

Engelward Lab Photolithography Protocol

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Purpose:

Creating microfeature molds from silicon wafers by lithographically patterning SU-8 photoresist.

Materials needed:

- 6" Silicon wafer
- SU-8 Photoresist
 - Note: This can be purchased from Microchem: <http://www.microchem.com/Prod-SU82000.htm>
 - When purchasing photoresist, check product data sheet to make sure desired film thickness is achievable.
 - Photoresist is good for ~5 years after written expiration date.
- Photomask with desired pattern
 - Note: The Engelward Lab orders photomasks from Advanced Reproduction
- Access to microfabrication facilities
 - Note: At MIT, this is the Microsystems Technology Laboratory.
 - Contact: Kurt Broderick
- Solvents: PGMEA (developer), IPA (for rinsing)
 - Note: At MIT, solvents are supplied by the Microsystem Technology Laboratory

Workflow:

Prep wafer for spin coating:

1. Dehydrate the wafer by placing the wafer on a flat hot plate, 175°C for 10 minutes. *(Longer and higher temperatures are ok! The front side of the wafer is the shiny side. Keep this surface up at all times and use tweezers to move wafer to avoid touching surface.)*

Prep two hot plates:

1. Check that hot plate surfaces are flat. *(You can cover the hotplates with foil to make cleaning up the wafers/photoresist easier)*
2. Set one hot plate to 65°C, and a second to 95°C. *(These will be used later in the bake steps)*

Spin coat photoresist onto silicon wafer:

1. Follow SU-8 product instructions on the Microchem website to determine spin parameters for achieving desired film thickness. *(To determine the spin parameters, check the spin speed vs film thickness graphs in the product information)*
2. Place wafer on the spin coater and pull the vacuum. Set desired RPM (determined in the previous step) and spin time for 30 seconds. Before pouring photoresist, start the spin coater to check whether wafer is centered and RPM is set properly.
3. Use a N₂ gun to blow N₂ over the wafer and clean the surface.
4. Pour photoresist onto the wafer by setting the bottle on its side, and letting the photoresist drip into the center of the wafer. *(Photoresist is viscous and can take some time to pour out.)*
5. Pull up the photoresist bottle while twisting the bottle to keep strings of photoresist from falling onto the wafer. *(Twisting motion is like pouring a bottle of wine. You can use aluminum foil to clean up edge of photoresist bottle before capping it again.)*
6. Let photoresist sit for ~1 minute on the wafer to spread out from the center.
7. Start spin coater. *(After the 30 second spin time has ended, you can go around edge of wafer with a Q-tip to clean off edges for thicker coats.)*

Soft bake:

1. After spin coating step is complete, remove wafer from spinner and place it on the hotplates prepared above. *(You can put on gloves and pick it up carefully around the edges, or use tweezers.)*
2. Follow Microchem's SU-8 instructions for selecting the soft bake time and temperatures on hot plate. *(Bake time will vary depending on thickness of film. It's ok to bake for a little longer than needed! Make sure to check that the wafer is placed flat on the hot place or the coating will be uneven.)*

UV exposure: (UV radiation permanently crosslinks photoresist onto a silicon wafer)

1. Follow instructions for operating mask aligner and place the wafer onto the chuck. *(Chucks have metal pins, avoid placing the wafer directly over these pins as wafer can break. Also, it's good to clean the glass mask with a Q-tip and acetone. Before the acetone has dried, rinse the mask with IPA and dry from the middle out with a N₂ gun. The cleaned side will be in contact with the wafer)*
2. Place the photomask directly on top of the SU-8 coated wafer. *(Place the mask ink down onto the wafer. On our photomasks, putting the letters face down will make sure the ink side is contacting the wafer.)*

3. Follow instrument instructions for setting exposure parameters and exposure time. *(The exposure energy will be determined by SU-8 manufacturer instructions for desired film thickness. Also, for a thick layer of photoresist, you can set try setting multiple exposures with wait times in between.)*

Post exposure bake:

1. Follow SU-8 instructions for post exposure bake conditions for desired film thickness *(It's still ok to bake for a little longer than needed)*

Developing features:

1. After the post exposure bake, place the wafer back on spinner. *(Set the spin speed really low and the time really long)*
2. Squirt the developer (PGMEA) from the center of the spinning wafer out to the edge. Repeat multiple times.
3. Rinse with IPA.
4. Spin wafer at a fast speed and use the N₂ gun to dry the wafer.
5. Check under microscope to see if wafer is fully developed *(It's fully developed if IPA sprayed on after the PGMEA doesn't turn a milky white. For thick layers of photoresist, you can develop submerged in PGMEA in sonication bath.)*

All the above steps should be done on a single day