

Continuing..

****PRINTED WIRING BOARD
TECHNOLOGIES****

MECHANICAL DRILLING OF HOLES FOR PWBs

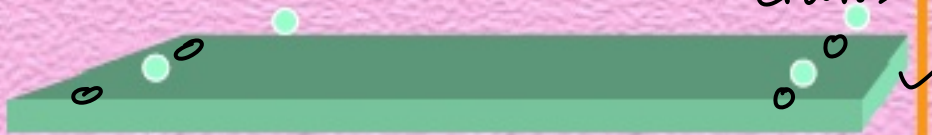
Why holes ?

4 MLB

Registration during PWB manufacture



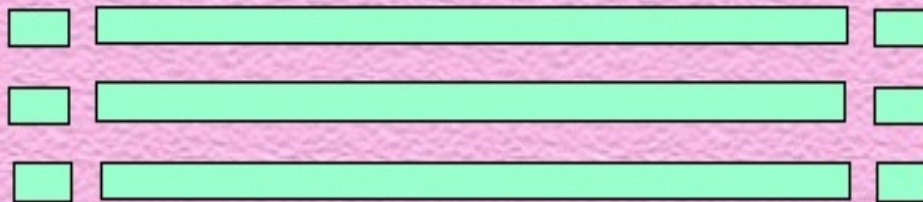
Mounting Holes for assembled PCBs



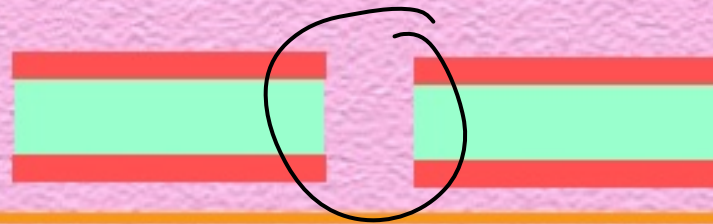
charis

3-4 PCBs stack

Stacking holes during drilling



Plated through holes to electrically connect different layers



Double Sided Plated Through Hole Printed Wiring Board

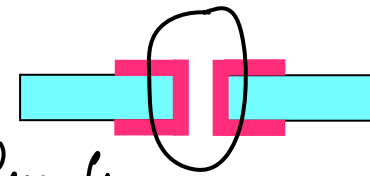
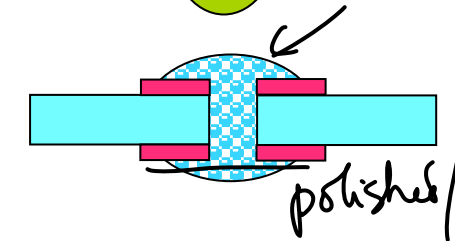
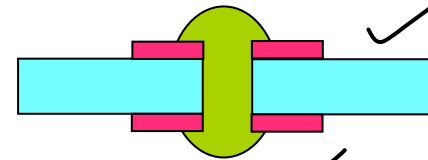
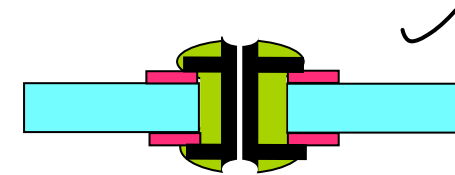
Interlayer connection..

Riveting Technology

Filling with solder

Filling with conducting
polymer paste

Metal deposition on
the hole wall- 1964 – Shipley



electroless Cu

Double sided board manufacture

- Design
- Photo-tooling (1:1)
- Drill holes (PTH)
- Plate (electroless)
- Image circuit
- Plate (Cu electroplate)
- Plate (Sn or Sn-Pb electroplate)
 - Strip
- Etch
 - Strip and Protect before assembly

