

Photolithography

Operating Instructions

The PR used during this laboratory session will be Microposit S1813 (from Shipley).

Make sure everyone is following the laboratory protocol.

- Wear lab coats, safety goggles, and gloves at all times.
- Do not touch the wafers with hand. Always use tweezers.
- Dispose of the waste based on its contents and nature.
- Use yellow light for the entire experiment, since photoresist chemistry is affected by any light with wavelength less than 500 nm (wavelength of the yellow light is about 570 nm).

Spin-Coating

1. Set the hotplate temperature to 100°C.
2. Line the fume hood with a layer of paper towel.
3. Make sure, you have enough acetone, isopropanol and DI water in the squeeze bottles.
4. Place the beakers to be used for cleaning purposes.
5. Start the flow of nitrogen gas and set the pressure using the valve. The pressure of nitrogen should be below 20 psi. Otherwise, the wafers might break. Stop the flow once the experiment finishes.
6. Prepare wafers for processing: Take a pair of tweezers, hold the wafer in between the tweezers and soak/rinse in Acetone, soak/rinse in Isopropanol (IPA), rinse in DI water and finally blow-dry using nitrogen. Make sure that acetone does not form a layer on the wafer. Make sure no water droplets remain post drying step.
7. Prepare the spinner tray and cover it using an aluminum foil. Make sure that the foil covers the base of the spinner. Turn on the vacuum pump to hold the wafer on the spinner chuck (see Figure1).



Figure 1.
Vacuum pump
For the spinner



Figure 2. Place the
wafer on the
chuck



Figure 3.
Controller for
spinner rotation
speed.

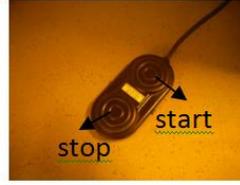


Figure 4. The
foot switch of
the spinner



Figure 5. Suct
photoresist
from the bottles

8. Use tweezers to place a clean wafer on the spinner chuck (see Figure 2).
9. Set the spinner speed at 4000 rpm (see Figure 3). Do not use acceleration dial. Also, set the spin time to 40 seconds. Press the right foot switch to test the centering and press the left foot switch to stop (Figure 4).
10. Squeeze the pipette bulb BEFORE placing the pipette into the resist to avoid air bubbles (see Figure 5).
11. Use a plastic pipette to remove some resist from the container and dispense the resist on the center of the wafer. Dispense enough resist to cover the entire wafer but avoid spilling too much PR over the wafer.
12. Note. No photoresist should contaminate the base of the spinner. If the base or the chuck gets contaminated with the photoresist, clean it using acetone and a paper towel.
13. Press the foot switch on the controller to start the spinner (see Figure 6) The spinner will stop once the set time is attained.
14. After the spinner has stopped, use tweezers to remove the wafer.
15. Bake wafer on the hotplate for 90 seconds at 100°C to evaporate the organic solvent from the photoresist (see Figure 7).
16. Remove the wafers and allow them to cool for 30 seconds on a paper towel.
17. Inspect the wafer for uniformity in the yellow light. If it is not uniform, you can remove the photoresist using acetone then rinse with IPA, DI water, blow-dry by, bake on the hotplate at 100°C for 90 seconds, and try again.
18. Measure the wafer thickness of photoresist by Filmetrics:
 - Load the recipe for S1813 on SiO₂ on Si.

- Set the baseline value for Si- wafer using the flat wafer and the angular mirror provided.
 - Once done with calibration, measure the thickness of photoresist on the wafer. Check the goodness of fit. The measurement should be repeated for at least 3 different points on the wafer to assess uniformity of coating.
19. Repeat this procedure with different silicon wafers with spinning speeds of 3000 RPM and 5000 RPM and record the thickness.
20. Once done with using the spinner, remove the aluminum foil from base of the spinner. Clean traces of photoresist, if found, using acetone and paper towel. Dispose of the foil, the pipettes, the paper towels, and contaminated gloves in the hazardous waste bin.



Figure 6. Dispense the photoresist at the center of the wafer



Figure 7. Soft bake the wafer at 100 °C



Figure 8. Turn on the vacuum pump for mask holder



Figure 9. Place the mask onto the mask holder



Figure 10. Place the mask holder to the aligner

2. Exposure Procedure

It is important that all students read the “KarlSussMJB3_User-SOP” [5] document before starting this procedure in order to be familiarized with the Pattern Replicator used in the laboratory (Aligner).

1. Start the pump to hold the mask (see Figure 8).
2. Place the mask on the mask holder (see Figure 9). Make sure that the opaque side of the mask faces top and the reflective side of the mask faces down on the mask holder.
3. Load the mask into the aligner (Figure 10). This step allows the opaque side of the mask to face the wafer and reflective side to face the incident light.
4. Focus the microscope on the mask.
5. Load the sample and move the sample under the microscope (see Figure 11).

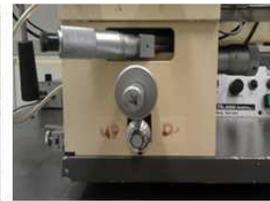


Figure 11. Place the sample on the sample holder.

Figure 12. Rotate the handle to make contact.

Figure 13. Indicator will lighten when making contact.

Figure 14. Z micrometer to adjust the contact.

Figure 15. Set the exposure time to 15s.

6. Make contact by shifting the handle. The indicator lights up when the mask and the sample are in contact (Figures 12, 13).
7. Bring the sample to contact position carefully, while using the microscope to establish the contact between the sample and the mask. Be gentle with this process because the sample and the mask may be broken if it is done incorrectly.
8. Select the right mode for the exposure with the aligner (i.e. hard contact) using recipe information.
9. Set the exposure time to 15 seconds (see Figure 15) Wear safety glasses at all times to decrease UV light exposure.
10. Expose the sample. Avoid direct eye contact with UV light.
11. Lower the separation lever and the light of contact lamp will fade out.
12. Unload the sample.
13. Turn the mask chuck off and then remove the mask and the mask holder from the aligner.
14. Turn the vacuum pump off. Make sure to remove the mask before turning off the pump.

Otherwise, you will damage the mask.

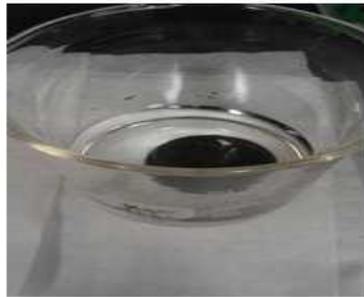
15. Repeat this procedure with two different exposure times (3 seconds and 1 minute) in order to analyze pattern profiles for under and over exposed samples.

3. Development procedure

1. Develop the resist for 60 seconds (see Figure 16)
2. Rinse the sample with DI water and use nitrogen to blow-dry the sample (see Figures 17 and 18). Make sure you rinse the sample with DI water or else the development of the photoresist will not stop.
3. Inspect the resist pattern under the microscope.



*Figure 16.
Dip the sample
into the
development
tank*



*Figure 17. rinse
the sample with
water*



*Figure 18. N₂ to
blow dry*

After you have experimented with various spin times, spin speeds, and/or exposure times, remove the PR from the wafer(s) used in these experiments (by rinsing the wafers in acetone, IPA and DI water and blow drying with N₂) and repeat the spinning, exposure, and development procedures using the optimal parameters. This is necessary to ensure that you have high quality patterns for further processing steps (wet and dry etching).