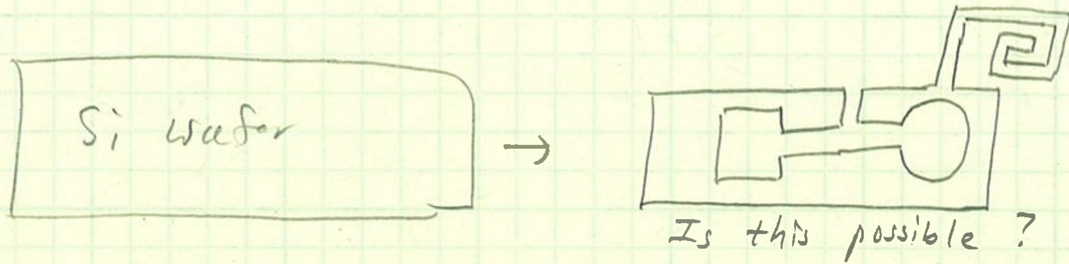
1. Points to Consider Regarding Microfabrication

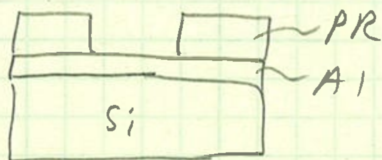
→ What can we really build?



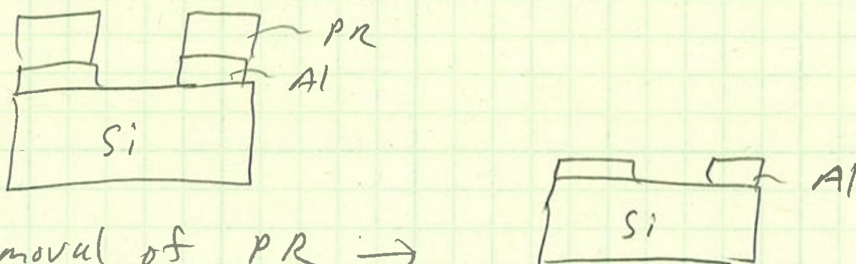
→ most MEMS processing consists of depositing thin layers, masking with thin layers, and etching thin layers

ex: (1) 1μm Al on Si wafer

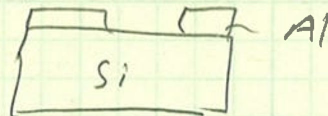
(2) Photolithography to define a pattern of exposed Al



(3) Timed chemical etch of exposed Al



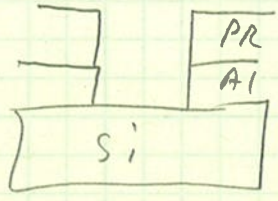
(4) Removal of PR →

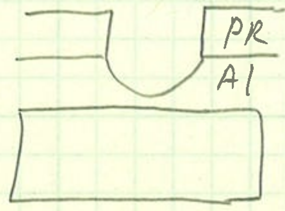


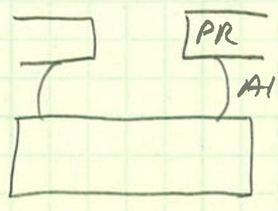
a. Etching Issues

① → Most etching processing are timed: etch rate of μm/min

ex: Desired — Underetching — Over etching

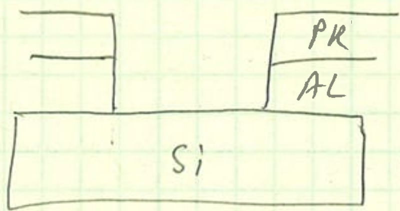




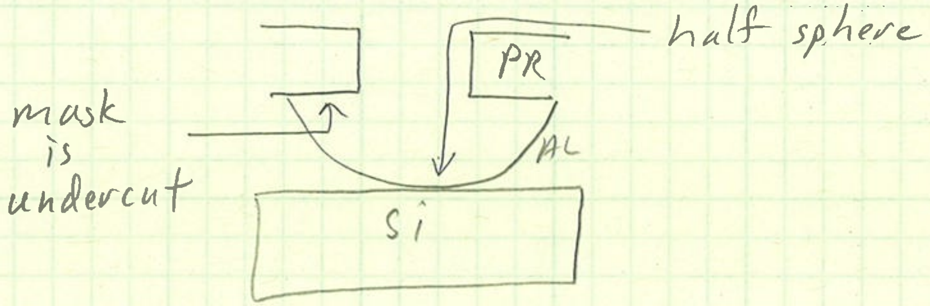


Pure Anisotropic etch: etches in only one direction

ex:



Pure Isotropic etch: etches equally in all directions



All etch processes fall somewhere between pure anisotropic and pure isotropic

② Selectivity

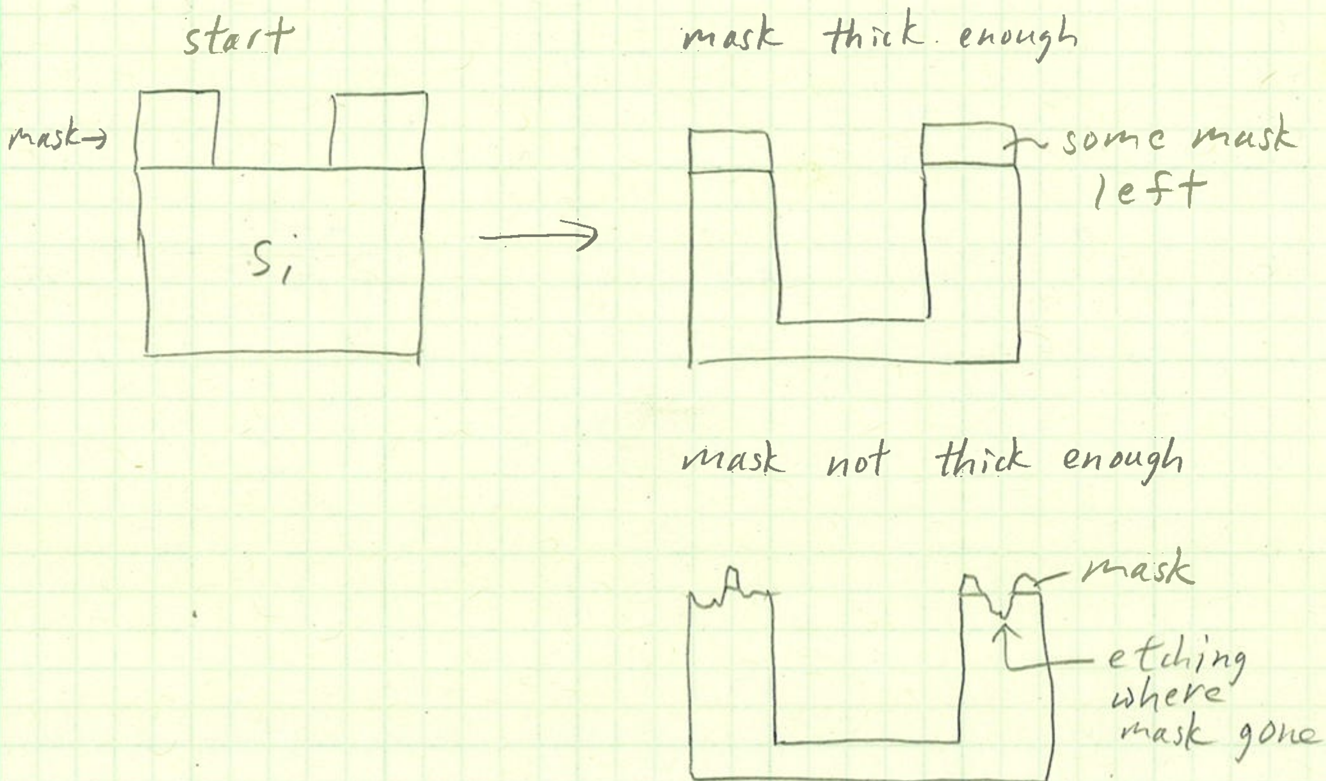
def: the ratio of the etch rate of the material you desire to etch, compared to the etch rate of other materials

TOPS

→ In particular, the selectivity of the etchant with regard to the mask material

ex: suppose a certain Si etch process has a 10:1 etch selectivity with the mask material, and you desire to etch 100μm into Si

∴ your mask needs be greater than 10μm

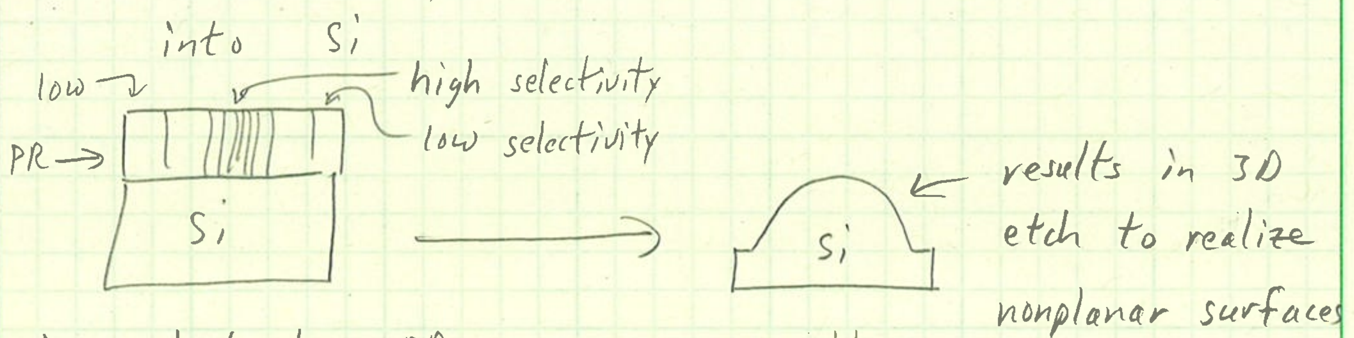


→ Important to make sure your etchant does not adversely affect other materials on your wafer

ex: Si, SiO_2, SiN, various metals (Cu, Al, etc), etc.

