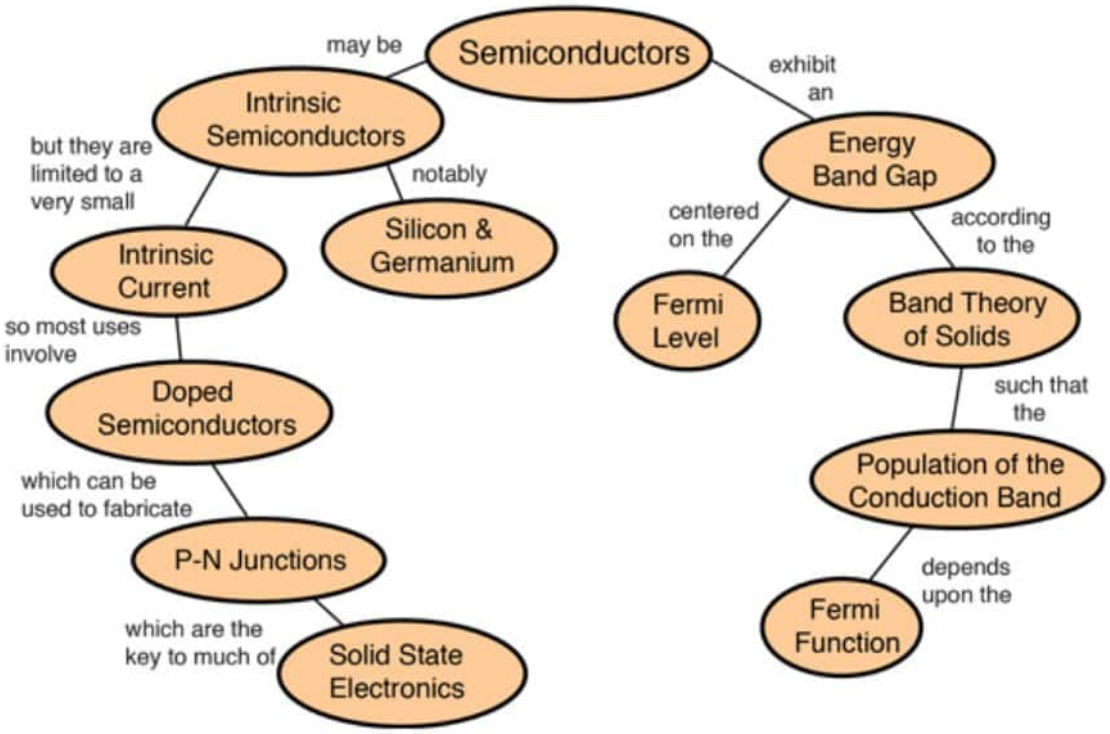


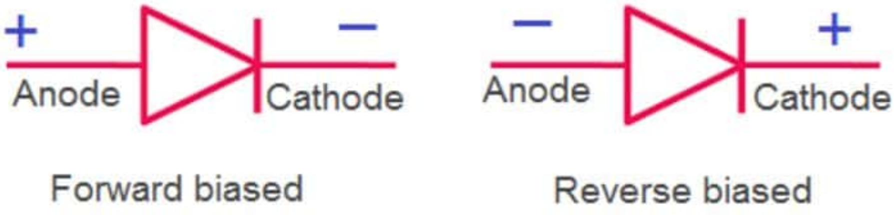
p-n junction semiconductor

A p-n junction diode is two-terminal or two-electrode semiconductor device, which allows the electric current in only one direction while blocks the electric current in opposite or reverse direction. If the diode is forward biased, it allows the electric current flow. On the other hand, if the diode is reverse biased, it blocks the electric current flow. P-N junction semiconductor diode is also called as p-n junction semiconductor device.

In n-type semiconductors, free electrons are the majority charge carriers whereas in p-type semiconductors, holes are the majority charge carriers. When the n-type semiconductor is joined with the p-type semiconductor, a p-n junction is formed. The p-n junction, which is formed when the p-type and n-type semiconductors are joined, is called as p-n junction diode.

The p-n junction diode is made from the semiconductor materials such as silicon, germanium, and gallium arsenide. For designing the diodes, silicon is more preferred over germanium. The p-n junction diodes made from silicon semiconductors works at higher temperature when compared with the p-n junction diodes made from germanium semiconductors.

