EE245 Discussion 10/4/10

Thursday, September 16, 2010
5:10 PM

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Office hours:
10:30-12 on Tuesdays in Cory 481

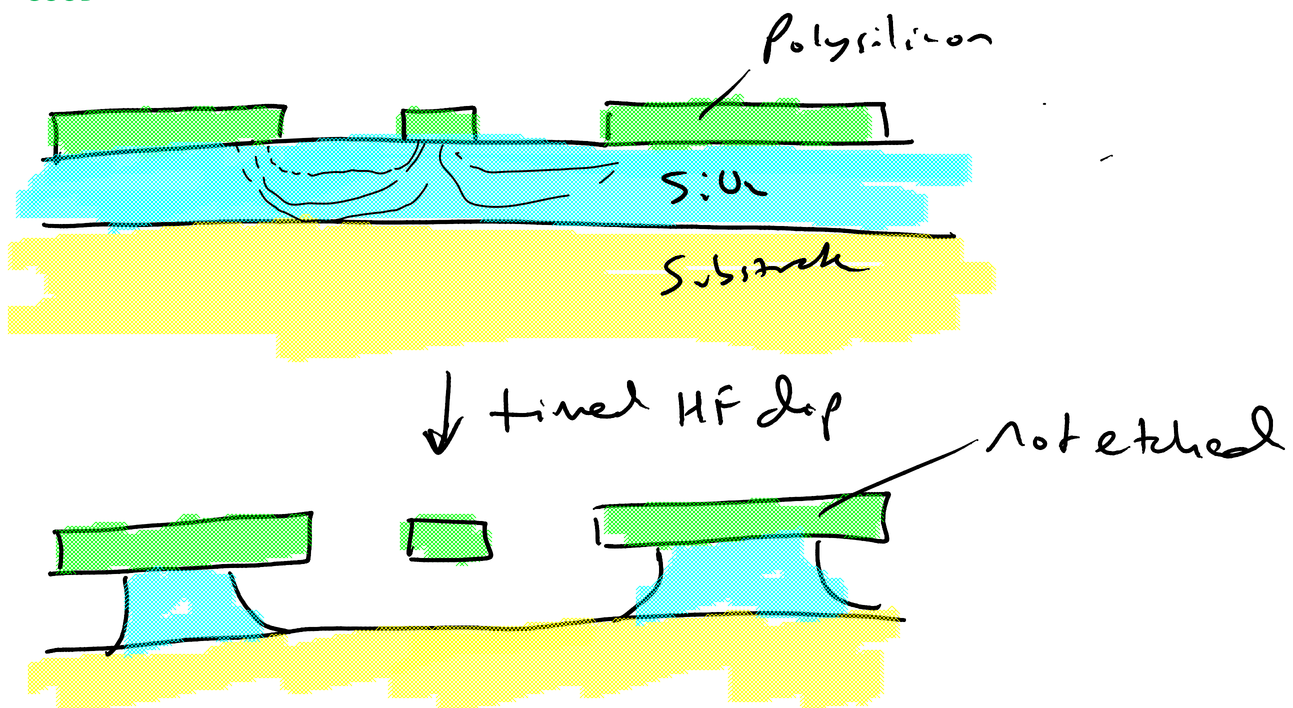
Today:
Selectivity and overetching
Etch-back
Liftoff
Anisotropic wet etching (KOH) of silicon
Electroplating

HW Tips
Process flow problems - general approach
Stiction equation, briefly

Selectivity

Selectivity refers to the relative etch rates of different materials or directions for an etching step.
In most cases, we desire infinitely selective etching. Sometimes, this is achievable.

Example: When using HF to etch SiO_2, Si is not etched at all.
==> GOOD



Sometimes, this is not what we get.

Example: How can we etch silicon carbide (SiC)? Photoresist won't work (it gets etched too… but faster).

