Continuing..

PRINTED WIRING BOARD TECHNOLOGIES

Manufacture of RIGID Laminate

Simple Multilayer Press

epoxy resin

- Formulate resin mix + solvents
- Select glass cloth (filler)
- Coat glass cloth with resin
- Remove solvents by drying → *Prepreg* / *B-stage resin*
- Lay copper foil on "prepreg" sheet 35μ Cu
- Press together at 400-700 psi pressure and 180 C
- Slowly cool and cut to size

organic; (1 or 2)

CCL
- Cu
- Resin
- Filler

(epoxy)

Fig. source: unknown

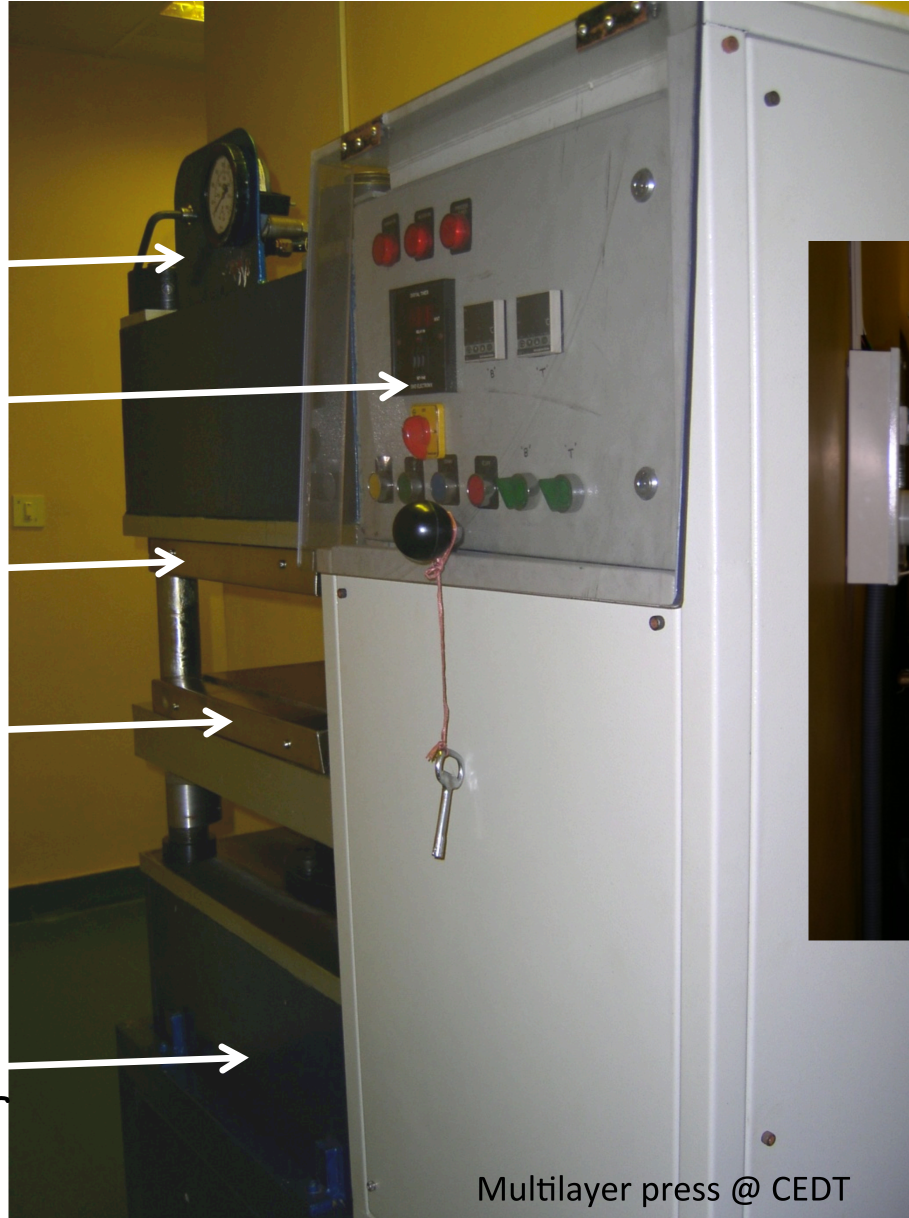
Pressure Gauge

Settings panel

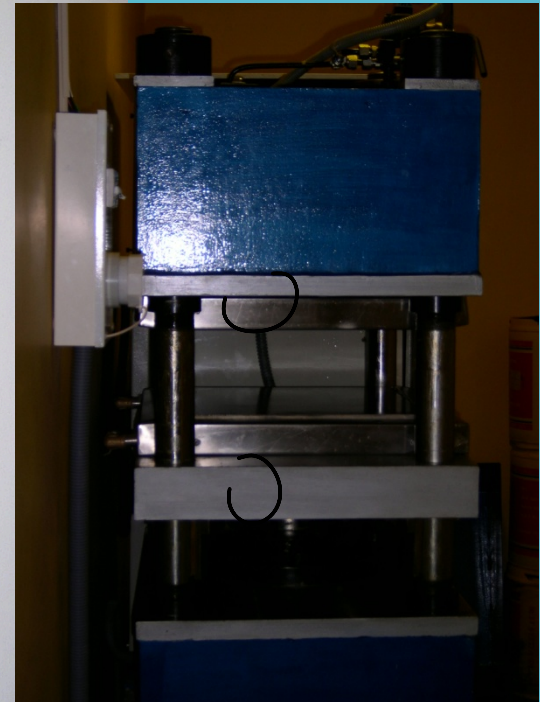
SS Plate Top

SS Plate Bottom

Oil cooling



Multilayer press @ CEDT



" Book "

Laminates Qualification

IPC :Institute of interconnecting and Packaging of Electronic Circuits
DoD: Department of Defense for Military Standard Specifications [MIL]
NEMA: National Engineering Manufacturers Association
UL: Underwriters laboratory

IPC Laminate Specifications

IPC-L-108A/B	Thin Laminates
IPC-L-109A/B	Glass cloth for laminates
IPC-L-115A/B	Rigid Laminates
IPC-L-125	Laminates for high frequency

MIL- Laminate Specifications

MIL - S - 13949

NEMA Laminate Specifications

NEMA- L1- 1- 1989

NEMA Grades

Grade	Description
FR-1	Phenolic-heavy paper base
FR-2	Phenolic-low paper base
FR-3	Phenolic- paper base/flame retardant
