Lecture 1:

Semiconductors

- Sold materials are classified in terms of electric conductivity.

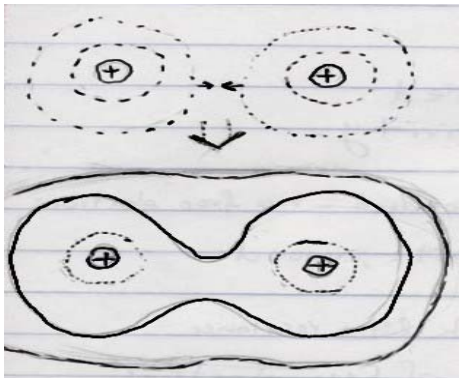
1. Insulators: do not conduct – no free electrons. e.g. Plastic, Wood.
2. Conductors: conduct with little resistance – abundancy of free electrons. e.g. Metals.
3. Semiconductors: conduct but with large resistance – have some free electrons. e.g. Silicon.

- Resistivity can be significally changed by adding certain impurities (Also called Dopants).

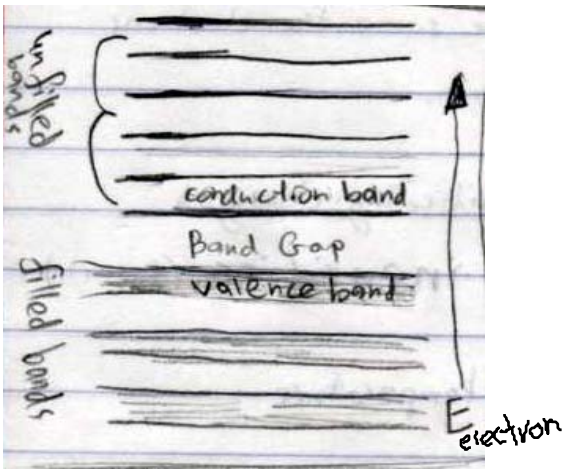
- Resistivity depends on temperature.

Energy Bands

When a solid is formed, energy levels in the atoms interact and form energy bands.

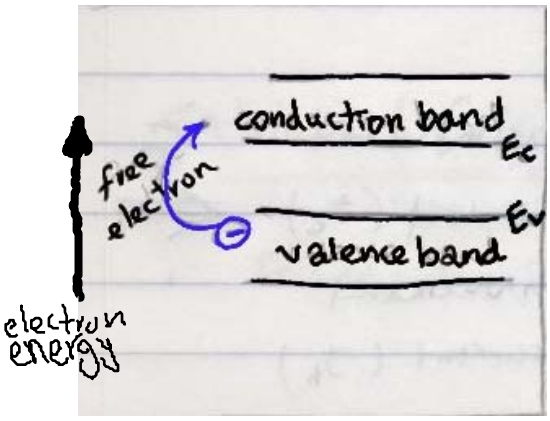


Energy Levels Splitting to form Bands



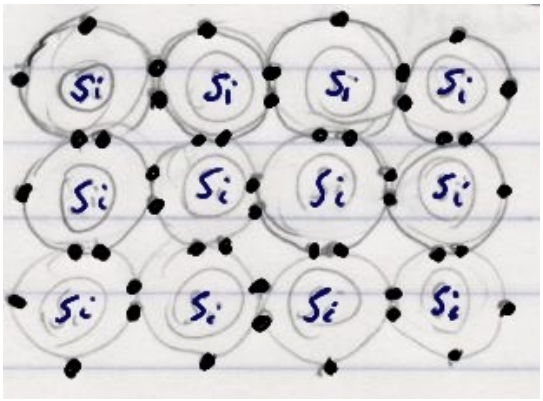
The Energy Bands

- the most important bands are:
  1. <u>the valence band:</u>
     - This is the outermost band filled with electrons. This is also the band where electrons that are involved in chemical bound exist
  2. <u>the conduction band:</u>
     - this is the band next to the valence band where free electrons would be if they exist. It is the lowest of the unfilled bands
- there is an energy gap between these two bands which determine whether the solid is (conductor / insulator / semiconductor)
- *Insulators* have large energy Gap (E.G>2 e.v)
- *Semiconductors* have smaller energy Gap (0<E.G<2 e.v)
- *Conductors* have the valence & conduction bands overlapped (E.G < 0 e.v)

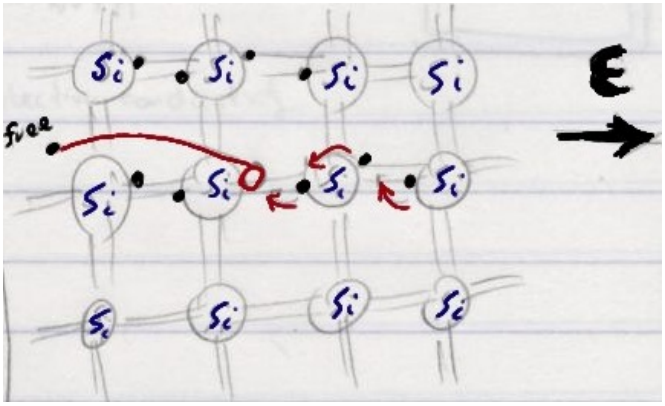


- The highest energy level of the valence band is called Ev.
- The lowest energy level of the conduction band is called Ec.
- $\mathbf{E_G}$ = Ec - Ev
- Energy Gap is a unique characteristic of a material, However, it can be slightly modified by applying physical pressure.

- An electron can become free by acquiring an energy (thermal / photons) = $\mathbf{E_G}$
  - It jumps from valence band to conduction band leaving a <u>hole in the valence band</u>.
  - This hols is positively charged & it is free to move within the valence band.
  - In Semiconductors, currents are transported via:
    1. electrons (-ve charges)
    2. holes (+ve charges)



Crystal structure, showing valence electrons associated with each bond



movement of a hole