P-N Junction

Basically p-n junction is a combination of n-type semiconductor and p-type semiconductor.

The n-type & p-type semiconductor's combination to produce p-n junction can be understand by the following figure and statements.

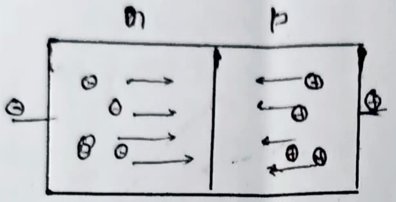

Figure - 1

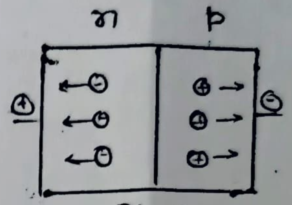

Fig. 2

It is obvious, the material on the left side of each junction in fig. 1 & fig. 2 is n-type semiconductor, it is obtained by doping Germanium with Arsenic or Antimony.

The negative sign represent extra electrons. The material on the right side of the junction is p-type semiconductor obtained by doping Germanium with Ga or In.

The positive signs represents the positive holes which is arising from the deficiency of electrons at the Indium impurity-Centres.

When an external electric field is applied in such a way as to cause the motion of electrons (n-current) from left to right and the motion of positive holes (p-electrons) from right to left as shown in figure-1, here the current is readily conducted.

If the direction of applied voltage is reversed so that there is separation of electrons and positive holes shown in fig. 2, there is cancellation of n-current and p-current and hence conduction stops.

Thus, the p-n junction permits the current from an outside source to flow in one direction only. It is therefore used as rectifier for changing alternating current into direct current. In the manufacturing of transistors the role of p-n junction is very important.

—x—

Super-conductivity

Superconductivity is a Phenomenon of exactly zero resistance and expulsion of magnetic flux field occuring in certain materials, called Super Conductors, when cooled below a characteristic critical temp.

In other words we can say the phenomenon of conducting electricity with zero resistance of the conducting material is called Super-Conductivity.

The Substance which can conduct electricity with zero resistance is called Super-Conductor.

Super conductivity is the properties of certain materials to conduct direct current (DC) electrically without energy loss when they are cooled below a critical temperature (T_c). These materials also expel magnetic fields as they transition to the super conducting stage.

In 1972 Nobel Prize for Physics has been awarded to Drs John Bardeen, Leon N. Cooper and J. Robert Schrieffer for their theory of Super conductivity. It is also refer as BCS Theory.

Super-Conductivity is of two types.

(1) L T S C
Low temperature super conductivity

(2) H T S C
High temp. Super Conductivity

(1) Low Temperature Super Conductivity (LTSC):-

At very low temperature, many metals, alloys and certain compounds become super conductors, the critical temperature for super conductivity has laying between 0.1 K and 10 K. Since a super conductor has almost zero resistance, it can carry an electric current withod losing energy.

A super conductor behaves like a perfect dia magnetic substance.

This Phenomenon of Low temp. super conductivity is explained by BCS Theory.

Leon N. Cooper has explained how two electrons interact in a super conductor forming a bound state (Cooper pair) despite their Coulombic repulsion.

The Cooper pair of electrons exist on account of the indirect interaction of two electrons via the nuclei of atoms in the Lattice.

The lattice is slightly deformed as an electron moves through it, with the positive ions in the path of electrons being displaced towards it.

The deformation produces a region of increased positive charge.

Another electron passing through this polarised region will be attracted by the greater concentration of the positive charge there.

If the attraction is stronger than the repulsion between the electrons, the electrons are effectively coupled together into a Cooper pair with the deformed lattice as the intermediary.

A Cooper pair undergoes less scattering than an individual electron as it travels through the lattice because the distortion caused by one electron can attract back of the other electron should it be scattered out of its path in a collision.

Since the Cooper pair is stable against scattering - it can carry charge freely through the solid giving rise to superconductivity.

The binding energy of the Cooper pair is of the order of 10^{-3} ev, that is why superconductivity is a low temp. phenomenon.

At high temp., the thermal energy exceeds the binding energy and Cooper pair break down.

<u>High Temp. Super Conductivity.</u> (HTSC)

A High temp. super conductivity of super conductor, $YBa_2Cu_3O_{7-x}$ ($x \leq 0.01$) with critical temperature of equal to 93K has discovered in 1987.

Super conductivity
This critical temp. is significant because it allow liquid - nitrogen (b.p. = 77K) to be used as coolant rather than more expansive. Helium (b.p. = 4K)

The non stoichiometry appears to be necessary for HTSC.

It also appears that copper is an essential element for super conductivity since efforts to replace it by other element have not been fruitful.

This cuparate has Perovskite structure.