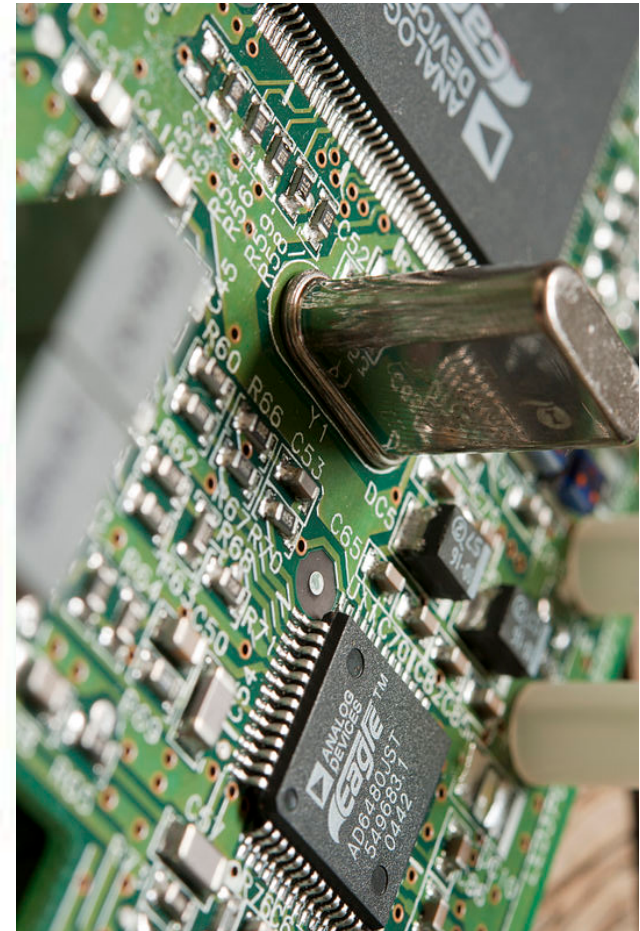


Fig. source: Wikimedia Commons 2011

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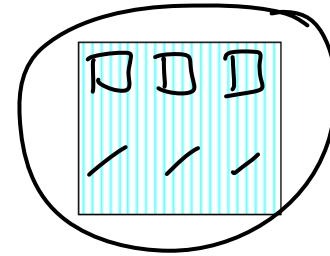
Step to Step description of DS PTH Board making

The laminate comes in 1150 mm x 980 mm size

Step 1 Panel cutting - Shearing/Circular Saw

Every PWB manufacturer will have a **fixed panel size** which is processed...individual boards are not processed..!

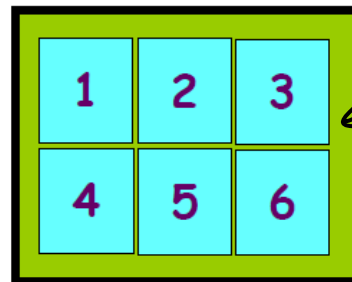
Design has to fit into some **COMMON** panel sizes: 600×600 mm, 450×600 mm, 450×450 mm, 450×300 mm or 300×300 mm



A Panel can carry one or more circuits

15 mm border allowance is preferred

Six smaller circuits are **STEP-REPEATED** in a given Panel Size



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Step 2 Insertion of Holes

Why holes are required?

- a. Component mounting [Through and through/round]
- b. Interlayer connection hole [Through and blind - Round]
- c. Stack Location holes [Through and through]
- d. Registration hole [MLB/Round/Oval]

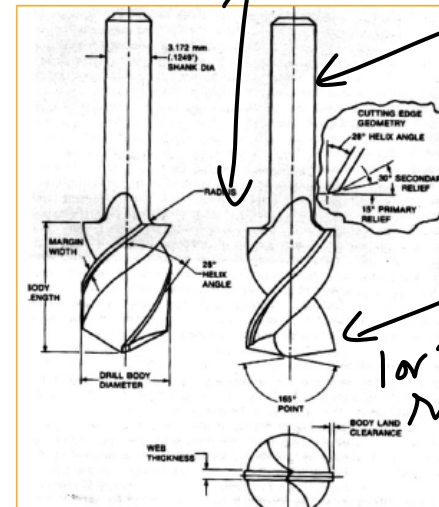
How to make holes? *automate*

Drill Bit Material?

