EE485A: Introduction to Microsystems
Laboratory Exercise 4: The Use of Standard Processes

One way to economically prototype a microsystem is to make use of a multi-user process such as MOSIS CMOS or MUMPS. Companies provide a pre-determined processing sequence and the customers provide the mask design. The company combines the mask submissions from the different customers and runs the process on a large batch of wafers. At the end of the process, the wafers are diced into individual chips and sent back to the customers. The advantage of such a system is that users get access to a professional-level process which is well characterized and clearly defined. The disadvantage of a multi-user process is that the user loses design flexibility (the user can no longer set layer thicknesses or doping levels, for example), and scheduling flexibility (the mask design deadline and processing time are pre-determined and there are normally only 3-4 design cycles a year, each of which take 2-3 months).

In this lab you will design a structure to be fabricated through the MEMSCAP PolyMUMPS process. Your deliverable is a mask set, executed in MEMS Pro, that meets all of the design rules for the PolyMUMPS process, as well as a report which explains your design, shows the predicted 3D structure, and includes the design equations and calculations that you used to determine your device dimensions. You may work in teams of two or three.

Problem Option 1: A piezoresistive accelerometer for a gaming system

Typical acceleration levels associated with waving a baton are 1 to 10g. Determine a way to implement an accelerometer in the PolyMUMPS process that uses piezoresistive sensing. (Use the Poly1 layer for your tether or spring part of your design and assume that the gauge factor for this layer is about -15.) For your design, verify that it has the desired dynamic range (i.e. the proof mass shouldn't hit a block before 10g of acceleration is reached), and estimate the "raw" signal values for no acceleration and 10g of acceleration, assuming a 9V battery is used as the power source. (To complete the system, you could then use an electronics circuit to amplify the signal, but you needn't design the electronics portion for this lab). Only worry about acceleration in one direction. (You could always combine 3 accelerometers in your final packaging to get 3D)

Problem Option 2: A hinged mirror

By now you have a sense of how most MEMS structures are fairly two-dimensional. One way around this is to create structures that can be folded up out of the plane after release. Design a mirror that will be 500 μm by 500 μm in area, and will be oriented orthogonally to the substrate when fully assembled. To do this, you should create a hinge at one edge and also include additional folds that can be rotated into place to hold the mirror up during assembly. Include a description of how you could assemble the mirror using a sharp probe on a micromanipulator, such as we have in our clean room. Some images to get you thinking are shown below: