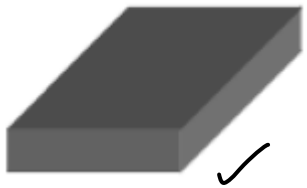
Continuing..

PRINTED WIRING BOARD TECHNOLOGIES

Photoresist

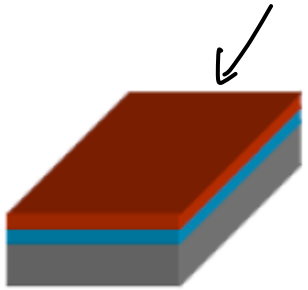
- Photoresist is an organic polymer which changes its chemical structure when exposed to ultraviolet light.
- It contains a light-sensitive substance whose properties allow image transfer onto a printed circuit board.
- There are two types of photoresist: positive and negative
  - A **positive resist** 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

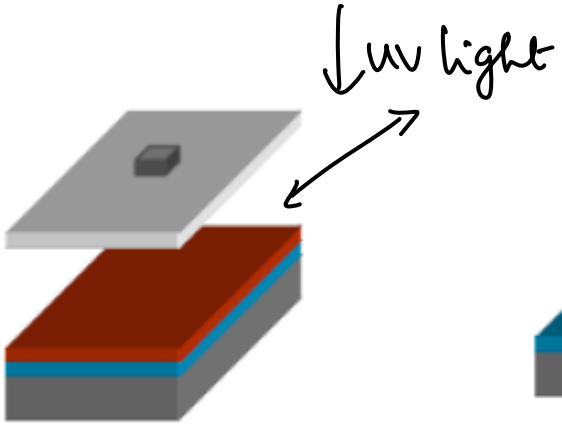


Substrate

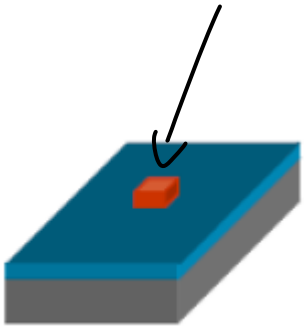
Copper clad



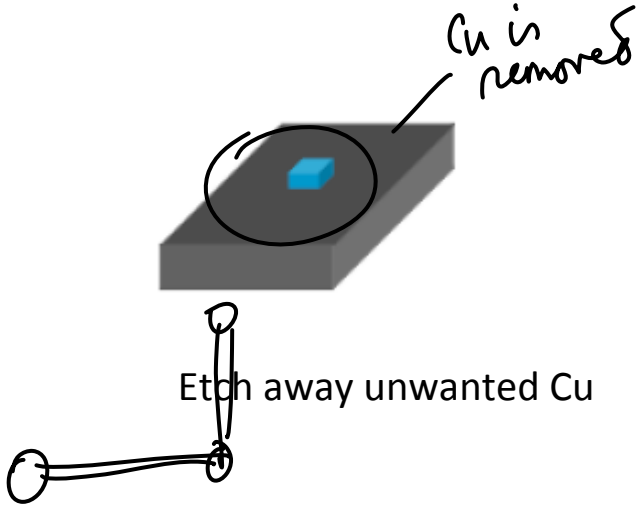
