

Homework 9

Jacob Taylor Cassady

Semiconductor Development Fundamentals

March 25, 2020

1 FOR LIGHT TO BE ABSORBED, WHAT RELATION BETWEEN THE ENERGY OF A PHOTON AND THE SEMICONDUCTOR BANDGAP MUST BE SATISFIED?

The energy of the photon must be larger or equal to the semiconductor bandgap.

2 CONSIDER A SILICON P-N JUNCTION WITH $N_A = 10^{17} \text{ cm}^{-3}$ AND $N_D = 10^{16} \text{ cm}^{-3}$. THE MINORITY CARRIER LIFETIME ON THE P-SIDE IS $1 \mu\text{s}$, AND THE MINORITY CARRIER LIFETIME ON THE N-SIDE IS $10 \mu\text{s}$.

2.1 WHAT IS THE DEPLETION REGION WIDTH, W ?

$3.069843109322047 \times 10^{-5} \text{ cm}$

2.2 WHAT IS THE REVERSE SATURATION CURRENT DENSITY, J_s ?

$1.907127968579501 \times 10^{-10} \text{ A / cm}^2$

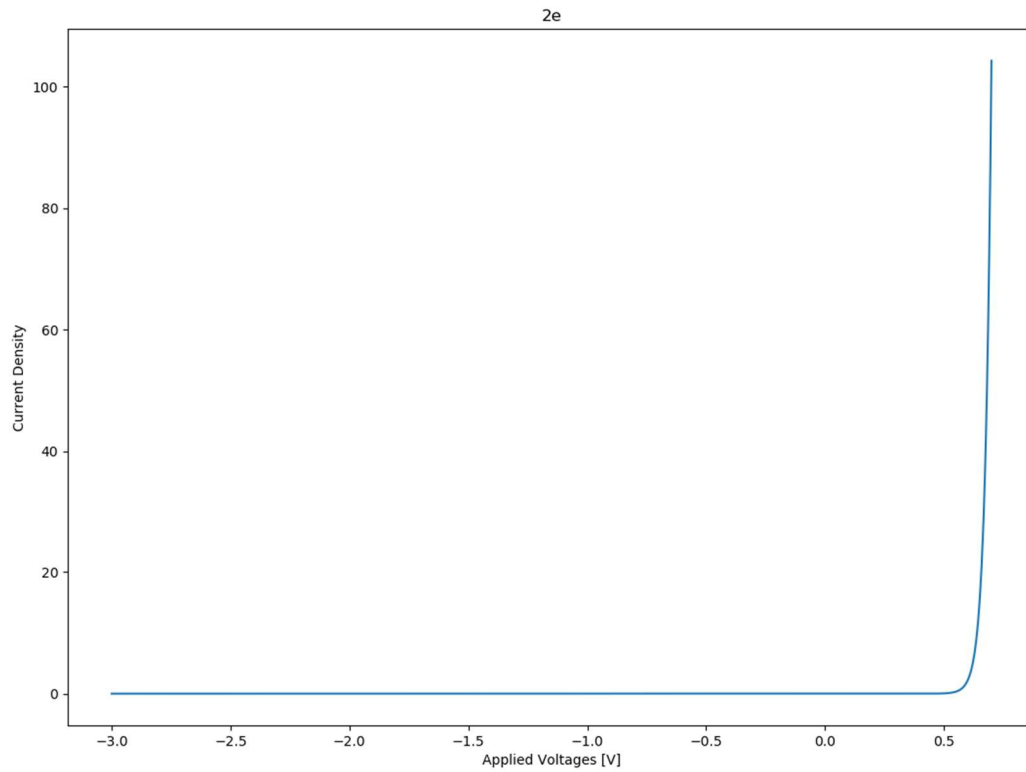
2.3 WHAT IS THE CURRENT DENSITY FOR $V_{app} = -3 \text{ V}$?

