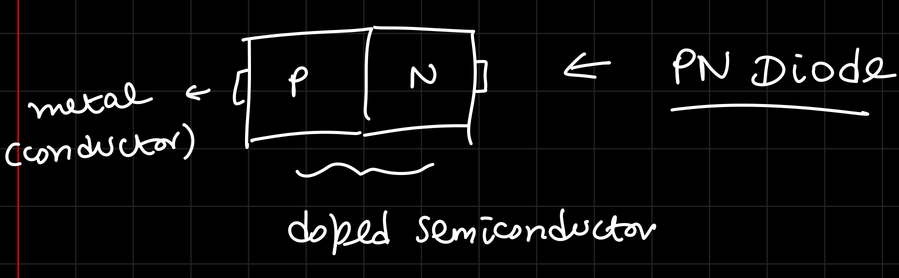
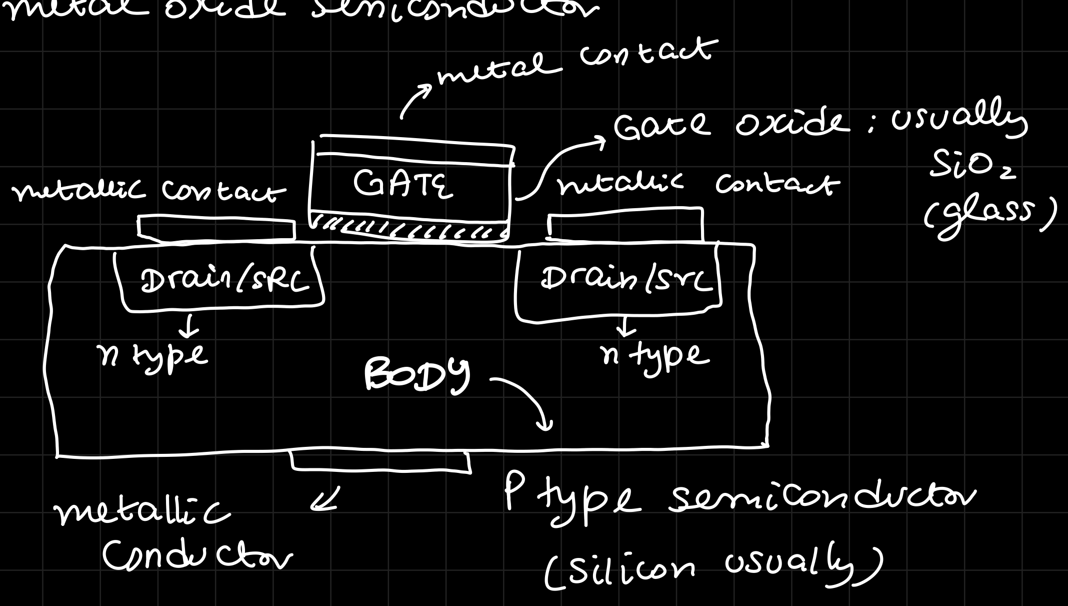
Lecture : PSD (7)

→ CRYSTAL STRUCTURE OF SOLIDS

PN Junction acts as a diode when we provide a bias to the terminals using a "connection"/electrodes



MOS Transistor
↓
metal oxide semiconductor



CRYSTAL PHYSICS

MATTER
- Gas
- Liquid / Liquid crystals
- Solid
- Plasma

Van-der-Waal force interaction in gasses ← very weak potential

Ionic / covalent bonding in Solids

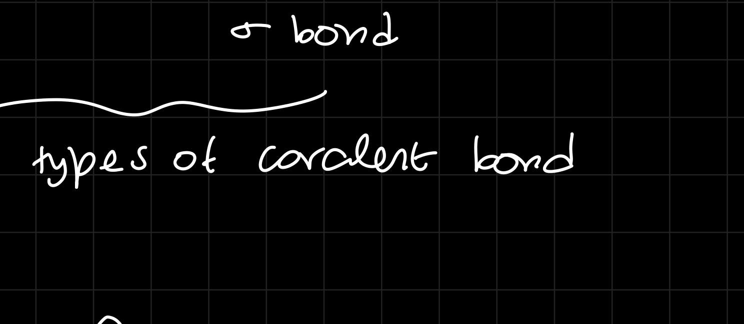
Silicon → sp^3 hybridization   tetravalent structure