Photoresist coated Cu



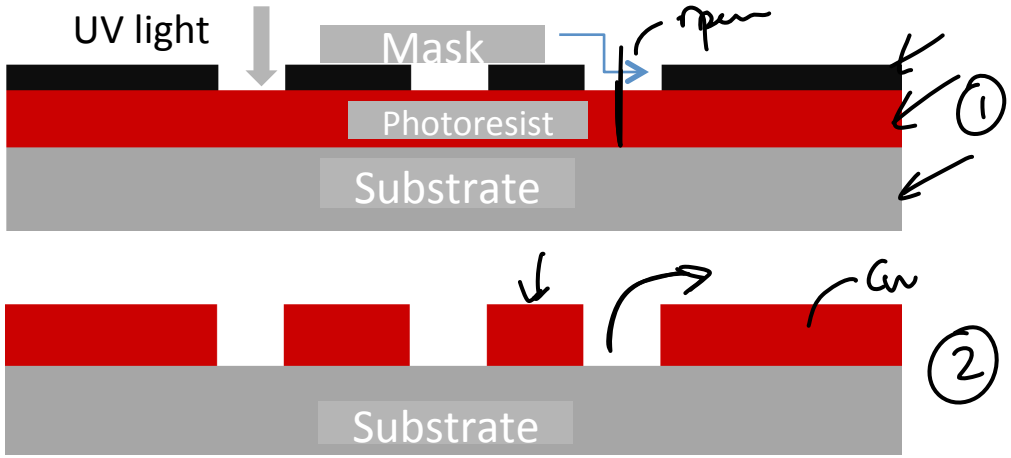
Use mask and expose to UV

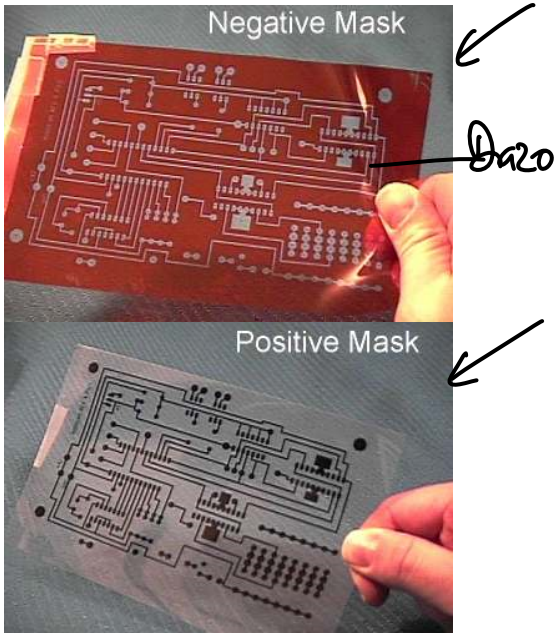


Pattern protected



Etch away unwanted Cu





Photoresists: Negative and Positive type

Negative mask and negative photoresist

- PR protects the pattern; typical of single sided board imaging

Positive mask and negative photoresist

- PR protects non-circuit areas; used when pattern plating is required; plating in circuit areas only (additive process)

- ❑ Positive photoresist and positive mask ??
- ❑ Positive photoresist and negative mask ??

Photoresist application> tacky cure> mask-UV exposure> Develop> hard cure> etching

