University of Delaware

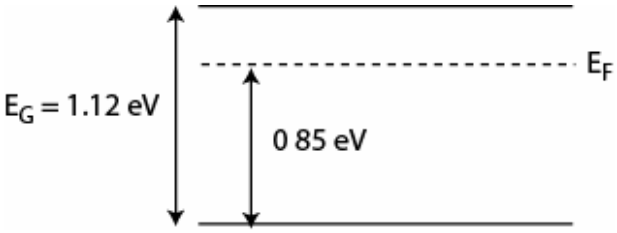
Department of Electrical and Computer Engineering

ELEG620: Solar Electric Systems

Homework #2: Semiconductor Basics and Junctions

1. SRH or defect recombination is enhanced if a defect level is located at the midgap rather than close to the conduction or valence band. Explain why this is true.

2. The simplified band structure of silicon ($n_i = 1 \times 10^{10}$ cm^{-3}) is shown below. Answer the following questions:



   (a) What is the doping in the material (type and dopant density)

   (b) What is the equilibrium minority carrier concentration?

   (c) There is a uniform excess minority carrier concentration of 1×10^{15} cm^{-3} throughout the material. Calculate and sketch both the quasi-Fermi levels.

3. A semi-infinitely long piece of material has a constant injection of minority carrier at one edge, denoted by N_{inj}.

   (a) Using τ for the minority carrier lifetime and D for the diffusivity, calculate the minority carrier diffusion current in the slab. Be sure to indicate what type of current (electron or hole) you are calculating.

   (b) What happens (describe, don't calculate) as the minority carrier lifetime tends towards very large values?

   (c) If the slab were made much thinner, and the surface recombination is large, briefly describe what would happen to the diffusion current.

4. Draw the band diagram of a pn junction under equilibrium and forward bias. Include the Fermi and quasi-Fermi levels, as appropriate.