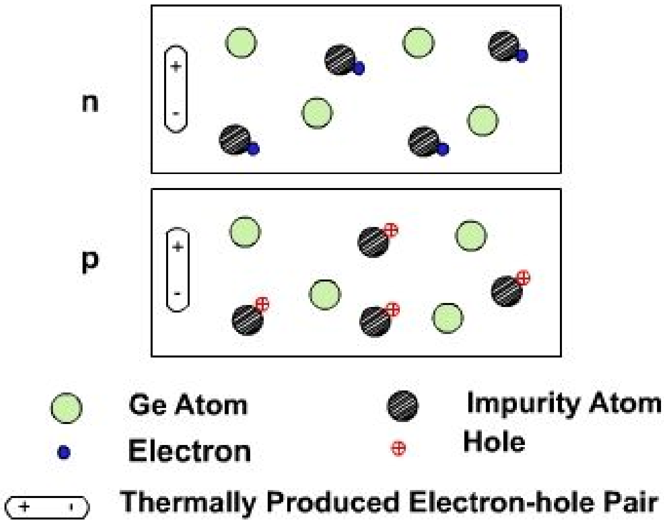
P-N JUNCTION DIODE

Consider first the condition of p-type and n-type Ge just prior to joining below figure. The majority and minority carriers are in constant motion. The minority carrier are thermally produced and they exist only for short time after which they recombine and neutralize each other.



In the mean time, other minority carriers have been produced and this process goes on and on. The number of these electrons hole pair that exist at any one time depends upon the temperature. The number of majority carriers is however fixed depending on the number of impurity atoms available. While the electrons and holes are in motion but the atoms are fixed in place and do not move.

The impurity atoms are fixed in their individual places. The atoms itself is a part of the crystal and so cannot move. When the electrons and hole meet, their individual charge is cancelled and this leaves the originating impurity atoms with a net charge, the atom that produced the electron now lack an electronic and so becomes charged positively, whereas the atoms that produced the hole now lacks a positive charge and becomes negative.

This region is produced immediately surrounding the junction that has no majority carriers. The majority carriers have been repelled away from the junction and junction is depleted from carriers. The junction is known as the barrier region or depletion region. The electric field represents a potential difference across the junction also called space charge potential or barrier potential **.** This potential is 0.7v for Si at 25^{o} celcious and 0.3v for Ge.

The physical width of the depletion region depends on the doping level. If very heavy doping is used, the depletion region is physically thin because diffusion charge need not travel far across the junction before recombination takes place (short life time). If doping is light, then depletion is more wide (long life time).

Reverse Bias:

If positive terminal of dc source is connected to cathode and negative terminal is connected to anode, the diode is called reverse biased as shown in **fig. 5**.

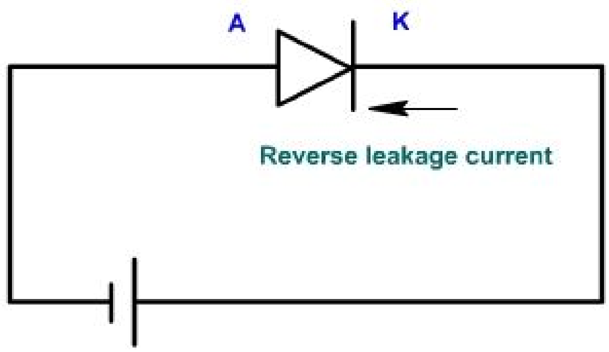


Fig.5

When the diode is reverse biased then the depletion region width increases, majority carriers move away from the junction and there is no flow of current due to majority carriers but there are thermally produced electron hole pair also. If these electrons and holes are generated in the vicinity of junction then there is a flow of current. The negative voltage applied to the diode will tend to attract the holes thus generated and repel the electrons. At the same time, the positive voltage will attract the electrons towards the battery and repel the holes. This will cause current to flow in the circuit. This current is usually very small (interms of micro amp to nano amp). Since this current is due to minority carriers and these number of minority carriers are fixed at a given temperature therefore, the current is almost constant known as reverse saturation current I_{CO}.

In actual diode, the current is not almost constant but increases slightly with voltage. This is due to surface leakage current. The surface of diode follows ohmic law (V=IR). The resistance under reverse bias condition is very high 100k to mega ohms. When the reverse voltage is increased, then at certain voltage, then breakdown to diode takes place and it conducts heavily. This is due to avalanche or zener breakdown. The characteristic of the diode is shown in **fig. 6**.

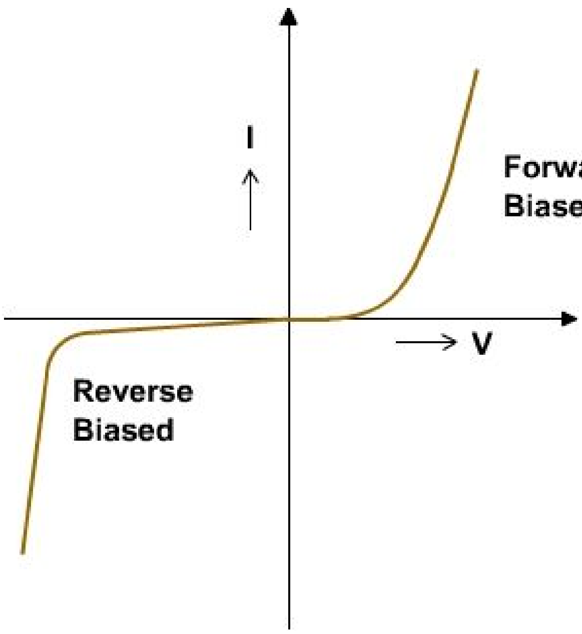


Fig.6

Forward bias:

When the diode is forward bias, then majority carriers are pushed towards junction, when they collide and recombination takes place. Number of majority carriers are fixed in semiconductor. Therefore as each electron is eliminated at the junction, a new electron must be introduced, this comes from battery. At the same time, one hole must be created in p-layer. This is formed by extracting one electron from p-layer. Therefore, there is a flow of carriers and thus flow of current.