FR-4	Epoxy-glass base/flame retardant
FR-5	Epoxy-glass base
FR-6	Polyester-glass base
CEM-1	Epoxy-woven glass + paper
CEM-2	Polyester-woven glass + paper
CEM-3	Epoxy-non-woven glass + paper
CEM-4	Polyester-non-woven glass +paper

MIL Grades

Grade	Description
GB	Poly-functional Epoxy-woven glass
GC	Cyanate ester-woven glass
GE	Epoxy - woven glass
GF	Difunctional Epoxy-woven glass-flame retardant
GH	Polyfunctional Epoxy-woven glass-high temp
GI	Polyimide-woven glass
QI	Polyimide - woven quartz
GR	
GP	Teflon- non woven glass
GT	
GX	
GY	Teflon - woven glass

Composite epoxy material: CEM

Rigid Laminates

- Core Laminate thicknesses:
- 0.8mm; 1.6mm; 3.2mm
- Copper thicknesses:
- 8micron; 18um; 35um

Type	Weight [g/ m²]	Thickness [mm]
106	25	0.050
1080	49	0.065
2112	70	0.090
2113	83	0.100
2125	88	0.100
2116	108	0.115
7628	200	0.190

- Different grades of prepreg:
- e.g. 7628 (200g/sqm) is 0.19mm thick
- 8 layers of such are used for a 1.6mm FR4 type laminate
- Another e.g. 2125 (88gms) is 0.10mm thick

MLB
0.8mm finished thickness 4 MLB
→ core 0.4mm
→ layers 0.4mm (prepreg Cu foils)

So, how is FR4 substrate dielectric prepared?
FR4 is a glass fiber epoxy laminate. It is the most commonly used PCB material. 0.8mm FR4 grade uses 4 layers of (7628) glass fiber material.

