Unit II

SEMICONDUCTING MATERIALS

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2.8.Schottky Diode

Definition

It is a junction formed between a metal and n-type semiconductor.

When the metal has a higher work function than that of n-type semiconductor then the junction formed is called schottky diode.

Figure shows schottky diode and its circuit symbol.

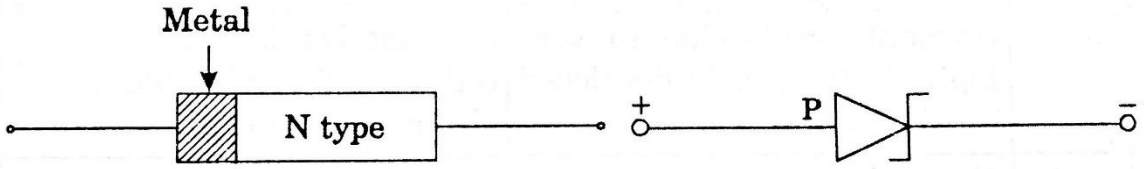

Fig2.8.1 schottky diode and its circuit symbol

The electrons in the conduction level of the semiconductor move to the empty energy states above the Fermi level of the metal.

This leaves a positive charge on the semiconductor side and a negative charge (due to the excess electrons) on the metal side as shown in figure. This leads to a contact potential.

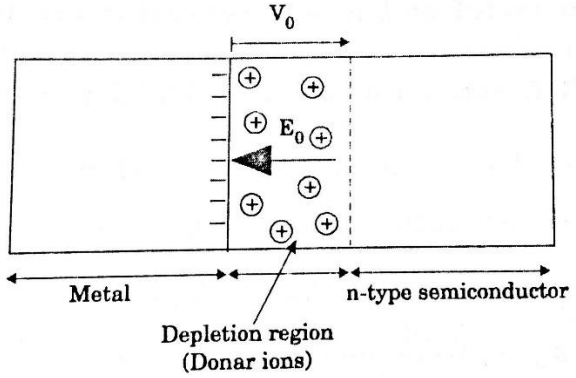

Fig 2.8.2Energy band diagram

When a Schottky junction is formed between metal and semiconductor, Fermi level lines up. Also a positive potential is formed on the semiconductor side. The formation of a depletion region of width W_D is shown below

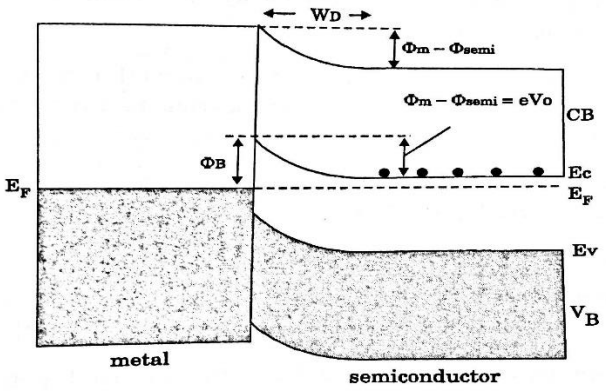

Fig 2.8.3 Formation of depletion layer

Working

The voltage is applied to the diode in two methods

(i) Forward bias

In this the metal is connected to positive terminal and n type semi conductor is connected to negative terminal of the battery.

The electrons injected from the external circuit into the n type semi-conductor.This leads to a current in the circuit.

(ii)Reverse bias:

A metal is connected to negative terminal and n type semiconductor is connected to the positive terminal of the battery.This increses the width of the depletion region and henc thee is npo flow of electron from semi conductor to metal.Now it acts as a rectifier.

V-I Characteristics

The V-I characteristics of the junction is shown in figure. There is an exponential increase in current in the forward bias while there is a very small current in reverse bias.

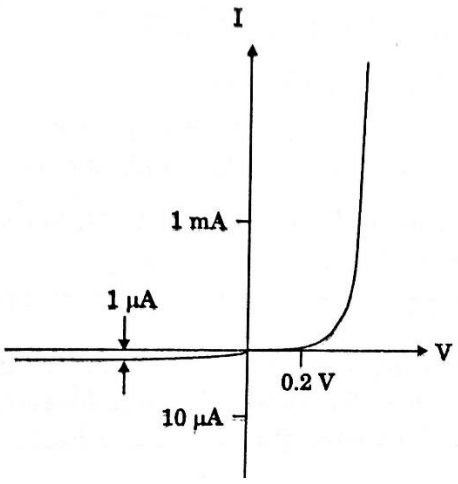

Fig 2.8.4-V-I Characteristics

Advantages of schottky diode

1. It has a very low cut-in voltage of about 0.3 V.
2. Schottky diode has very low switching time.
3. Schottky diode has very low power consumption.
4. it has a very rapid response to a change in bias.
5. The Schottky diode is closer to the ideal diode.
6. Schottky diode has negligible storage time.

The disadvantages of Schottky diode,

- Schottky diode is more expensive.

Application of Schottky diode

1. Schottky diode is used as a fast switching device in digital computers.
2. It can be used in clamping and clipping circuit.
3. The Schottky diode is used in AC to DC (ADC) converters.
4. It is used in mixer and detectors.
5. The Schottky diode is used in RADAR system.
6. It is used in switch mode power supply.
7. Schottky diodes are used as general-purpose rectifier.
8. It is used to detect signals.
9. It is used in logic circuit.

