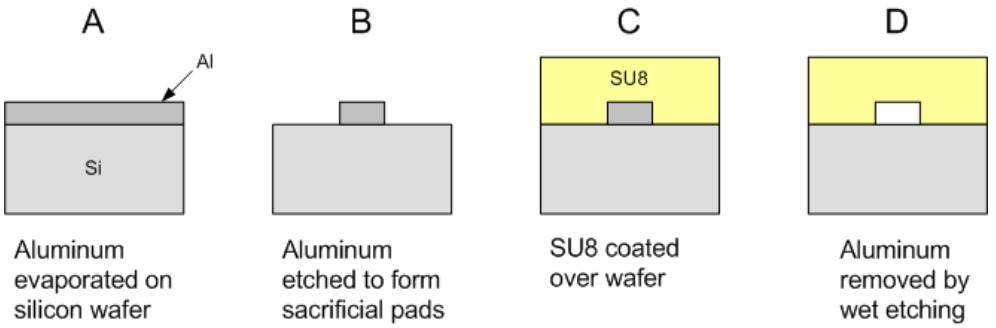
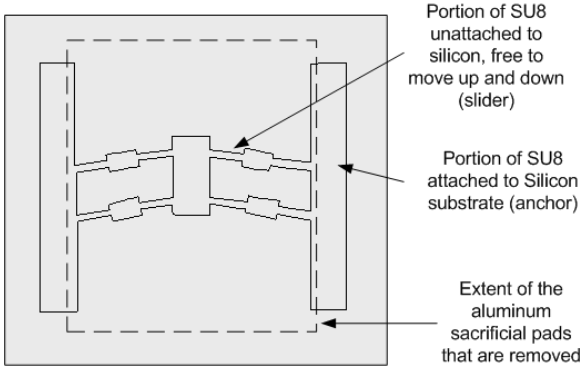
ECEn 550 – MEMS
Fabrication Lab
Week 3
"Compliant Mechanisms Part A"

Description

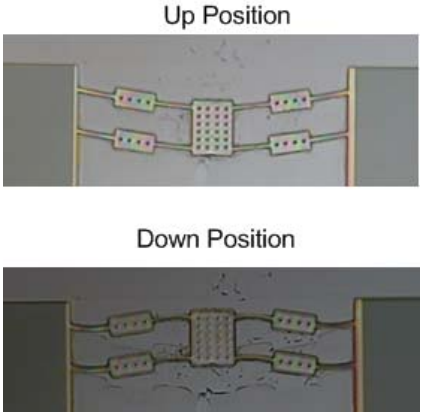
In this lab exercise you will fabricate polymer based compliant mechanism structures using sacrificial etching. If you complete the structures correctly, you should be able to move them back and forth with a micro-probe tip and watch them switch from one stable position to another. By the time you reach this lab activity, you will have learned about the principles and designs behind the compliant mechanism switch in the modeling portion of these lab exercises, and so only a brief description of the structure and materials used to make the switches will be given here.

Compliant switches will be made using a sacrificial etch process in which aluminum will be used as the sacrificial material. SU8, a photodefinable epoxy polymer will be used for the main body of the switch. The anchored portion of the switch will be attached directly to a silicon wafer. The main process steps are shown in the diagram below, which illustrates what is happening to a cross section of a device. A top view diagram is also shown along with photos of completed compliant mechanisms.





Top View Diagram of Compliant Mechanism Structure



Photographs of fabricated SU8 Compliant Mechanisms switched up and down

Major Objectives

1. Metal Evaporation. Using the e-beam evaporator or thermal evaporator, evaporate 500 nm of Aluminum on a 4 inch silicon wafer. (The beginning lab group for the day should do at least 2 wafers, one for them, and one for the group following). Obtain wafers from the lab T.A. who will also assist you with deposition if you need help.

2. Photoresist Patterning. Dehydration bake your wafers in the dehydration bake oven for at least 10 minutes at 120°C. Spin on HMDS, followed by 2020 photoresist (~2um thick) using the photoresist spinner and soft bake for 60 sec on a hotplate at 110°C. Load wafers into the aligner along with the 1st compliant mechanism device mask which is labeled MEM SAC CORE on the bottom. It appears as simply squares. Expose the resist for 8 seconds. Develop the pattern for 60 seconds (or until the exposed resist is gone) in MIF300 developer.

3. Etching Aluminum. 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. When you are satisfied, remove the resist from your wafer using the solvent chemical cleans. Then, using the PEII, do a one minute O2 Plasma Descum at 200-250 W.

4. SU8 Patterning. Dehydration bake your wafers in the dehydration bake oven for at least 10 minutes at 120°C. Spin on SU8 25 (~30 um thick) using the Headway or Polyimide spinner. Soft bake at 65°C for 9 minutes, then ramp up to 95°C for 9 minutes. Load wafers into the aligner along with the 2nd compliant mechanism device mask, which is labeled MEM STRUCTURE on the bottom. Expose the SU8 for 45 seconds. Bake again at 65°C for 8 minutes, and ramp up to 95°C for 9 minutes. Develop the pattern for 2 minutes (or until the unexposed SU8 is gone) in SU8 developer. (SU8 is a negative resist so the portions that are exposed will remain). Do the following heat treatment to SU8 using a hot plate: 190°C for 3 minutes. The fabrication process can stress the legs of the devices so that they may crack at the joints, this heating process will cause the cracks to disappear.

5. Sacrificial Aluminum Etching. Place your wafer in a dish containing aluminum etchant. We want the sacrificial etching to go fairly slowly so **DO NOT** heat up the aluminum etchant. Leave the wafer in the dish for 24 hours. Make sure you put a cleanroom towel under the dish explaining what it is. After 24 hours, the TA will remove your wafer from the Aluminum etchant, rinse it in DI water, allow it to dry, and then place it in your group's storage box in the cleanroom.