
Problem 2.26 A piece of silicon has a resistivity which is specified by the manufacturer to be between 2 and 5 Ohm cm. Assuming that the mobility of electrons is 1400 cm²/V-sec and that of holes is 450 cm²/V-sec, what is the minimum possible carrier density and what is the corresponding carrier type? Repeat for the maximum possible carrier density.

Solution The minimum carrier density is obtained for the highest resistivity and the material with the highest carrier mobility, i.e. the n-type silicon.

The minimum carrier density therefore equals:

$$n = \frac{1}{qm_n r_{\max}} = \frac{1}{1.6 \times 10^{19} \times 1400 \times 5} = 8.92 \times 10^{14} \text{ cm}^{-3}$$

The maximum carrier density is obtained for the lowest resistivity and the material with the lowest carrier mobility, i.e. the p-type silicon.

The maximum carrier density therefore equals:

$$p = \frac{1}{qm_p r_{\min}} = \frac{1}{1.6 \times 10^{19} \times 450 \times 2} = 6.94 \times 10^{15} \text{ cm}^{-3}$$