2.9.OHMIC CONTACT

Definition

An ohmic contact is a type of metal semiconductor junction. It is formed by a contact of a metal with a heavily doped semiconductor.

When the semiconductor has a higher work function than that of metal, then the junction formed is called the ohmic junction.

Here, the current is conducted equally in both directions and there is a very little voltage drop across the junction.

Before contact, Fermi levels of the metal and semiconductor are at different positions as shown in figure.

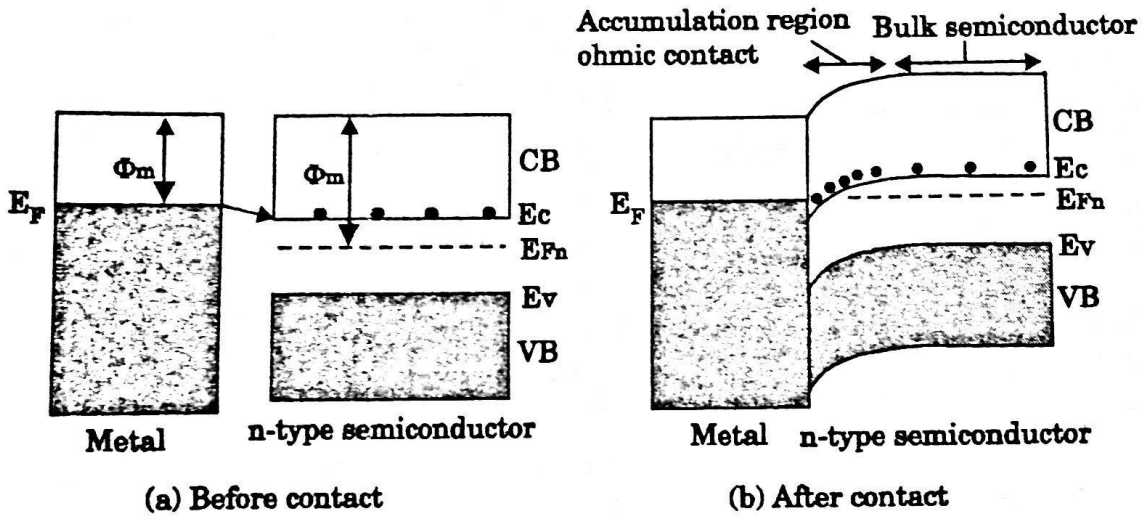

Fig 2.9.1 Ohmic contact before and after contact

Working

After contact, the ohmic junction is shown in figure(b). At equilibrium, the electrons move from the metal to the empty states in the conduction band of semiconductor. Thus, there is an accumulation region near the interface (on the side of conductor).

It results in line up of Fermi levels of metal and semiconductor as shown in figure (b).

The accumulation region has a higher conductivity than the bulk semiconductor due to this higher concentration of electrons.

Thus, a ohmic contact behaves as a resistor conducting in both forward and reverse bias. The resistivity is determined by the bulk resistivity of the semiconductor.

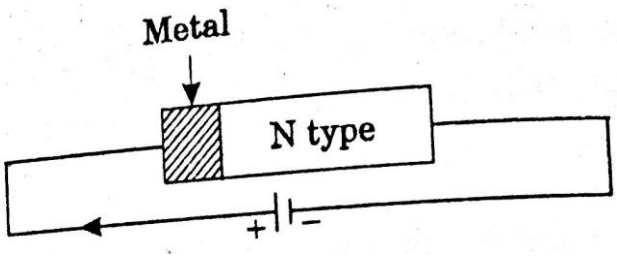

Fig 2.9.1.Symbol of ohmic contact

V-I Characteristics

The volt ampere (V-I) characteristic of the ohmic contact is shown in figure,

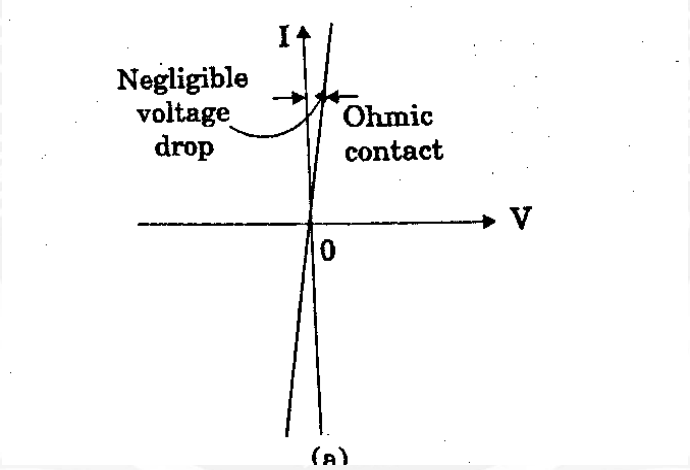

Fig 2.9.3;.V-I Characteristics

The current is directly proportional to the potential across the junction and it is symmetric about the region, as shown in figure.

Thus, ohmic contacts are non-rectifying and show negligible voltage drop and resistance irrespective of the direction and magnitude of current.