ECE 340 Midterm 1
Review Questions

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October 2019

1 Band Diagrams

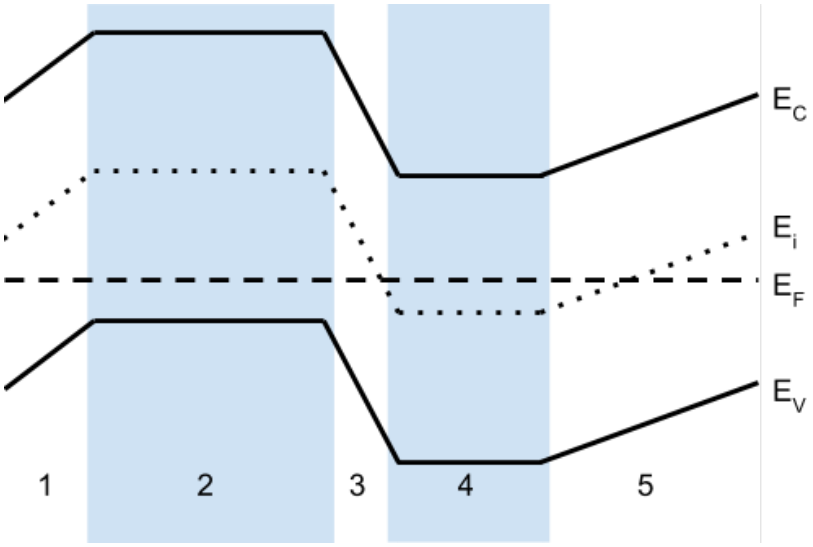

Figure 1: Semiconductor Band Diagram

1.1 Name the majority carrier in regions 2 and 4.

1.2 Which region has the highest conductivity?

1.3 This sample is at 300 K. At T = 100 K, would the resistivity in the region from 1.2 increase, decrease, or stay the same?

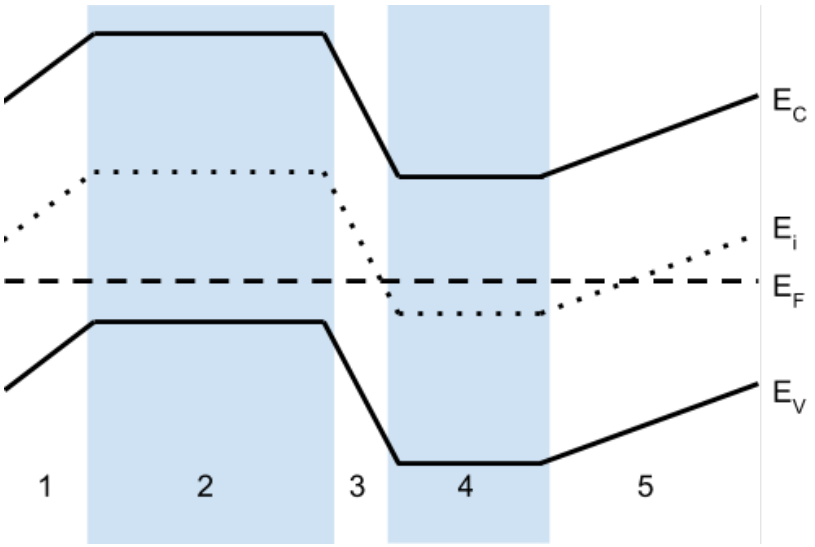

Figure 1: Semiconductor Band Diagram

1.4 Draw the direction and relative magnitude of electron diffusion in each region.

1.5 Draw the direction and relative magnitude of hole drift in each region.

1.6 Explain how you could determine the corresponding electron drift and hole diffusion based on your answers to 1.4 and 1.5.