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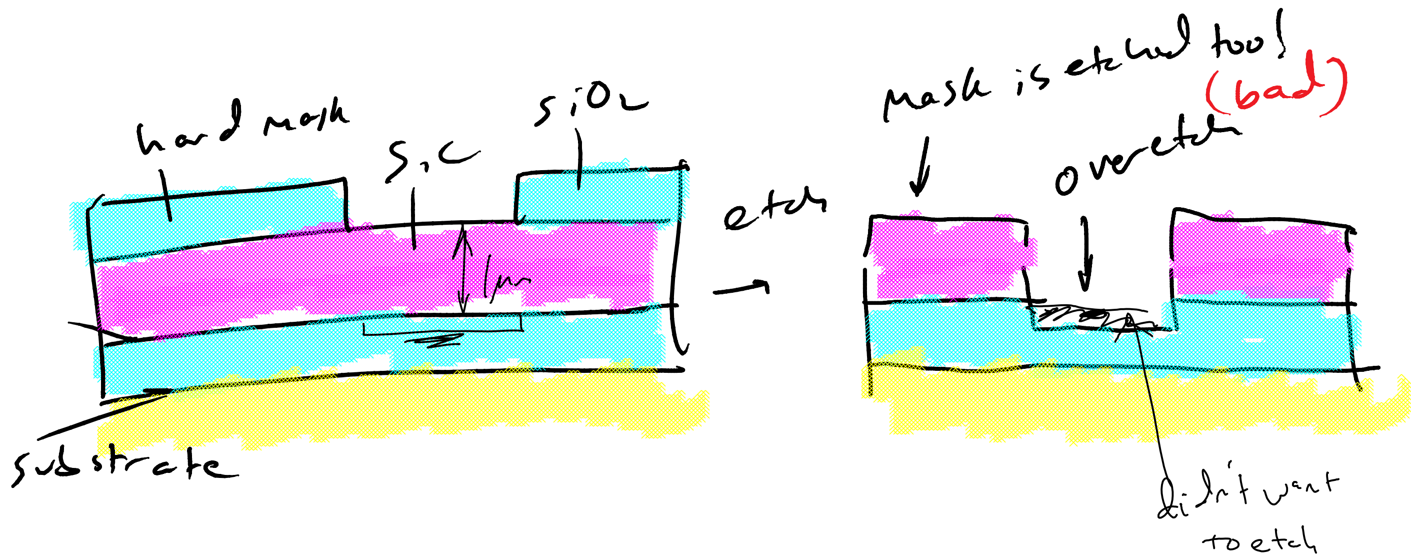
Solution: Use a hard mask other than photoresist, (which itself is patterned using photoresist).

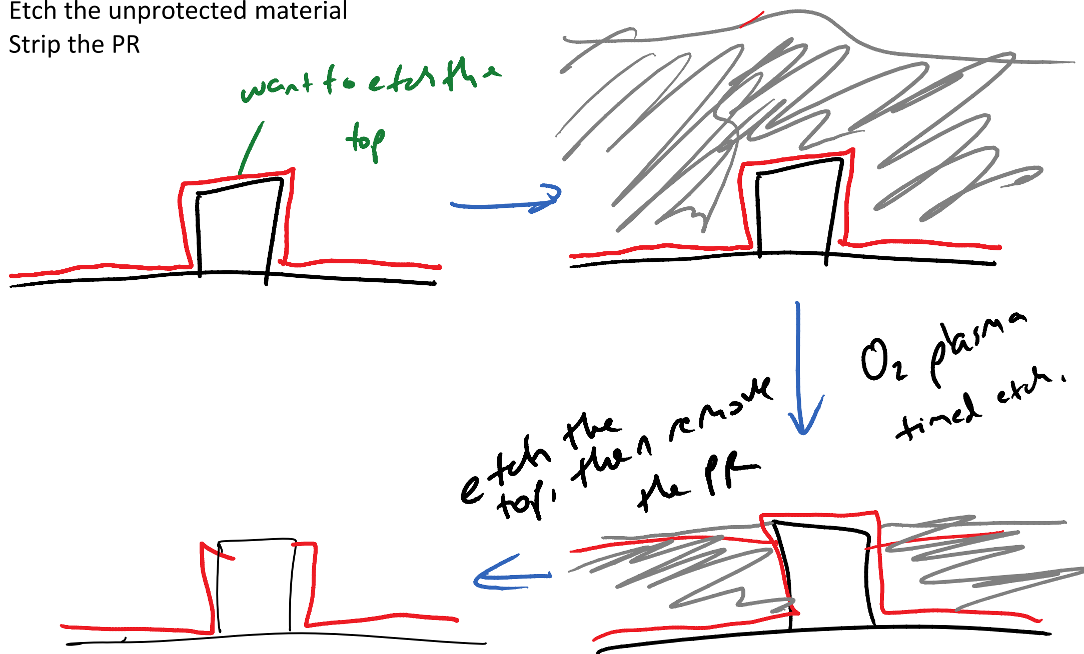
We can use an SiO_2 hard mask.
Problem: 1.5 to 1 selectivity of SiC to SiO_2. (==> BAD)



***Even better solution: Use a nickel hard mask instead (the selectivity of SiC to nickel is higher). Unfortunately nickel is not allowed in some etching chambers because it might contaminate other peoples' projects.*