Isn't FR4 green in color?
No, it is usually transparent. The green color comes from the solder mask in the PCB finished product

Laminate Properties

Physical, Thermal, Electrical and Environmental requirements ← **for ALL materials**

Physical

1. Laminate integrity

- Laminate thickness
- Resin starvation
- Voids
- Foreign inclusion

2. Bow and Twist

Very important as it induces strain on Solder Joints

flat

no warpage

3. Flexural Strength

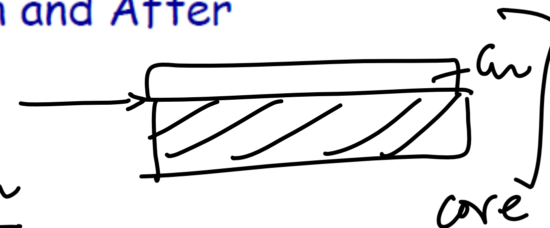
Ability not to FLEX under mechanical load

4. Peel Strength

As received After Solder float

After burn-in and After etching

delamination



Thermal

1. Glass Transition Temperature

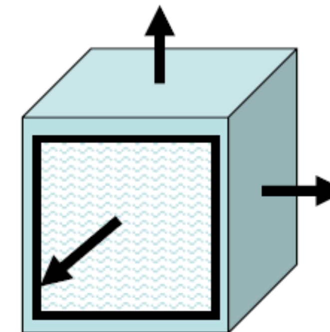
Temperature at which the polymer begins to soften…glassy state – denoted by Tg

Significant because the laminate see a series of "heat shocks" Soldering, Hot air leveling, Burn-in ,and repair

2. Coefficient of Thermal Expansion [ppm/°C] CTE

Materials expand on application of heat.
A composite material expands differently in different directions

Material	x-y axis	z axis
Epoxy-glass	15-18	45-60
Polyimide-glass 1	5-18	45-60
Epoxy-Aramid	6-8	95-110



Thermal – contd..

3. Thermal Conductivity

Generally, all Polymers are POOR conductors of heat
Reinforcements are used to improve the Thermal conductivity

4. Flammability

Should Extinguish within 50 seconds (FR4)

5. Water absorption

Surface should not absorb water. Diffusion of water will create problems electrically.

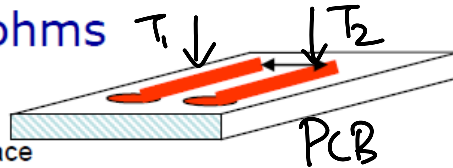
Electrical

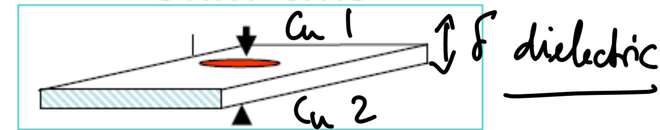
1. Insulation Resistance - Surface and Volume