Fig.: Mask photos: happyelectron.com

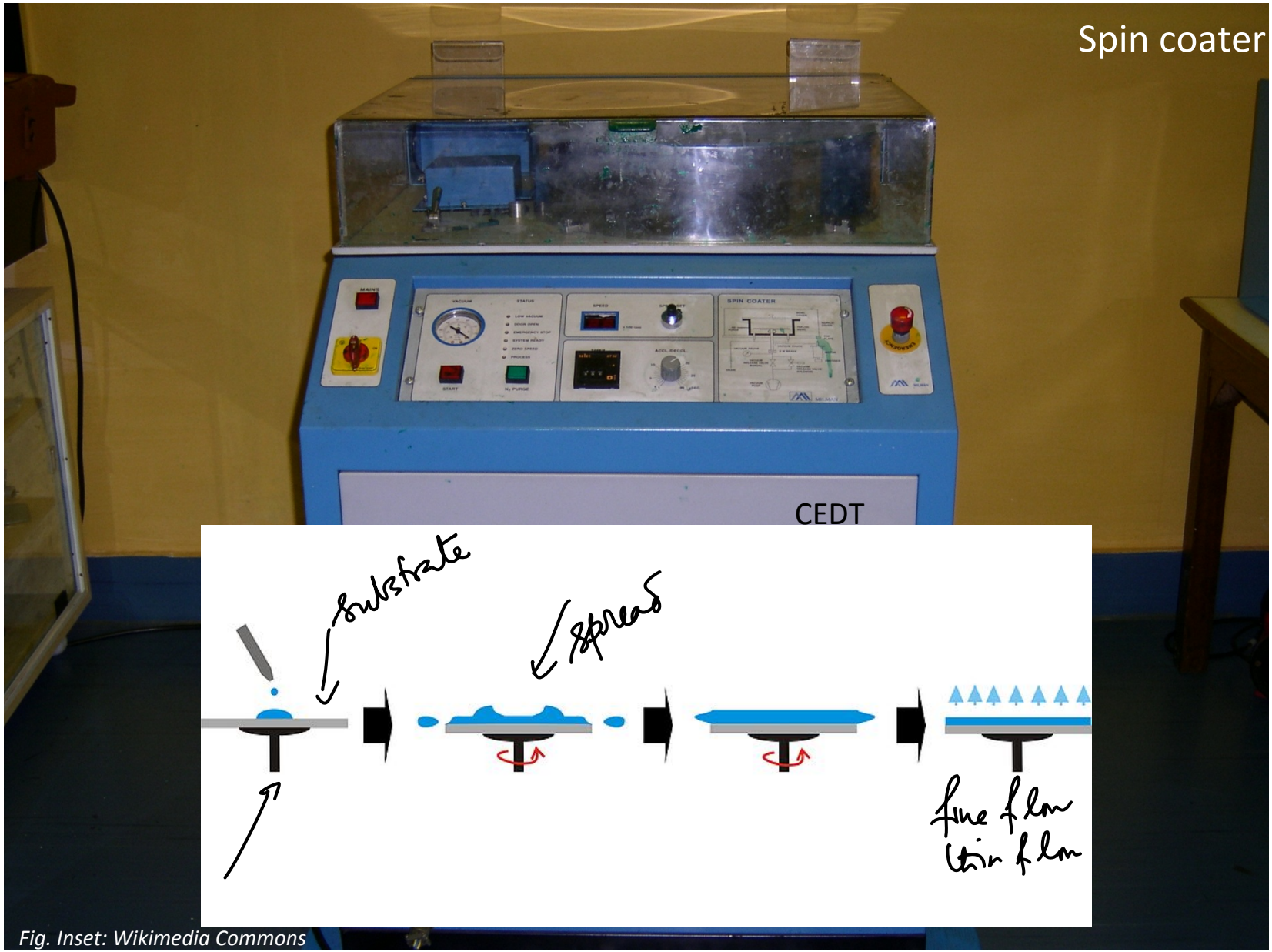
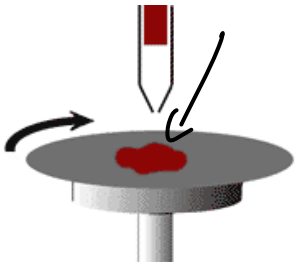
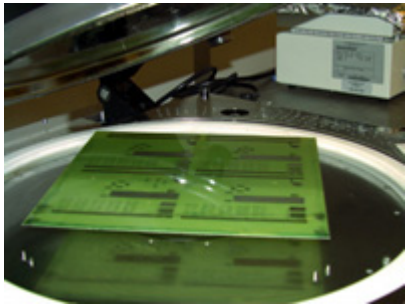


Fig. Inset: Wikimedia Commons

Spin coating is the preferred method for application of thin, uniform films to flat substrates. This process is very simple, illustrated in the figure at the right. An excess amount of polymer solution is placed on the substrate. The substrate is then rotated at high speed in order to spread the fluid by centrifugal force. Rotation is continued for some time, with fluid being spun off the edges of the substrate, until the desired film thickness is achieved. The solvent is usually volatile, providing for its simultaneous evaporation.