✓ Solid Tungsten Carbide (Co inclusions)
Iso-statically Pressed

CNC Drilling machines 30-40 lakhs
multi-spindle m/c 1.5 Cr

Drill Geometry?

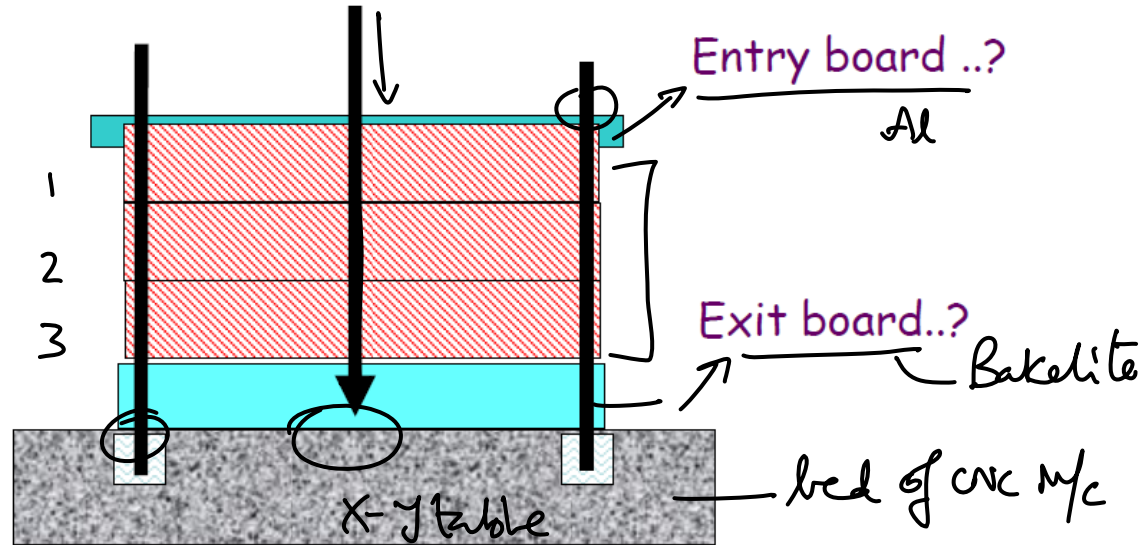


1 or 2 times resharpen

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Step 3 Stacking for Drilling

Stack of three laminates



Drilling machine table

To increase productivity

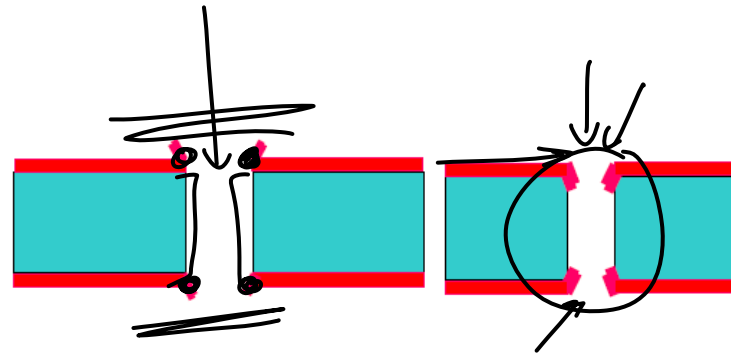
Manual Drilling machine for PWB application

