LITHOGRAPHY

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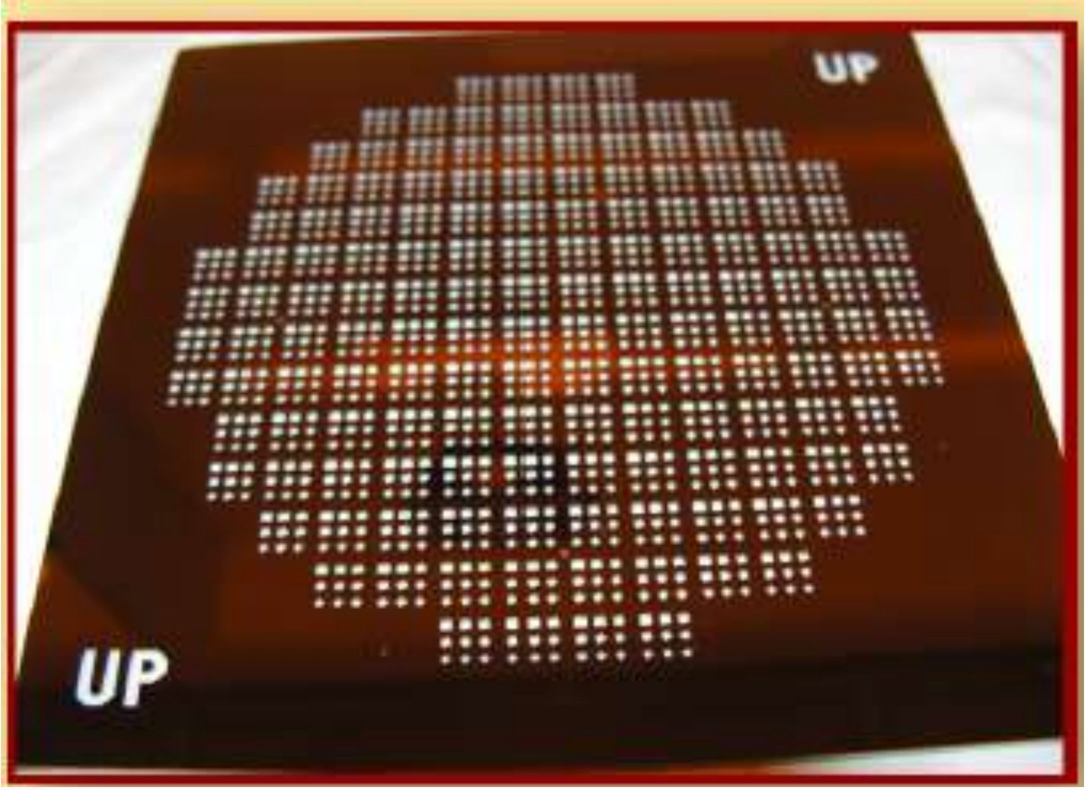
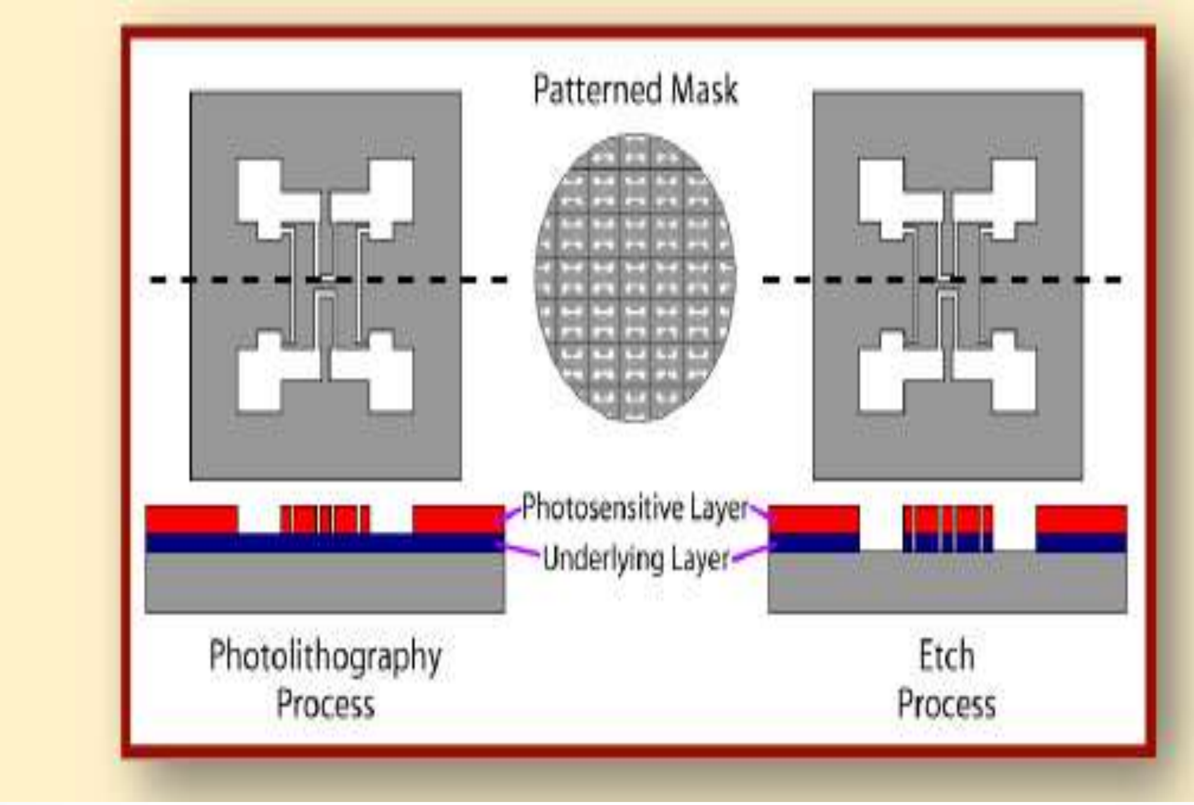
PHOTOLITHOGRAPHY OVERVIEW FOR MICROSYSTEMS