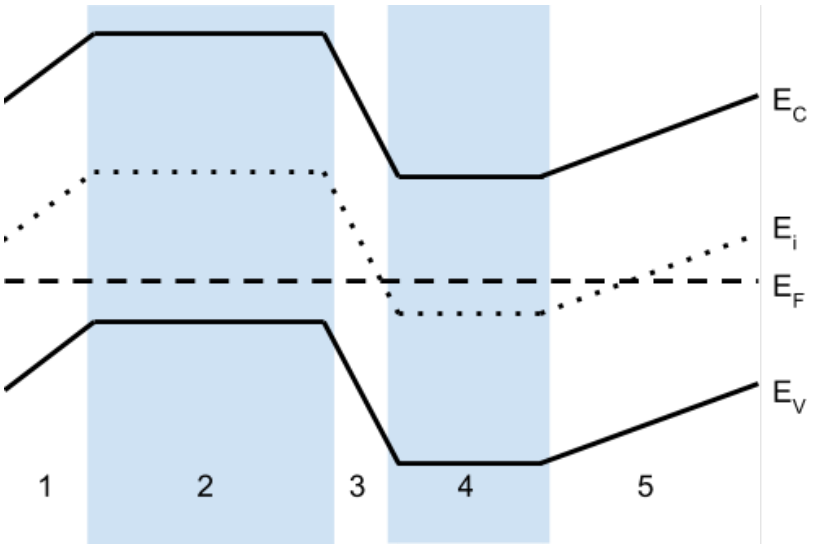

Figure 1: Semiconductor Band Diagram

1.7 Draw the corresponding electric field. (Assume +x is to the right)

2 Optical Absorption

2.1 Create a plot of light intensity vs distance into a semiconductor when illuminated with photons with $h\nu > E_G$. Sketch two traces for different absorption coefficients such that $\alpha_1 < \alpha_2$.

2.2 What would change if $h\nu < E_G$?

3 Optical Generation

3.1 Create a qualitative plot of δp vs time for an n-type semiconductor that had been uniformly illuminated for a long time, but with light turned off at $t = 0$. Sketch two traces for different carrier lifetimes such that $\tau_1 < \tau_2$. (Assume $\tau = \tau_p = \tau_n$)

3.2 For which τ is $E_i - F_p$ largest for $t < 0$?

4 Thermal Effects

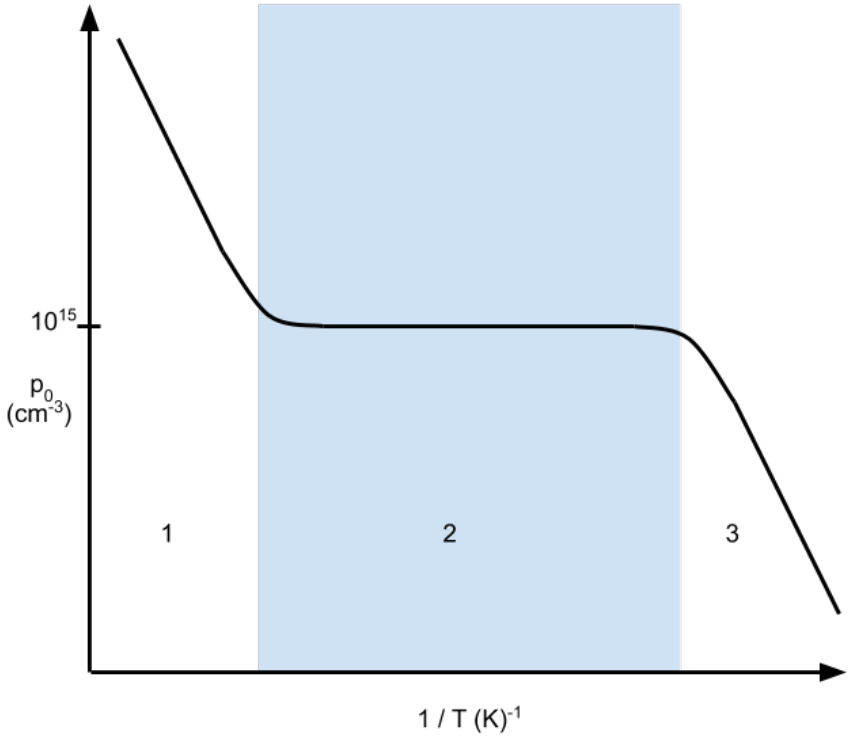

Figure 2: Carrier Concentration vs Temperature^{-1}

4.1 Suppose this is a sample of silicon ($n_i = 10^{10}$). Is this material doped with n or p type impurities?

4.2 What is the dominant effect in each region? Explain.

5 Approximations

5.1 What is the Boltzmann tail approximation, and when can it be used?

5.2 When is $n \approx N_D - N_A$?

5.3 What is the low-level injection approximation, and when can it be used?