Chapter 9

Integrated Circuit Fabrication

9.1 :- Category of Integration

SSI →	Small scale integration	<10 gates per chip
MSI →	Medium " "	10-100 " " "
LSI →	Large " "	100-1000 " " "
VLSI →	Very large " "	>1000 " " "

chip:- Tiny piece of Semiconductor crystal which all Components of an IC are constructed on it.

Monolithic IC :- IC Fabricated entirely on a Single Silicon Crystal.

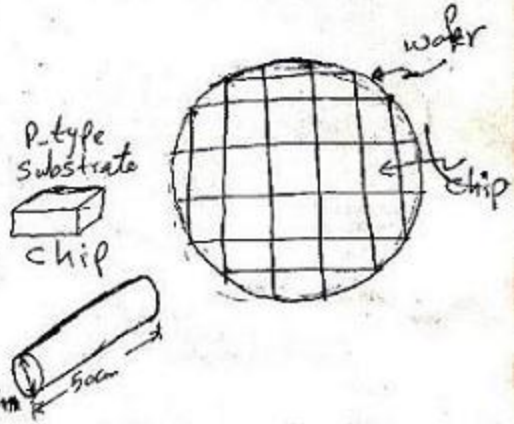
hybrid IC :- Contain on or more monolithic interconnected with external res. or Capacitors.

9.2 Monolithic IC Technology steps

IC Fabrication Consists of ~~seven~~ six or seven indepandant steps.

9.2.1 :- Crystal Growth of wafer

A Single p-type Crystal ingot of order (10 cm) in diameter & (50 cm) long is grown. By CCZ Technique), the ingot is subsequent sliced into round (wafers) approx. (0.2-0.3 mm) in thickness that forms the substrate on which all integrated components will be fabricated. The wafer is sawed in to 100 to 10000 rectangular chips having sides of 1 to 10 mm.



9.2.2:. Epitaxial Growth

It is used to Grow a layer of Single-Crystal silicon as an extension of an exsisting Crystal wafer. It is performed in a furnace called a reactor in which silicon wafer ar heated to 900 - 1000 C°. Current Technology Uses the hydrogen reduction of gases SiH_4 or $SiCl_4$ at a source of silicon to be grown

$$SiCl_4 + 2H_2 \xrightarrow{1200\,C^\circ} Si + 4\,HCl$$

An n-type epetaxial layer typically (6-25) Mm-thick is grown into a p-type substrate. n-type or p-type impurities such as phosphore (PH_3) for n-type & diborane (B_2H_6) for p-type must be introduced in the $SiCl_4$ gas.

9.2.3:. Oxidation

Silicon Technology has the ability to grow oxide layer on the silicon surface. The Silicon dioxide has the Cabability of being etched by hydrogen fluoride (Hf) & the impurities used to dope the silicon donot panetrate the silicon dioxide. one method is to pass Oxygen over the surface of Silicon wafer at 1200 C° & its thickness is about 0.02 - 2 Mm. Fastest growth my be obtained by passing steam on the wafer

$$Si + H_2O \longrightarrow SiO_2 + 2H_2.$$

9.2.4 photolithography

It is used to select aremoved regions of SiO_2 to form opening through which impurities may be diffused. It involves two operations:

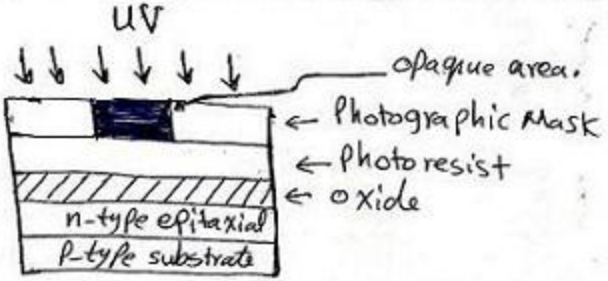
9.2.4.1:. Mask production:.

It involves compliated and expansive processes. After the cct layout has been determined, a large scale drowing is made showing the locations of openinings to be etched in SiO_2.

The drawing is magnified to scale 500:1, so several reduction stages are required (masking levels).

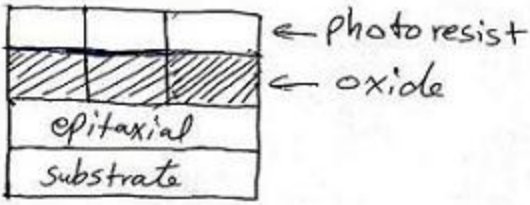
9.2.4.2:- Photo-etching

It etches the [redacted] SiO_2 for cutting the windows for diffusion. Initially the slice is covered with thin film photoresist, & then the slice exposed to (Ultra Violet UV) light. The opaque area of the mask is correspond to the area to be etched away. as in fig(1)

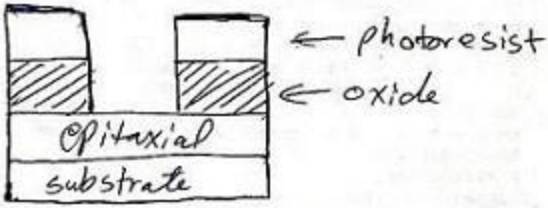


(a) Exposure the photo resist to UV, so the Transparant region will be polymerized.

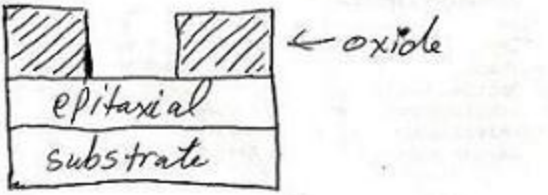
(b) washing using trichloro ethylene



(c) Etching by hydrofluaric acid (Hf)



(d) stripping of photo resist by chemical solvent (H_2SO_4).



9.2.5: Diffusion:-

It is used to diffused impurities into the slice. the impurity Concentrations is performed in a diffusion furnace at a Temp. of about 1000C° over a 1 – 2 hours. Impurities sources Can be gases, liquides or solides. Gases impurities is more Popular and Generally the hydrides of Boron arsenic AsH3 & Phosphorus PH3 are the famous.

9.2.6: Ion Implantation

It is a Second methode of introducing impurities in a vaCum. A beam of ions are accelerated by energies between 30 – 200 kev. The depth of penetration of these ions is determined by the accelerated energy and the beam Current. It is used when a thin layer of doped silicon is required such as Emitter in BJT. This performed in low Temp.

9.2.7: Metalization:-

It is used to form interConnections of Component on chip. These are formed by the deposition of thin film Layer of Aluminum & Gold over entire surface of chip. A mask is used to define the Connection pattern between Components and unwanted aluminum is removed.