VLSI Technology Assignment

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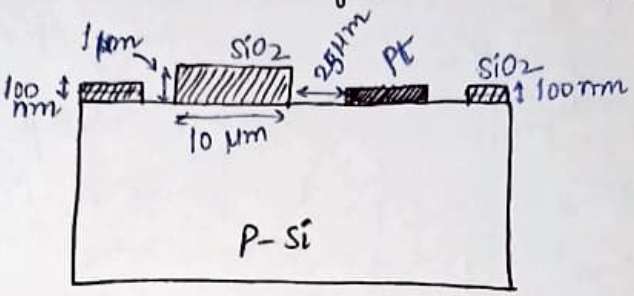
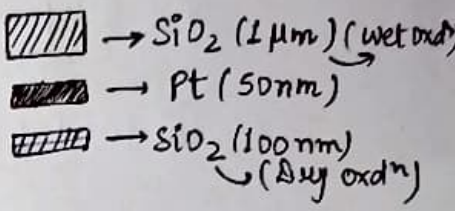
SC22B146

Realize the structure.

① write all the steps with picture.
② Mention the recipe also.
③ You are starting with P-Si.
④ There is deposition of SiO_2.
⑤ PR can be used as mask for RIE (300°C).





Solution:

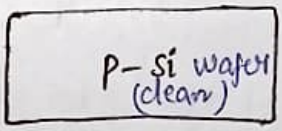
Step-①: Wafer Cleaning : RCA clean (removes organics and particles).

RCA-1 : $NH_4OH + H_2O_2 + H_2O$ at 75-80°C (5-10 minutes)

RCA-2 : $HCl + H_2O_2 + H_2O$ at 75-80°C (5-10 minutes)

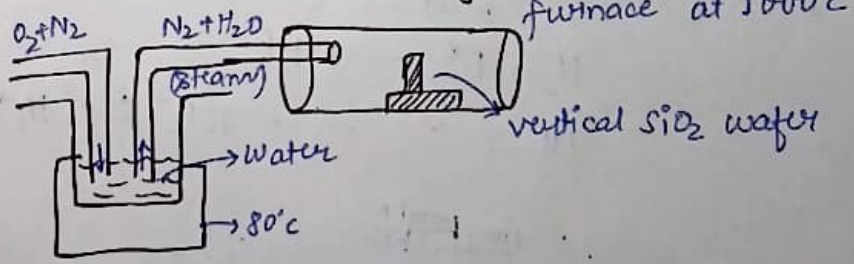
HF dip : 1% HF to remove native oxide before oxidation (10-30 sec).

Result:



Step-②: Wet Oxidation (for 1 μm oxide layer in center)

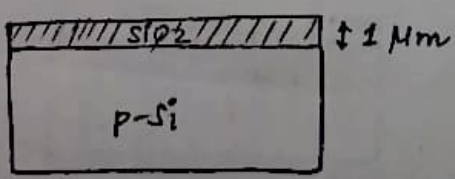
Equipment:



$$Si + 2H_2O \xrightarrow[1000°C]{wet} \underset{(solid)}{SiO_2} + 2H_2\uparrow$$ [For 90-120 minutes]

To produce 1 μm SiO_2, ~0.5 μm Si will be consumed.

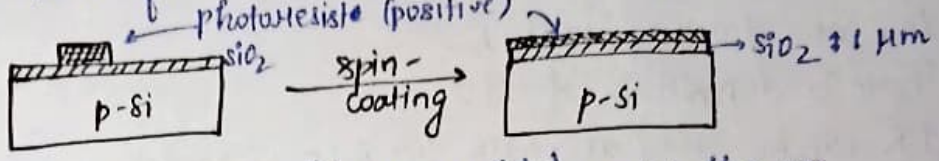
Result:



Step-③: Patterning central SiO_2

Photolithography: ⓘ Apply positive photoresist (PR) on oxide layer and spin the wafer at high speed.

ⓘⓘ Bake the wafer at ~90-100°C to evaporate the solvent.

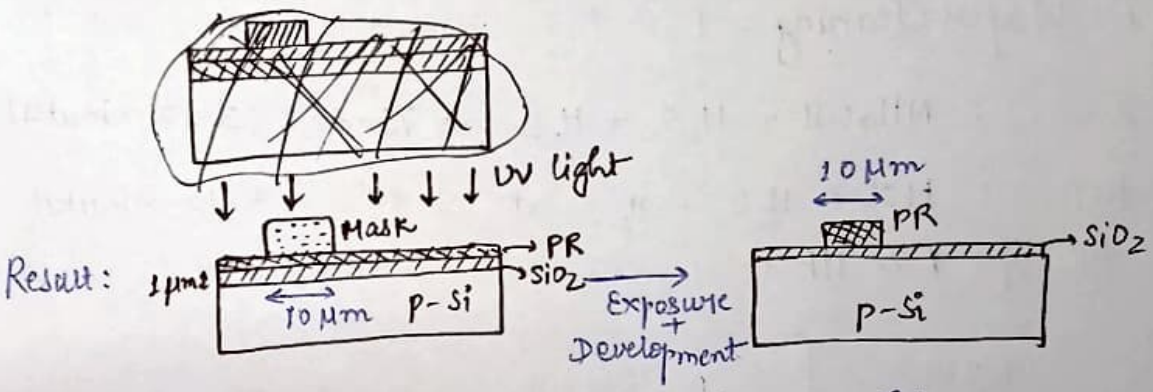


ⓘⓘⓘ Align a photo mask (10 μm wide) over the PR.