Photolithography and MEMS

- Microsystems (MEMS) fabrication uses several layers to build devices.
- Each layer of this linkage system is a different component of the device and requires a different pattern.
- Photolithography defines and transfers a pattern to each respective layer.

Photolithography



- Each layer within a microsystem has a unique pattern.

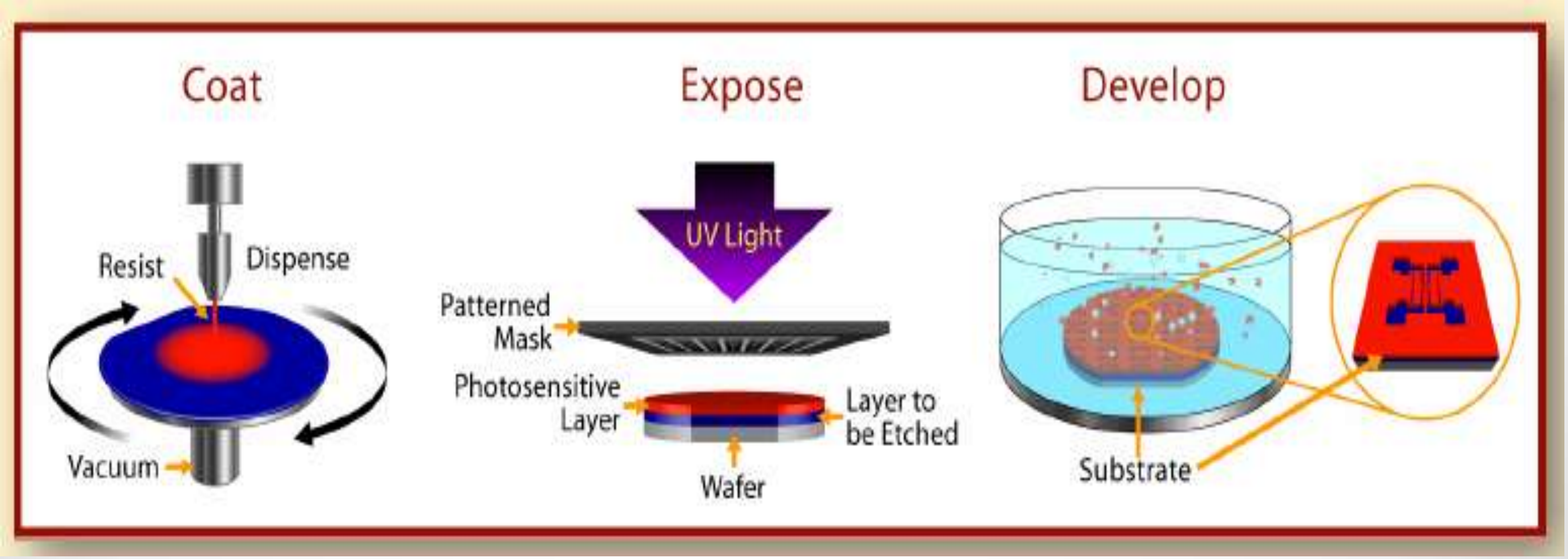
Photolithography transfers this pattern from a mask to a photosensitive layer.

