ME 363 LAB #10: SOFT LITHOGRAPHY PART II

Photoresist coating and pattern development

Meet in MEG28

Purpose: To be trained for using soft lithography facilities, including spin coater, mask aligner, and hotplate. Use mask made in previous lab (lab#9) to microfabricate the pattern onto the photoresist and PDMS.

Instruments: 144 sq. ft. class 10,000 clean room (in MEG28), Class 10 solvent hood, Suss MA1006 mask aligner, Delta-10 spin coaters, Hot plate and convection oven

Materials: SU-8 2025 photoresist, 4" Round silicon (glass) wafer, PDMS elastomer, SU-8 photoresist developing chemicals, Falcon wafer container.

Dress code: **long pants, closed-toe shoes**, no wrist watches or hand jewelry.

Procedures:

1. MMC Lab Safety Walk-thru:

You must have already read ALL of the material for new users at MMC website (https://engineering.purdue.edu/MMC/Click general certification under User Info) before participating in this walk-thru.

2. Print out facility user manuals:

Before attending lab make sure to print and read the online manuals for

(a) Spin coater
(b) Mask aligner
(c) Hotplate
(d) Convection oven.

3. Gown for clean room

(a) Lab coat
(b) Hair net (must cover all hair)
(c) Gloves are always worn when performing experiments.

4. Solvent clean substrate:

To removes organic contaminants

1. Cover the surface of the wafer with Acetone.
2. Thoroughly scrub the surface of the wafer with a swab.
3. Rinse the wafer with IPA (isopropanol).
4. Blow dry the wafer with N2 gun.

5. Spin coat photoresist:

In this lab we are using an acid-catalyzed negative photoresist (the area exposed to UV stays), SU-8, first developed and patented by IBM. The radiation incident on the photoresist (UV, x-ray, or electrons) initiate chemical reactions resulting in cross-linking between polymer chains. The cross-linking gives the material its strength resulting in a glass-transition temperature. It is sensitive to UV light between 365 and 436 nm with the greatest sensitivity at 365 nm. The procedure for spin coat SU-8 is:

1. Bake the wafer for dehydration. 120 ºC hotplate 4-5 min and cool it down.
2. Mount the wafer onto vacuum chuck of the spin coater and apply SU-8 onto it. Note: Approximately 8 ml Su-8 needed for a 25 μm coating on a 4-inch wafer.
3. Setup Spin coater parameters and Spin SU-8 on the wafer.
   Step 1: spin cycle→ 500 rpm, 5 seconds, maximum acceleration
   Step 2: spin cycle→ 4000 rpm, 30 seconds, maximum acceleration
4. Soft baking of SU-8: to evaporate the solvent and densify the SU-8 film
   65 ºC hotplate 2 min, following with 95ºC oven 5 min
5. Relaxation: cool the wafer for 5-10 minutes

6. SU-8 exposure:

Mount the mask and the wafer onto the mask aligner and preset the exposure parameters:
35 seconds at UV light density of 21 mW^2/cm^2
Refer to MA1006 manual on MMC website (http://widget.ecn.purdue.edu/~mmcenter/)

7. Post exposure baking:

Bake the SU-8 on a hotplate for acid-initiated, thermally driven epoxy cross-linking.
65 ºC hotplate 1 min, following with 95ºC oven 3 min

8. Development:

Develop with SU-8 developer with agitation until the pattern is clear (usually it takes 3-4 min), rinse with isopropyl alcohol (IPA).

9. Mold and cure the PDMS

3. Mix the resin with the hardener (resin 40 ml: hardener 4 ml=10:1)
4. Pour the mixture on the wafer and wait for most bubbles to be removed
5. Cure it for 24 hours at room temperature (pick up next day in ME32)
6. Peel cured PDMS off of the wafer.

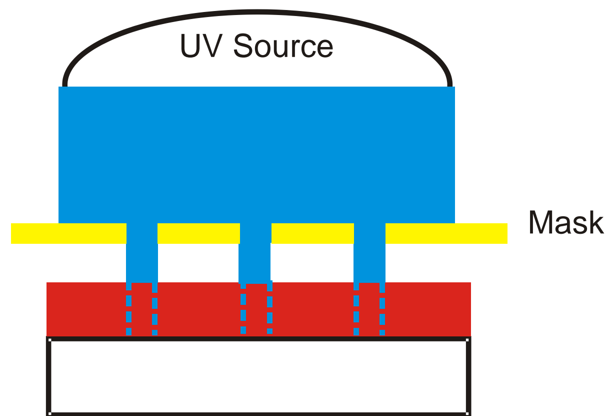
10. Evaluate stamped pattern with Optical microscope or atomic force microscope.

<u>**The items to be included in the report: (one final report for lab#9 and lab#10)**</u>

1. Write a report describing the overall procedure including lab#9 and lab#10. Write as more detail as possible. You can take advantage of the attached drawing when describing lab#10 procedure.
2. (optional) Your own pattern printed in paper, with dimensions labeled
3. Pattern on transparency
4. Completed table in Lab#9 manual.

APPENDEX 1: Key process of soft lithography

Spin photoresist SU-8 onto the substrate



Mask-wafer alignment and exposure

Photoresist master (after development)

CAST PDMS