ECSE-2210 Microelectronics Technology
Class Activity 9

1. A Si slab of thickness 100 μm is illuminated from one side with light of energy 1.2 eV. Calculate the wavelength of the light. Calculate the fraction of light intensity that is transmitted through the slab (ignore any reflections). Assume an absorption coefficient of $\alpha = 20\ cm^{-1}$ at 1.2 eV (see figure 3.20).

2. If the light energy is 3 eV in the above case, what will be the fraction of light intensity that is transmitted? What fraction will be absorbed? Assume the absorption coefficient at 3 eV is $10^5 cm^{-1}$. Will Si be transparent or opaque to 3 eV radiation?

3. Suppose we have to make a photo-conductive detector to detect radiation of energy 1 eV. Of the three (Ge, Si and GaAs) which one will you use? Explain. (Hint: To detect, the radiation has to be absorbed by the semiconductor!!).

4. Consider three semiconductors: Si, ZnSe and SiC. Which one will look transparent to visible light, and why? (The bandgap energies are: Si = 1.1 eV, ZnSe = 2.7 eV, and SiC = 3.26 eV).

5. Explain what is meant by "low-level injection".

6. Explain what is meant by "life-times of minority carriers".

7. Why are we concerned with the lifetimes of ONLY the minority carriers? (i.e., when we generate excess holes, we generate excess electrons as well. But we don't care about the excess electrons we generate in n-type, for example).

8. A p-type Si sample with $N_A = 10^{15}\ cm^{-3}$ is steadily illuminated such that excess carrier concentrations $\Delta n = \Delta p = 10^{12}\ cm^3$. Assume that $\tau_n = \tau_p = 1$ μs in this sample. Assume $\mu_n = 1350\ cm^2/Vs$; $\mu_p = 480\ cm^2/Vs$.

(a) Is this low-level injection? Explain.

(b) What is the conductivity of the sample before and after the excitation?

(c) Suddenly, the optical excitation is removed (say, at time $t = 0$ s). Plot the carrier concentration as a function of time, and calculate the carrier concentrations (n and p) at the time $t = 1\mu s$. What will be n and p at $t \to \infty$?