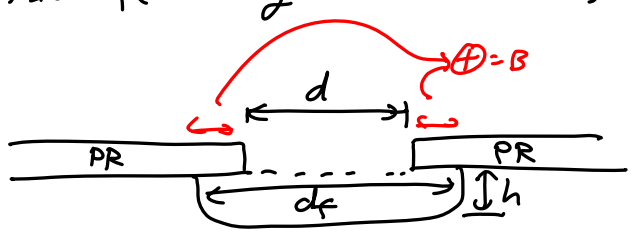
Lecture 13: Film Deposition III

- Announcements:
- HW#6 due tomorrow at 8 a.m.
- HW#7 online; will be due next Friday at 8 a.m.
- I'm traveling starting Wednesday; back next week
- Wei-Chang will give lecture on Thursday
- ---
- Lecture Topics:
  - Etching
    - Anisotropy
    - Selectivity
      - Deep Reactive Ion Etching (DRIE)
    - Wet Etching
    - Dry Etching
      - Plasma Etching
      - Reactive Ion Etching (RIE)
- ---
- Last Time:

① Anisotropy -

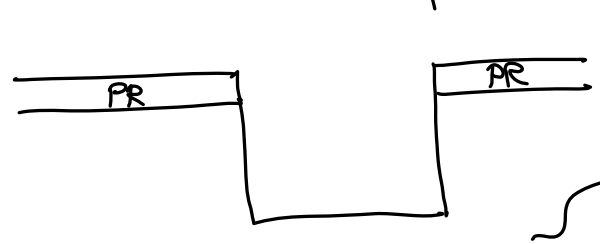
(a) Isotropic Etching: (most wet etches)



If 100% isotropic: $d_f = d + 2h$

Define. $B = d_f - d$ (total undercut)

If $B = 2h \Rightarrow$ 100% isotropic



Degree of Anisotropy: (definition)

$A_f = 1 - \frac{B}{2h} \rightarrow = 0$ if 100% isotropic

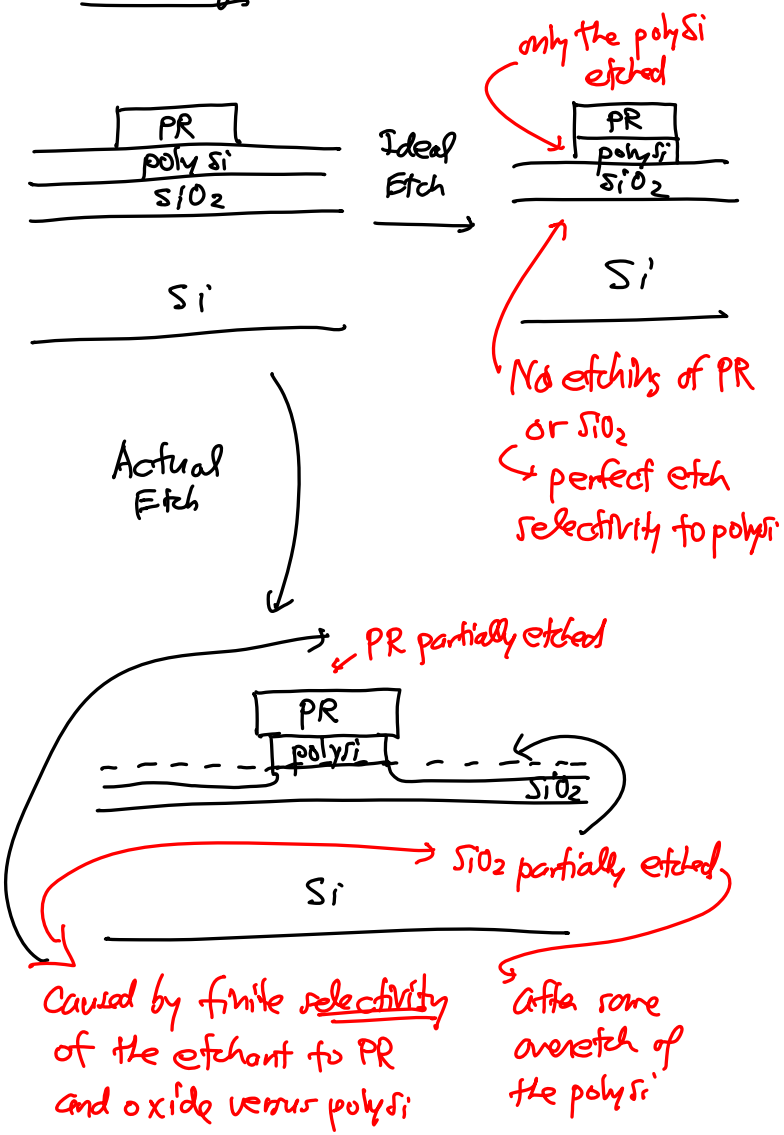
in general $0 \le A_f \le 1$

100% anisotropic

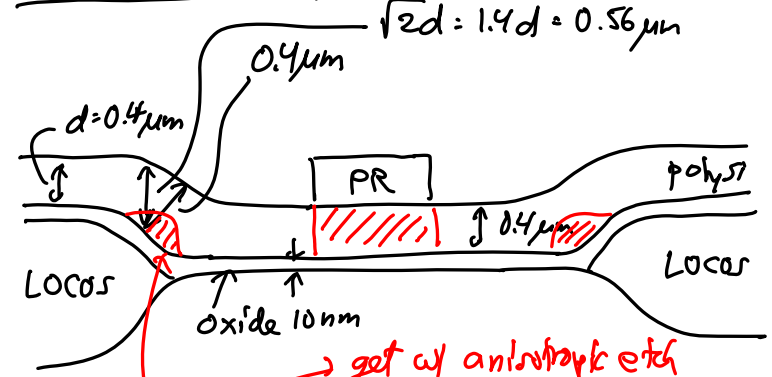
over

Copyright © 2014 Regents of the University of California

② Selectivity -



Why overetch the poly Si?



"stringer" → get w/ anisotropic etch
→ need to remove
→ otherwise, it will short many devices!

Caused by topography

Thus, must overetch $0.16\mu m$ of polySi → 40%

40% overetch → $(0.4\mu m)(0.4) = 0.16\mu m$ polySi
= ??? oxide

Depends on the selectivity of the etchant to polySi versus oxide

Copyright © 2014 Regents of the University of California

Define Selectivity to A over B:

$$S_{ab} = \frac{E.R._a}{E.R._b}$$

$E.R._a$ ← etch rate of etchant to A

$E.R._b$ ← etch rate of etchant to B

S_{ab} ← selectivity of A over B

e.g., wet polysilicon etch ($HNO_3 + NH_4F + H_2O$)

$S_{polySi/SiO_2} = \frac{15}{1}$ (very good selectivity)

$S_{polySi/PR}$ = very high

↳ (but be careful: PR can still peel off for > 30 min.)

e.g., polysilicon dry etch:

$S_{polySi/SiO_2} = \frac{5\to}{1}$ ← "regular" RIE

→ depends on the type of etcher

very high density plasma → ECR: 30:1

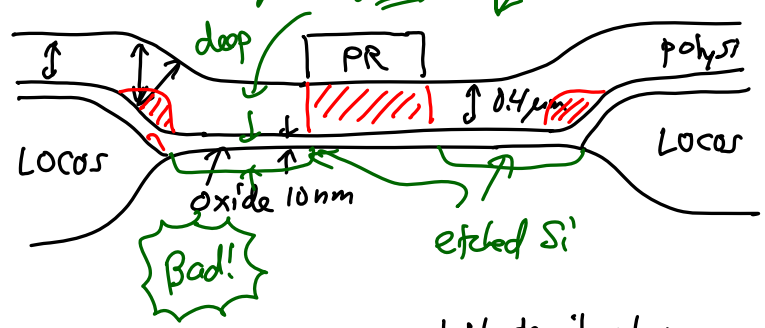
DRIE: 100:1 (or better)

"Deep Reactive Ion Etch" → Bosch process

If $S_{polySi/SiO_2} = \frac{8}{1}$ ⇒ 40% overetch removes:

$\frac{0.16\mu}{8}$ = 20 nm oxide!

This etches all polySi, then goes thru 10 nm of oxide, then etches the Si substrate in a hurry + very fast!



w/ better selectivity:

e.g., $S_{polySi/SiO_2} = \frac{30}{1}$ (ECR Etcher) ← high density plasma

40% overetch removes $\frac{0.16}{30}$ = 5.3 nm (better)

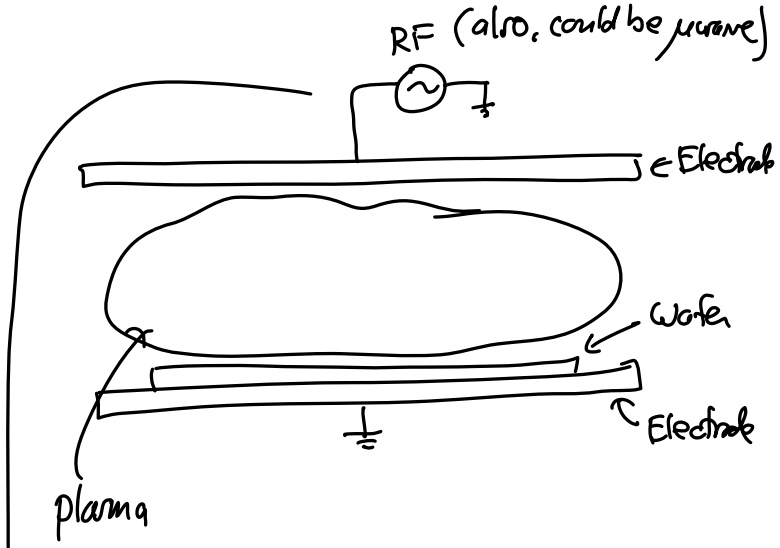
- Now, go through the "Wet Etching" slides in Module 4

Copyright © 2014 Regents of the University of California

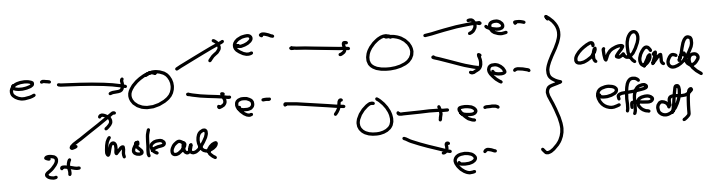
Dry Etching

- Physical Sputtering
- Plasma Etching
- Reactive Ion Etching

} All based on plasma processes.



RF Energy → inelastic collisions between e⁻'s & molecules → (+) ions



Copyright © 2014 Regents of the University of California