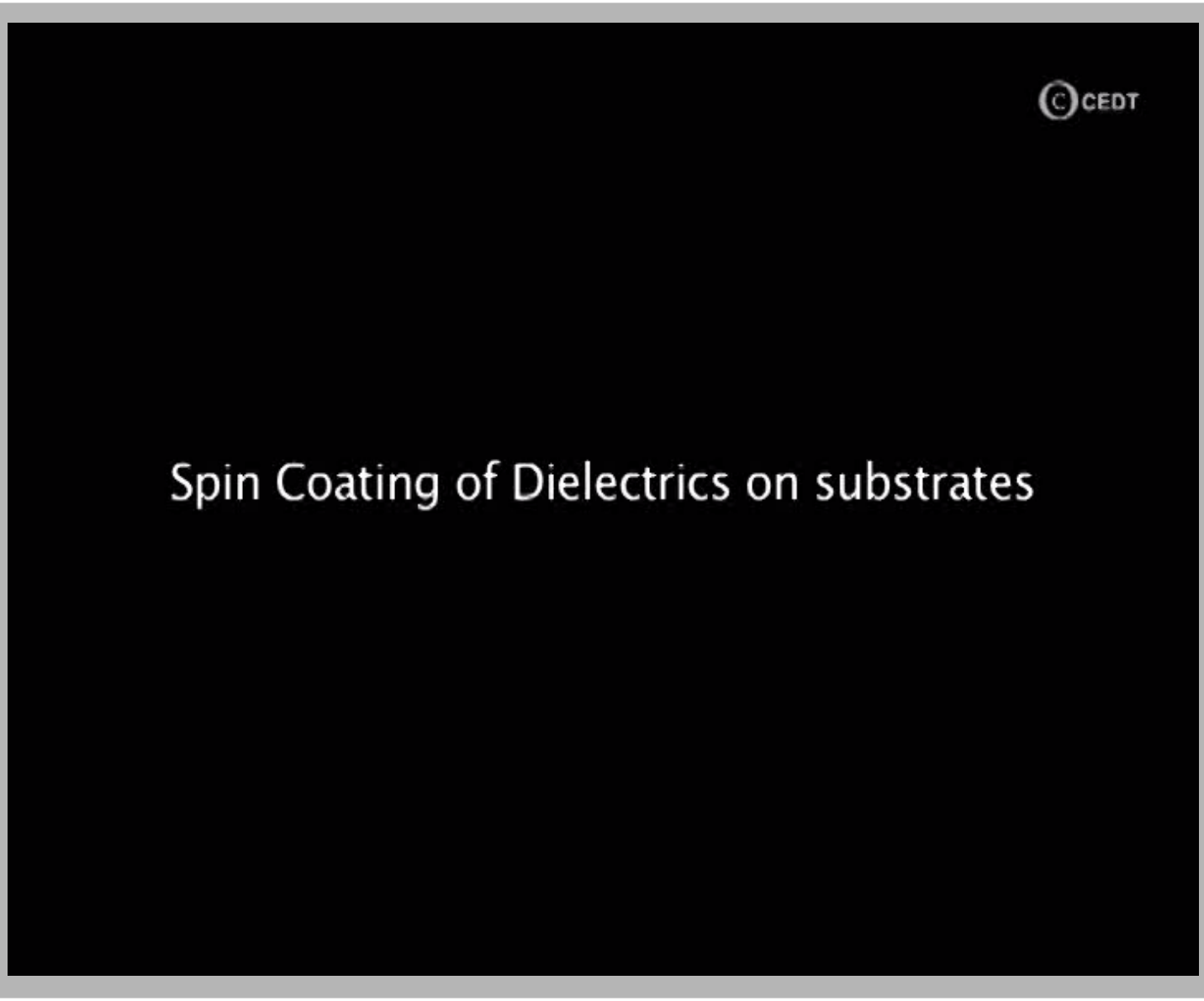




- ✓ Film too thin
- ✓ Film too thick
- ✓ Air bubbles
- ✓ No wetting on surface
- ✓ Swirl pattern
- ✓ Centre spot thick
- ✓ Uncoated areas
- ✓ Pin holes
- ✓ No repeatability
- ✓ Poor film quality