CNC Drilling for PWBs

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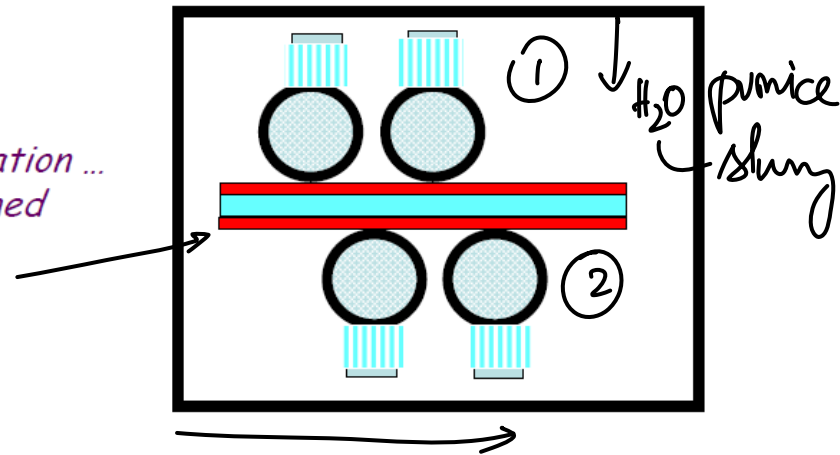
Step 4 Deburring

Entry and exit burrs



Burrs are to be removed.....they cause plating problems

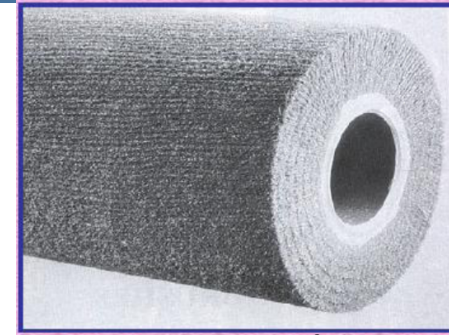
*This is called as "deburring" operation ...
...note that Cu surface is not touched*



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Step 5 Brushing

Cleaning and roughening of Copper surface
Expected increase in surface area - 2 to 4 times

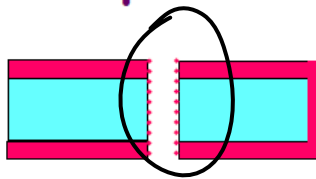


Machine brushing gives best results

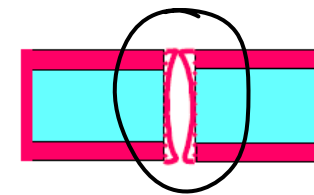
parallel axis is important

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Step 6 Hole cleaning & Rinse



Hole walls carry a lot of loose dust particles... bad base for copper plating



Cleaned by Slurry blast or Ultrasonic cleaning

Reduced diameter of hole after plating

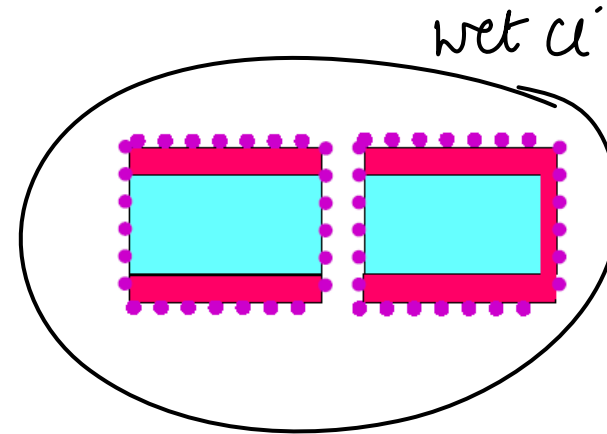
→ epoxy smear
glass fibre

0.6mm → 0.5mm

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Step 7 Sensitizing

preparing for electroless copper
dip in 30% HCl - halide rich surface.....

