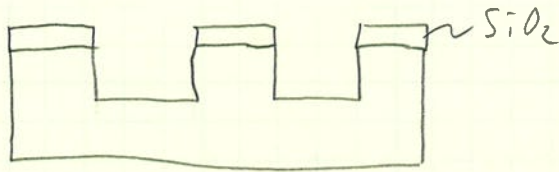
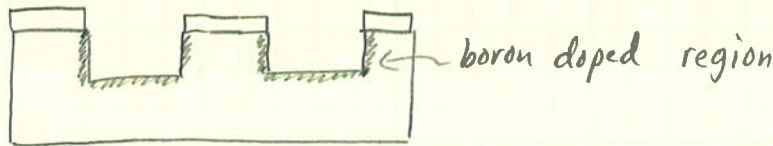


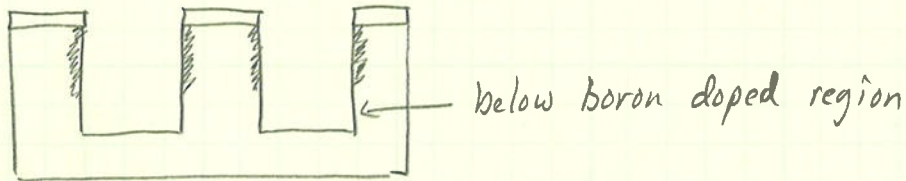
② DRIE to a desired depth



③ Boron diffusion doping \rightarrow heavily doped Si \rightarrow Conformal coating

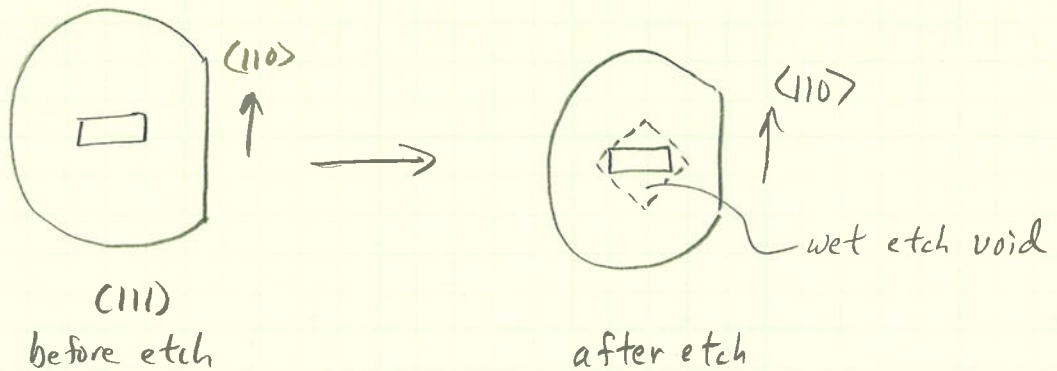
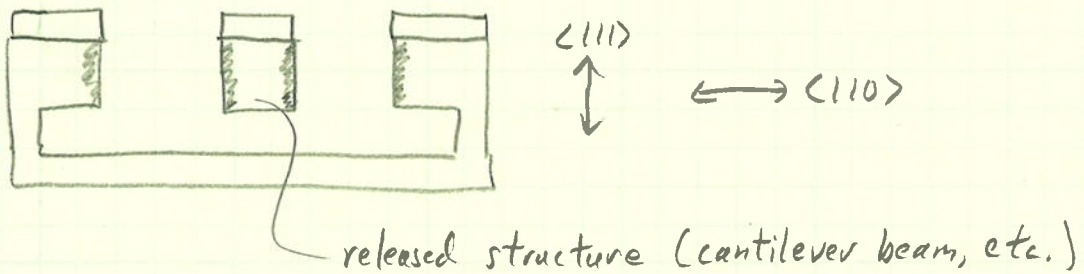


④ More DRIE



heavily doped Si resists anisotropic wet etching

⑤ Timed wet anisotropic wet etch (etches much faster in undoped regions)

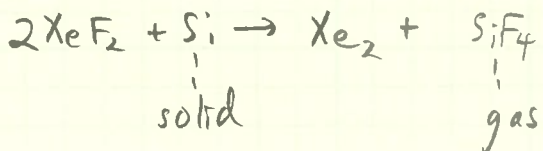


3) ~ Isotropic Etches

1) Wet Etch → HNA → mixture of HF, Nitric acid and Acetic acid

2) Dry Etch → XeF₂ and BrF₃

XeF₂ → use in a vacuum chamber



danger: XeF₂ + H₂O → HF + ...