ⓘⓥ Exposure: Expose the photoresist to UV light through the mask.

ⓥ Development: Immerse the wafer in developer solution. This dissolves the exposed region of the PR.

ⓥⓘ Hard bake at ~120°-150° to strengthen the pattern.



Wet etching using HF: Selective etching of SiO_2.

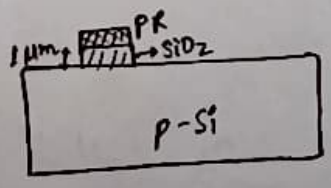
$$CF_4 \xrightarrow[\text{plasma}]{<300^\circ C} CF_3 + F^*$$

$$H_2 + F^* \longrightarrow HF$$

$$HF + SiO_2 \longrightarrow SiF_6^{2-} \uparrow + H_2 \uparrow$$

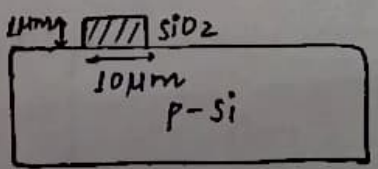
[constant etching rate]
[~ 15 minutes]

Result:



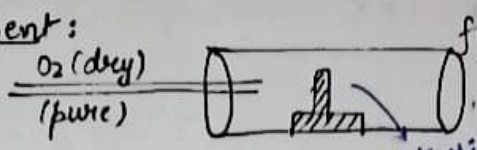
PR stripping: Remove PR strap using $H_2SO_4 + H_2O_2$ solution.

Result:



Step-④: Dry oxidation (for 100 nm oxide layer at corners)

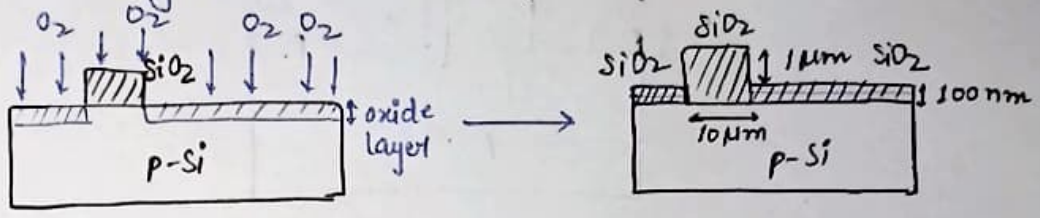
Equipment:



$$Si + O_2 \uparrow \xrightarrow{1000^\circ C} SiO_2$$
(pure) (solid)

Rx: To produce 100 nm SiO_2, around 50 nm Si will be consumed. This oxidation will only affect the Si substrate as no reaction with SiO_2 is possible. Also current SiO_2 layer is much thicker than one being formed.

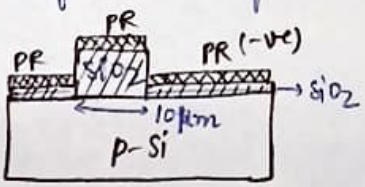
Result:



Step-⑤: Patterning Corner SiO_2

Photolithography:

① Apply negative photoresist on SiO_2 layer, spincoat and bake the wafer to evaporate the solvent.

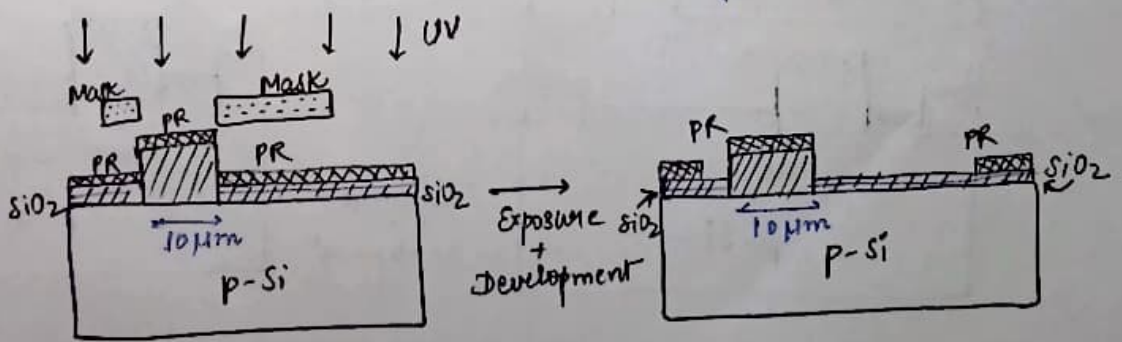


② Align a patterned mask over the PR as in the figure.

③ Expose the PR to UV through the mask.

④ Apply developer to remove unwanted PR.