- Another process step transfers the pattern from the photosensitive layer into an underlying layer.

- After the pattern transfer, the resist is stripped (removed).

Three Steps of Photolithography

- Coat
- Expose
- Develop

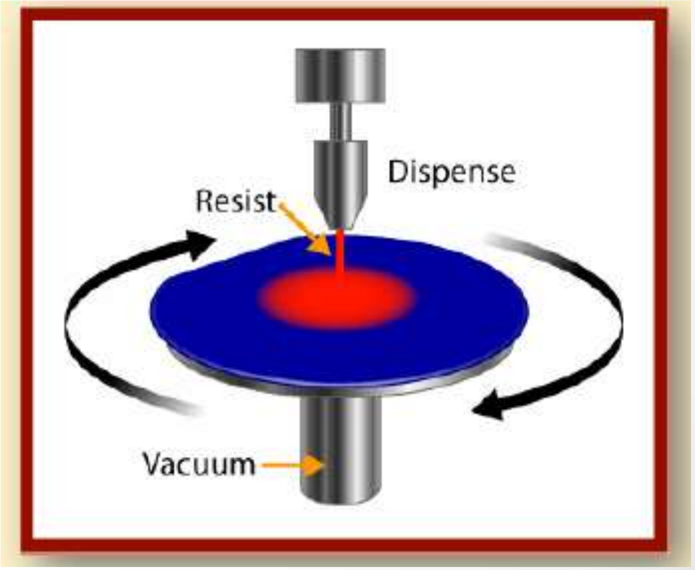


Coat Step: Surface Conditioning

- In most applications, surface conditioning precedes the
- photoresist.
- Surface conditioning prepares the wafer to accept the photoresist by providing a clean surface.
- It coats the wafer with a chemical that boosts adhesion of the photoresist to the wafer's surface. (Usually Hexamethyldisalizane or HMDS)

Spin Coating

- Wafer is placed on a vacuum chuck
- A vacuum holds the wafer on the chuck
- Resist is applied
- Chuck accelerates for desired resist thickness
- Chuck continues to spin to dry film



Photoresist (Resist)

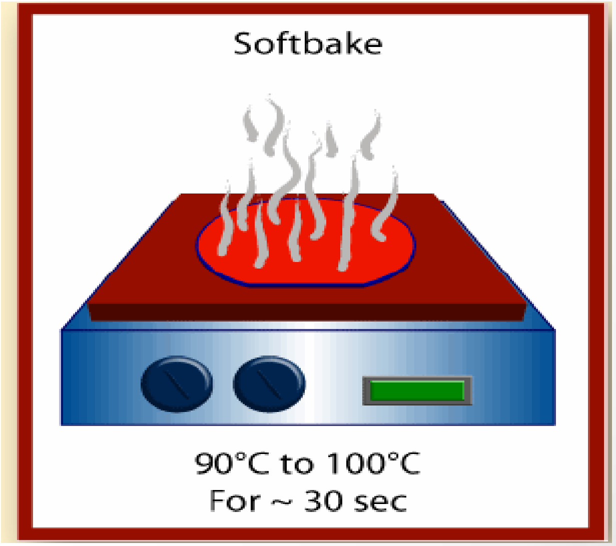
- Photoresist is a mixture of organic compounds in a solvent solution.
- Two types of resist: Positive resist – Exposed regions become more soluble.
- A positive mask is left after develop.

Negative resist – Exposed materials harden. A negative mask is left after develop.

Softbake

- After the photoresist is applied to the desired thickness, a *softbake is used to remove the residual solvents of the photoresist.*

- After the softbake, the wafer is cooled to room temperature.



