Electronics
Lecture 2

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Semiconductor Diode:

An electronic component made of semiconductor material that allows conduction of current in one direction is termed as Diode. It is two terminal device by fusing p & $n\ type$ material.

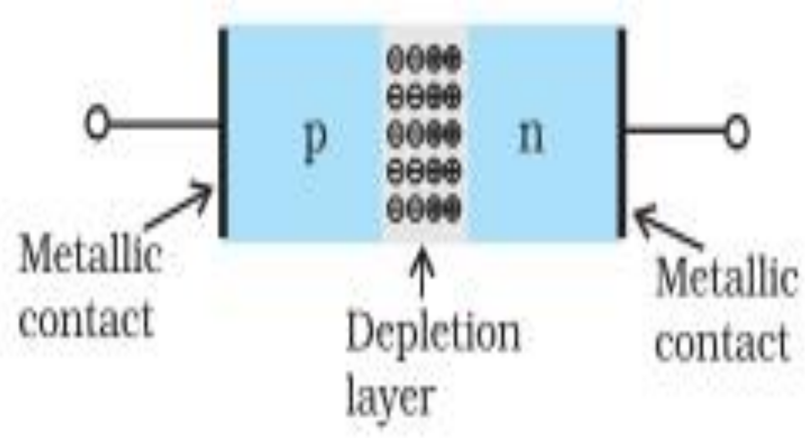

Fig 1

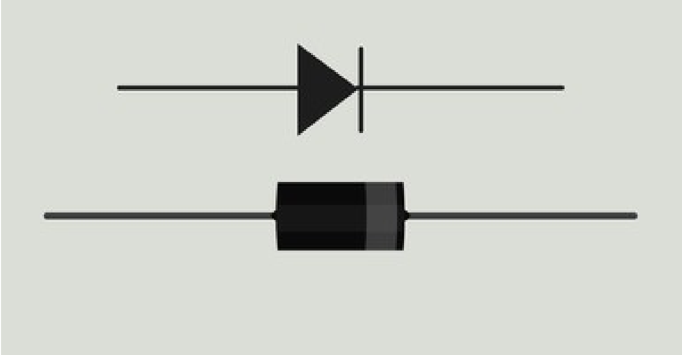

Fig 2

Here p-type material holds holes as its majority carrier and electrons in it minority carrier. On the other hand $n - type$ material has electrons as majority carrier and holes as minority carrier. The junction is nothing but a layer of immobile ions termed as depletion layer. When no proper potential is provided then the conducting and nonconducting states is noticed. Now operation of diode involved unbiased, forward biased and reversed biased condition.

At **unbiased condition** ie no voltage is applied across the diode the holes from $p - side$ and electron from $n - side$ get combined with each other at the junction. Due to this a depletion region is formed at the junction. It is noticed that a flow of charge carriers across the cross-sectional area is known as diffusion.

Hence current at no biased condition is known as diffusion current. The potential difference across the depletion region generate an electric field in it. Due to this electric field any further movement of majority charge carrier is allowed. This is the reason that the depletion region is fixed. The potential at depletion region acts as a barrier for further movement of majority charge carrier. However still minority carrier drift across the depletion region and a negligible current flows which is known as drift current.

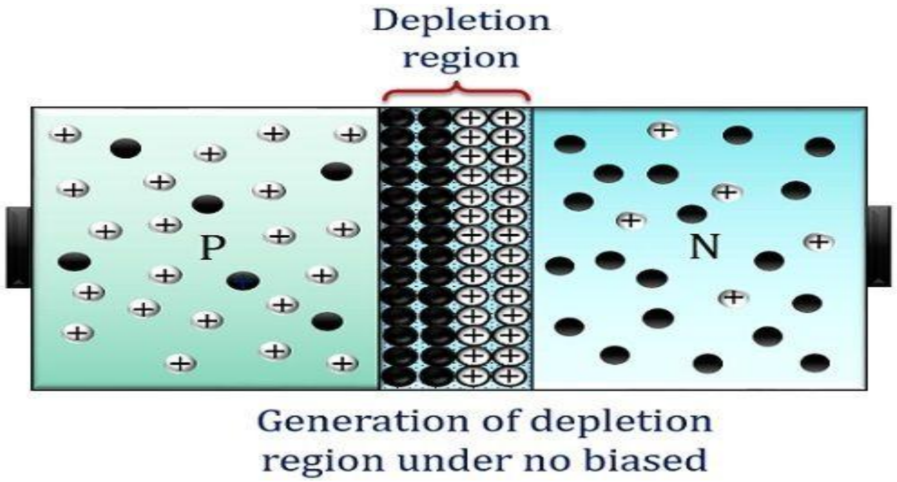

Fig 3

Forward Biased Condition:

At forward biased condition, $p - side$ of the device is connected with positive terminal of the supply. The $n - side$ is connected with negative terminal. Therefore the junction is said to be in forward biased. When forward biasing is applied the holes in the $p - side$ experience repulsive force from the positive terminal. Similarly $n - side$ also experience a repulsive force from the negative terminal of the supply provided.

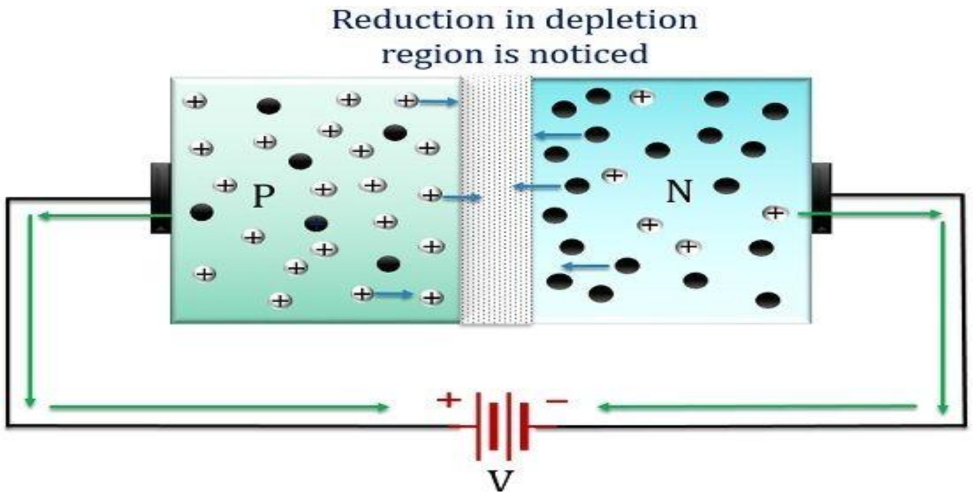

Fig 4

However initially the majority charge carrier from both sides do not move across the junction due to barrier potential. When barrier potential exceeded the majority charge carrier starts to move across the junction. This movement of charge carriers after overcoming the barrier potential generates current. This current is known as majority current. At the moment the barrier potential is removed the resistance offered by the junction becomes zero. Now a forward currents starts to flow through the device. The barrier potential for Si is $0.7\ v$ and for Ge it is equal to $0.3\ v$. So after overcoming the respective potential in case of both the materials, forward current starts flowing through the device.

Revere Biased Condition:

When we externally provide the potential to the device in such a way that $p - side$ is connected to the negative terminal of the supply and $n - side$ is connected with the positive terminal. Then the device is said to be in reverse biased. When a reverse potential is applied the holes from the p-side experience attraction from the negative terminal of the supply provided.

