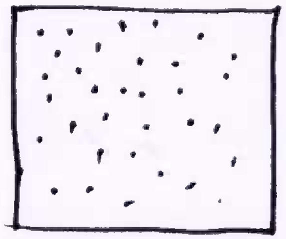
Crystal Structures

Solid Material are of Three kind :

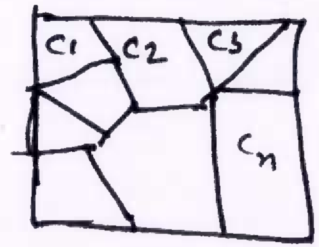
1. Amorphous 2. Polycrystalline 3. Crystalline

depending upon Periodicity of Lattice

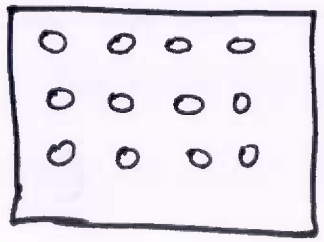
Amorphous :— Non Periodic →



Polycrystalline :— Partially Periodic



Crystalline :— Periodic



Each of these have been used in Fabrication of Devices.

Arrangement of Atoms in Solid is called arrangement of lattices.

Most Semiconductors like Silicon, Germanium and III-V Compound Semi conductors show crystal arrangement called Cubic Lattice.

1. Simple Cubic — Polonium
2. Body Centered Cubic — Tungsten, Molybdenum & Tantalum
3. Face-Centered Cubic — Copper, Gold, Silver, Platinum
4. Zinc-Blend Cubic. — Silicon and GaAs.
   Diamond

CDEEP
IIT Bombay

$$V_{T_n} = \phi_{ms} + 2\phi_F - \frac{Q_{ox}}{C_{ox}} - \frac{Q_{Bulk}}{C_{ox}}$$

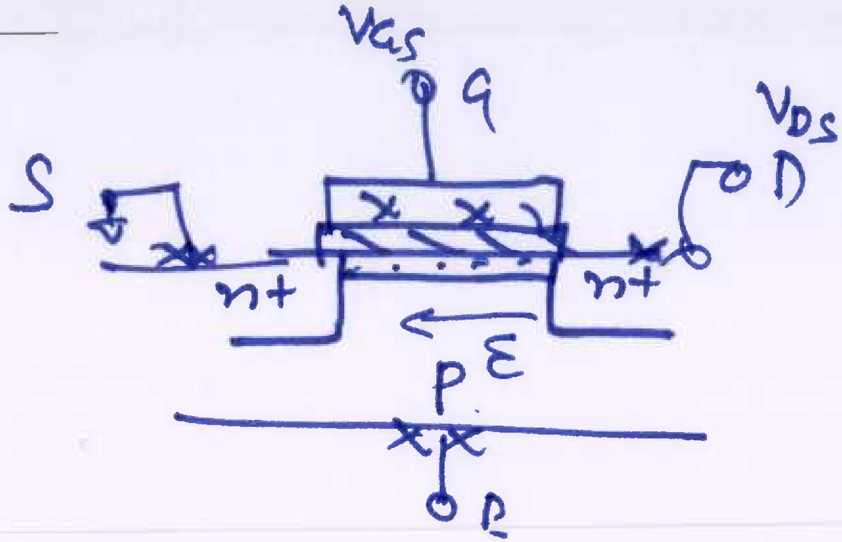
$$2\phi_F = \frac{2kT}{q} \ln \frac{N_{a,d}}{n_i}$$

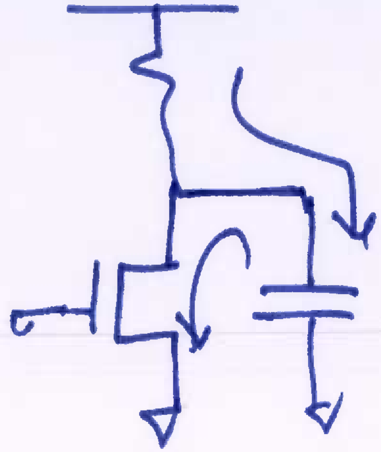
$$Q_B = \pm q N_{a,d} x_{d_{max}}$$

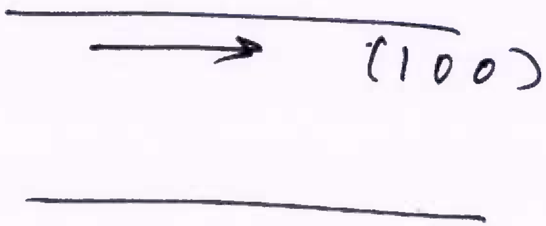
$$x_{d_{max}} = \sqrt{\frac{2 K_s \epsilon_0 (2\phi_F)}{q N_{a,d}}}$$