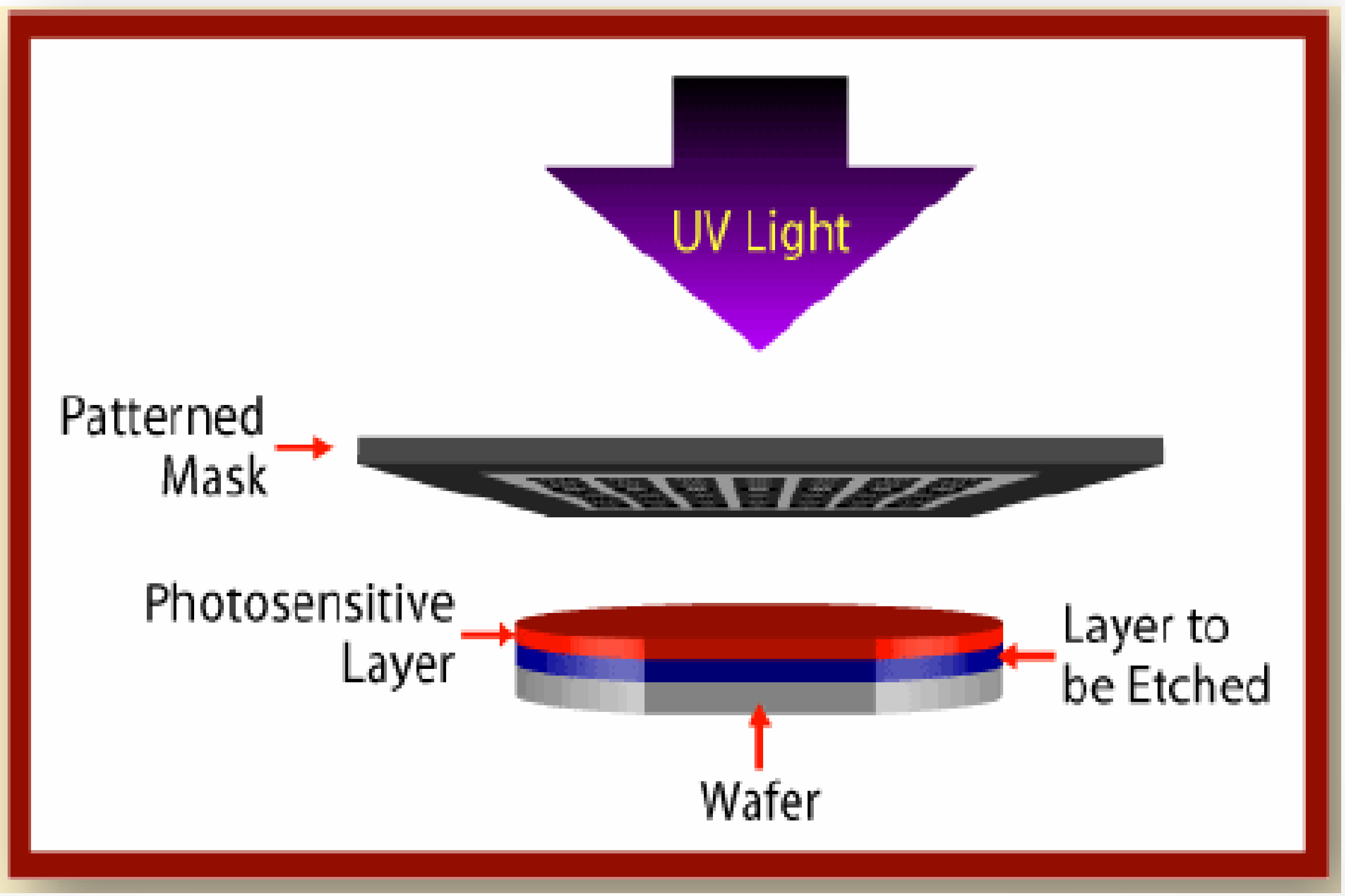
Alignment

- "Align" is one of the most critical steps in the entire microsystems fabrication process.

- A misalignment of one micron or smaller can destroy the device and all the devices on the wafer.

- Each layer must be aligned properly and within specifications to the previous layers and subsequent layers.

Expose


UV Light
Patterned Mask
Photosensitive Layer
Layer to be Etched
Wafer

- The wafer is exposed by UV (ultraviolet) from a light source
- traveling through the mask to the resist.
- v A chemical reaction occurs between the resist and the light.
- v Only those areas not protected by the mask undergo a
- chemical reaction.

Electron-beam lithography

Electron-beam lithography (often abbreviated as e-beam lithography) is the practice of scanning a focused beam of electrons to draw custom shapes on a surface covered with an electron-sensitive film called a resist (exposing).

The process of forming the beam of electrons and scanning it across a surface is very similar to what happens inside the everyday television or CRT display, but EBL typically has three orders of magnitude better resolution.

- **The main attributes of the technology are**
- **1) it is capable of very high resolution, almost to the atomic level;**
- **2) it is a flexible technique that can work with a variety of materials and an almost infinite number of patterns;**
- **3) it is slow, being one or more orders of magnitude slower than optical lithography; and**
- **4) it is expensive and complicated - electron beam lithography tools can cost many millions of dollars and require frequent service to stay properly maintained.**