OHMIC CONTACT

When a metal and a semiconductor are joined, two possible types of contact can result :

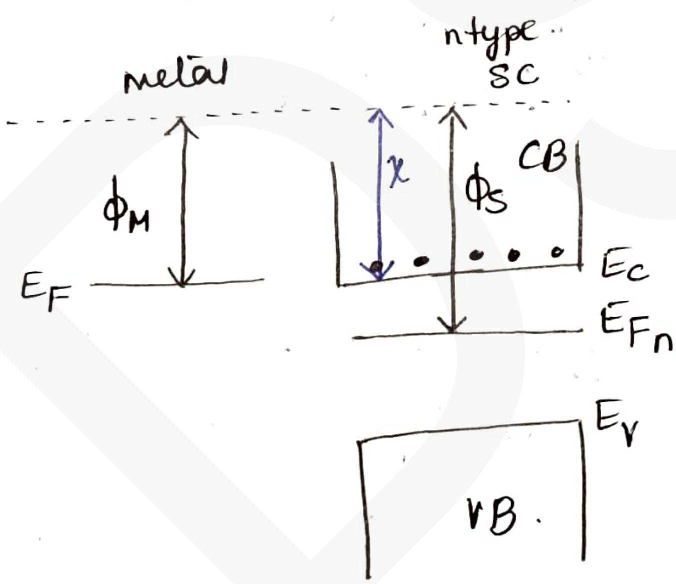
Rectifying type : allows current to pass in one direction. (aka schottky barrier contact)

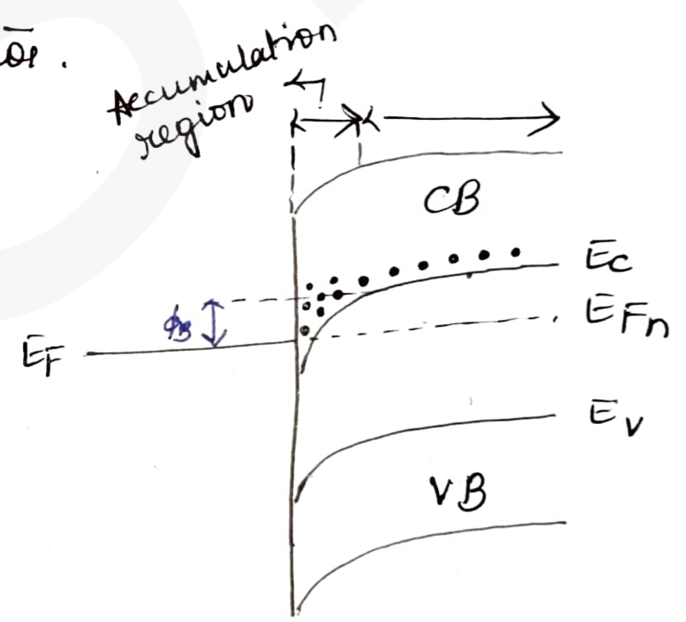
Ohmic type : allows current to pass in either direction.

Ohmic contacts are formed when work function of semiconductor is higher than work function of metal.

$$\phi_M < \phi_S$$

This occurs when a contact is established between metal & heavily doped semiconductor.





Before contact, Fermi level of metal is higher than Fermi level of semiconductor.

Once the contact is established, the electrons from metal move to the lower energy states of semi-conductor.

This results in an "accumulation region" near the interface on the semiconductor side.

The Fermi level of semiconductor lines up with Fermi energy of metal and the energy bands bends upward.

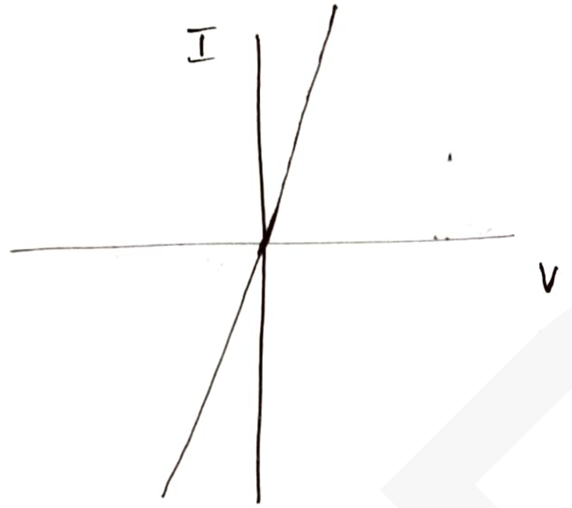
Forward bias:

when metal side is supplied +ve voltage, there is no barrier to electron flowing from semiconductor into metal. Hence, they flow from semiconductor to metal.

