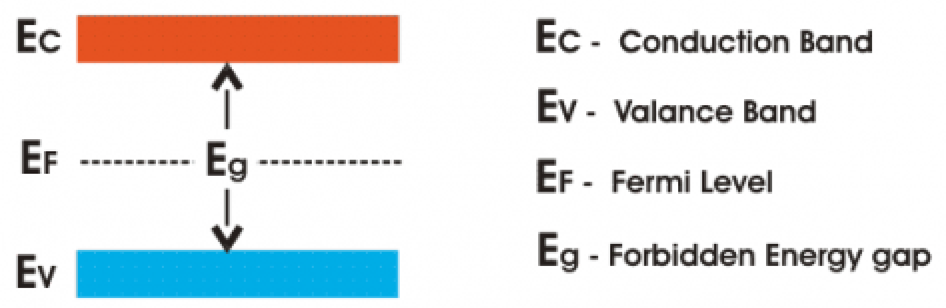
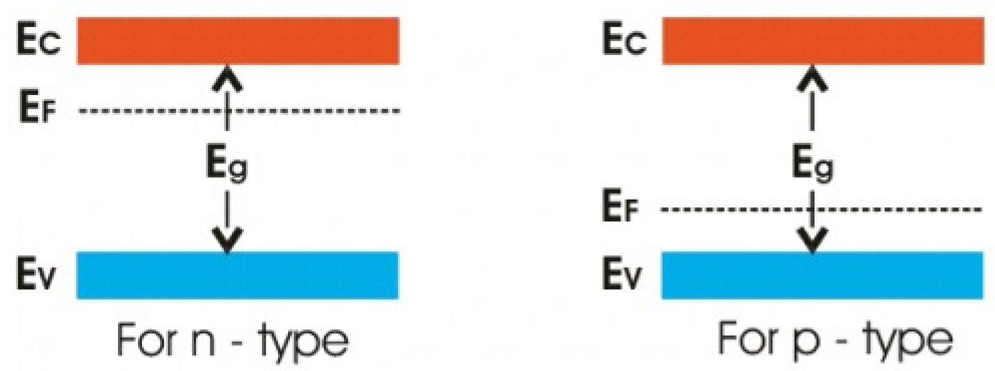
Energy Band Diagram of Silicon

Energy band diagram of silicon shows the levels of energies of electrons in the material. In intrinsic silicon, the Fermi level lies in the middle of the gap. When the intrinsic silicon is doped with donor atoms, it becomes n - type and then Fermi level moves higher i.e. closer to the conduction band. When intrinsic silicon is doped with acceptor atoms, it becomes p - type and Fermi level moves towards valance band.

Energy Bands Diagram of Intrinsic Silicon



Energy Bands Diagram of Extrinsic Silicon



Valence and conduction bands

In solid-state physics, the valence band and conduction band are the bands closest to the Fermi level and thus determine the electrical conductivity of the solid. The valence band is the highest range of electron energies in which electrons are normally present at absolute zero temperature, while the conduction band is the lowest range of vacant electronic states. On a graph of the electronic band structure of a material, the valence band is located below the Fermi level, while the conduction band is located above it. This distinction is meaningless in metals as the highest band is partially filled, taking on the properties of both the valence and conduction bands.

- Hall effect measurements using configuration allows determination of Charge carrier type (n or p)

When the N-type semiconductor and P-type semiconductor materials are first joined together a very large density gradient exists between both sides of the PN junction. The result is that some of the free electrons from the donor impurity atoms begin to migrate across this newly formed junction to fill up the holes in the P-type material producing negative ions.

However, because the electrons have moved across the PN junction from the N-type silicon to the P-type silicon, they leave behind positively charged donor ions (ND) on the negative side and now the holes from the acceptor impurity migrate across the junction in the opposite direction into the region where there are large numbers of free electrons.

As a result, the charge density of the P-type along the junction is filled with negatively charged acceptor ions (NA), and the charge density of the N-type along the junction becomes positive. This charge transfer of electrons and holes across the PN junction is known as diffusion. The width of these P and N layers depends on how heavily each side is doped with acceptor density NA, and donor density ND, respectively.

This process continues back and forth until the number of electrons which have crossed the junctionhave a large enough electrical charge to repel or prevent any more charge carriers from crossing over the junction. Eventually a state of equilibrium (electrically neutral situation) will occur producing a "potential barrier" zone around the area of the junction as the donor atoms repel the holes and the acceptor atoms repel the electrons.

Since no free charge carriers can rest in a position where there is a potential barrier, the regions on either sides of the junction now become completely depleted of any more free carriers in comparison to the N and P type materials further away from the junction. This area around the PN Junction is now called the Depletion Layer.