CL27_Q1. Explain the concept of density of states and density of occupied states in metals.

Answer

Density of states is defined as the number of electron states per unit volume in an energy interval of a metal. It is given by the expression

$$\mathbf{g(E)dE = \frac{\pi}{2}\left(\frac{8m}{h^2}\right)^{\frac{3}{2}} E^{\frac{1}{2}}\, dE}$$

The probability that an energy state is occupied is given by the Fermi factor

$$F_d = \frac{1}{1 + e^{\left(\frac{E - E_f}{k_B T}\right)}}$$

The density of occupied states of electrons in a metal is given by, $N(E) = g(E) * F_d$

$$\mathbf{N(E) = \frac{\pi}{2}\left(\frac{8m}{h^2}\right)^{\frac{3}{2}} E^{\frac{1}{2}}\, dE * F_d}$$

CL27_Q2. Calculate the density of occupied states, for copper, at an energy level which is 0.026 eV above the Fermi level, at a temperature 300K. Assume Fermi energy of copper as 7eV.

Answer

Solution: Given $\Delta E = 0.026\ eV$, T= 300K, E_F= 7 eV, E- E_F= 0.026 eV= 4.16 X 10^{-21} J

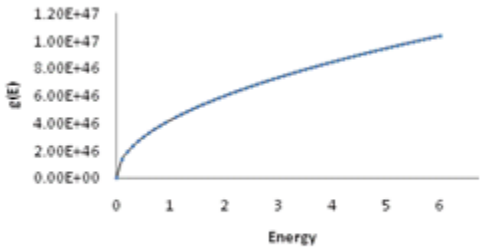
$$N(E) = g(E) * F_d$$

$$N(E) = \frac{\pi}{2}\left(\frac{8m}{h^2}\right)^{\frac{3}{2}} E^{\frac{1}{2}}\, dE * \frac{1}{1 + e^{\left(\frac{E - E_f}{k_B T}\right)}}$$

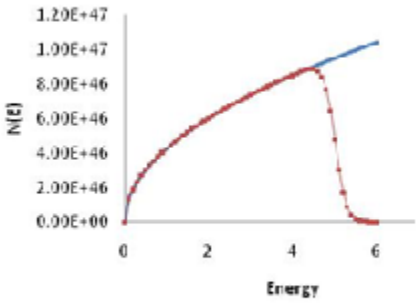
$$\mathbf{N(E) = 3.02\ x\ 1046\ states/m^3/J}$$

CL27_Q3. Draw density of states graph and the density of occupied states graph at $T \neq 0\ k$

Answer



Density of States



Density of Occupied States