Surface Insulation Resistance
Meg-ohms

Volume Insulation Resistance
Ohm-cms

Electrical resistance between two metal conductors on a substrate surface





2. Dielectric constant or permittivity

Electrostatic energy storage capability of the material

Influence the signal travel speed - propagation delay

Lower the "dielectric constant" lower will be the propagation delay

3. Dielectric strength or breakdown voltage

Disruptive Voltage in "kilo-volts" measured between two points inch apart

Summary- Laminates

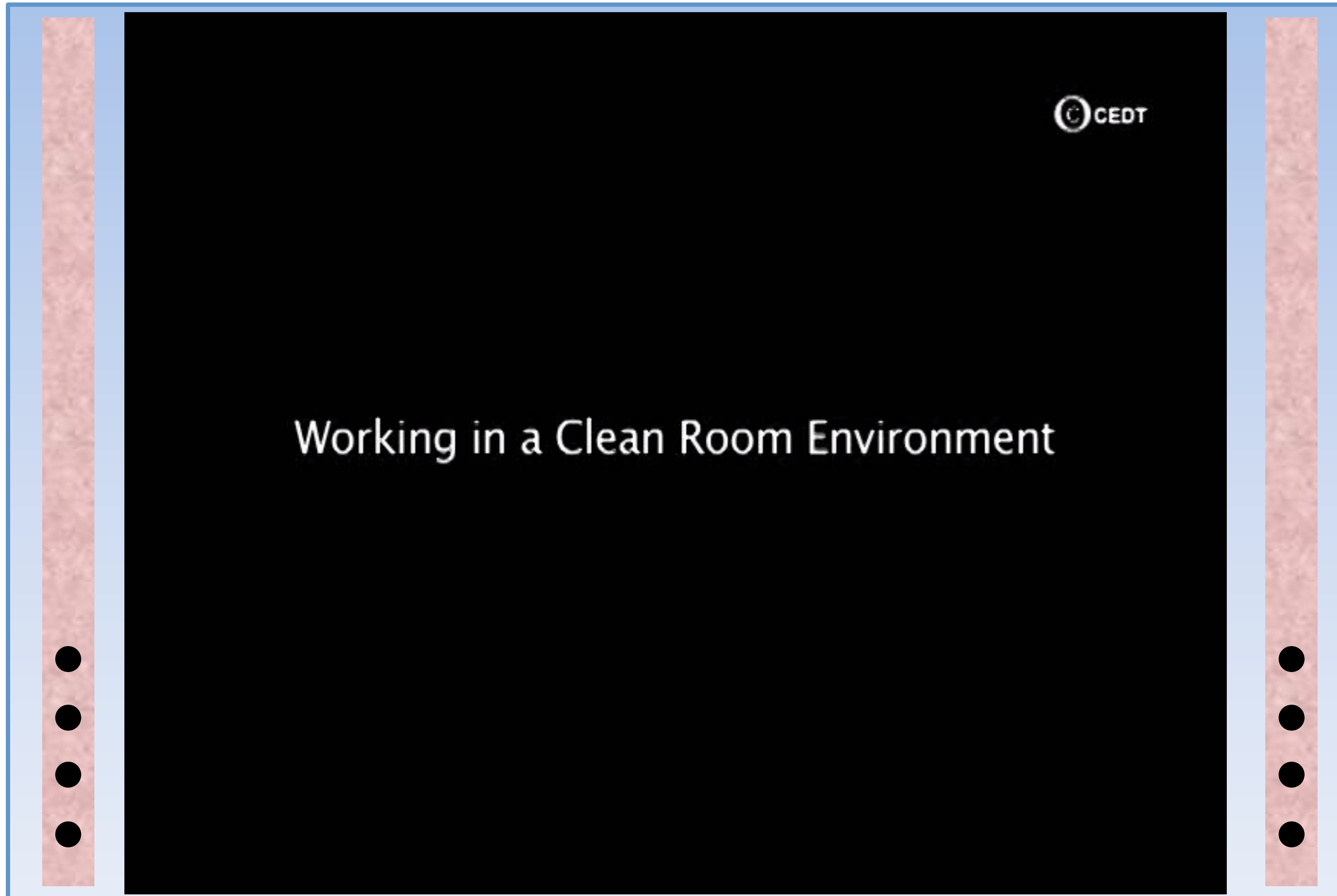
- Substrates are organic – rigid, flexible, and molded
- Standardization bodies – JEDEC, IPC, NEMA & Military
- Sub-standard laminates - affect the board quality
- Substrate selection - influences reliable performance
- Designer - freezes the laminate type and construction

(*) Bromine is banned material (laminates)