$-1.907127968579501 \times 10^{-10} \text{ A / cm}^2$

2.4 WHAT IS THE CURRENT DENSITY FOR $V_{app} = 0.5 \text{ V}$?

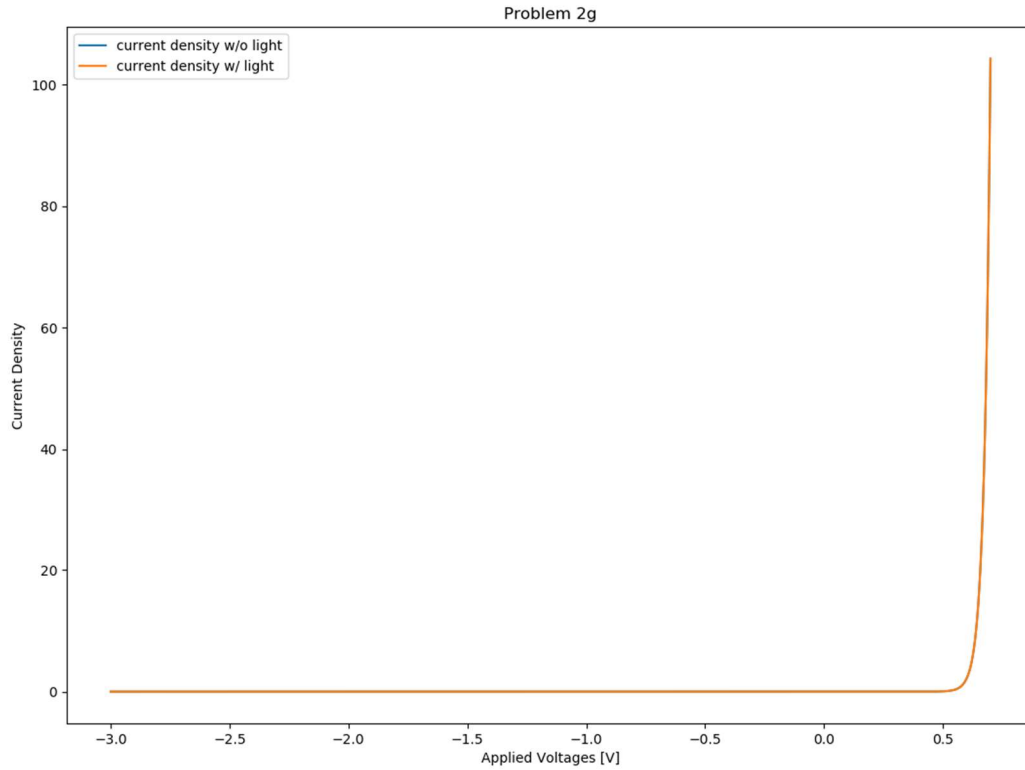
$0.04617885821490352 \text{ A / cm}^2$

2.5 USING A COMPUTER, PLOT THE CURRENT DENSITY FOR AN APPLIED VOLTAGE RANGING FROM -3 V TO 0.7 V.



2.6 LIGHT SHINES ON THE SEMICONDUCTOR WITH UNIFORM ILLUMINATION. THE GENERATION RATE IS $10^{18} \text{ cm}^{-3} / \text{s}$. WHAT IS J_{op} ?
 $-0.0019 \text{ A} / \text{cm}^2$

2.7 REDO THE PLOT FOR PART E. ON THE SAME PLOT, SHOW THE CURRENT DENSITY WHEN LIGHT IS APPLIED. RESCALE AS NECESSARY.

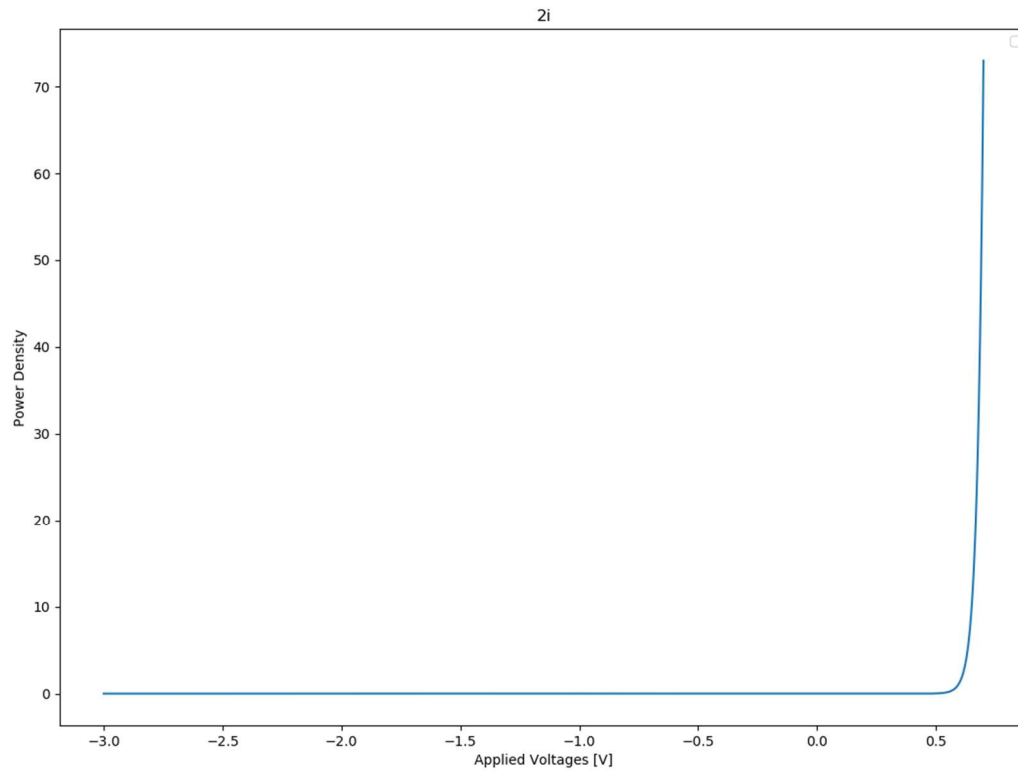


2.8 WHAT IS THE SHORT CIRCUIT CURRENT DENSITY AND THE OPEN CIRCUIT VOLTAGE FROM THIS LEVEL OF ILLUMINATION?

Short circuit current density = -0.0019 A / cm^2

Open circuit Voltage = 0.410 V

2.9 USING A COMPUTER, PLOT THE POWER DENSITY VERSUS APPLIED VOLTAGE RANGING FROM -3 V TO 0.7 V. $P_{density} = V_{app} J$



2.10 WHAT IS THE MAXIMUM AMOUNT OF POWER THAT MAY BE OBTAINED FROM THIS LEVEL OF ILLUMINATION?

72.97239659284001 [W]