- **Plastic deformation**: Cold working like forging, rolling or wire drawing introduces crystal distortions and increase in dislocations. These tend to d3eflect and scatter the moving electrons. This causes an increase in the resistivity.
- **Heat treatment**: Hardening by quenching or precipitation increases resistivity. This is because of increased grain boundaries which hinder the flow of electrons. Annealing has the reverse influence and decreased resistivity.

Example (AMIE Summer 2012, 4 marks)

The resistivity of pure silicon at room temperature is 3000 ohm m. Calculate the intrinsic carrier density. Given the electron and hole mobilities are 0.14 m^2/Vs and 0.05 m^2/Vs, respectively.

Solution

The intrinsic charge carriers in pure silicon are electrons and holes in equal numbers.

$$n = n_e = n_h = \frac{\sigma}{(\mu_e + \mu_h)e}$$

$$= \frac{1}{(0.14 + 0.05)x3000x1.62x10^{-19}} = 1.095x10^{16}\ m^{-3}$$

Example

Find the conductivity and resistivity of a pure silicon crystal at temperature 300°K. The density of electron hole pair per cc at 300°K for a pure silicon crystal is 1.072 x 10^{10} and the mobility of electron μ_n = 1350 cm^2/volt-sec and hole mobility μ_h = 480 cm^2/volt-sec.

Solution

Conductivity of pure silicon crystal is given by

$$\sigma = n_i e(\mu_e + \mu_n) n_i = 1.072x10^{10}$$

$$\sigma_i = 1.072x10^{10}x1.6x10^{-19}(1350 + 480) = 3.14x10^{-6}\ mho/cm$$

$$\mu_n = 1350\ cm^2/volt\text{-}sec$$

$$\mu_h = 480\ cm^2/volt\text{-}sec$$

$$e = 1.6x10^{-19}$$

Resistivity of silicon crystal is given by

$$\rho_i = \frac{1}{\sigma_i} = \frac{1}{3.14x10^{-6}} = 3.18x10^5\ ohm-cm$$