The basic symbol of p-n junction diode under forward bias and reverse bias is shown in the below figure



In the above figure, arrowhead of a diode indicates the conventional direction of electric current when the diode is forward biased (from positive terminal to the negative terminal). The holes which move from positive terminal (anode) to the negative terminal (cathode) give the conventional direction of current.

The free electrons moving from negative terminal (cathode) to the positive terminal (anode) actually carry the electric current. However, due to the convention we have to assume that the current direction is from positive terminal to the negative terminal.

Biasing of p-n junction semiconductor diode

The process of applying the external voltage to a p-n junction semiconductor diode is called **biasing**. External voltage to the p-n junction diode is applied in any of the two methods: forward biasing or reverse biasing.

If the p-n junction diode is forward biased, it allows the electric current flow. Under forward biased condition, the p-type semiconductor is connected to the positive terminal of battery whereas; the n-type semiconductor is connected to the negative terminal of battery.

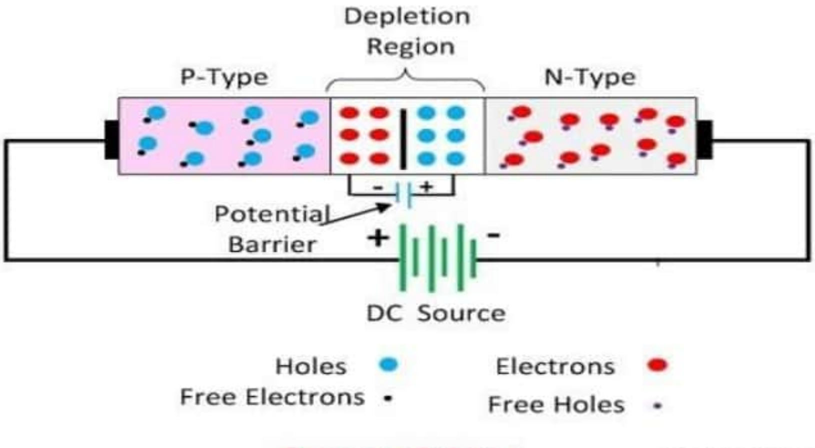
If the p-n junction diode is reverse biased, it blocks the electric current flow. Under reverse biased condition, the p-type semiconductor is connected to the negative terminal of battery whereas; the n-type semiconductor is connected to the positive terminal of battery.

Zero Biased Condition

In this case, no external voltage is applied to the P-N junction diode; and therefore, the electrons diffuse to the P-side and simultaneously holes diffuse towards the N-side through the junction, and then combine with each other. Due to this an electric field is generated by these charge carriers. The electric field opposes further diffusion of charged carriers so that there is no movement in the middle region. This region is known as **depletion region** or space charge.

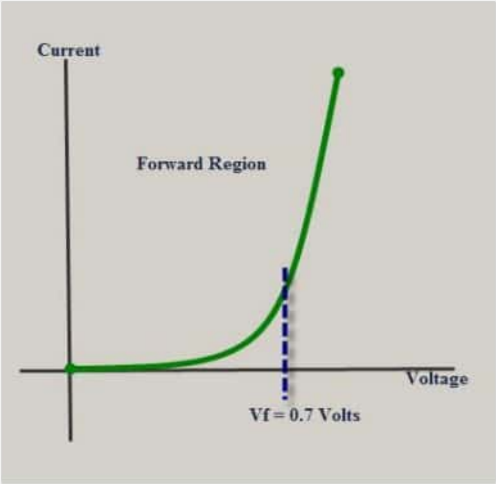
Forward Biasing

In forward biasing the external voltage is applied across the PN-junction diode. This voltage cancels the potential barrier and provides the low resistance path to the flow of current. The forward bias means the positive region is connected to the p-terminal of the supply and the negative region is connected to the n-type of the device.



