Schottky Diode theory W<λ

We may consider the other case when the width of the barrier is less than free path of electron. let us assume the width ≈ 10-6 cm. now we may neglect the diffusion component when calculating the current through thin space charge layers and may consider therefore only these electron move the semiconductor to metal .the kinetic energy of which is sufficient to pass through the contact potential barrier of height (Δφ-V)

Now the mean velocity

$$\bar{v} = \sqrt{\frac{8kT}{m^{*}\pi}}$$

$$\frac{1}{2}\bar{v} = \sqrt{\frac{2kT}{m^{*}\pi}}$$

$$= 2\sqrt{\frac{2kT}{m^{*}\pi}}$$

In this case there will be jump of electrons which kinetic energy is higher .Hence the whole of the energy of electron utilized to over the barrier.

$$\frac{1}{2}m^*v^2\rangle e(\Delta\Phi - V)$$

The current flowing from semiconductor to metal

$$J_1 = \frac{1}{2}n\bar{v}e$$

$$= \frac{1}{2}n_b e^{\frac{-e\Delta\Phi}{kT}}\bar{v}e$$

If we apply forward bias

$$J_1 = \frac{1}{2}n_b e^{\frac{-e(\Delta\Phi - V)}{kT}}\bar{v}e$$

$$J_2 = \frac{1}{2}n_b e^{\frac{-e\Delta\Phi}{kT}}\bar{v}e$$

$$J = J_1 - J_2$$

$$J = \frac{1}{2}n_b\bar{v}ee^{\frac{-e\Delta\Phi}{kT}}\left\{e^{\frac{eV}{kT}} - 1\right\}$$

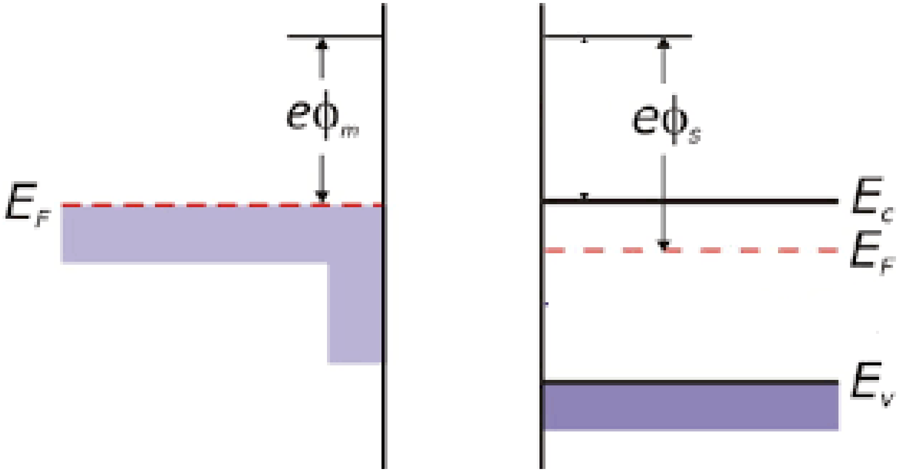
$$= \frac{1}{2}n_s\bar{v}e^{\frac{-e\Delta\Phi}{kT}}\left\{e^{\frac{eV}{kT}} - 1\right\}$$

$$= J_0\left\{e^{\frac{eV}{kT}} - 1\right\}$$

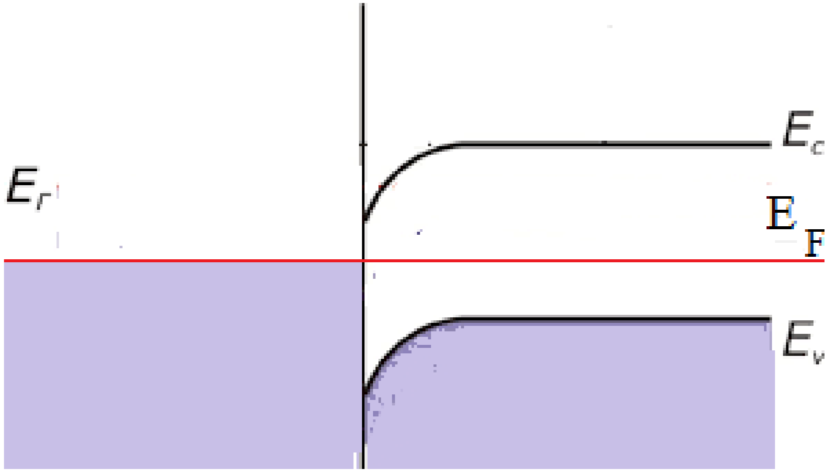
In this case J_0 is very sensitive to temperature but independent of field

Ohomic Contact/non rectifying contact

The other case of metal semiconductor contact $\varphi_m < \varphi_s$ for n type semiconductor results in non rectifying contact or ohomic contact. In many cases we wish to have an ohomic metal semiconductor contact having a linear I-V characteristics in both biasing direction. Electron will flow from metal to semiconductor forming a layer of enriched electron.



Before equilibrium



After equilibrium

Bending of bands shown in the figure after equilibrium. To accommodate excess electrons in conduction band then E_c will be close to E_F.

Though we get a small barrier even at room temperature ,the carrier from the metal side will be able to cross the barrier and the junction will always will be flooded with electrons. These leads to ohomic contacts

Difficulties

Unlike p-n junction ,which occurs with in a single crystal ,a Schottky barrier junction includes a termination of the semiconductor crystal , semiconductor surface contains surface states due to incomplete covalent bonds which can lead to changes at the metal semiconductor interface. Further there is an interfacial layer which is neither semiconductor nor metal. Si crystal are covered by a thin (10-20 Å)oxide layer. Because of the surface state interfacial layer it is difficult to grow junction with barriers near the the ideal values predicted from work function of the two isolated materials .For Si good Schottky barrier Au, Pt.