Reverse bias:

When metal side is supplied with -ve voltage a small voltage barrier develops on metal side.
This barrier is fairly small for a heavily doped semiconductor. The $\bar{e}$ on metal side can easily overcome this barrier & flow from metal to semiconductor side.

Thus current flows in either direction.



I - V characteristics of ohmic contact.

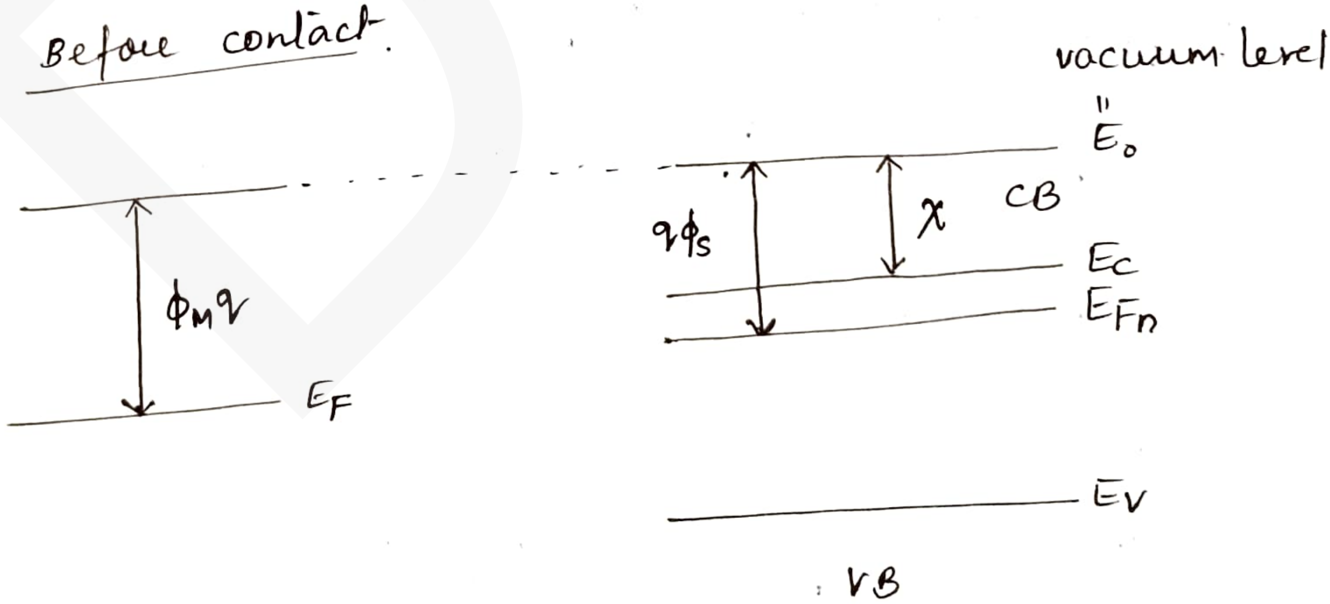
Schottky barrier contact & Schottky diode

A contact established between a metal with a higher workfunction and n type semi conductor with a lower workfunction is of rectifying type and is also known as schottky contact.