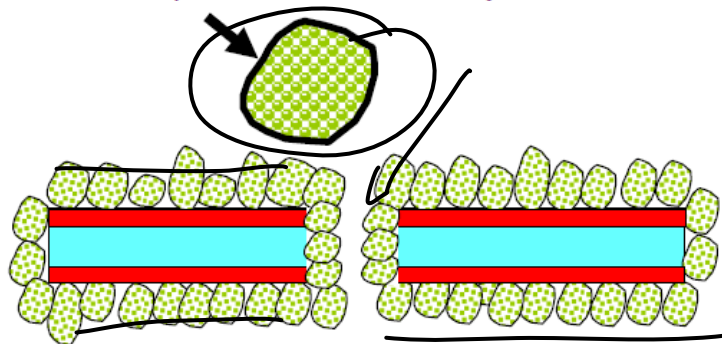


- Microetch using $(\text{NH}_4)_2\text{S}_2\text{O}_8$
- Swell / Etch using alkaline KMnO_4

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Step 8 Pre-Activation

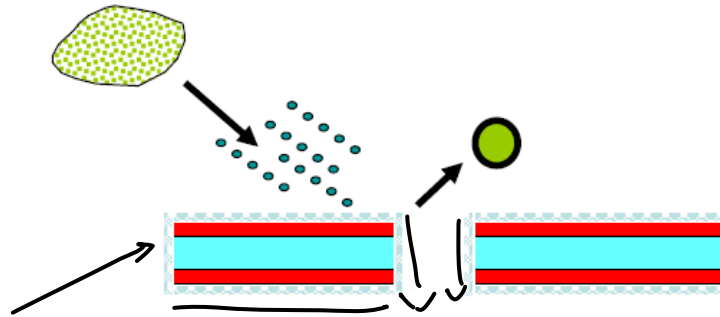
Dip in a colloid solution of palladium
Adsorption of "embryo" containing colloidal palladium



Agglomerates of palladium
atoms encapsulated in
alfa-stannic acid as
carrier is adsorbed on the
surface

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Step 9- Activation/ Accelerator



Breaking of the "embryo" and spilling of palladium atoms

palladium atom/catalyst

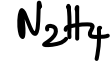
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Step 10 - Cascade Rinse

