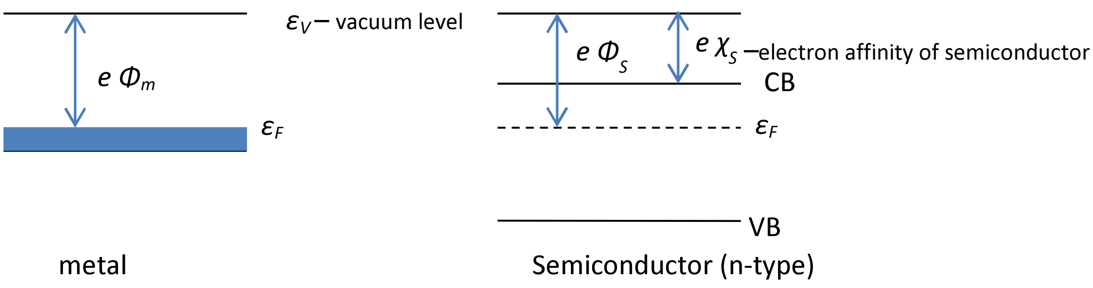
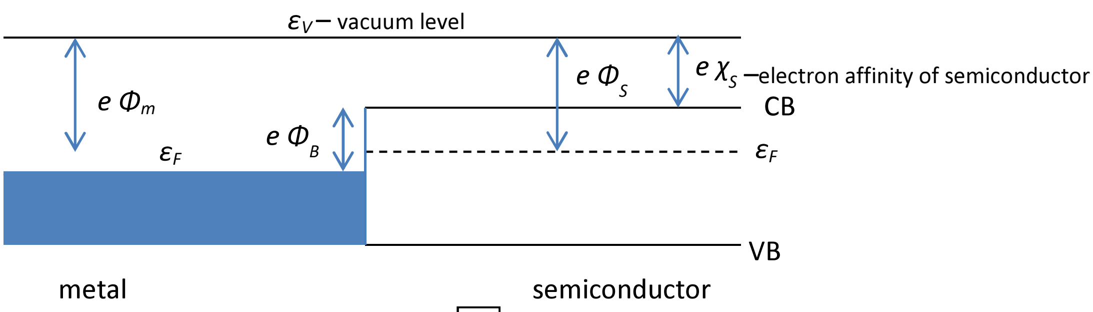
Metal-Semiconductor Junction. Schottky Contacts

We considered in quite some details the properties of PN-junction relevant to understanding of real-life semiconductor devices. Metal-semiconductor interface is, of course another important part of any device and we shall consider the properties of just such junction – *Schottky contact* (after Walter H. Schottky, 1886-1976). First experiments in late 1800 (Ferdinand Braun) and in early 1900 ("crystal detectors" in radio receivers).

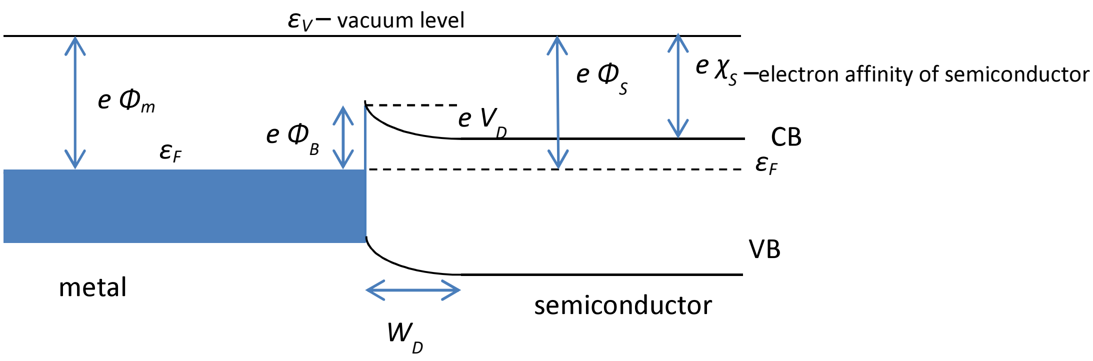
Removal of an electron from metal requires a finite amount of energy (work). This can be described with the aid of a Work Function (Φ_m, see photoelectric effect). The amount of work required to remove an electron is then $e\,\Phi_m$.





Schottky barrier height:

$$e\Phi_B = e\Phi_m - e\chi_S$$

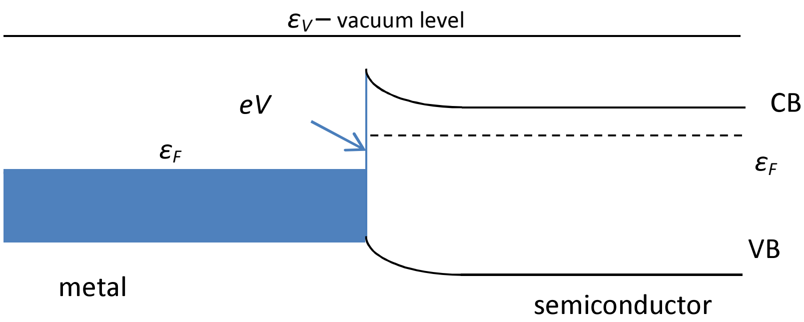


Electrons transfer to metal until Fermi levels are equalised which results in an electric field across W_D and in a diffusion potential V_D:

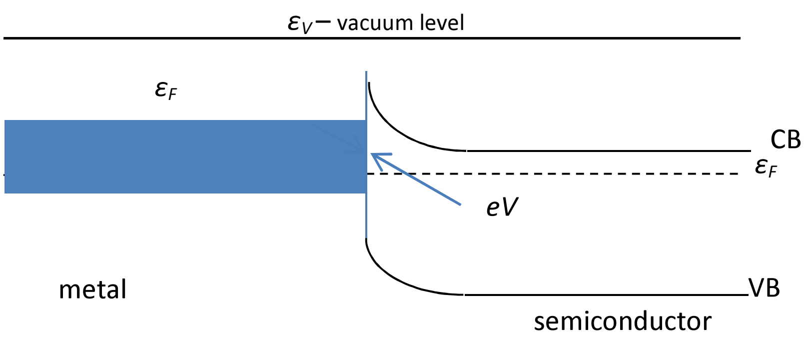
$$eV_D = e\Phi_B - (\varepsilon_C - \varepsilon_F)$$

Now let's see what would happen if we should apply forward and reverse bias and derive I-V characteristics.

Forward bias (metal + semi -)



Reverse bias (metal - semi +)



$$I = I_S\left(e^{eV/kT} - 1\right)$$

Where I_s is a reverse saturation current: $I_S \propto e^{-e\Phi_B/kT}$.

We can see that I-V characteristics are not far off the pn-junction and can be controlled by doping levels.

***I-V* CHARACTERISTIC**