<u>Etch-back</u>

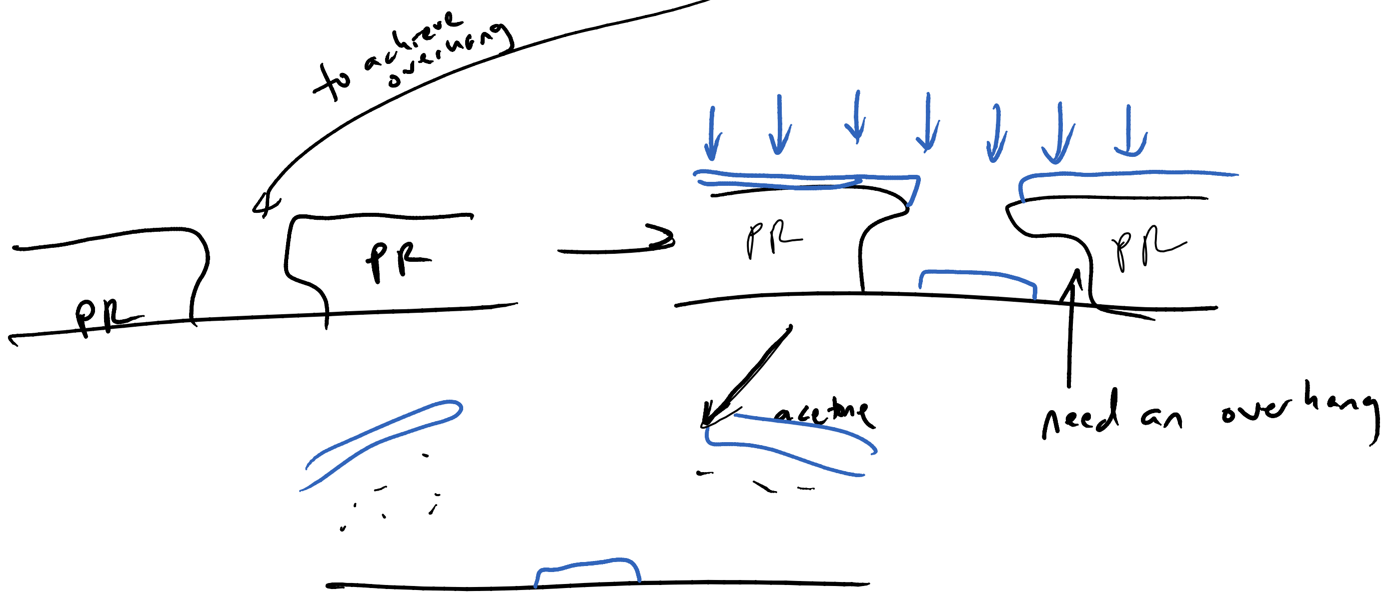
Deposit thick PR
Use a timed O_2 plasma etch to remove some of the PR to expose the top of a structure
Etch the unprotected material
Strip the PR



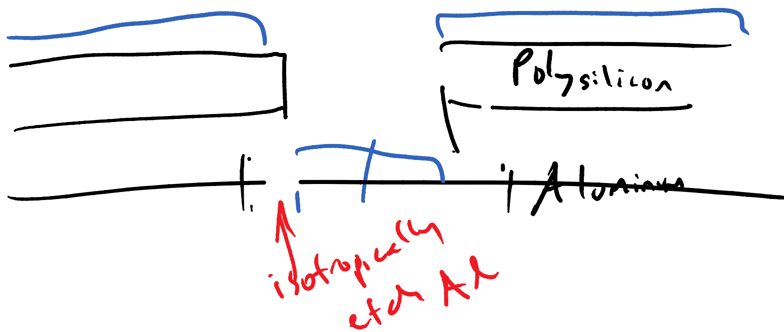
Lift-off

Problem: Some materials are difficult to etch without attacking the substrate. Or, we just want to pattern a material without etching.

Solution: Deposit and remove the material using liftoff instead. No etching required.
Method:
-Deposit PR first, expose (using a negative mask), soak the PR in chlorobenzene for ~5 minutes, develop.
-Deposit the material using a highly direction deposition method ~~(e.g. evaporation~~)
-Remove the PR with acetone.



Alternative method:
-Use an aluminum/polysilicon bilayer structure to make a better "umbrella"