Note: One person's "problem" may be another person's "solution"

ex: Grayscale Lithography → vary PR structure (i.e. selectivity) to etch non-planar structures into Si



low selectivity → PR goes away quickly

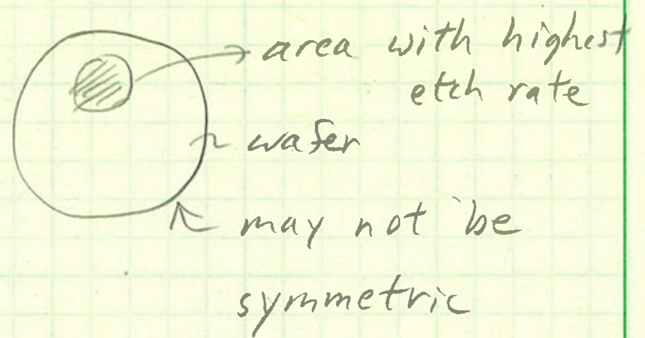
high selectivity → PR goes away slowly

③ Backside protection

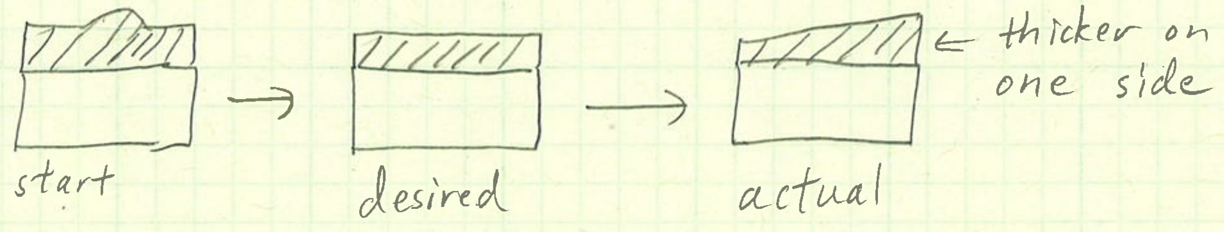
→ Remember to mask backside of substrate during frontside etch process if etchant could damage backside of wafer or structures on it.

④ Non-uniform etch rate

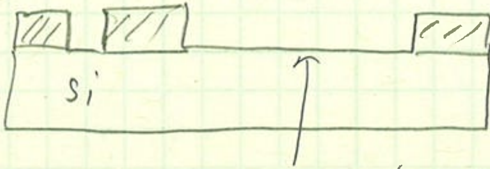
→ some processes have a sweet spot with highest etch rate. ex: DRIE



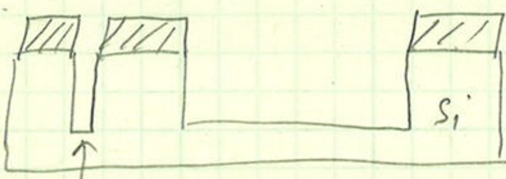
ex: substrate polishing



Features may cause etch rate to vary:



etch rate may slow here due to lack of reactive chemicals (used up due to big etch area)

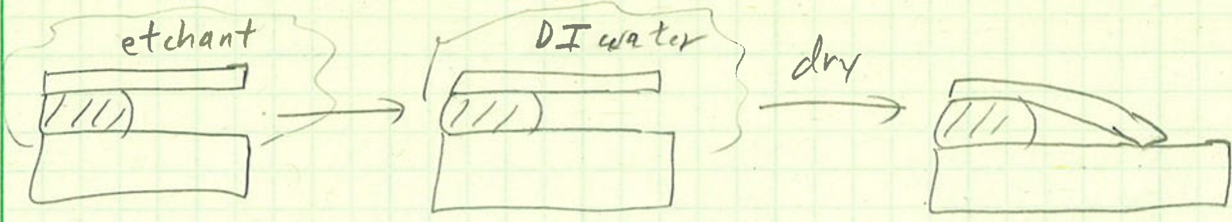


etch rate may slow here due to lack of reactive chemicals (new reactive chemicals slow to get into narrow deep feature)

⑤ Etchant Removal

→ wet etchant chemicals must be removed after timed etch

→ generally replaced with inert chemicals: DI water, isopropyl alcohol, etc.



surface tension of drying liquids can pull micro-structures into contact, where they stay permanently stuck together → stiction

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