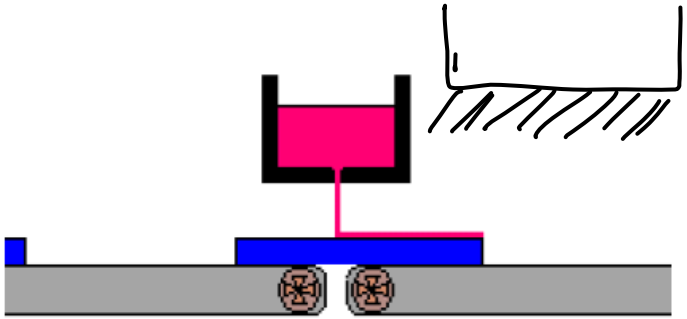
Speed (rpm) for the coating and viscosity of dielectric are important

Fig.: brewerscience.com; GTech PRC


CEDT
Spin Coating of Dielectrics on substrates

Curtain coating is the art of applying a thin layer of liquid onto a solid material.

- ❑ The curtain coating machine disperses the liquid at a controlled rate over the width of its coating head.
- ❑ The resulting wide, thin flow of liquid resembles a "curtain" hence the name "Curtain Coater."
- ❑ By passing the receiving material or substrate through the curtain of liquid an even layer of liquid is deposited.
- ❑ By controlling the flow rate of the liquid and the speed of the substrate a very accurate thickness of the coat is obtained.



Meniscus coating is the process of applying a liquid substance such as a photosensitive polymer onto the top of a substrate.

The applicator has one closed end and one open end, so that material can be pumped into the tube. The material then flows out of a slot, located at the top of the tube, and is deposited onto the substrate. The applicator tube moves beneath the substrate and the coating is formed as the meniscus contacts the substrate. Unused material is collected in a reservoir and re-circulated through the tube. Wastage is less.

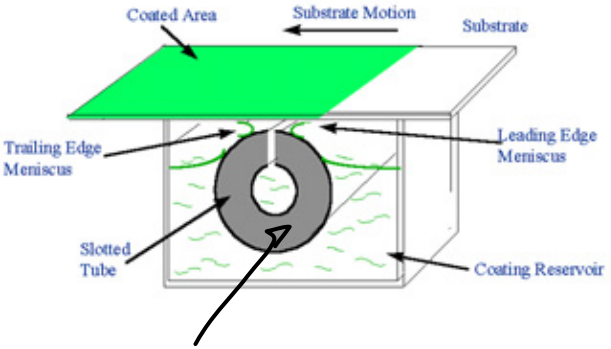
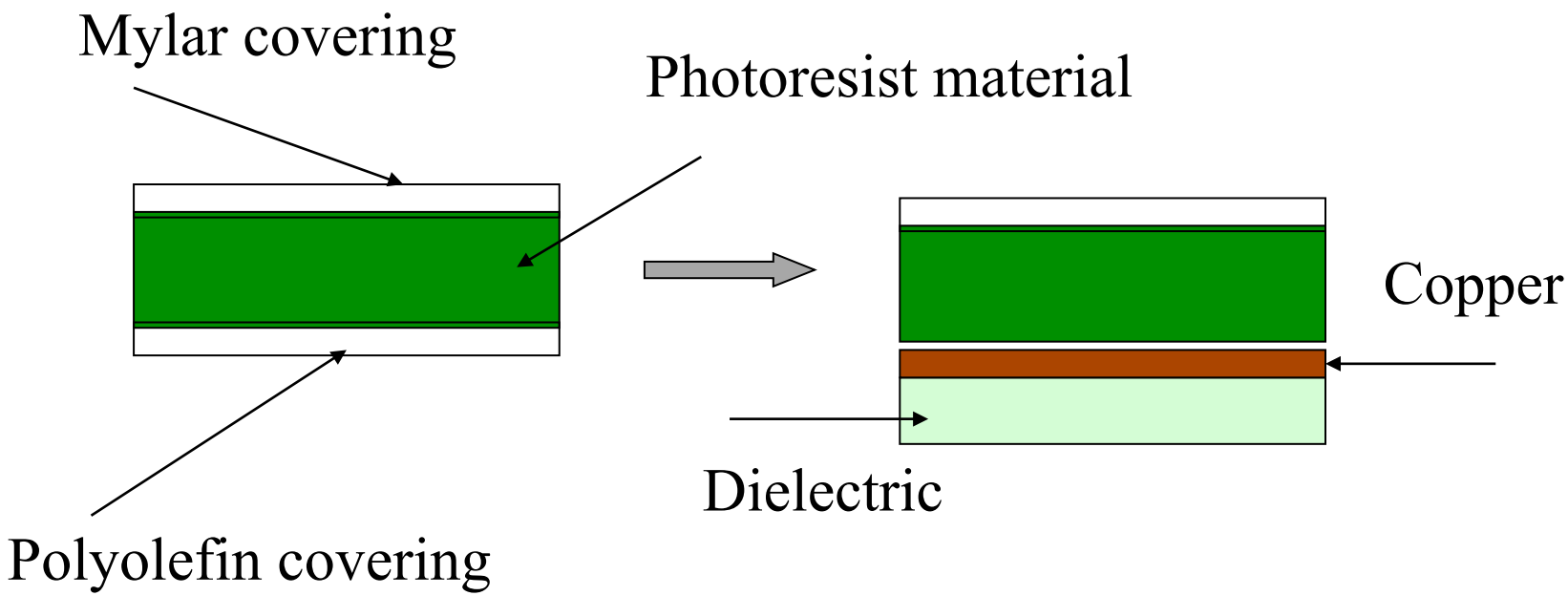


