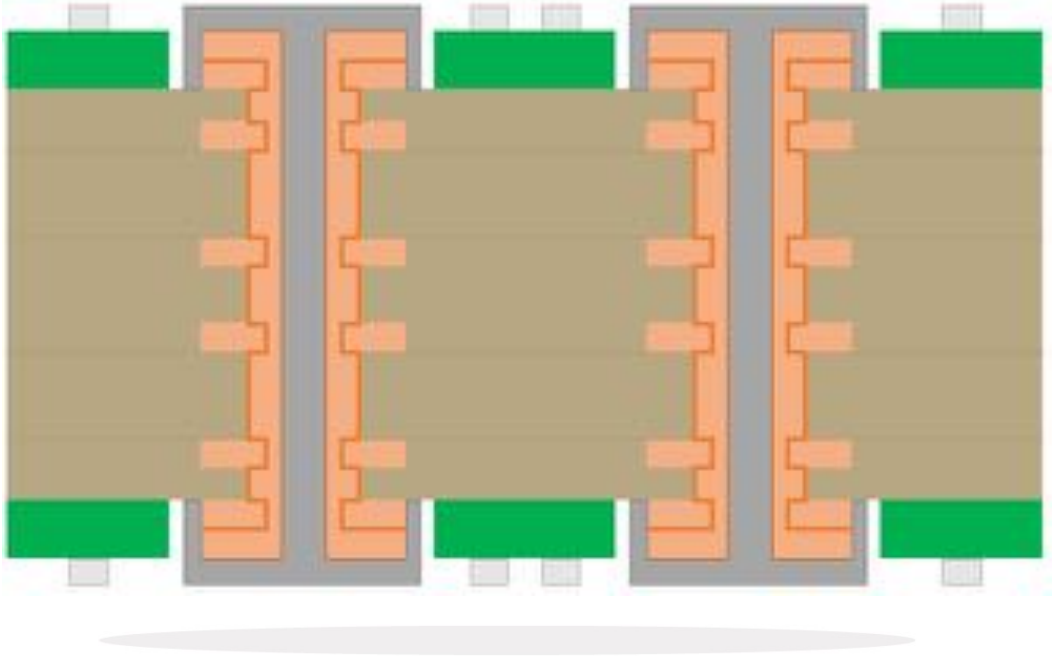
a. Final finish applied to exposed copper

Step 16: Ink Legend

- The ink legend is often referred to as “silk screen” which is a term that originated from the prior way of “screening” legend onto boards