Step 11- Electroless copper plating



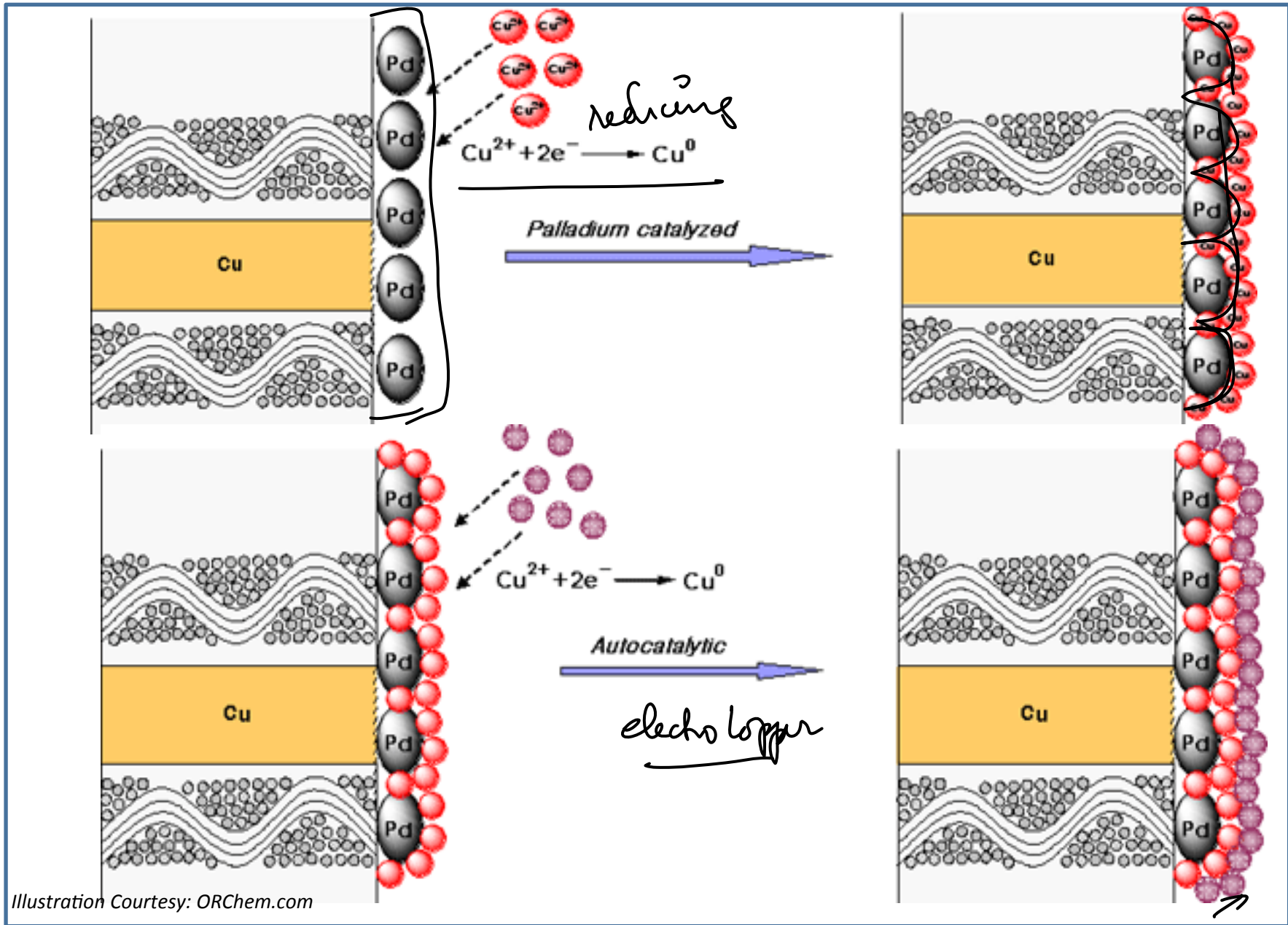
Palladium atoms "catalyze" copper reduction from a solution containing copper ions... Cu²⁺ ion source and reducing agent..



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Each "nascent" copper atom formed in itself acts like catalyst and the reaction continues; hence also known as "auto-catalytic" deposition

PTH process ends here

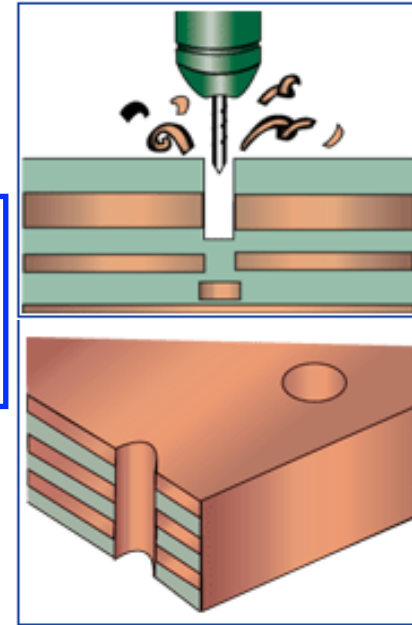


Electroless Copper Plating-Rate of deposition

Low build electroless copper gives 1 micron/hour
Medium build electroless copper gives 3 microns/hour
High build electroless copper gives 6 microns/hour

Electroless Copper thickness is not adequate for “reliability” of the plated barrel.....