Fig.: tciinc.com; GTech

Dry Film Lamination

- Trend to thinner polyester coversheets and thinner photoresist layers
- Coversheet: 25 microns to 18 microns
- Polyester base: ~16 microns
- Photoresist layer thickness: 25 to 50 microns
- Driver: Need for high resolution and support from enabling technologies

Laminator



Lamination process using dry film photoresist material

No air gap between substrate surface and PR film;
use vacuum based lamination for better imaging.

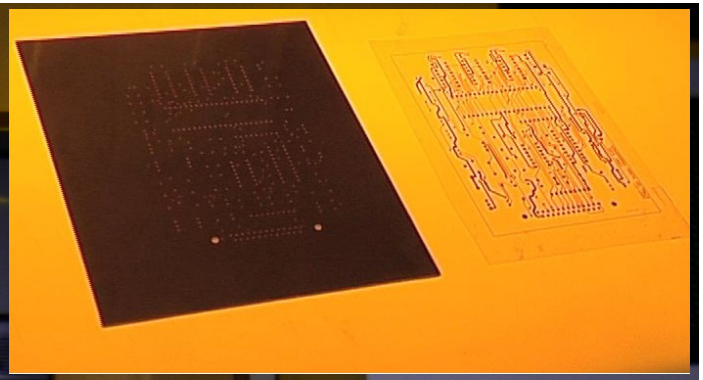
Dry Film Vacuum Laminator

UV expose and develop

- Photoresist material cross-linking is initiated by UV light
- Develop using aqueous solution or organic solvent
- Positive and negative photoresists
- Critical process for design translation onto board
- Exposes Cu area for removal from board or plating onto board
- Usually ‘post-bake’ for improved adhesion on board
- Ready for Etching Copper


CEDT
Photoresist Application

UV exposure unit for imaging



Conditions: UV light density/intensity; thickness of PR; time of exposure; developing

