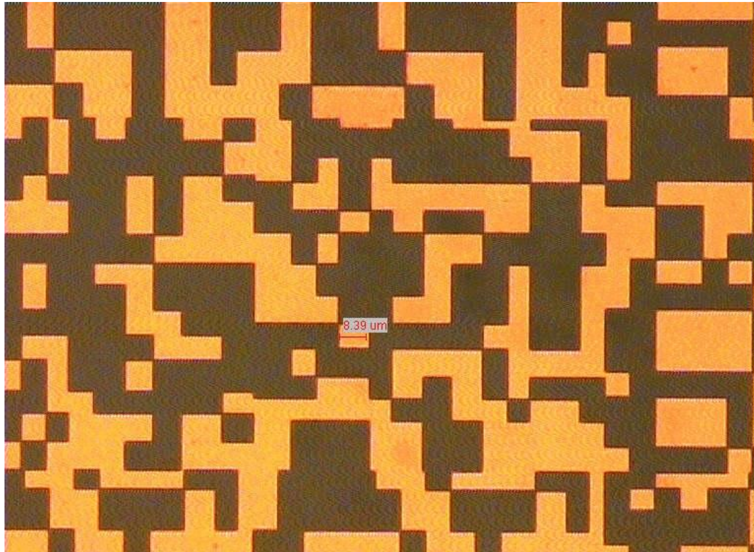
Photolithography Lesson

Photolithography, also called **optical lithography** or **UV lithography**, is a process used in microfabrication to pattern parts of a thin film or the bulk of a substrate (also called a *wafer*). It uses light to transfer a geometric pattern from a photomask (also called an *optical mask*) to a photosensitive (that is, light-sensitive) chemical photoresist on the substrate. A series of chemical treatments then either etches the exposure pattern into the material or enables deposition of a new material in the desired pattern upon the material underneath the photoresist. Photolithography shares some fundamental principles with photography in that the pattern in the photoresist etching is created by exposing it to light, either directly (without using a mask –direct writing laser beam or electron beam) or with a projected image using a photomask.

HMx Square Machine: Strip / Clean + Develop + Etch Photomask Processing

Photomask



Fragment of photomask magnified in optical microscope.

Photolithography process steps

1. Wafer cleaning.

1. **Chemical cleaning** in Acetone, IPA or Piranha cleaning in HMx Square Machine to remove particulate matter on the surface as well as any traces of organic, ionic, and metallic impurities

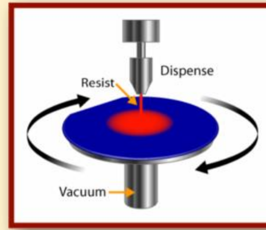
2. **Plasma cleaning**. Plasma cleaning is an important process in plasma surface technology. Through a chemical reaction with the ionized gas, particles of dirt are removed, converted into the gas phase and carried away by the continuous flow of gas via the vacuum pump.

Pico Plasma system: plasma cleaner, plasma asher, plasma etcher, plasma activation

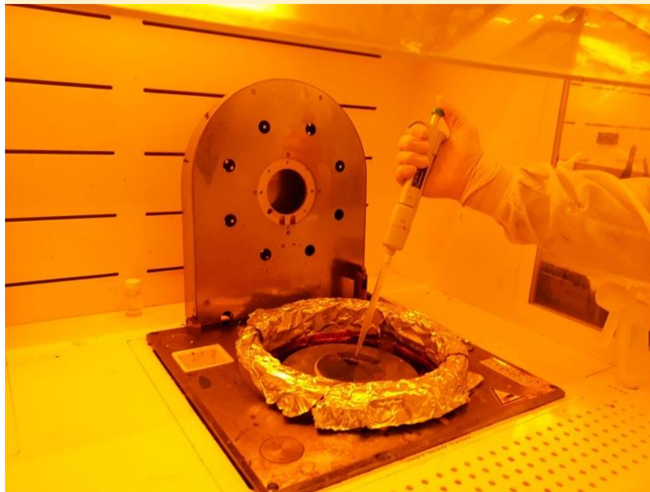
2. Photoresist spin- coating

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



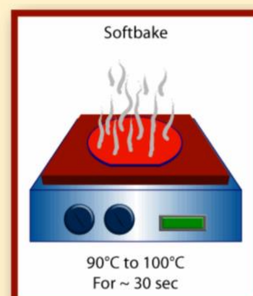
Spin Coating



3. Soft bake

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.



Contact hot plate

4. Expose

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.
- A chemical reaction occurs between the resist and the light.
- Only those areas not protected by the mask undergo a chemical reaction.