4) Native Oxide

At room temp → thin SiO₂ layer forms on exposed Si ~ 40Å thick

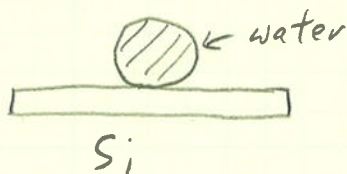
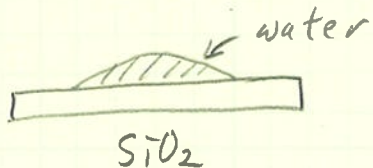
→ Native oxide can prevent some wet or dry Si etching

∴ Native oxide can be removed by quick dip in

HF solution

→ Test → SiO₂ → hydrophilic → water wets

→ Si → hydrophobic → water does not wet, but beads up



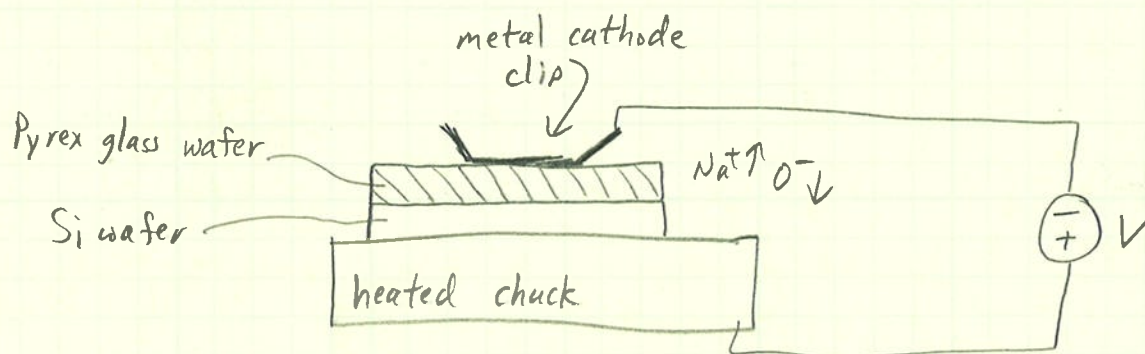
1) Wafer Bonding

→ the process of permanently or temporarily attaching (i.e. bonding) two or more wafers (may or may not be Si wafers) together

→ a number of techniques for doing this:

① Fusion Bonding - 2 "very clean" Si wafers are brought into contact and subjected to high temperature $\sim 300^\circ\text{C}$ to 800°C
 → may be followed by a 800°C to 1100°C anneal in O_2

② Anodic Bonding - Borosilicate (PyrexTM) glass wafer can be permanently bonded to Si wafers using heat and high voltage



$$T \sim 350^\circ\text{C}, U \sim 400\text{V}$$

at temperature, the high voltage pulls positive ions from the glass wafer away from the Si wafer to form a permanent chemical bond at the glass/Si interface between Si and O^- atoms.

③ High Temperature Bonding - Si to metal or glass, $\sim 1000^\circ\text{C}$

④ Adhesive Bonding - An adhesive layer is used to "glue" two wafers together → various bonding temperatures available

⑤ Au-Si Eutectic Bonding → Au + Si eutectically bonds at $\sim 363^\circ\text{C}$

⑦ Other Eutectic or Solder Bonding - coat each wafer with a film of a material that will form a eutectic bond together

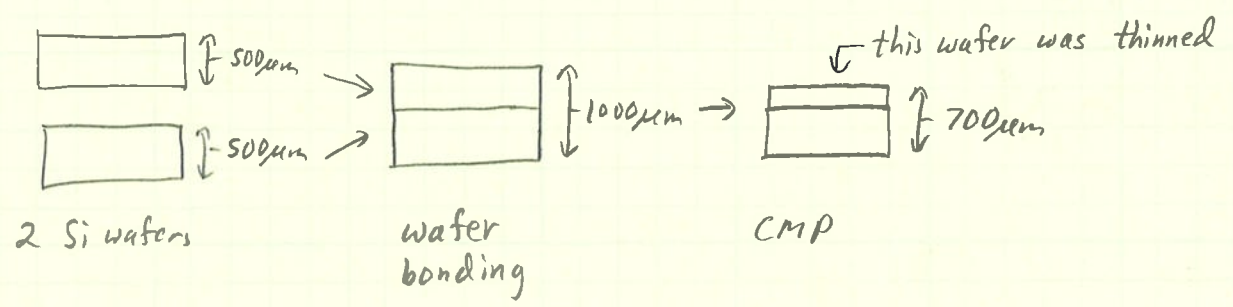
examples: 63/37 SnPb \rightarrow 183°C
80/20 SnAu \rightarrow 280°C

⑧ Low temp Si-Si Bonding \rightarrow specially treated Si wafers can be bonded at relatively low temperatures \leq 110°C

2) Wafer Bonding Post Processing

\rightarrow Sometimes one of the bonded wafers is thinned to a desired thickness using CMP \rightarrow Chemical-Mechanical Polishing

Ex:



3) Silicon-On-Insulator (SOI) wafers

① start with a Si wafer and thermally grow a SiO₂ layer on it of a desired thickness (~0.5 to 4µm)