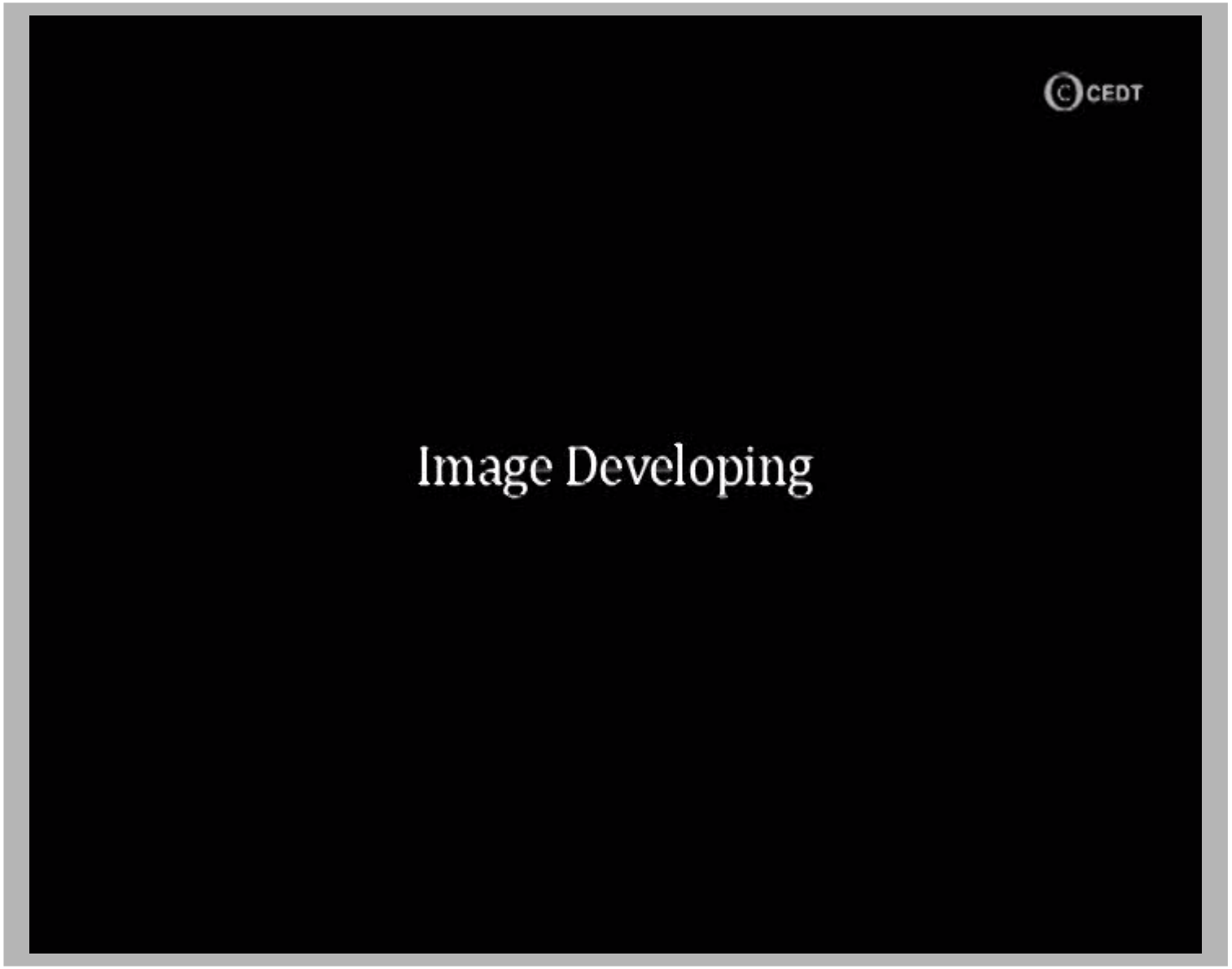

©CEDT
Photolithography

Photoresist Developer

- Highly-pure buffered alkaline solution
- Removes proper layer of photoresist upon contact or immersion
- Degree of exposure affects the resolution curves of the resist

Hard Baking

- Final step in the photolithographic process
  - Not always necessary; depends on the resist
- Hardens the photoresist
- Improves adhesion of the photoresist to the wafer surface


CEDT
Image Developing

Printing Technologies

1 Contact Printing

- Inexpensive; not complex; fast process
- Mask wear and defect generation due to contamination
- Mask usually 1:1 of the design to be patterned

2 Proximity Printing

- No contact with the substrate
- No wear and contamination therefore
- Fast process; Mask separated from wafer; diffraction an issue

3 Projection Printing

- No mask wear or contamination; expensive though
- De-magnification 1X to 10X
- Longer time for exposure; precision required; stepper motor

Next Generation Lithography>>:Electron Beam (e-beam) lithography