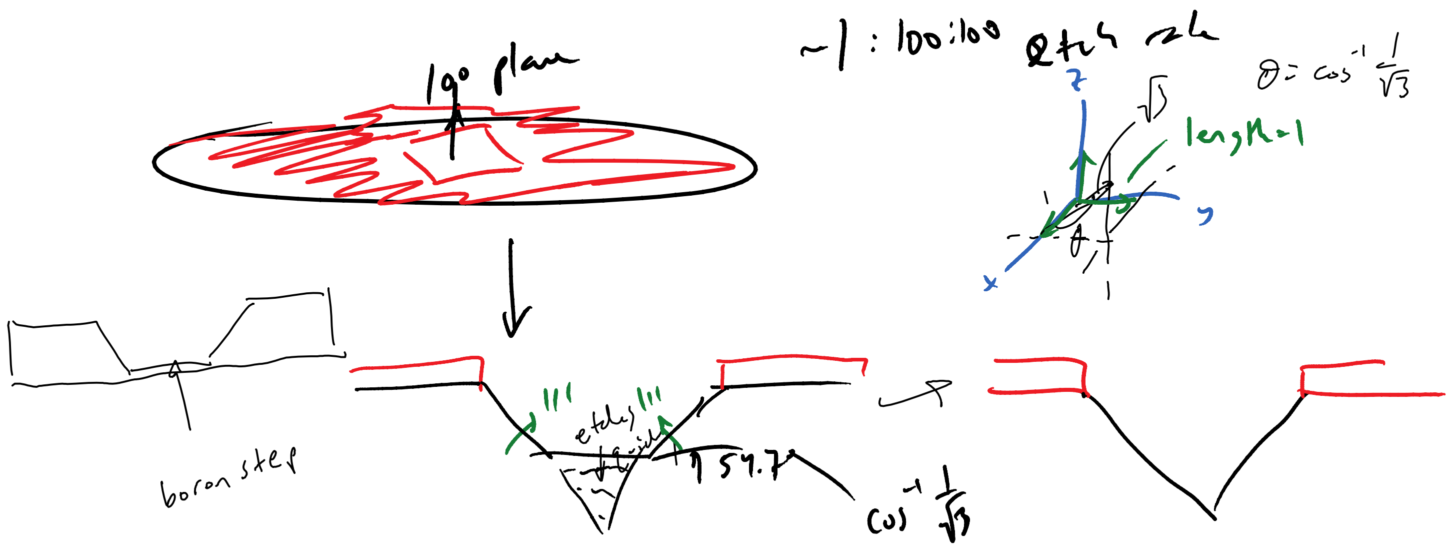
Bulk Micromachining

It is often useful to etch deep into the silicon wafer.

Example: Create a membrane with a precisely controlled thickness (use a boron etch stop).

KOH is an anisotropic etchant for Si,

(111) (100) (110)



Electroplating (deposition method for many metals)

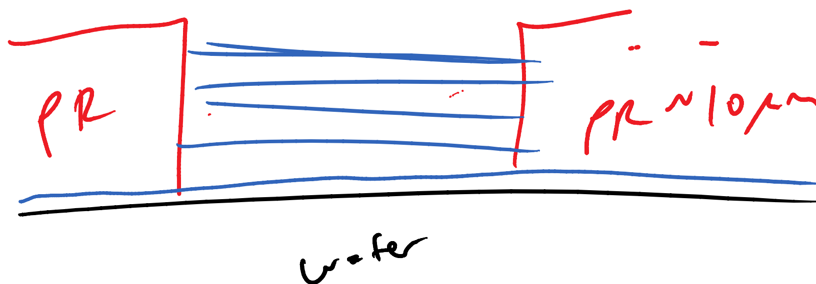
Place the wafer in a solution containing ions of the material to be electroplated.

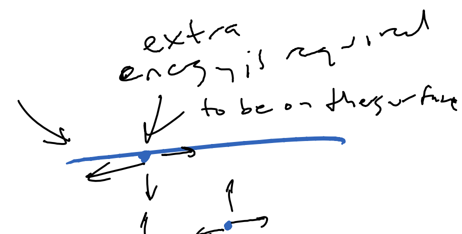
One ion from the solution and one or two electrons combine to form a deposited atom.

Need a potential difference between the wafer (cathode) and an electrode placed in the solution (anode)

Need a seed layer upon which the metal can grow

Need a mold to confine the growth of the metal. (Typically, use photoresist and a dark field mask)





HW #3 tips:

Processing question - draw the cross section

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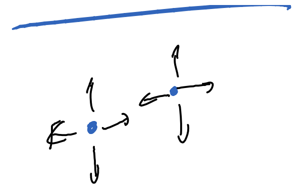

Processing question - draw the cross section

-You don't really need to draw the photoresist while building your cross section, *usually*.
-Focus on the thicknesses of the materials being deposited, and the masks used to etch.
-Identify CF/DF masks, and whether etch steps are anisotropic or isotropic.

Stiction equation:

$$F_{stiction} = \frac{2\,A\,\gamma_{la}\cos(\theta_c)}{g}$$

A is the area
γ_{la} is the surface tension at the liquid air interface ~ [N/m] = [J/m^2]
θ_c is the contact angle (dependent on liquid, air, solid, temperature and pressure, and also whether the liquid is receding or advancing)
g is the gap

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