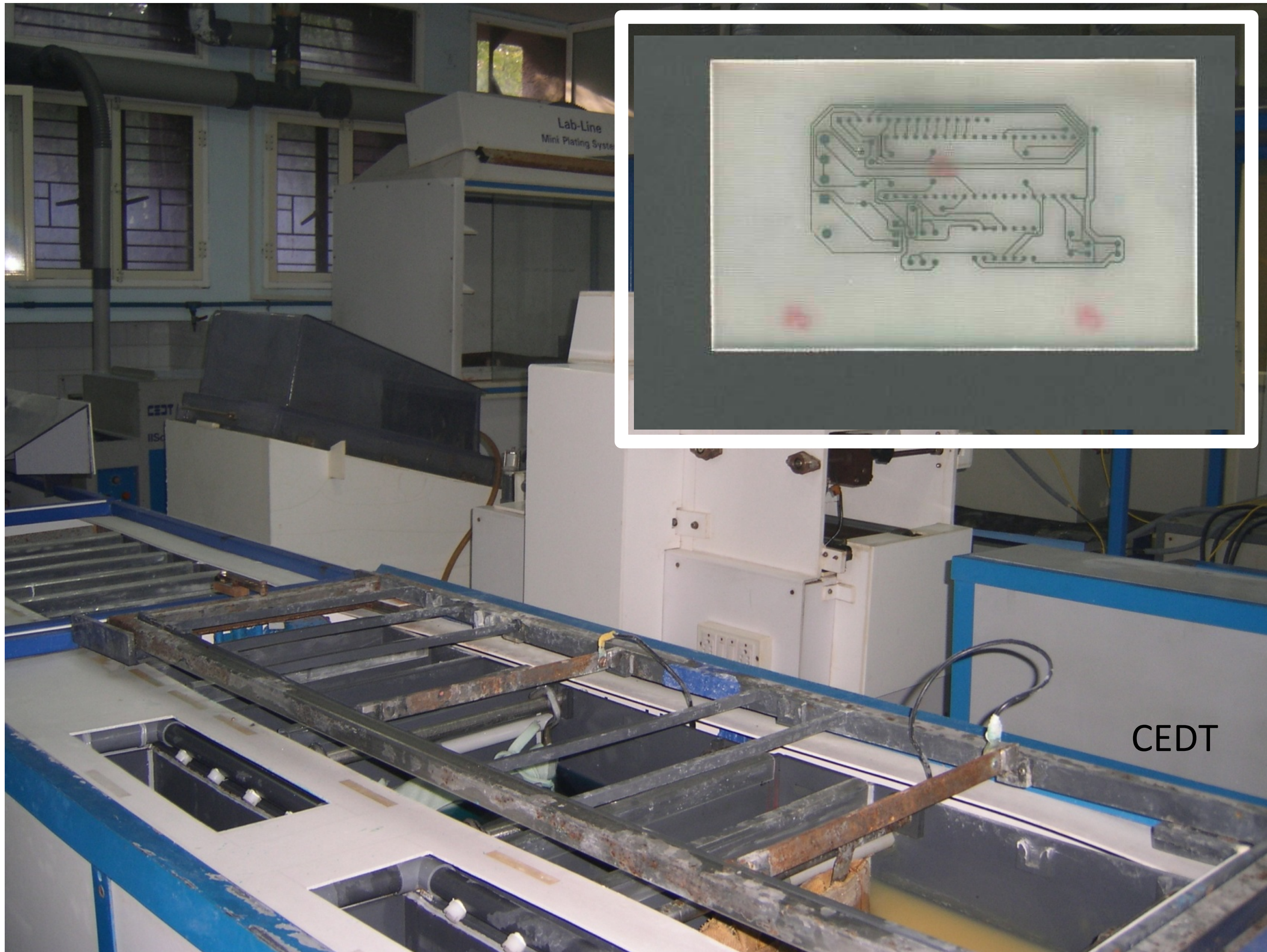
Board Fabrication Process

- ❑ Know the safety procedures before entering the lab/ work spot
- ❑ Right to Know about Materials Safety
- ❑ Read the Materials Safety Data Sheet
- ❑ Follow Clean Room work procedures
- ❑ Make sure fire fighting equipment is in place
- ❑ Make sure the nearest health centre/ security telephone numbers are made available to all personnel in the lab/ work spot