A minimum of 12-15 microns copper thickness is necessary



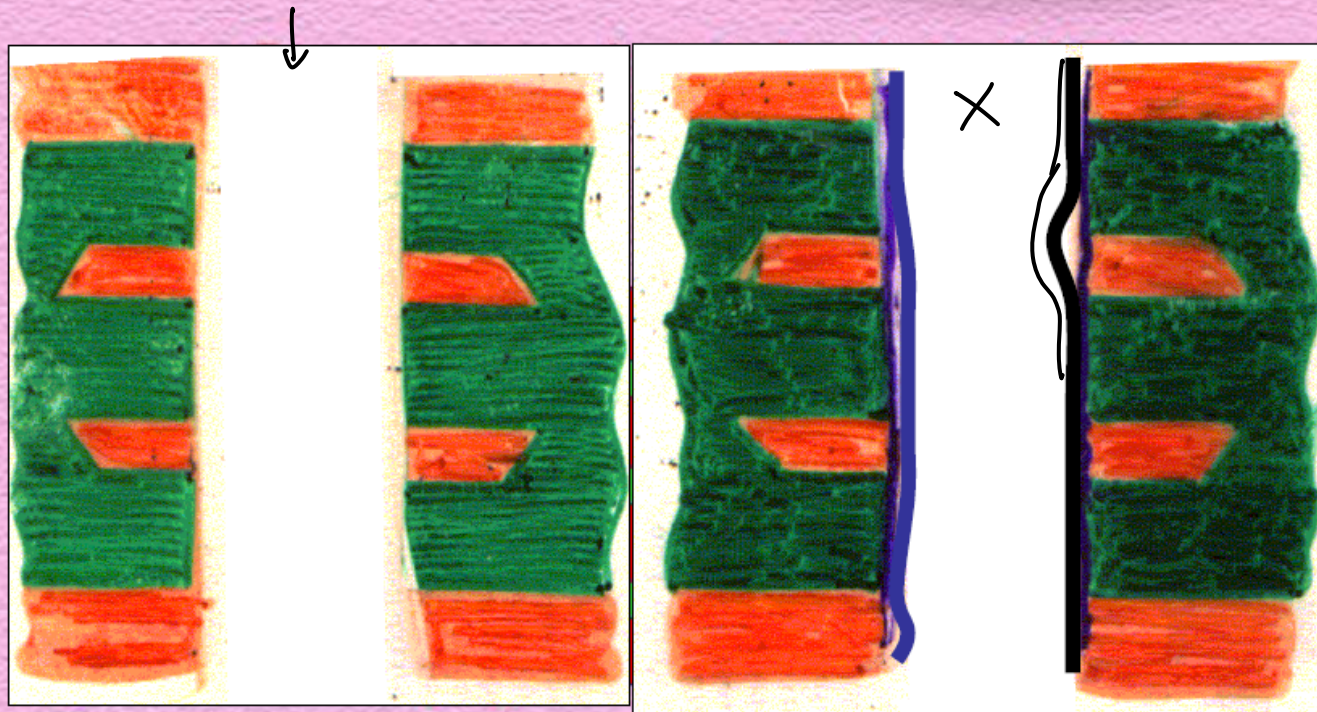
Additional copper thickness is added through Electroplating

Two routes are possible in electroplating

- panel plating method - medium dense boards
- pattern plating method - high dense boards

