Semiconductor Diode

Manoj Kr. Das
Associate Professor
Department of Physics
J N College, Boko

What do you mean by semiconductor?

Germanium & Silicon are best example of semiconductor.

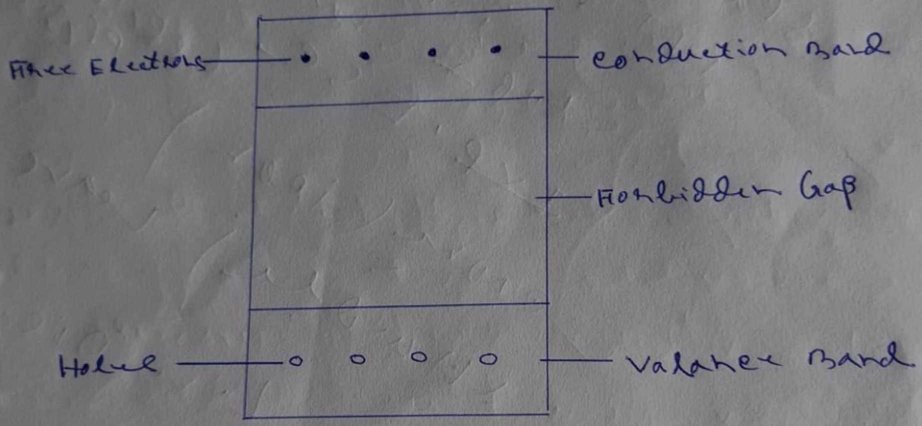
Let us take the case of Germanium.

In case of Germanium there are four valance electron in the outer orbit.

Usually the electrons are in the valance band.

When it excited the electrons goes to conduction band. Now the electrons here are known as Free Elactron.

The vacant space remains in the valance band as it is & these are known as Holes.



Fig(1). Germanium.

Free electrons are (-) charged particles & Holes are treated as (+) charged particles.

Types of Semiconductor:

There are two types of semiconductor. One is known as p-type semiconductor and other is known as n-type semiconductor.

In case of p-type there are holes present there & in case of n-type there are free electrons available.

Semiconductor Diode:

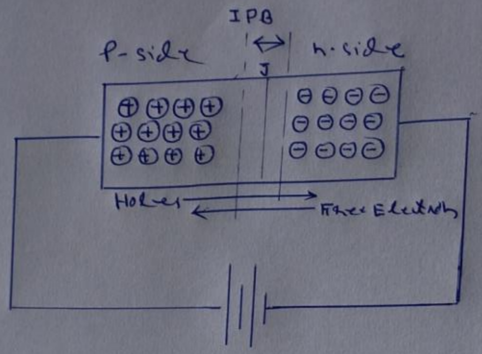
If there are holes in the left side & free electrons in theright side, the semiconductor is known as diode.

Biasing:

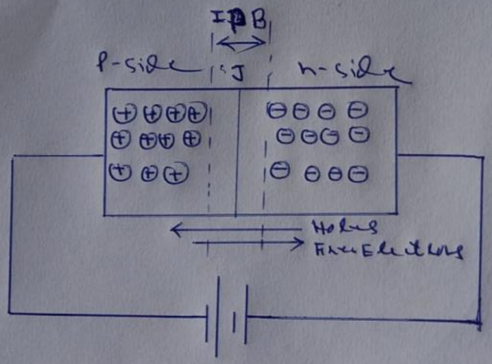
In case of p-n diode when the p - side is connected with (+) terminal of the battery and the n - side is connected with (-) terminal, the diode is said to be in Forward biased condition.

Again p-side is connected with (-) terminal & n-side is connected with (+) terminal the diode is said to be in Reversed Biased condition.

In case of Forward Biased p-side as well as n-side get positive i.e. same potential, but in case of Reversed Biased p-side & n-side get opposite potential.



Fig(ii) Forward Biased Condition



Fig(iii) Reversed Biased condition

Fig(iv). Symbol

Forward Characteristic:

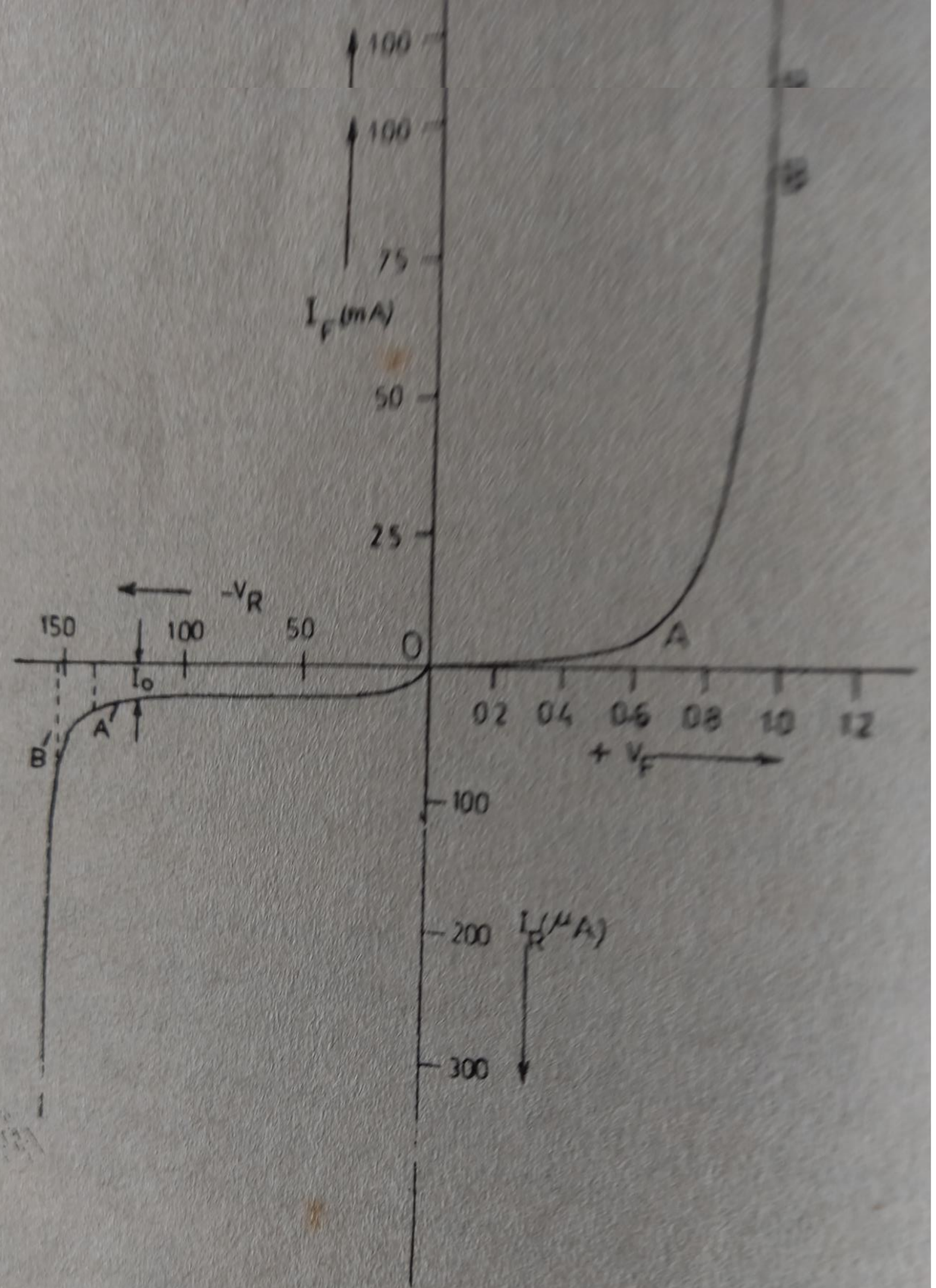
Let the circuit is in forward biased.

The forward voltage increased from zero & the resulting current is recorded by milliammeter.

The graph of forward current against the applied forward voltage shows in the next slide.

This shows that

It is not a straight line. Therefore the ratio V/I is not constant. This means that a semiconductor diode does not obey Ohm’s Law.



100
75
50
25
I_F (mA)
-V_R
150
100
50
O
I_o
A'
B'
A
B
0.2
0.4
0.6
0.8
1.0
1.2
+ V_F
100
200
300
I_R (μA)

Fig. 2·7

Hence a semiconductor diode is a non-linear conductor of electricity

For small values of the forward voltage (V_F) less than the internal potential barrier (V_0), the forward current (I_F) is zero.

For Germanium, IPB IS 0.3 V

For Silicon, IPB is 0.7 V

When $V_F < V_0$ the potential barrier prevents holes from p-side and electrons frm n-side to flow across the depletion region in opposite direction.

When $V_F > V_0$ a small current a small current flow & after that it increase rapidly. This V_F is known as cut-in, threshold, offset or break-point voltage.

Now V_F is further increased the current increases very rapidly. This is because increase of the forward bias increases the speed of flow of electrons and holes.

When the electrons moving with increased kinetic energy collide with crystal atoms, some covalent bonds are broken, consequently some pairs of holes & electrons are created. This effect again increases the current. As current increases, heat is generated & this causes again the current increase.

Reverse Characteristic:

When V_R increases from zero to a suitable value the resulting current is measured by a micro-ammeter.

The graph is drawn between V_R against I_R.

From graph it seems that –

As V_R increases from zero, I_R increase and reaches a maximum value I_0 at a small value of V_R.

As V_R is further increased the reverse current is almost independent of the magnitude of reverse voltage up to a certain critical value of V_R.

This current is known as RSC or leakage current.

When V_R is increased beyond the critical value, I_R increases rapidly. The critical value of V_R is called is known as Turn-Over Voltage. After that a small increase in V_R produces a large increase in I_R. This value is known as Break-Down Voltage.

The behaviour of p-n diode are –

When the p-n diode is forward biased it allows a large number of forward current to flow through it i.e. it offers a very small resistance

When the diode is reversed biased & if the reverse voltage is less than the turn over voltage, it allows a very small reverse current to flow through it i.e. it offers a very high resistance.