⑤ Hard bake at ~120°-150°C to strengthen the pattern.



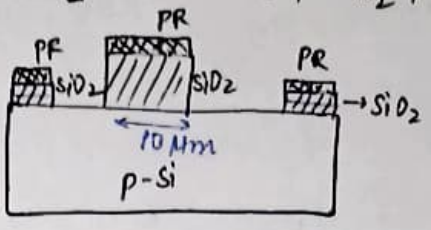
Wet etching using HF: Selectively etches SiO_2.

$$CF_4 \xrightarrow[\text{plasma}]{< 300^\circ C} CF_3 + F^*$$

$$H_2 + F^* \longrightarrow HF$$

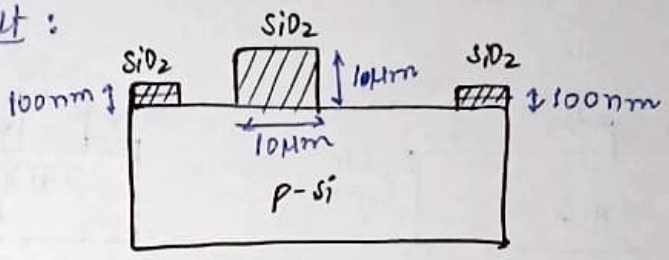
$$HF + SiO_2 \longrightarrow SiF_6^{2-} \uparrow + H_2 \uparrow$$

Result:



PR stripping: Use $H_2SO_4 + H_2O_2$ solution.

Result :



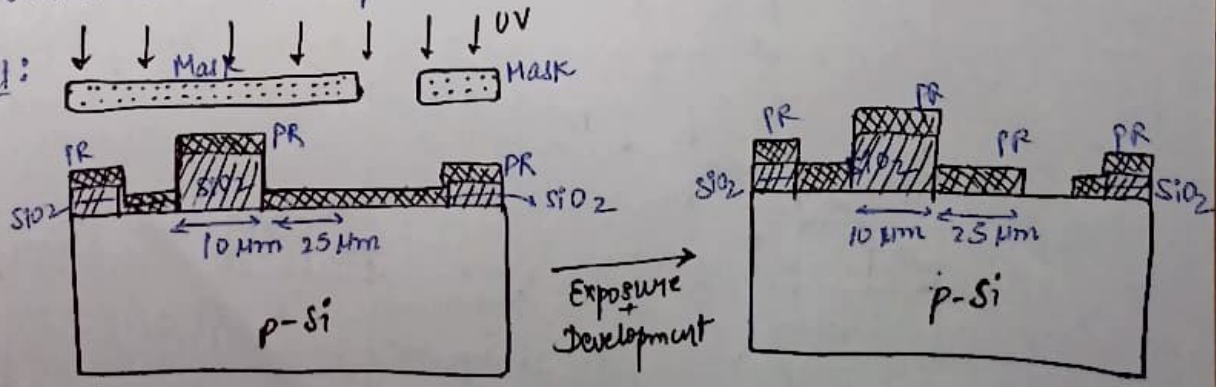
Step ⑥: Pt Patterning using Liftoff.

↳ used to deposit metal in a precise pattern over a photoresist when the metal layer must not be etched (eg, noble metals like Pt).

Photolithography:

① Spin-coat a positive photoresist on the wafer (thickness $\sim 1-2$ μm).
② Soft bake at ~90–100°C to evaporate the solvents from PR.
③ Use a photomask aligning the window as shown in the figure.
④ Expose to UV light.
⑤ Immerse in developer to remove the exposed PR.

Result:



Metal Deposition: Deposit metal using a physical vapour deposition technique (sputtering).

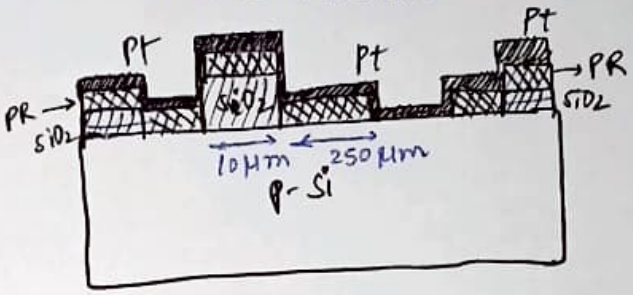
This will deposit a uniform 50 nm Pt layer everywhere — on the exposed SiO_2 surface and on top of PR.

Equipment: DC Magnetron Sputtering System

→ First, add a 5–10 nm Ti or Cr adhesion layer before Pt deposition (via sputtering) to improve the Pt adhesion.

→ Sputtered Pt coats both on the substrate and photoresist sidewalls. [Solution: Use directional deposition, e.g., evaporation. or use undercut.

Result:



Lift-Off: Soak the wafer in acetone to dissolve the PR. This lift-offs the metal on top of PR.

↳ Metal remains only in the area where no PR was present

↳ Rinse in Isopropyl alcohol (IPA) to remove acetone residues.

↳ Finally rinse with DI water to eliminate IPA's particles.

↳ Drying: N_2 gun or spin dryer to prevent water marks.

Final structure: