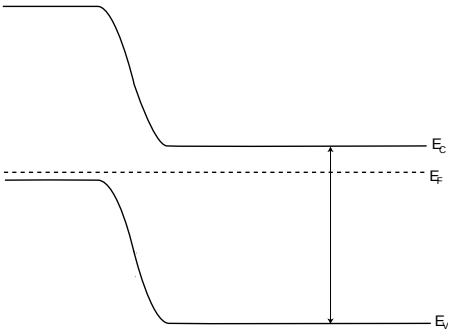
University of Delaware

Department of Electrical and Computer Engineering

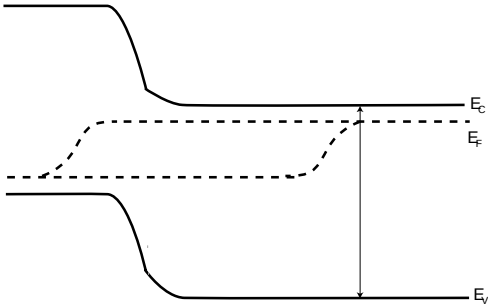
ELEG620: Solar Electric Systems

Homework #3: Solar Cells

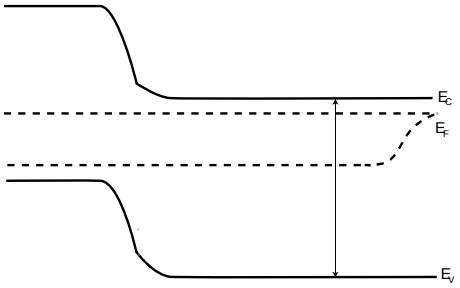
1. The following band diagrams are all for the same solar cell, under varying conditions. Determine: (a) Which side is more heavily doped; (b) The bias condition in each case; (c) If possible, information about the minority carrier lifetime and/or surface recombination.



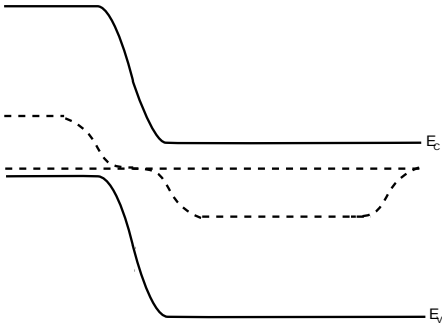
Case (1)



Case (2)



Case (3)



Case (4)

2. The following plot is the normalized saturation current density J_0'/J_0 versus normalized thickness. The normalized saturation current density is J_0'/J_0 where J_0 is the ideal wide base diode case and J_0' is the saturation current including the effects of surfaces. Normalized thickness is the ratio of the physical thickness to the diffusion length.

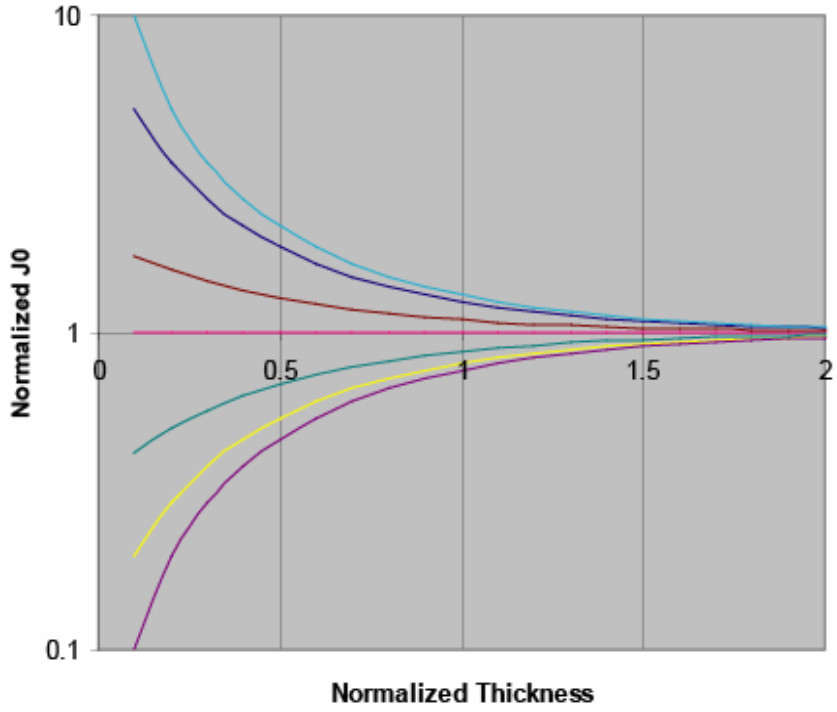


Figure 1: Normalized saturation current density vs. normalized thickness. The different curves correspond to changing SL/D, with SL/D = 0.001 (light blue), 0.1, 0.5, 1, 3, 10, 1000.

(a) Explain physically why the saturation current changes with thickness as shown in the plot.

(b) Explain physically and mathematically why SL/D = 1 has a normalized J_0 of unity.

(c) What implications does the above plot have for solar cell design?

3. The following is a plot of carrier concentration in the base of a solar cell.

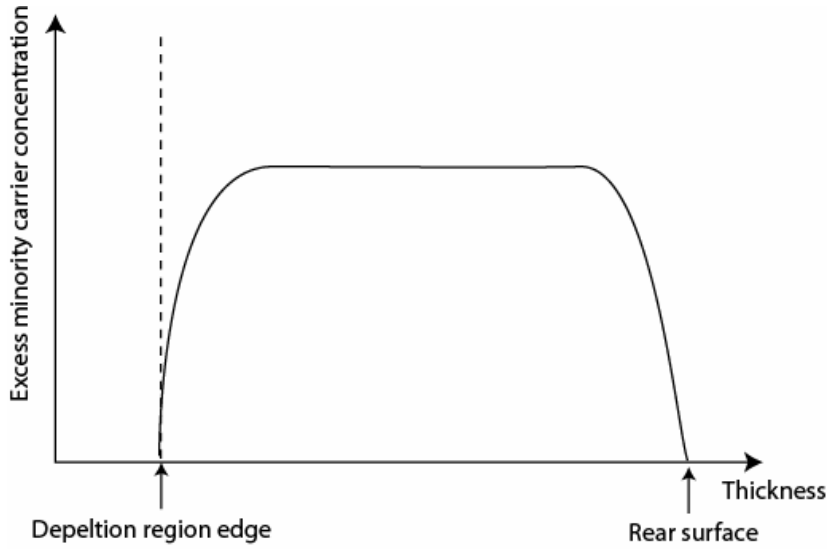


Figure 2: Excess minority carrier concentration vs. thickness in the base of a solar cell.

(a) What are the bias conditions (short circuit, open circuit, forward bias in the dark, etc) for the plot of the carrier concentration?

(b) What is the surface recombination velocity at the rear of the solar cell – is it high, low, etc. Justify your answer.

(c) What is the generation rate in the base of the solar cell? Justify you answer.

(d) Estimate how many of the light generated carriers are collected by the base of the solar cell. Justify your answer.