Working in a clean room environment- a short video

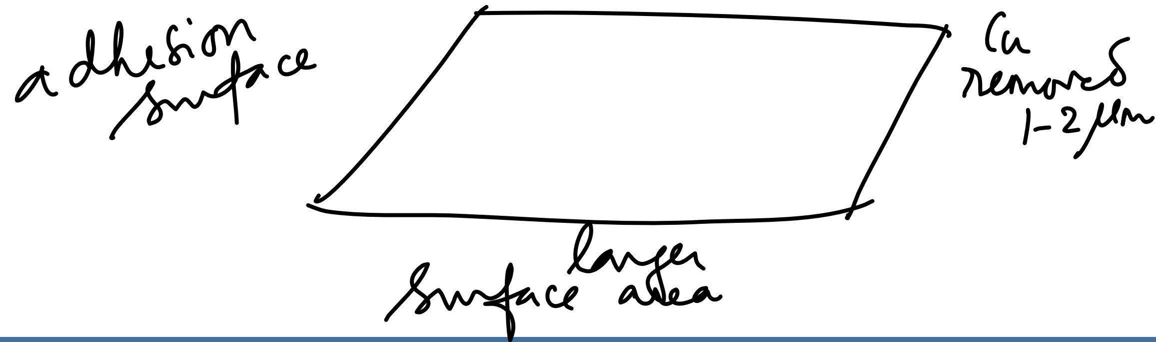


BOARD PREPARATION or SURFACE PREPARATION



Surface preparation

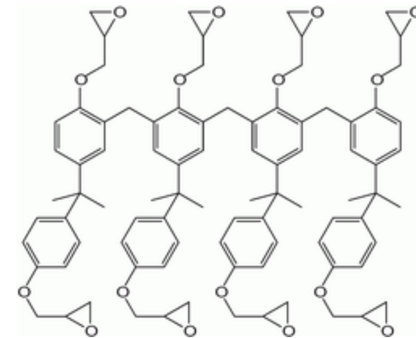
- Organic degreasing to remove oils, greases and stains from the surface of Cu to promote adhesion-use of organic solvents: TCE or IPA (iso propyl alcohol)
- Acid cleaning- mild HCl
- Alkali cleaning- mild caustic solution
- Mechanical brushing-rolling brushes with Alumina (Al_2O_3) impregnated
- Micro-etching- Ammonium per sulfate
- Washing with DI water (De ionized)
- Drying in controlled conditions

