ECE 447/547 (Semiconductor Devices)

Southern Illinois University Carbondale

Project #3: Design a p-n Diode With a Certain Breakdown Voltage

PART-1: Analytical Design (using appropriate formulae):

A one-sided abrupt silicon *p-n* junction diode is to be designed to have a breakdown voltage of at least 60 V and to have a forward-bias current of 50 mA for an applied voltage of 0.625 V while still operating under low injection. The minority carrier lifetimes are $\tau_0 = \tau_{n0} = \tau_{p0} = 2 \times 10^{-7} sec$. Determine the doping concentrations and the minimum cross-sectional area.

Here, next time, put the calculation steps needed for the design.

PART-2: Verification Using nanoHUB Simulations:

Use the doping densities obtained from above as well as the given carrier lifetimes to numerically verify your design and gather more information using the online simulator available at: https://nanohub.org/resources/pntoy (do not use the newer version).

Answer the following questions:

1) What is the built-in potential in equilibrium, V_{bi}?
2) What is the maximum electrical field, E_{max}?
3) Is this possible to arbitrarily increase doing concentration?
4) Do you obtain the same forward-bias current from these two calculations (analytical and simulation)? Why or why not?
5) What happens to the *I-V* curve if temperature is increased to 500 K? Why?
6) Using simulations, discuss what happens to the *I-V* curve if carrier lifetimes are increased by a factor of 100 (that is recombination is suppressed).

Independent Learning: How to fabricate a pn junction in a Fab.

Report:

Follow the IEEE style while preparing the report. Attach appropriate calculations and images or figures obtained from nanoHUB simulations.