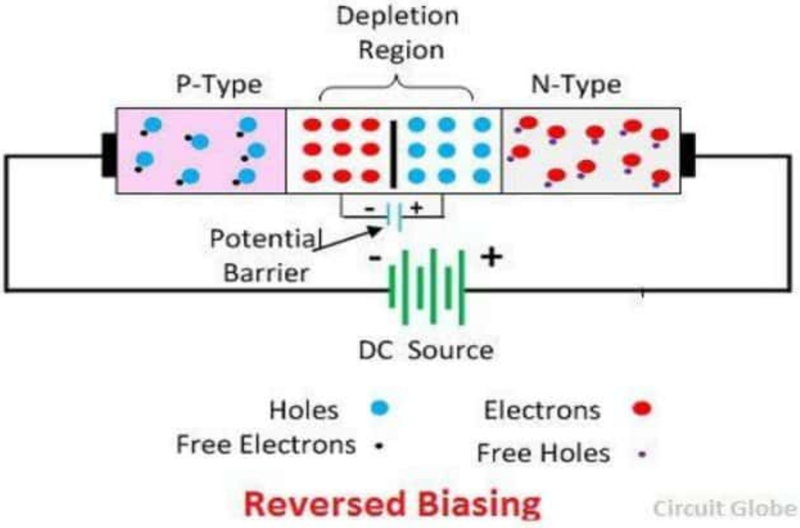
Forward Biasing

The potential barrier voltage is very small (nearly 0.7 V for silicon and 0.3 V for germanium junction) hence very few amount of voltage is required for the complete elimination of the barrier. The complete elimination of the barrier constitutes the low resistance path for the flow of current. Thus, the current starts flowing through the junction. This current is called **forward current**.



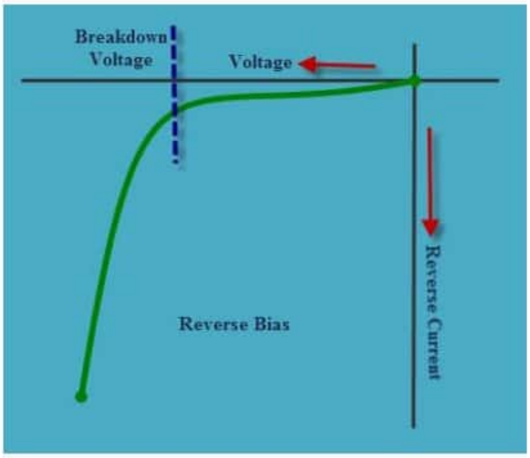
Reverse Biasing

In reversed bias the negative region is connected to the positive terminal of the battery and the positive region is connected to the negative terminal. The reverse potential increases the strength of the potential barrier. The potential barrier resists the flow of charge carrier across the junction. It creates a high resistive path in which no current flows through the circuit.

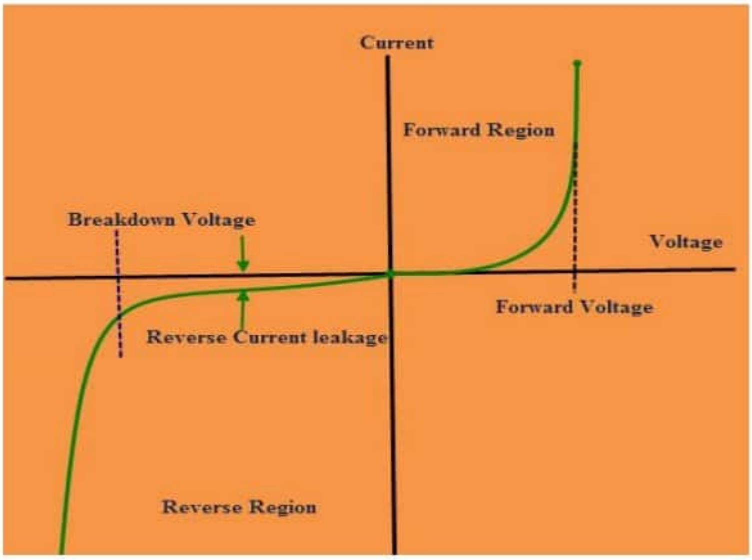


However, p-n junction diode allows the minority charge carriers. The positive terminal of the battery pushes the holes (minority carriers) towards the p-type semiconductor. In the similar way, negative terminal of the battery pushes the free electrons (minority carriers) towards the n-type semiconductor.

The positive charge carriers (holes) which cross the p-n junction are attracted towards the negative terminal of the battery. On the other hand, the negative charge carriers (free electrons) which cross the p-n junction are attracted towards the positive terminal of the battery. Thus, the minority charge carriers carry the electric current in reverse biased p-n junction diode.



The electric current carried by the minority charge carriers is very small. Hence, minority carrier current is considered as negligible



<u>V-I Characteristics of P-N junction Diode</u>

Key Differences between Forward and Reverse Biasing

1. The forward bias reduces the strength of the potential barrier due to which the current easily move across the junction whereas reverse bias strengthens the potential barrier and obstruct the flow of charge carrier.
2. In forward biasing the positive terminal of the battery is connected to the p-region and the negative terminal is connected to the n-type material while in reverse bias the positive terminal of the supply is connected to the n- type material and the negative terminal is connected to the p-type material of the device.