Interaction gives the idea of state of matter and its distribution

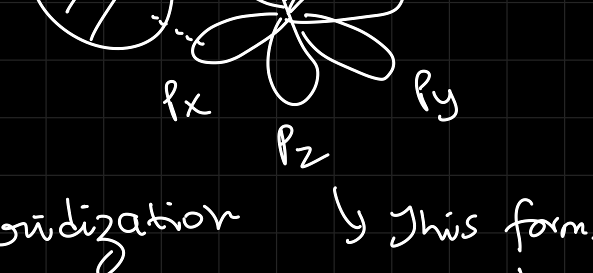
CARBON
- sp^2 Graphite → metal
- sp^3 Diamond → insulator
- Buckminster - Fullerene → semiconductor

Same element but displays different properties because of different crystal structure

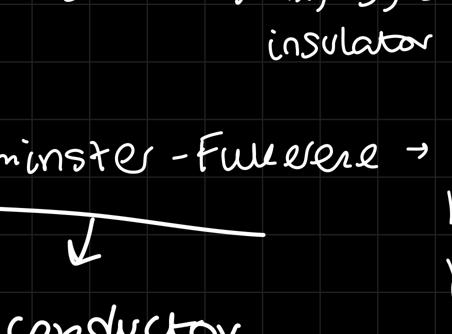
Graphite →



single layer of graphite ≡ graphene



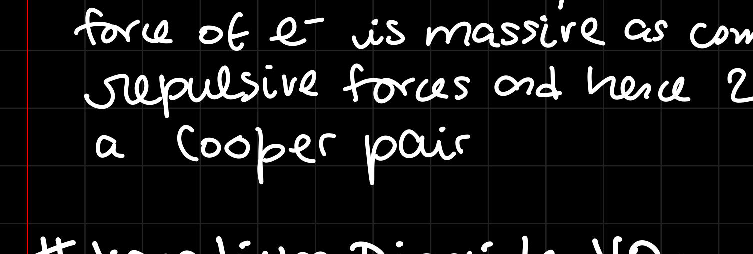
types of covalent bond



sp^2 hybridization   ↳ This forms the van der waal

Diamond → all P_x, P_y, P_z form bonds
insulator

Buckminster - Fullerene → between sp^2 & sp^3 has hexagonal and pentagonal structure
↓
Super conductor
↳ conducts electricity without any resistance
≡ zero resistance conduction



is it possible that $2e^-$ form a pair ?
(usually) No, due to coulomb force, like charged particles have this repulsive force

BUT at 0-50K temperature, the attractive force of e^- is massive as compared to repulsive forces and hence $2e^-$ form a Cooper pair

Vanadium Dioxide VO_2

↳ Insulator — Monoclinic VO_2
Metal — Rutile VO_2 (cubic struct)

as we increase the temperature ⇒ resistivity decreases

Just changing the temperature, changes the nature and structure of the crystal

---

Insulators don't have as many free e^- as conductors

Insulators have higher band gap

Conductors don't have band gap

band gap → distance between conduction band and valence band

Mean Free Path : The distance an e^- travels between two successive collisions
↓
dependent on temperature

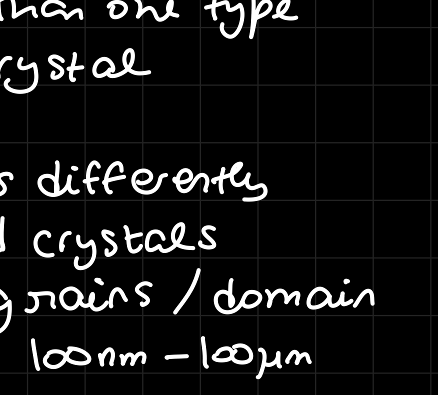
```c
#include <stdio.h>

int main (int argc, char** argv) {

    fork();
    printf ("Chemistry sucks");
    return 0;

}
```

This code will print the stmt twice
why?
because fork(); creates a parallel child process on another thread

SOLID MATERIALS
- CRYSTALLINE (single crystal)
- POLYCRYSTALLINE
- AMORPHOUS

same particles kept at periodic distances
↳ periodic structure

single crystal } from any point, it behaves the same



AMORPHOUS → no periodicity / pattern structure

POLYCRASTALLINE → more than one type of crystal
- used in gate metal in MOS Transistor
- contains differently oriented crystals called grains / domain
  - ↳ usually 100nm – 100μm in diameter
  - ↳ separated with each other by grain / domain boundaries

⇒ Polycrystals with grains that are <10nm in diameter are called nanopolycrystalline.

if we dope polycrystalline structure, it behaves as metal (conductor)

" " amorphous structure, it behaves as oxide (insulator)

Remember : for p type we have trivalent impurities for doping wrt Silicon eg: Boron

for n type, we have pentavalent impurities for doping wrt silicon.
eg: phosphorus

does it change the structure?
it → doping, structure → Silicon

→ GaN : gallium nitrite
↳ only p type doping with magnesium

So, when we say doping, we define reference as well