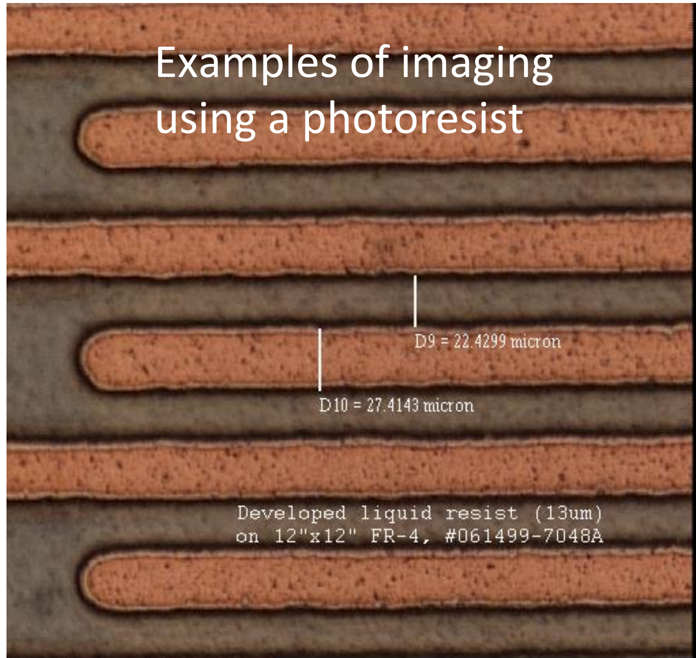


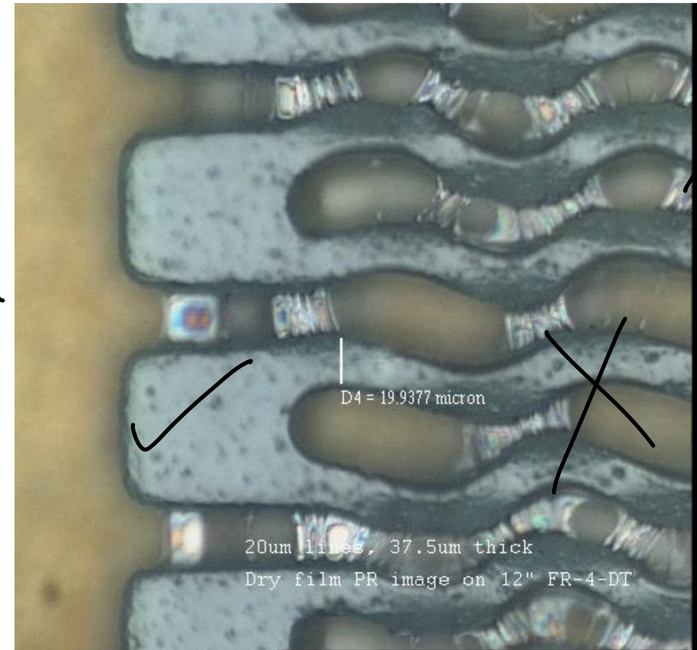
BOARD SURFACE PREPARATION- A SHORT VIDEO

Imaging

- Application of photoresist, dry or wet film depending on design requirement
- light sensitive material, short storage life
- cross-linking of polymeric material, requires initiator
- Wet film: Dip coating, Spin coating, Curtain coating, Meniscus coating
- Dry film: Vacuum laminator
- Advantages of dry film over wet film; vice-versa
- Du Pont and Ciba among many others
- PMMA, PV based, DQ (diazoquinones),
- SU-8 etc (epoxy based), Novolac
- Solvent: Organic or Aqueous based







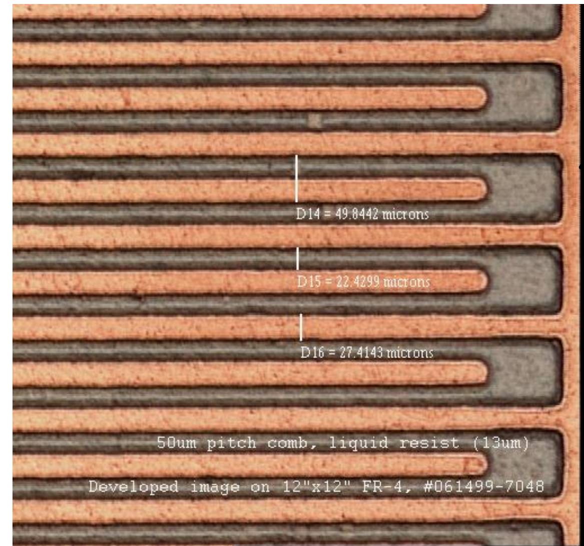


Fig.: Dr Fuhan Liu, GTech

Photoresist

- Photoresist is an organic polymer which changes its chemical structure when exposed to ultraviolet light.
- It contains a light-sensitive substance whose properties allow image transfer onto a printed circuit board.
- There are two types of photoresist: positive and negative
  - A **positive resist** is a type of photoresist in which the portion of the photoresist that is exposed to light becomes soluble to the photoresist developer and the portion of the photoresist that is unexposed remains insoluble to the photoresist developer.
  - A **negative resist** is a type of photoresist in which the portion of the photoresist that is exposed to light becomes relatively insoluble to the photoresist developer. The unexposed portion of the photoresist is dissolved by the photoresist developer.
  - Use the right combination of negative or positive mask along with a negative or positive resist as the application may require.

Photoresist application and Patterning Circuit