Lecture 7: Surface Micromachining I

- Announcements:
  - HW#2 due Thursday, 2/21 at 9 a.m.
  - Surface Micromachining Module 5 & Handouts online

- Today:
  - Senturia, Chpt. 3; Jaeger, Chpt. 2, 3, 6

Lecture Topics:
- Example MEMS fabrication processes
- Photolithography
- Etching
- Oxidation
- Film Deposition
- Diffusion
- Ion Implantation

- Reading: Senturia Chpt. 3, Jaeger Chpt. 11, Handouts: “Surface Micromachining for Microelectromechanical Systems”, “Etch Rates for Micromachining—Part II”

Lecture Topics:
- Polysilicon surface micromachining
- Stiction
- Residual stress
- Topography issues
- Nickel metal surface micromachining
- 3D “pop-up” MEMS
- Foundry MEMS: the “MUMPS” process
- The Sandia SUMMIT process

- Last Time: Diffusion section of Module 4
• **Straight or Sloped Sidewalls:**
  - Often want sloped sidewalls in order to reduce the sharpness of corners
    - Easier to deposit over
    - Sharp corners concentrate stresses
    - High stress can weaken structures creating a reliability concern
    - High stress can dissipate energy, lowering Q
  - When you want straight sidewalls (e.g., for lateral electrostatic drive), use a hard mask
    - PR can’t last for thick structures
    - A hard mask suppresses angle transfer

**Etching Sloped or Straight Sidewalls**

**Assume: perfectly anisotropic etch**

- Straight sidewalls

**Reality:** PR will be stopped

**Anisotropic Etch (still)**

- Result: straight sidewalls

**Remarks:**
1. If want sloped sidewalls → can expose the PR

Put if can’t straight sidewalls: for $S_{\text{SiO}_2}$ high

- Hard mask
- Side

- Result: straight polySi sidewall