Deep Reactive-Ion Etching (DRIE)

The Bosch process: ← High Density Plasma

- Inductively-coupled plasma
- Etch Rate: 1.5-4 μm/min
- Two main cycles in the etch:
  - Etch cycle (5-15 s): SF_6 (SF_x^+) etches Si
  - Deposition cycle: (5-15 s): C_4F_8 deposits fluorocarbon protective polymer $(CF_2^-)_n$
- Etch mask selectivity:
  - SiO_2 ~ 200:1
  - Photoresist ~ 100:1
- Issue: finite sidewall roughness
  - scalloping < 50 nm
- Sidewall angle: 90° ± 2°

Mask
Silicon
Polymer(nCF2)

DRIE Issues: Etch Rate Variance

20μm

- Etch rate is diffusion-limited and drops for narrow trenches
  - Adjust mask layout to eliminate large disparities
  - Adjust process parameters (slow down the etch rate to that governed by the slowest feature)

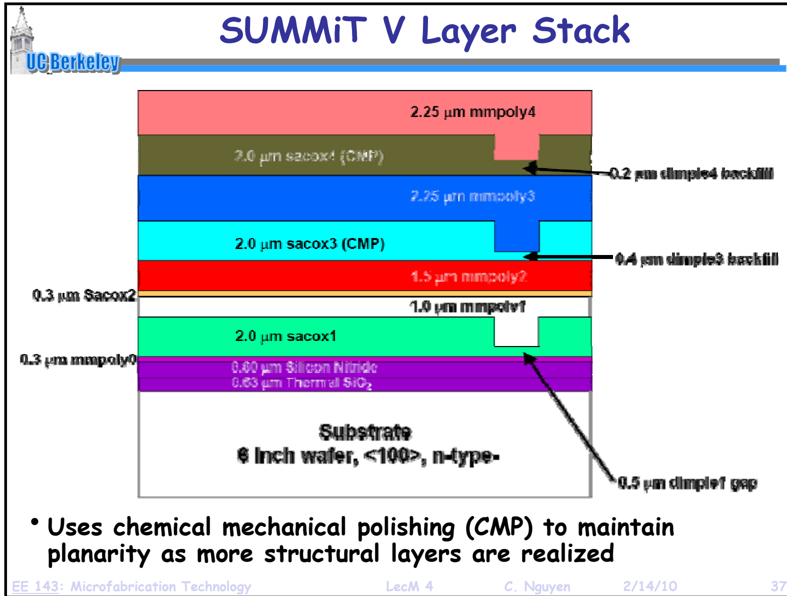
Aspect Ratio: ∞ 15 7.5 5.0 3.8 3.0 2.5 2.1 1.9
Etch Rate (μm/min)
Trench Width (μm)
Etch rate decreases with trench width

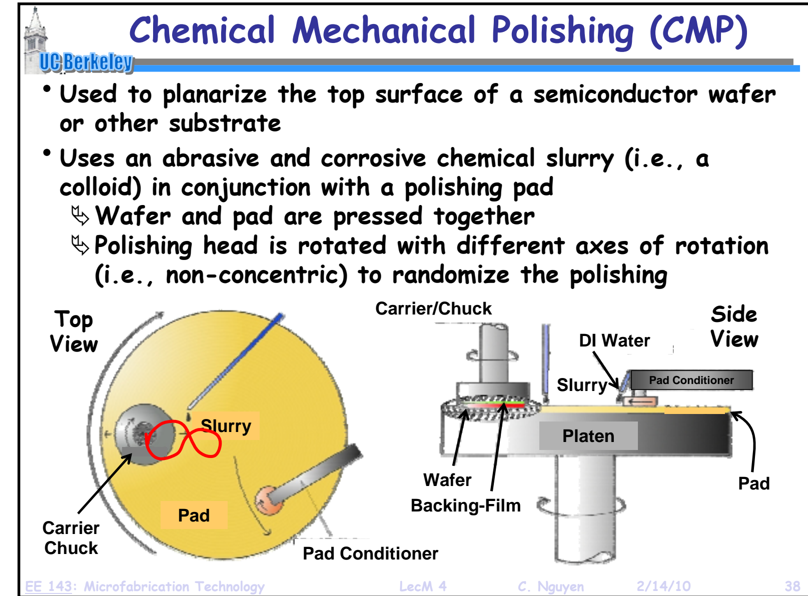
Chemical Mechanical Polishing (CMP)