Legend is ink-jet printed over solder mask

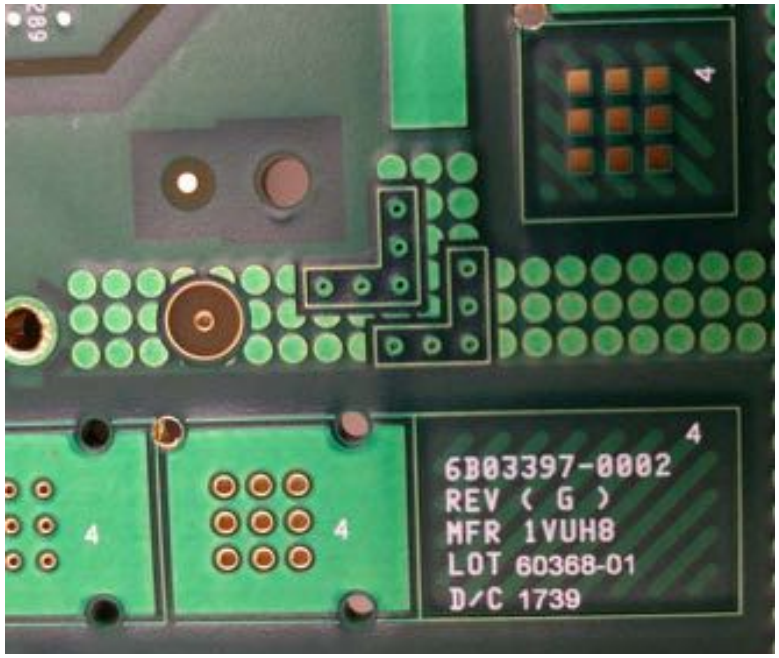


a. Ink legend applied over solder mask

Ink Legend Equipment

Ink Jet Printer

Legend

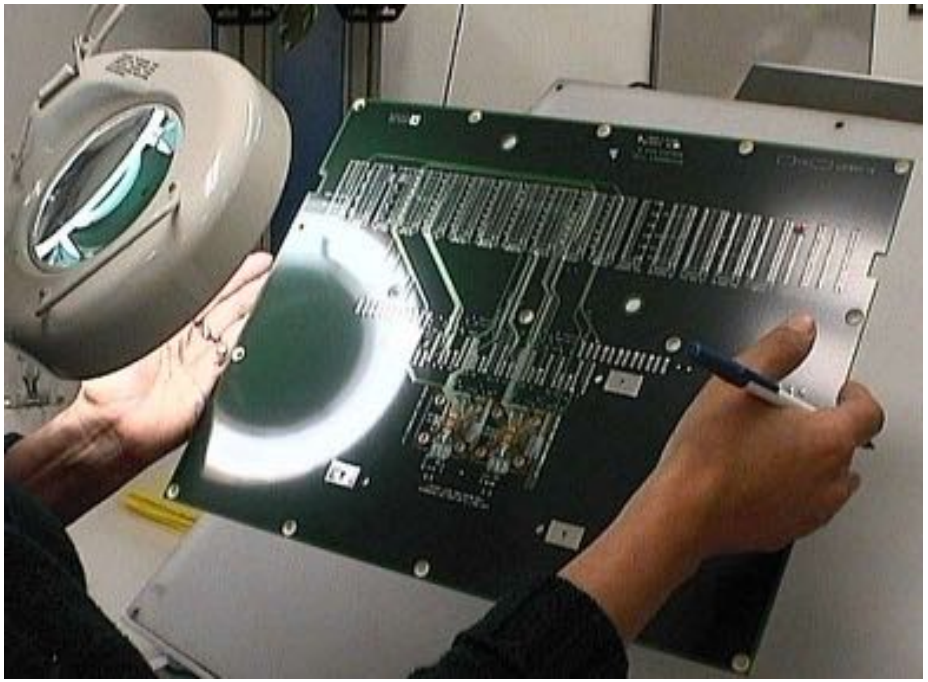


Step 17: Electrical Test

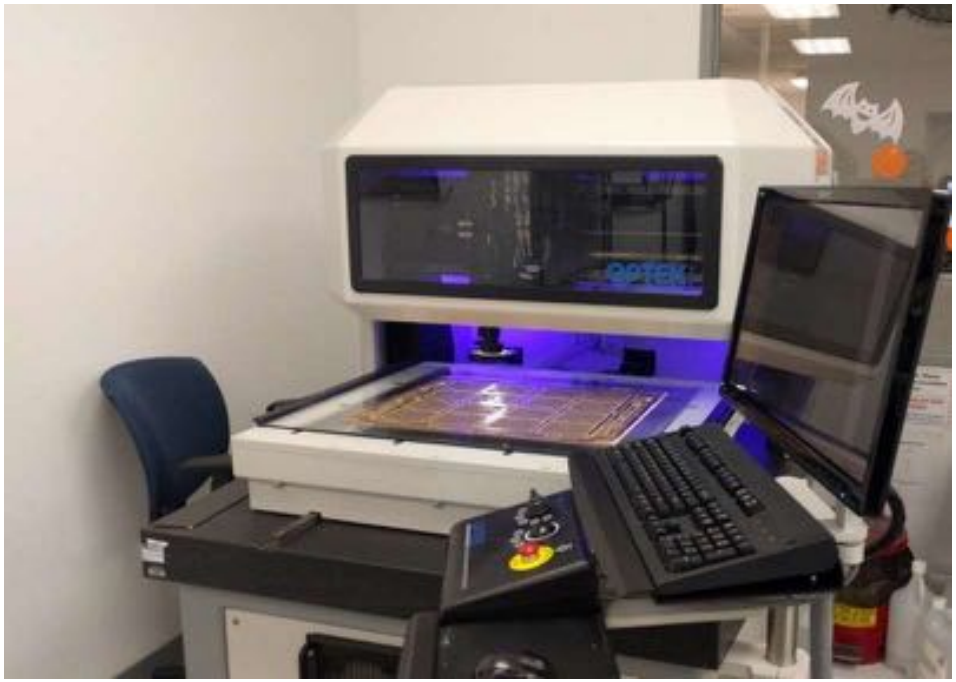
Step 18: Route Boards & Coupons