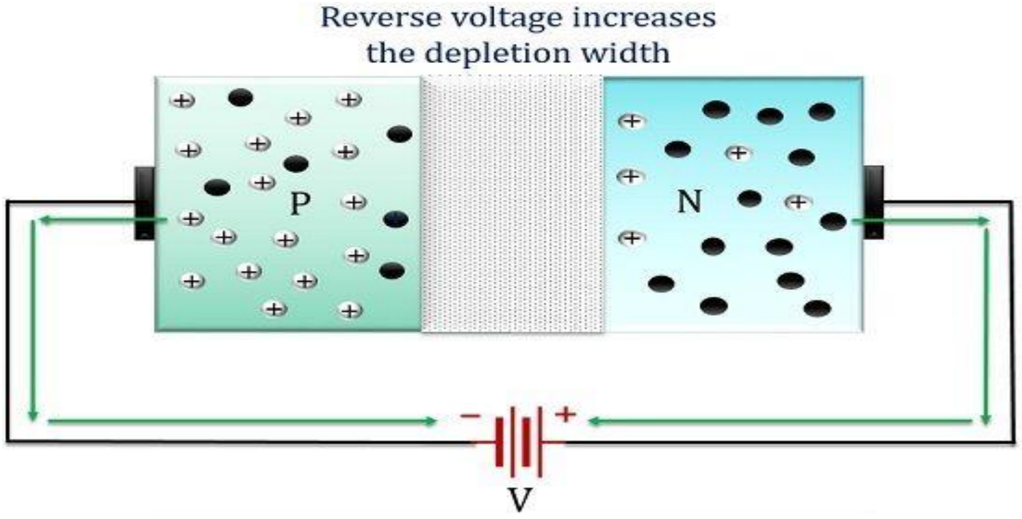

Fig 5

Due to this the majority carrier present in both side move in the direction away from the junction. This broadens the with of the depletion region and the potential barrier increased. This makes the device in nonconducting state. However due to minority carrier present in both $p \,\&\, n \; side$ a very small current flows. This small current in the device is known as leakage current. This reverse current is independent of barrier potential and depends only on temperature and construction of device.

Characteristic Curve of Diode:

As shown in Fig 13 region A represents the curve for forward biased diode and region B represents the curve for the revere biased diode. Let us consider that the diode is made of silicon material. Hence the external potential is required to overcome the barrier potential is $0.7\ v$.

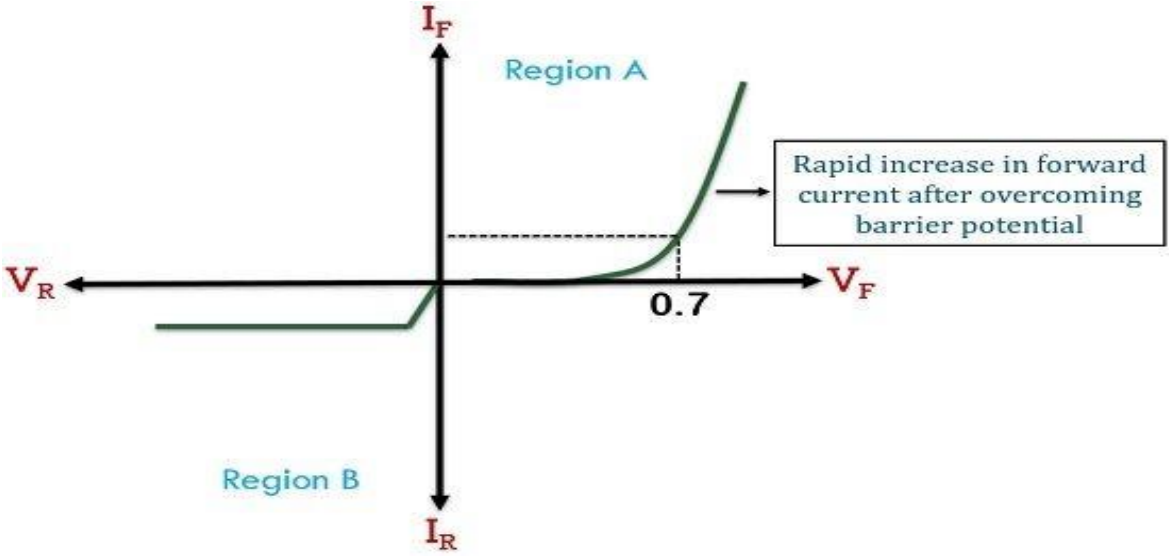

Fig 6

Thus it is seen in forward bias region a rapid increase current is noticed after $0.7\ v$. This is known as knee voltage after which the barrier potential is totally removed and the device starts to conduct. On the other hand region B represents the reverse bias condition of the device. In this case the width of the depletion region is very large as well as the barrier potential. Thus the curve represents the reverse saturation current that flows only due to movement of minority charge carrier through the device. For Si it is equal to less than $1\mu amp$. It is noted that at a nominal reverse voltage a small reverse current flows.

But on increasing the reverse voltage a condition arises that causes the junction of the diode to break down. This causes an immediate increase in the reverse current through it.