

Assignment 2.1 - Semiconductor Basics.

① N-type vs. P-type Materials.

The difference between these two is how the silicon is "doped" with extra atoms:

→ N-type : We add atoms like Phosphorus that have extra electrons. Since electrons are negative, can call this "N" type.

→ P-type : We add atoms like Boron that have fewer electrons, which creates "holes". These holes act like positive charges, so can call it "P" type.

② forward and Reverse Bias.

These terms describe how we connect a battery to a PN junction diode.

Forward Bias: We connect the positive terminal to the P-side. This squashes the depletion region and allows current to flow easily.

Reverse Bias: We connect the positive terminal to the N-side. This pulls charges away from the middle, making the barrier wider and blocking the current.

③. What is an "Ideal" Device?

In engineering, "ideal" refers to a perfect ~~version~~ version of a component used for simple calculations. An ideal diode is seen as a perfect switch: It has zero resistance and no voltage drop when it is "on" and it blocks all current perfectly when it is "off".

④ Calculations.

(a). Thermal Voltage (V_T) at 25°C first,

Convert °C to K,

$$T_K = 25 + 273 = 298 \text{ K.}$$

Using the formula,

$$V_T = \frac{kT}{q}$$

$$k = 1.38 \times 10^{-23}$$

$$q = 1.6 \times 10^{-19}$$

$$V_T = \frac{1.38 \times 10^{-23} \times 298}{1.6 \times 10^{-19}} = 25.7 \text{ mV}$$

(b). Diode current (I_D) Using:

$$I_S = 40 \text{ nA, } n = 2 \text{ and } V_D = 0.5 \text{ V}$$

$$I_D = I_S (e^{V_D/nV_T} - 1)$$

$$I_D = 40 \text{ nA} (e^{0.5/(2 \times 0.0257)} - 1)$$

$$I_D = 40 \text{ nA} \times (e^{9.727} - 1)$$

$$I_D = 40 \text{ nA} \times 16763$$

$$\underline{I_D = 0.67 \text{ mA}}$$