Assignment 6.3 (2)

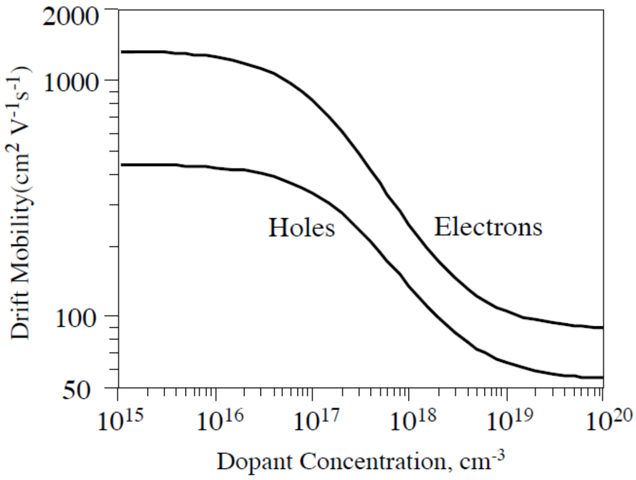

Figure 1. The variation of the drift mobility with dopant concentration in Si for electrons and holes at 300 K

Question 1:

Consider a Si ($n_i = 1.45 \times 10^{10}$ cm^3, ε_r is 11.9) *pn* junction diode, with an acceptor concentration N_a of 10^{18} cm^{-3} on the p-side and donor concentration N_d of 10^{15} cm^{-3} on the n-side. The drift mobility refers to Figure 1. The diode is forward biased and has a voltage of 0.6 V across it. The diode cross-sectional area is 1 mm^2. The minority carrier recombination time, τ, depends on the dopant concentration, N_{dopant} (cm^{-3}), through the following approximate relation

$$\tau = \frac{5 \times 10^{-7}}{\left(1 + 2 \times 10^{-17} N_{dopant}\right)}$$

Calculate the diffusion current and the recombination current. What is your conclusion on the contributions to the total diode current?

Question 2:

An Si p^+n junction diode has a cross-sectional area of 1 mm^2, an acceptor concentration of 5×10^{18} cm^{-3} on the p-side, and a donor concentration of 10^{16} cm^{-3} on the n-side. The recombination lifetime of holes in the n-region is 420 ns, whereas that of electrons in the p-region is 5 ns due to a greater concentration of impurities (recombination centers) on that side. Mean thermal generation lifetime (τ_g) is about 1 μs.

(a) Calculate the minority carrier diffusion lengths.

(b) What is the built-in potential across the junction?

(c) What is the current when there is a forward bias of 0.6 V across the diode at 27 ℃?

Assume that the current is by minority carrier diffusion.

(d) What is the reverse current when the diode is reverse biased by a voltage V_r = 5 V?