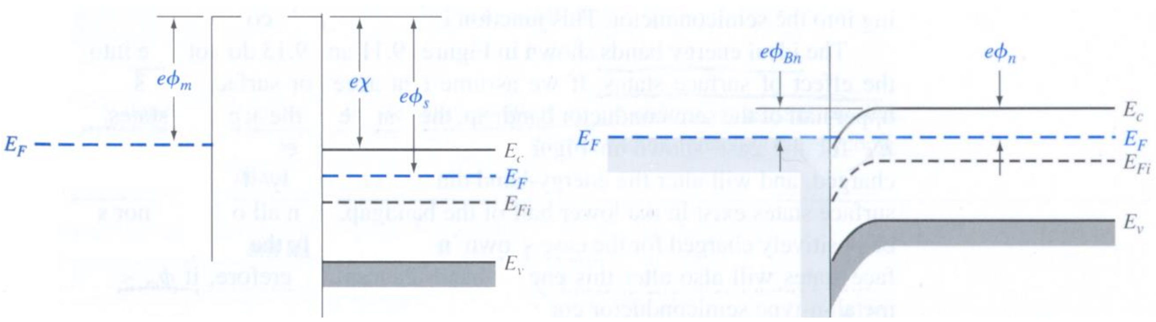
Note: The reverse saturation current of the Schottky barrier diode is orders of magnitude larger than the pn junction diode, but the turn on voltage of Schottky barrier diode is less than that of pn junction diode.

Metal-semiconductor ohmic contact

Contacts must be made between any semiconductor devices, or integrated circuit and the outside world. These contacts are made via ohmic contacts. An ohmic contacts is linear is a low resistance junction providing conduction in both directions between the metal and semiconductor. The current through the ohmic contact is a linear function of applied voltage and the slope should be very small. To get metal- semiconductor ohmic contact for n-type semiconductor the case should be $\Phi_M < \Phi_s$ as shown in the Fig.14.5.



(a) (b)

Fig.14.5 (a) we see the energy level before contact and, figure (b) the barrier after contact in the thermal equilibrium.

Heterojunctions

In the discussion of pn junctions in the previous sections, we assumed that the semiconductor material was homogeneous throughout the entire the entire structure. This type of junction is called a **homojunction**. When two different semiconductor materials are used to form junction, the junction is called a semiconductor **heterojunction**. Since the two materials used to form a heterojunction will have different energy bandgaps, the energy band will have a discontinuity at the junction interface.

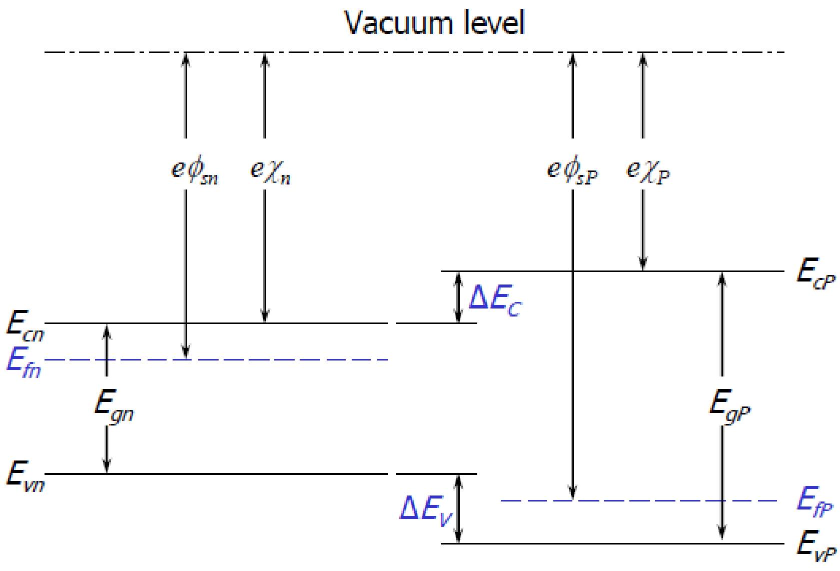


Fig.14.6 Energy-band diagrams of a narrow-bandgap and a wide-bandgap material before contact.

To have a useful heterojunction, the lattice constant of two material must be well matched. The figure shows an example of the energy band diagram of isolated n-type and p-type materials, with a vacuum level used as a reference.

Problems

Q1: Sketch the band diagram of metal-semiconductor (MS) rectifying contact (Schottky barrier diode) in the case of; (i) isolated energy band diagram of the metal and the semiconductor, (ii) MS in thermal equilibrium, (iii) MS contact in forward bias and (iv) MS contact in reverse bias. Identify each parameter in the sketch.

Q2: Consider chromium to n-type silicon Schottky diode at T=300K. Assume that $N_d=3\times10^{21}/m^3$. Determine the barrier height, built in potential and maximum electric field in a metal-semiconductor diode with an applied reverse bias $V_R=5V$.

(Ans: $\varphi_B=0.49V$, $V_{bi}=0.253V$, $E_{max}=7\times10^6 V/m$)

Q3: Schottky barrier height of silicon Schottky diode is $\varphi_B=0.59V$ at T=300K, Richardson constant is $114\times10^4 A/K^2m^2$ and the cross-section area $10^{-8}m^2$. Determine the reverse saturation current and the diode current with an applied voltage $V_R=0.3V$.

(Ans: $I_s=1.31\times10^{-7}A$, I=14.1mA)