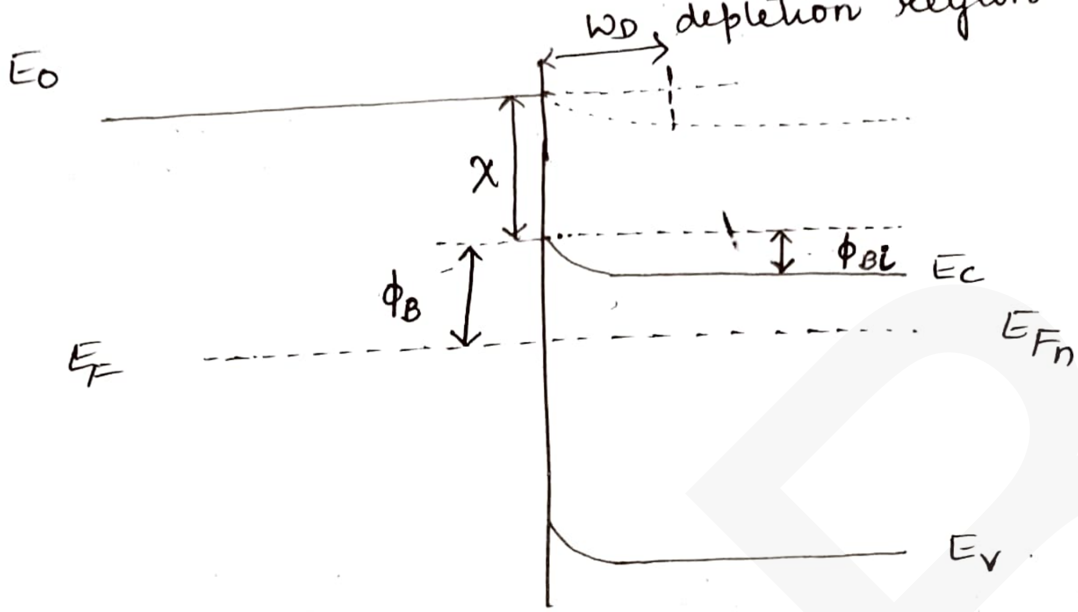
It allows current flow in only one direction.

$$\phi_M > \phi_S$$

Before contact.



After contact-



χ : electron affinity ; E_F : Fermi energy of metal
E_{Fn} : Fermi level of semiconductor ; E_c bottom of conduction band ; E_V top of valence band.
E_0 is vaccuum level ; ϕ_M work function of metal ; ϕ_S work function of semiconductor
ϕ_{Bi} is built in work function.

$$\phi_{Bi} = eV_0 = (\phi_M - \phi_S) = \text{Built in potential}$$

$$\phi_B = \phi_M - \chi$$

<u>Working</u> :

* when contact is made, e^-s flow from semiconductor region to metal in order to lower their energy.

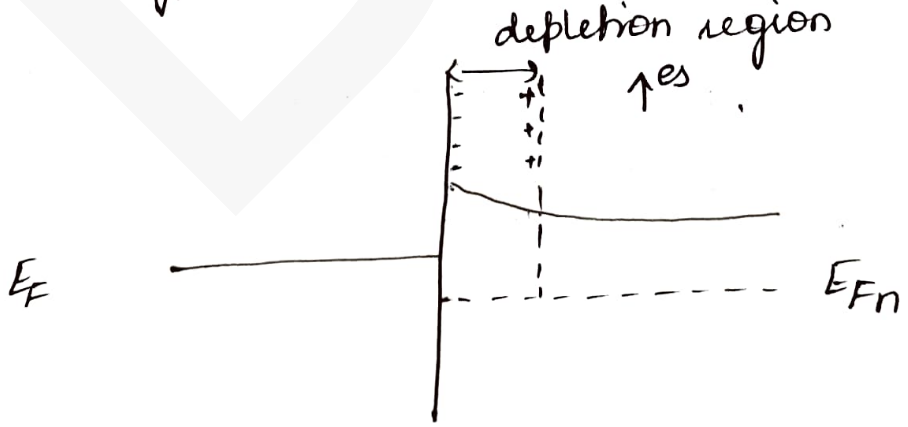
* The resulting build-up of charges on the metal - semiconductor interface causes a deformation of the band structure.

* The Fermi level of semiconductor comes inline with Fermi energy of metal.

* The transfer of electrons from semiconductor to metal leaves +ve charge on semiconductor side & -ve charge on metal side leading to formation of contact potential. ~~[illegible]~~ $eV_0 = \phi_{Bi}$

* The deformed band structure forms a potential barrier which e^-s must overcome in order to flow from the semiconductor into metal

(a) Reverse bias
* metal is connected to the -ve terminal of battery & n type is connected to +ve terminal.