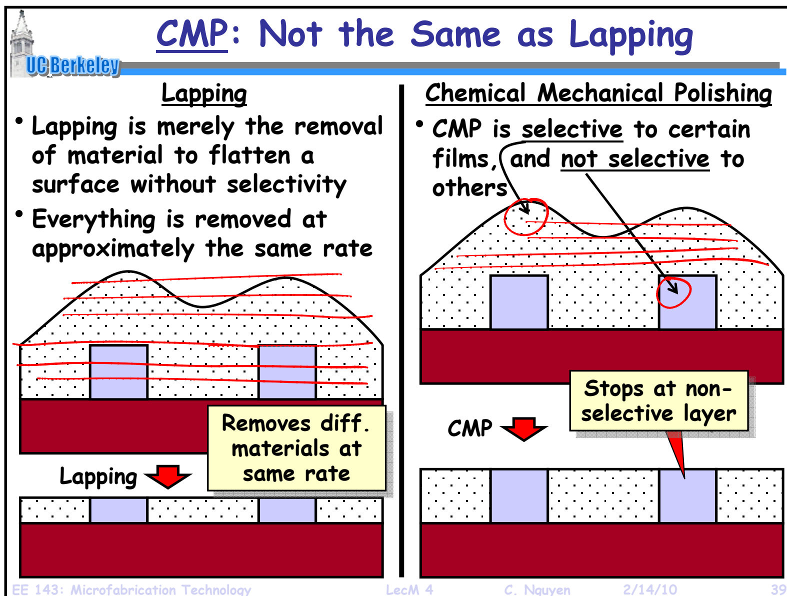
Sandia's SUMMiT V

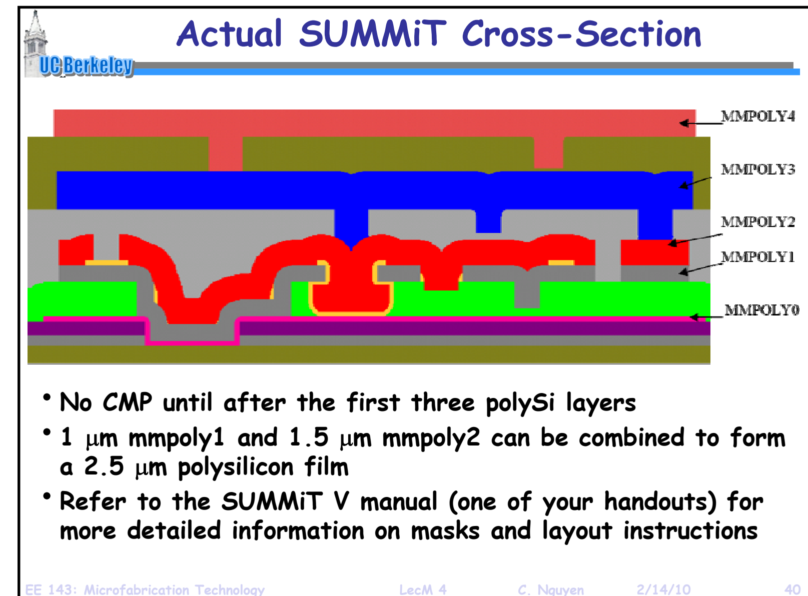
- SUMMiT V: "Sandia Ultra-planar Multi-level MEMS Technology 5" fabrication process
  - Five-layer polysilicon surface micromachining process
  - One electrical interconnect layer & 4 mechanical layers
  - Uses chemical mechanical polishing (CMP) to maintain planarity as more structural layers are realized
  - 14 masks

Copyright @ 2010 Regents of the University of California at Berkeley









Copyright @ 2010 Regents of the University of California at Berkeley