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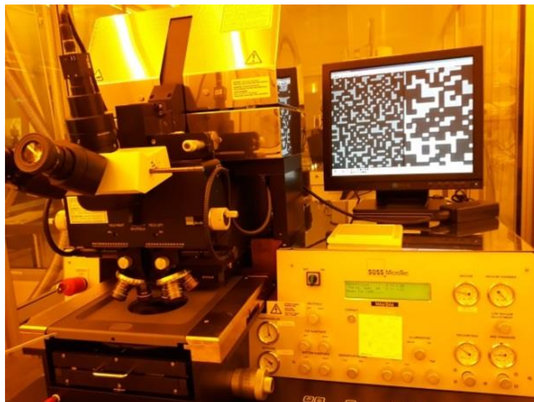
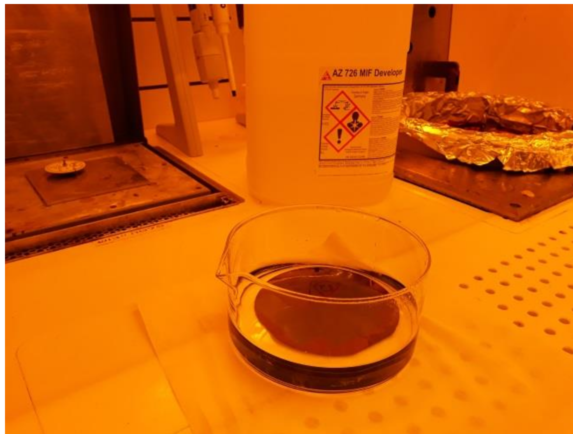


Karl Suss MA6 Mask Aligner: Alignment of photomask and wafer and UV expose

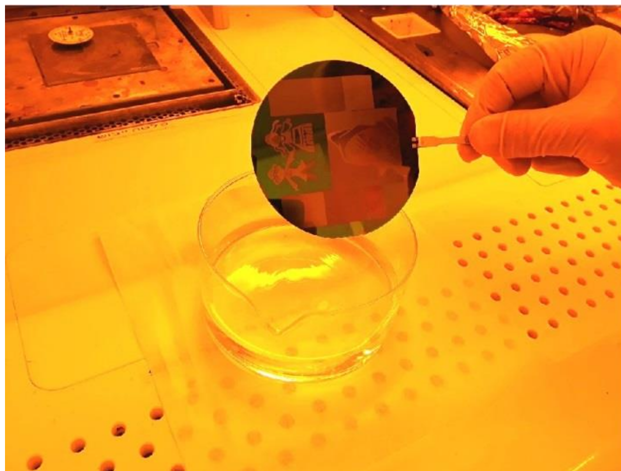
5. Development

Develop

- Portions of the photoresist are dissolved by a chemical developer.
- With positive resist, the exposed resist is dissolved while the unexposed resist remains on the wafer.
- With negative resist, the unexposed resist is dissolved while the exposed resist remains.



Immersion development



<u>Process flow</u>

1. Wafer cleaning

1.1. Rinse the entire wafer with acetone

1.2. Rinse the entire wafer with IPA

1.3 Blow dry the wafer with nitrogen

1.4. Plasma clean in plasma asher for 10 min.

2. Spin coating

2.1. Spin coat **S1805** photoresist at 3000 rpm for 30 sec

3. Soft bake

3.1. Bake on contact hot plate at 110C for 1min30sec

3.2. Cool down for 5 min

4. Expose

4.1 Expose for 10 sec using mask aligner and "ami&tami" photomask

5. Develop

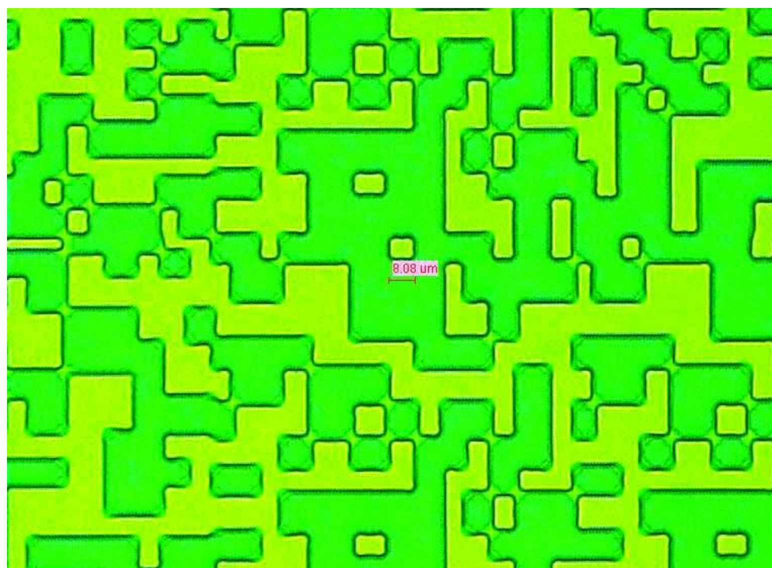
5.1. Immerse in **AZ 726** developer for 15 sec.

5.2. Rinse with DI water

5.3. Blow dry with nitrogen

6. Inspection

Wafer after photoresist development



Fragment of patterned photoresist magnified in optical microscope.