520.495/530.495/580.495 Microfabrication Laboratory

Flow Cytometer **Lab 2: Cavity Photolithography**	

This week we'll begin the process of fabricating the flow cytometer by doing photolithography to oxidized wafers. This will form the mask for the anisotropic etch that will follow to make the channels in the silicon. We use positive photoresist to define the regions where the channels for the waveguides will be formed. Buffered HF will finally be used to remove the silicon dioxide from the channel regions. In an industrial setting, photoresist spinning and photolithography is done right after the wafers get out of the furnace to avoid the problems with moisture on the surface. Because the wafers were oxidized for you a few days ago, we will dehydrate the wafers in the Blue-M oven.

<u>Preliminaries:</u>

1. Transfer wafers with tweezers, try to grasp the wafer at the same place each time, usually at the flat edge.
2. All the cleaning procedures (except using spin/rinse/dryer) should be done in the hood. Aprons, protective sleeves, gloves, face shield, lab coat, and goggles must be worn during cleaning procedures. Wear plastic disposable gloves at all times.

<u>I. PRELAB ASSIGNMENT:</u>

1. Describe in your own words the purpose of this laboratory assignment.
2. How do you grow a layer of silicon dioxide on top of your wafer? Can silicon dioxide form at room temperature?
3. Is silicon dioxide an insulator or a conductor?

II. LAB WORK:

Task #1: Photoresist Deposition:

1. Dehydrate the oxidized wafers using the hot plate: TEMP= 150C, t= 5 minutes then let the wafer cool down to room temperature.
2. Program the spinner so that its spinning speed=3500 RPM and spinning time = 60 seconds.
3. Spin photoresist S1813 onto the polished side of the wafer. (safety glass must be worn at all time and double check to see if the vacuum is on before start spinning process.)
4. Using a transfer pipette, carefully withdraw approximately 1 ml of positive photoresist S1813 from the bottle into the pipette. Again, to minimize contamination, do not touch any part of syringe that is going into the photoresist bottle, and use a new pipette each time.
5. Dispense photoresist on to the wafer slowly, and try not to create any air bubbles.
6. Double check that vacuum is on and cover the spinner then press START to start spinning.
7. Soft-bake the wafer on the hot plate for 60 seconds at 95°C.
8. Repeat the above for the back side of the wafer but now spinning at 2500 RPM.

Task #2: Wafer Exposure:

1. Set wafer on to the chuck of the photo mask aligner, and align the major flat of the wafer with the cutout in the mask. Set exposure timer at 15 seconds. **Turn away from the aligner during exposure**.
2. Soft-bake the wafers on the hot plate at 95°C for 60 seconds.
3. Develop the photoresist by immersing the wafer in the 453 developer for about 60seconds. (IMPORTANT: Do not over develop. Rinse the wafer by first immersing the wafer in the beaker of DI water, then again under running deionized water at the sink for 30 seconds. Dry the wafer using the filtered nitrogen gun, and inspect the wafer under the microscope.
4. Hard-bake the wafer on the hot plate for 10 minutes at 120°C.
5. Carefully get the wafer off the hot plate and place them in their carriage.
6. Let the wafers cool down for 5 minutes in their carriers but in the laminar flow hood.

Task #3: Oxide Etch:

1. Make up buffered oxide etch in a 1000 ml plastic beaker. Weigh out 296 g NH_4F, and add to 425 ml of deionized water with stirring. Then add to this mixture 106 ml HF. Fill a 2000 ml beaker with deionized water for rinsing.
2. Carefully pour 700 ml of buffered oxide etch into a 1000 ml plastic beaker. Fill a 2000 ml beaker with deionized water for rinsing Develop the photoresist by immersing the wafer in the 453 developer for 50 seconds. (IMPORTANT: Do not over develop. Rinse the wafer by first immersing the wafer in the beaker of DI water, then again under running de-ionized water at the sink for 30 seconds. Dry the wafer using the filtered nitrogen gun, and inspect the wafer under the microscope.
3. Load wafers into carrier, and immerse into etchant, with gentle agitation, for 5 minutes. Lift carrier out of etch and observe the solution running off the back side of the wafer. If the etch has removed the unprotected silicon dioxide, the etchant will not wet the exposed silicon regions
4. Rinse wafers for 1 minute with DI water, dry using the filtered nitrogen gun, and inspect wafers under microscope.
5. Fill a 1000 ml beaker with 750 ml acetone. Fill a second 1000 ml beaker with 750 ml of isopropanol. Fill a 2000 ml beaker with 1500 ml of deionized water.
6. Load wafers into carrier, and immerse into acetone. Gently agitate for a few minutes until the photoresist is removed. Transfer wafers into the isopropanol and rinse for 5 minutes. Finally, transfer the wafers into the deionized water and rinse.
7. Dry a wafer using the filtered nitrogen gun, and use the profilometer to measure the thickness of the oxide layer and store the wafers in their carriers till next week. Record this for future reference.
8. Transfer the acetone and isopropanol to waste bottles. Clean the beakers in detergent and rinse thoroughly in hot tap water, then deionized water.

III. Postlab Assignment:

1. Why do we turn away from the mask aligner during exposure?

2. Why did we spin photoresist on the back of the wafer?

3. Make suggestions of how to improve the lab procedures (this handout).

Lab procedure prepared by A.G. Andreou, Fall 2003, revised by H. Vo, Fall 2004.