De-smearing for PTH

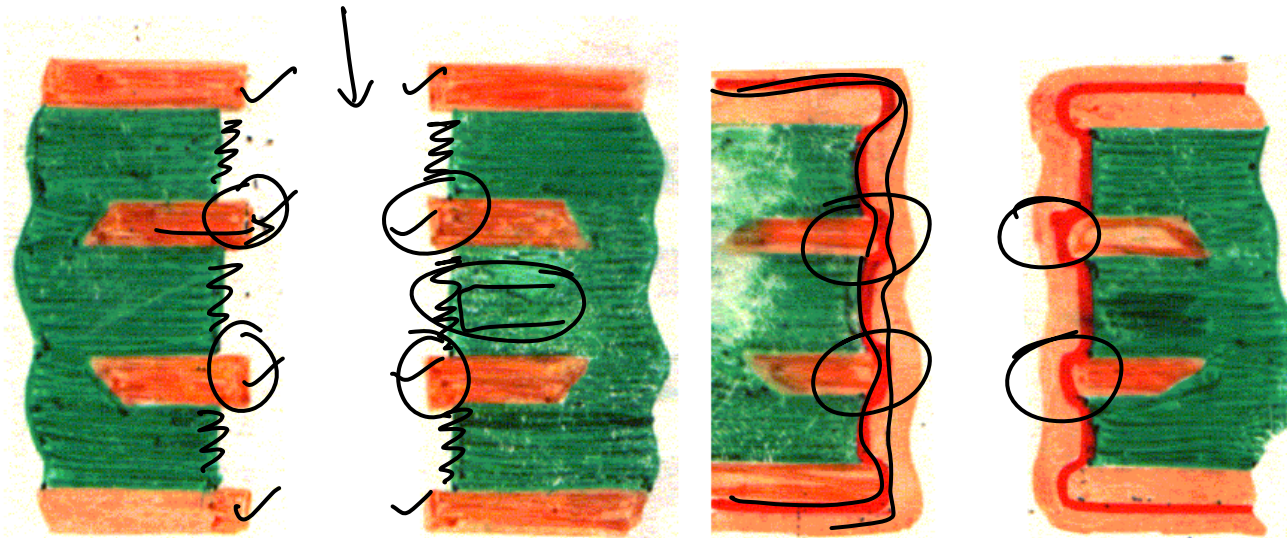
What is drill SMEAR...?



During drilling, drill bits become heated resulting in the melting and smearing of the epoxy-resin base material across the inner-layer copper surfaces within the hole barrel to which subsequent through-hole plating must connect. If not corrected the smear would constitute a dielectric layer between the inner-layer copper surfaces and the plated copper, and the circuit would be defective.

Etch-back

Exposing COPPER ENDS for better bonding



During etchback, in addition to smear removal, the glass fibers themselves are etched back from the hole wall. The goal is to remove about 0.25 mil from the top and bottom of the innerlayer copper so that it will protrude out from the hole wall. This creates three surfaces (also known as a three-point connection) for the copper to bond to during the making holes conductive step. Glass etchants include hydrochloric acid, ammonium bifluoride, and hydrofluoric acid (rarely used). Etchback with plasma can be achieved by varying the type and amount of reactive gases. KMnO_4 is also used.

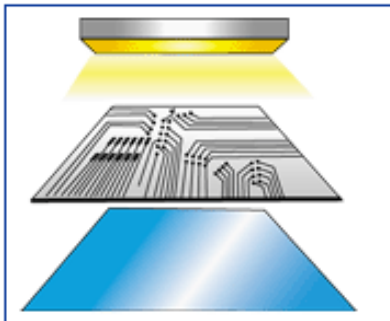
Panel Plating ✓

Cut Laminate ✓
Drill the holes ✓
PTH Plating-Electroless ✓

⊗ Cu Electroplate the Panel

IMAGE DRY film - Tent the PTH Holes

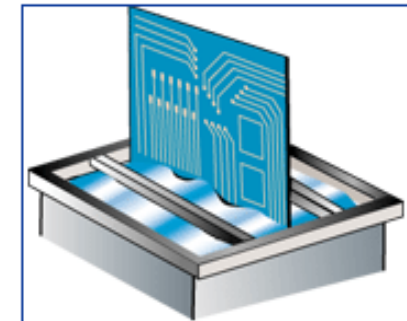
- ✓ Plate TIN AS ETCH Resist
- ✓ ETCH-ALKALINE NH_3
- ✓ Strip Dry film
- ✓ POST Operations



Pattern Plating ✓

Cut Laminate ✓
Drill the holes ✓
PTH Plating-Electroless ✓
IMAGE DRY FILM -NO TENTING ✓

Cu Electroplate the PATTERN ✓
Sn Electroplate- AS ETCH ✓
Resist ✓
ETCH-Alkaline NH_3 ✓
Strip Dry film ✓
POST Operations ✓



Bare board is complete

Image Transfer

1

Video highlights-PTH process sequence- complete steps



PTH Electroless Copper Plating

2

Video highlights-PTH process sequence- complete steps