

520.495/530.495/580.495 Microfabrication Laboratory

Optical Waveguides

Lab 5: Silicon Oxidation II (Cladding)

This week we continue the fabrication of the Optical Waveguides by fabrication the waveguide cladding out of silicon dioxide. This is going to be a long oxidation and thus the lab assistants will take the wafers out of the furnace. We first remove any residual oxide by performing a BHF etch of the wafers.

Preliminaries:

1. Transfer wafers with tweezers, try to grasp the wafer at the same place each time, usually at the flat edge.
2. Turn on the water supply to cooling coils of the furnace before turning it on. Check for proper flow of water at the drain. Turn it off when done and after the temperature has dropped to below 200°C. Have Nitrogen gas running through the furnace tube while furnace is running without wafers inside, set float tube to 10.
3. Using the spin/rinse/dryer: Turn on nitrogen gas (50 psi). Test the spin/rinse/dryer to make sure that the door seals after pressing start. Line the wafers in the blue wafer holder so that the wafers are far apart. After rinsing and drying, do not open washer door until wafer holder has automatically turned right side up.
4. 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. Based on the design requirements/specifications of 4 micron thick oxide, confirm that the the amount of time necessary to perform dry oxidation at 1100° C, is **30 hours!**

II. LAB WORK:

Task #1: Buffer HF 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.
3. Do a BHF etch until the wafers are free of silicon dioxide (they do not wet in water). 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.
4. Use the calipers to carefully measure the thickness of the wafers.

Task #2: 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 **30 hours**.
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 stored 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. Make suggestions of how to improve the lab procedures (this handout).

<http://www.ece.jhu.edu/faculty/andreou/495/2000/LectureNotes/Oxidation.pdf>

Lab procedure prepared by A.G. Andreou, Fall 2003.