Reading assignment: Chapter 2

Homework #2

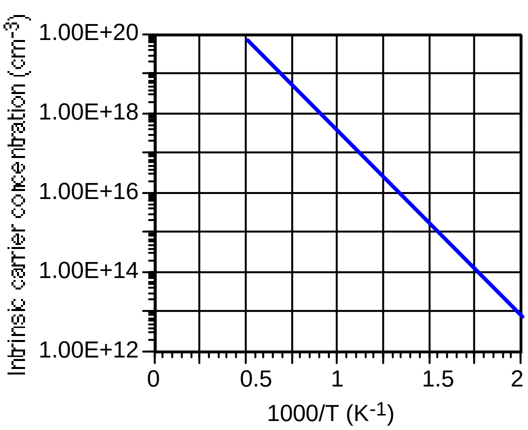
1. 2-3-2. /20

Consider an insulating epoxy which incorporates many randomly distributed metal balls. Does this medium behave as a dielectric or as a metal? (This problem is related to electron transport in amorphous semiconductors.)

2. 2-3-3. /30

In many semiconductors, the dependence of the electron energy, E, on the wave vector, k, for the lowest minimum of the conduction band differs from a simple parabolic relation $E = \frac{\hbar^2 k^2}{2m_n}$. A more accurate equation linking E and k is given by $E(1+\alpha E) = \frac{\hbar^2 k^2}{2m_n}$, where m_n is the effective mass for $E = 0$, k is the wave vector, and α is a constant (called a non-parabolicity constant). In this case, the electron effective mass, m^*, defined as $m^* = \frac{\hbar^2}{\partial^2 E / \partial k^2}$ is a function of energy. Calculate the dependence of the effective mass, m^*, on energy.

3./20 The figure shows the dependence of the intrinsic carrier concentration on inverse temperature for a semiconductor material. What is the energy gap of this semiconductor?



4. 2-4-3. /30

Calculate and plot the density states, g_n, (in cm^{-3}/eV) versus $E - E_c$ (in eV) and electron density per unit energy, dn/dE, (in cm^{-3}/eV) for Si at T = 300 K for $E_F - E_c = -0.2$ eV and $E_F - E_c = 0.2$ eV. The effective density of states mass of Si is 1.18 m_e. Compare with Fig. 2.4.2.

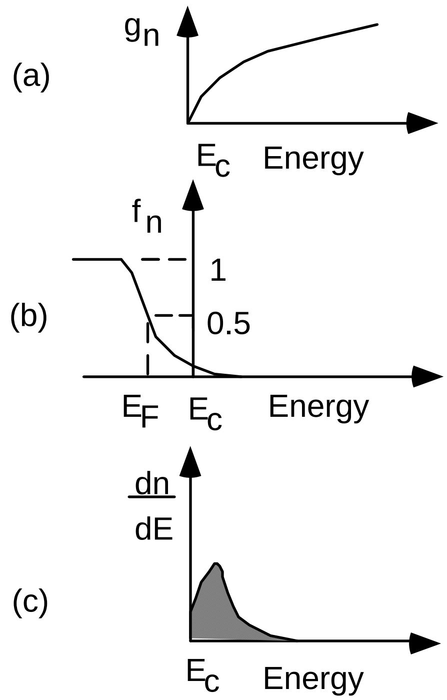


Fig. 2.4.2. (a) Density of states, (b) distribution function, and (c) electron density per unit energy. The dashed area is equal to the electron concentration in the conduction band (From M. S. Shur. Introduction to electronic Devices, Wiley, 1996.)