Step 19: Final Inspection

Final Inspection

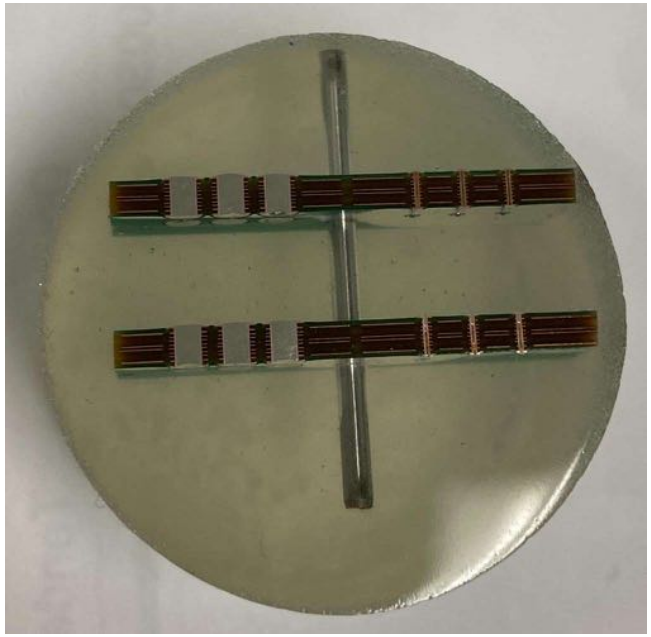


Coordinate Measuring Machine (CMM)

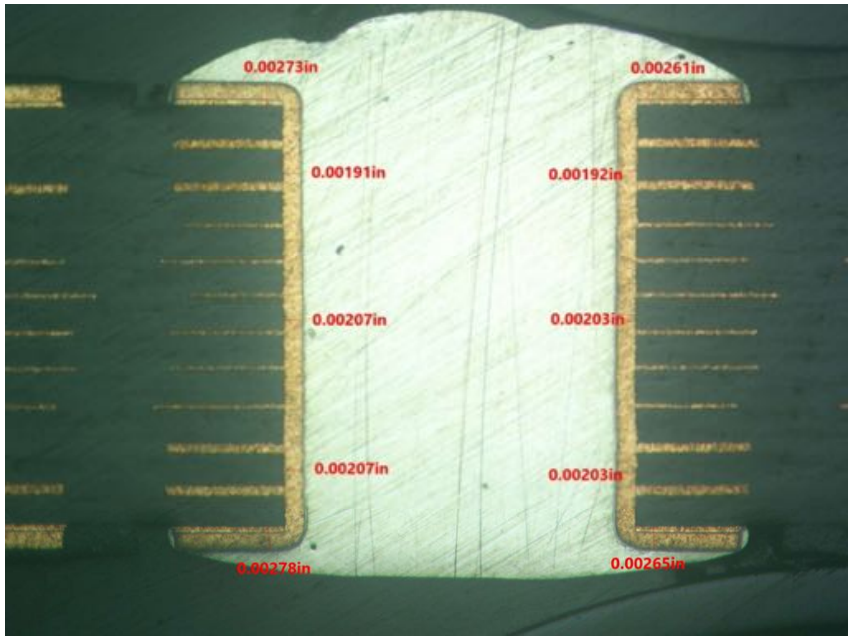


Step 20: Coupon Microsection & Analysis

Coupon Puck



Cross-section of coupon



SUMMIT INTERCONNECT

INSULECTRO

Questions?