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 on oxidized wafers. This will form the hard mask for the anisotropic etch to make the channels in the silicon. We use positive photoresist to define the regions where the channels for the flow cytometer will be formed. BOE will be used to remove the silicon dioxide (hard mask material) 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 on the hotplate.

Preliminaries:

1. Transfer wafers with tweezers, try to grasp the wafer at the same place every 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.

I. PRELAB ASSIGNMENT:

1. How do you grow a layer of silicon dioxide on top of your wafer? Can silicon get oxidized at room temperature?
2. Is silicon dioxide an insulator or a conductor? (Hint: How do you define a conductor or an insulator? Which physical parameter characterizes the conductivity of a material ?)

II. LAB WORK:

Task #1: Measurement of oxide thickness:

1. Use the optical thin-film measurement system, the Filmetrics, to measure the oxide thickness at 3 different locations across the wafer.

2. Use the measured thicknesses to calculate the oxide etch time. The etching rate of the BOE solution is about 900 Å/min.

Task #2: Photoresist Deposition:

1. Dehydrate the oxidized wafers using a hot plate: TEMP= 150°C, t= 5 minutes then let the wafer cool down to room temperature.
2. Program the spinner so that its spinning speed=2500 RPM and spinning time = 60 seconds.
3. Spin photoresist S1813 onto the backside 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. Dispense photoresist on to the center of wafer slowly, and try not to create any air bubbles.
5. Double check that vacuum is on and cover the spinner then press START to start spinning.
6. Hard-bake the wafer on the hot plate for 5 minutes at 120°C.
7. Repeat the above for the frontside of the wafer but now spinning at 3500RPM and bake for 90 seconds at 95 °C.

Task #3: Wafer Exposure:

1. Set wafer on to the chuck of the photo mask aligner and follow the instructions on the screen for exposure. Set exposure timer at 15 seconds. **(Turn away from the aligner during exposure!)**
2. Develop the photoresist by immersing the wafer in the CD26 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.
3. Hard-bake the wafer on the hot plate for 2 minutes at 120°C.
4. Carefully get the wafer off the hot plate and place them in their carriage.
5. Let the wafers cool down for 5 minutes in their carriers but in the laminar flow hood.

Task #4: 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.

2. Carefully pour buffered oxide etch into a Teflon petri dish.
Fill a 2000 ml beaker with deionized water for rinsing

3. Hold the wafer with tweezers and immerse into prepared BOE, with gentle agitation. According to the calculated time in Task #1, take the wafer out 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 first in the 2000ml beaker filled with DI water for 1 minute followed by the running DI, dry using the filtered nitrogen gun, and inspect wafers under microscope.

5. Prepare a Teflon Petri dish of acetone, half full and another one with isopropanol. Fill a 2000 ml beaker with 1500 ml of deionized water.

6. Immerse wafer into acetone. Gently agitate for a minute or until the photoresist is completely removed. Transfer wafers into the isopropanol dish and let it soak for a minute. Finally, transfer the wafers into the deionized water and rinse for 30 seconds.

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 indetergent 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).

4. There are several baking steps in this lab. What are they and what are the purposes of these different baking steps?

Lab procedure prepared by A.G. Andreou, Fall 2003, revised by H. Vo, and T. Yeh, M. Ho and A.G. Andreou, Fall 2007.