ECEn 550 – MEMS Fabrication Lab Week 5 "Capacitive Switch Part A"

Description

In this lab exercise you will fabricate capacitive switches that will move up and down based on electrostatic forces. If you complete the structures correctly, the switch structure should have an air gap in between a metal layer and a bottom substrate that can be changed by applying voltage to the metal. After making these structures you will be applying voltage and testing for phenomenon like pull-in voltage and capacitive changes. In the modeling portion of the laboratory exercises, you will model the electrical and mechanical behavior of a very similar device.

Capacitive switches will be made using a sacrificial etch process in which reflowed photoresist will be used as the sacrificial material. Aluminum will be used for the main body of the switch. The switches will be formed on a silicon wafer coated with thermally grown oxide. Because the silicon is semiconducting, it will serve as the bottom electrode of the switch while the aluminum will serve as the top electrode. A side view diagram of the process we will use to fabricate capacitive switches is shown below. Below that is a top view diagram of what the switches will look like from above and then a side view diagram of what the switches will look like as various voltages are applied.



Top View Diagram of Capacitive Structure

Diagram of Capacitive Switch Structure at two different voltages

Major Objectives

- <u>Photoresist Patterning.</u> Obtain a wafer from the T.A. that has 500 nm of thermal oxide grown on it. Make sure the oxide has been removed from the wafer's back side. Dehydration bake your wafers in the dehydration bake oven for at least 7 minutes at 150° C. Spin on AZ3330 photoresist using the photoresist spinner and soft bake for 60 sec on a hotplate at 90°C. Load wafers into the aligner along with the 1st capacitance switch device mask which is labeled EE550 Mask 1 PR on the bottom. Expose the resist for 10 seconds. Develop the pattern for 40 seconds (or until the exposed resist is gone) in MIF300 developer.
- 2. <u>Resist Reflow</u>. Heat the patterned photoresist on a hot plate at 115°C for 2 minutes. This will allow the photoresist to liquefy and flow into a rounded shape. This rounded shape will be easier to coat with aluminum. After this reflow, descum the wafers for 15 seconds with oxygen plasma in the PEII parallel plate etcher.
- 3. <u>Metal Evaporation</u>. Using the thermal evaporator, evaporate 500 nm of Aluminum on a 4 inch silicon wafer (or as much aluminum as you can using three boats). It is important to rotate the planetary fixture while the deposition is taking place to ensure that you get an even and conformal aluminum coating.
- 4. <u>Photoresist Patterning II.</u> Spin on HMDS and then AZ3330 photoresist using the photoresist spinner and soft bake for 60 sec on a hotplate at 90°C. Load wafers into the aligner along with the 2nd capacitance switch device mask which is labeled EE550 Mask 1 AL on the bottom. Align this mask to the original features already on the wafer. Expose the resist for 10 seconds. Develop the pattern for 40 seconds (or until the exposed resist is gone) in MIF300 developer.
- 5. <u>Etching Aluminum</u>. Aluminum etching will be done using a special mixture of acids that includes phosphoric acid. Essentially etching will take place by immersing a wafer coated with aluminum into an etch solution. Place your wafer in the aluminum etchant at heated to 50°C. It should be obvious when all the aluminum has etched the portions not covered with resist because they will appear black. Rinse your wafer thoroughly in deionized water and examine the pattern under a microscope to make sure all the aluminum was etched away.
- 6. <u>Sacrificial Photoresist Etching</u>. Cleave your wafer in half. Place ½ of your wafer in a dish containing acetone for 25 minutes. This should remove the photoresist over the top of the aluminum pattern as well as that below it. When the resist is gone, move the wafer into a dish of isopropanol, and then dry using the Critical Point Dryer (CPD). Place this part of your wafer into a wafer holder ready for testing during the next week's lab. Place the other ½ of your wafer back in the cassette without removing the resist. It will be a backup in case something goes wrong on the first piece.