Semiconductor Device Theory: Conductivity – Theoretical Exercise

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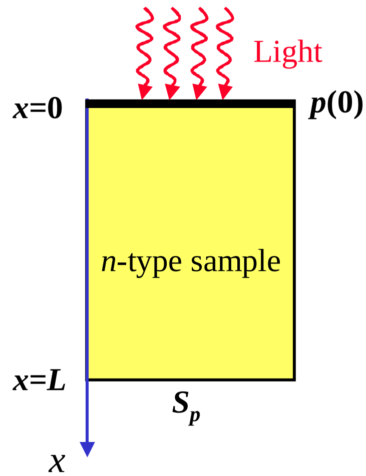
1. An electron is moving in a piece of lightly-doped Si under an applied field at T=300K, so that its drift velocity is 1/10 of its thermal velocity. Calculate the average number of collisions it will experience in traversing by drift a region 1 μm wide. What is the voltage applied across this region? The mobility of the carriers is 600 cm^2/V-s. Use $m^*=0.91m_0$, where m_0 is the free electron mass.

2. Conductivity of a silicon sample in thermal equilibrium is given by
$$\sigma = q\left(n\mu_n + p\mu_p\right)$$
Assume that the sample temperature is 300 K. The intrinsic carrier concentration of Si at this temperature is about $1.5\times10^{10}\,cm^{-3}$. The electron and hole mobilities are $\mu_n = 0.1\ m^2/(Vs)$ and $\mu_p = 0.03\ m^2/(Vs)$. The sample is doped by donors with the donor concentration $10^{16}\,cm^{-3}$ and then compensated by acceptors. What values of the acceptor concentration will yield the resistivity of 1 Ωcm?

3. Consider an *n*-type semiconductor, shown schematically in the figure below. The ultraviolet light shining at the surface is absorbed in a very thin layer near the surface, creating hole concentration at the surface $p(0) = G_L t_{eff}$. The backside contact has a surface recombination rate S_p. Calculate and plot the steady-state hole distribution in the sample for the following values of S_p: 10^3 *cm/s*, 10^5 *cm/s* and 10^7 *cm/s*. Neglect the intrinsic concentration of holes in the sample. Use the following values of the parameters: D_p=30 cm^2/s, $\tau_p=10^{-7}$ *s*, *L*=10 μ*m*, $t_{eff}=10^{-8}$ *s*, $G_L=10^{24}\ cm^{-3}s^{-1}$.


Light
x=0
p(0)
n-type sample
x=L
Sp
x