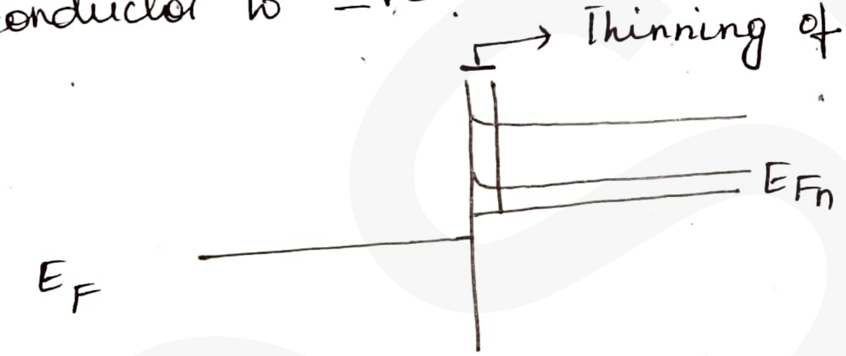


* The external potential is applied in same direction as that of junction potential hence causes a greater potential barrier and a larger depletion layer.

* Hence, no current flows from semi conductor to metal.

Forward bias

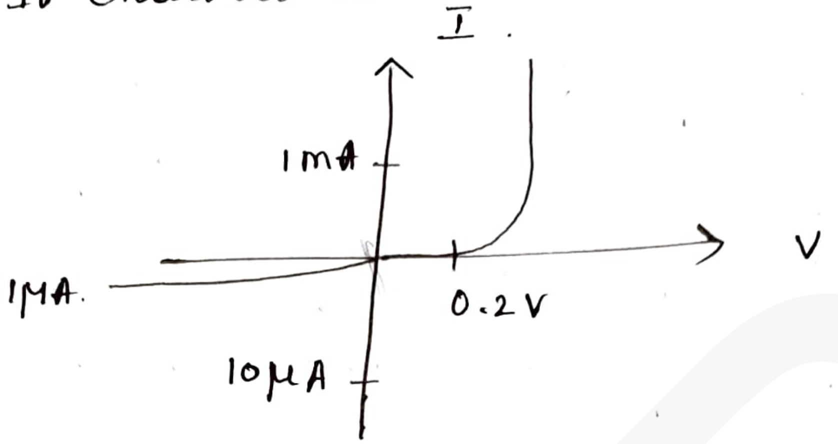
* Metal is connected to +ve battery terminal and semi-conductor to −ve.



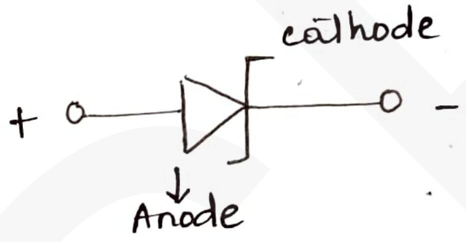
* In forward bias, the external potential opposes the in built potential. The potential barrier is much lower and the depletion region is quite thin.

* Electrons can easily tunnel through the barrier and a large current flows into the metal.

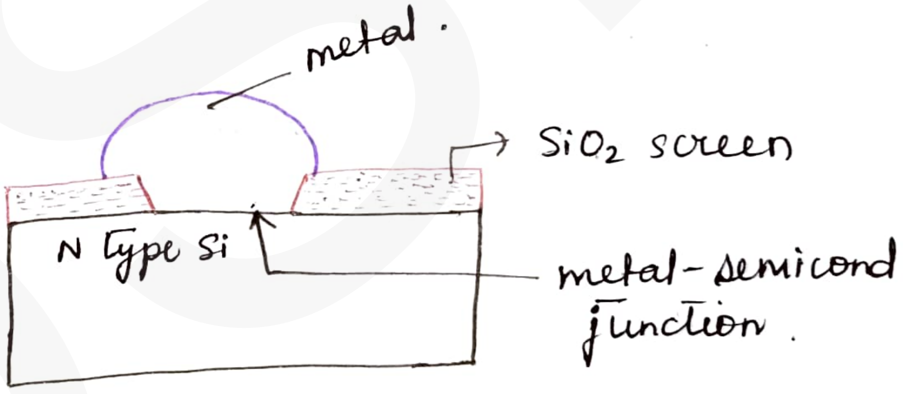
IV characteristics



symbol



construction



The above figure represents structure of a Schottky diode. It consists of an N type semiconductor, over which a metal structure is grown.

At the junction of metal and semiconductor a Schottky contact is established because $\phi_M > \phi_S$.