KTH Information and Communication Technology

IH1611 Spring 2019

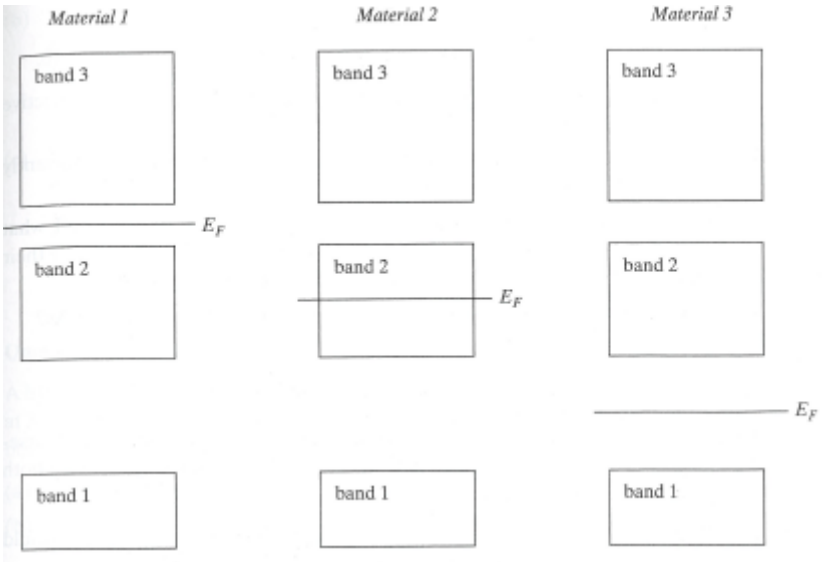
Problems to student recitation 1

1. Sketch the Fermi-Dirac distribution $f(E)$ at room temperature (300 K) and at a lower temperature such as 77 K.
2. The probability of a state being filled at $E_C + kT$ is equal to the probability of a state being empty at $E_C + 3kT$. Where is the Fermi level located? Use a graphical method to solve the problem!
3. The photo shows a piece of a semiconductor wafer with small integrated circuits. What can you tell about the bandgap energy and why.

4. Study the figure below:

   a) Characterize each of the materials 1, 2, and 3 as a metal, semiconductor, or an insulator.

   b) Which of the three materials is most likely to be transparent for visible light?



5. In a silicon sample the Fermi level is located at 0.21 eV above the intrinsic Fermi level at T = 300 K. What is the doping type? No calculations are needed to answer this part, only a figure!
   What are the electron and hole concentrations at T = 800 K and where approximately is E_F.
   Comment on your results.

6. Show that the values of the Fermi-Dirac distribution $f(E)$ at a pair of energies symmetric about the Fermi Level E_F are complementary for all values of ΔE and all temperatures:

$$f(E_F - \Delta E) + f(E_F + \Delta E) = 1$$

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