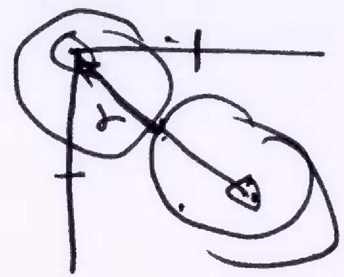
$$I_{DS} = \mu C_{ox} [\qquad]$$

$$D_n = \frac{kT}{q} \mu_n$$


VGS
G
VDS
S
D
n+
n+
p
E
B




(100)



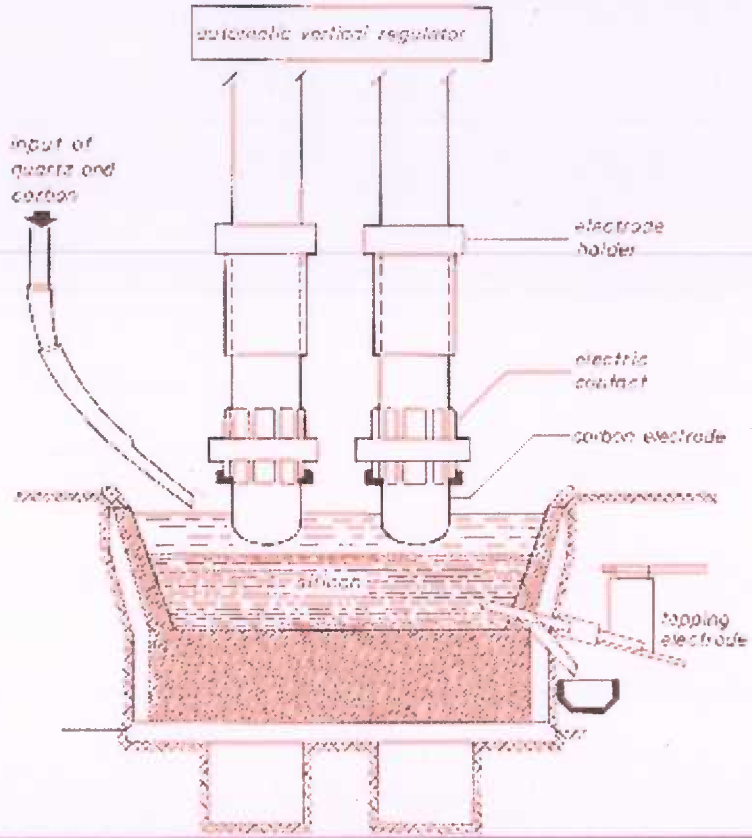
$$r = \frac{1}{2}\sqrt{\left(\frac{a}{2}\right)^2 + \left(a/2\right)^2 + \left(a/2\right)^2}$$

$$r = \frac{\sqrt{3}\,.a}{8}$$

$$\text{Vol} = \frac{4}{3}\pi r^3.$$

$$\text{Packing Density} = \frac{\text{No of atoms} \times \text{Vol}}{\text{Cell vol.}} = \frac{2\left(\frac{4}{3}\right)\pi\left(\frac{\sqrt{3}a}{8}\right)^3}{a^3}$$

Silica to (Metallurgical) Silicon Conversion



$SiO_2 + 2C \Rightarrow Si_{MG} + 2CO$ at 2000^0 C

Intermediate reactions:

$SiO + CO = SiO_2$ $\quad _{1500}{}^0C$

$SiO + 2C = SiC + CO$ $\quad 1780^0$ C

$SiC + SiO_2 = Si + SiO + CO$ $\quad > 1780^0$ C

Fluid- Bed Reactor

From Si (MG Grade) we wish to get purer Silicon source (by 10^9 times than MG Grade).

In a Fluid based reactor we treat Si with HCl at 300 ^{0}C.

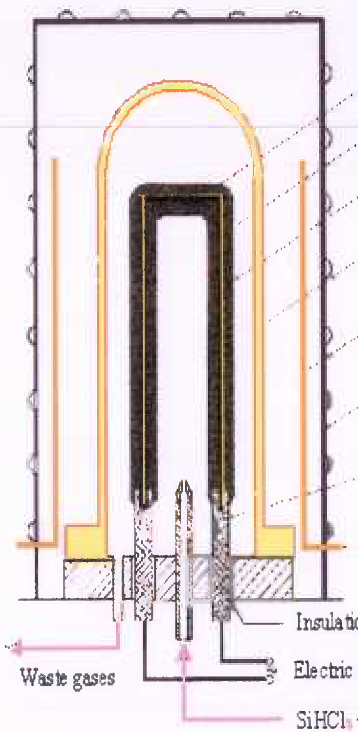
The reaction is

$$Si + 3HCl = SiHCl_3 + H_2$$

Some other possibilities are creation of Dichlorosilane(SiH2Cl2) ,

Silicon Tetrachloride (SiCl4) or Silane (SiH4).

Pure Polysilicon Chemical Vapour Deposition



$SiHCl_3 + H_2 = Si + 3\,HCl$

The CVD temperature is around `1000 Degree C