**520.495/530.495/580.495 Microfabrication Laboratory**

## Optical Waveguides

## Lab 2: Silicon Oxidation

This week we'll begin the process of fabricating the hybrid silicon/polymer waveguides by first cleaning the wafers, forming an insulating layer of silicon dioxide on the wafers in a high temperature furnace. This will form the mask for the anisotropic etch that will follow. We use positive photoresist to define the regions where the channels for the waveguides will be formed. In an industrial setting, the wafers out of the box will be cleaned using a series of steps to remove organic and inorganic contaminants. Since we're not making transistors and our time is limited we will only do a DHF (Dilute HF) to remove any residual oxide from the surface of the wafers before beginning the processing.

### Preliminaries:

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.

### I. PRELAB ASSIGNMENT:

1. How do you grow a layer of silicon dioxide on top of your wafer? Can silicon dioxide form at room temperature?

2. Is silicon dioxide an insulator or a conductor? (Hint: How do you define a conductor or an insulator? What is the physical parameter being used?)

## II. LAB WORK:

### Task #1: Wafer thickness measurement:

The wafers that we will use come with a nominal thickness between 350 and 600 micron. To find out the exact thickness of your wafer, use the micro-caliper in the lab. Clean the surfaces of the micro-caliper that come in contact with the wafer so that you do not contaminate the wafer.

Exercise great caution in closing the caliper on the wafer as it does not take much to break a silicon wafer. This is something you ought to remember throughout the lab sessions.

### Task #2: Wafer Dilute HF cleaning:

1. Prepare the dilute 30:1 HF cleaning solution by sequentially adding de-ionized $H_2O$ (600 ml) and HF (20 ml) to a 1000 ml beaker. Fill a 2000 ml beaker with 1500 ml de-ionized $H_2O$ for rinsing the wafers following cleaning. If the DHF is already prepared just refill the 2000ml beaker with de-ionized water.

2. Hold the wafer with tweezers and immerse into prepared BOE, with gentle agitation, for 30 seconds.

3. Rinse wafers first in the 2000ml beaker filled with DI water for 5 minute.

4. Transfer the wafers from the rinse water to the spin/rinse/dryer wafer carrier. (This should be done quickly to prevent the wafers from drying.) Load the carrier into the spin/rinse/dryer. Rinse for 120 seconds, and dry for 300 seconds. Turn off the nitrogen supply to the dryer when you are finished.

### Task #3: Wafer oxidation:

1. Before performing the wet oxidation step, make sure that:

- The furnace is at 1100° and all 3 sections in the furnace are stable
- The water temperature inside heating mantle is near 100°C (rheostat set at 20) and water is boiling gently.
- The tube from the boiling water flask is indeed connected to the inlet of the oxidation furnace.
- The oxygen is turned on and the float set at 20

2. Transfer wafers from the single carriers into the quartz wafer "boat". Place the wafer “boat” into the quartz carrier. Remove the end cap of the furnace and slide the boat into the furnace with the quartz push rod. (Don't touch any part of the rod that will go in the furnace so as not to introduce any contamination.) To prevent the wafers from breaking due to a rapid temperature change, push the

boat in slowly (approx 5 inches every minute for 5 minutes, use red tape marks on the floor). Oxidize for **120 minutes**.

3. Remove the wafers from the furnace with the quartz push rod (again over 5 minutes time) and set wafers under the hood until completely cooled about 15 minutes.

4. When wafers cooled place them carefully in plastic wafer carriers and mark the carriers with your section and names. This is how wafers will be storted from one laboratory session to another.

## III. Postlab Assignment:

1. Note the colors of the wafers before and after oxidation. What color is your wafer? Can we estimate the thickness of the oxide from the change in color? Explain why? Based on the color of the wafer how thick is the oxide? Are you sure? (see page 55 of the book).

2. Based on the amount of time and oxidation temperature, estimate how much oxide was deposited on the wafers. Figure 3.8 in the book or previous year's lecture notes on oxidation have graphs to help you. Does this agree with the answer in Question 1.

3. What is the resolution of the caliper you used in this lab?

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