
THE DOPING GAME

Contestant 1

$$N_a = 1 \times 10^{16} cm^{-3} \qquad N_d = 1 \times 10^{16} cm^{-3}$$

$$qV_o = kTln\left(\frac{N_d N_a}{{n_i}^2}\right) = 0.0259 * ln\left(\frac{1 \times 10^{16} * 1 \times 10^{16}}{(1.5 \times 10^{10})^2}\right)$$

qV_o =0.695eV $\qquad$ V_o=0.695V

$$W = \sqrt{\frac{2\epsilon V_o}{q}\left(\frac{N_d + N_a}{N_d N_a}\right)} = \sqrt{\frac{2 * 11.8 * 8.85 \times 10^{-14} * 0.695}{1.6 \times 10^{-19}}\left(\frac{1 \times 10^{16} + 1 \times 10^{16}}{1 \times 10^{16} * 1 \times 10^{16}}\right)}$$

$$W = 0.378\mu m$$

Contestant 2

$N_a = 1 \times 10^{16} cm^{-3}$ $\qquad$ $E_c - E_F = 0.25eV$

$$n_o = N_c e^{-(E_c - E_F)/kT}$$

$$N_c = 2\left(\frac{2\pi m_n{}^* kT}{h^2}\right)^{1.5} = 2.87 \times 10^{25} \rightarrow [m^{-3}]$$

$$n_o = 2.87 \times 10^{19} e^{-.25/.0259} = 1.6 \times 10^{15} cm^{-3}$$

$$qV_o = kT ln\left(\frac{N_d N_a}{n_i{}^2}\right) = 0.0259 * ln\left(\frac{1 \times 10^{16} * 1.6 \times 10^{15}}{(1.5 \times 10^{10})^2}\right)$$

qV_o =0.651eV $\qquad$ V_o=0.651V

$$W = \sqrt{\frac{2\epsilon V_o}{q}\left(\frac{N_d + N_a}{N_d N_a}\right)} = \sqrt{\frac{2 * 11.8 * 8.85 \times 10^{-14} * 0.65}{1.6 \times 10^{-19}}\left(\frac{1 \times 10^{16} + 1.6 \times 10^{15}}{1 \times 10^{16} * 1.6 \times 10^{15}}\right)}$$

$$W = 0.718 \mu m$$

Contestant 3

$N_a = 1 \times 10^{16} cm^{-3}$ $\quad$ $E_F - E_i = 0.285eV$

$$n_o = n_i e^{(E_F - E_i)/kT}$$

$$n_o = 1.5 \times 10^{10} e^{0.285/.0259} = 9.015 \times 10^{14} cm^{-3}$$

$$qV_o = kTln\left(\frac{N_d N_a}{{n_i}^2}\right) = 0.0259 * ln\left(\frac{1 \times 10^{16} * 9 \times 10^{14}}{(1.5 \times 10^{10})^2}\right)$$

qV_o =0.632eV $\quad$ V_o=0.632V

$$W = \sqrt{\frac{2\epsilon V_o}{q}\left(\frac{N_d + N_a}{N_d N_a}\right)} = \sqrt{\frac{2 * 11.8 * 8.85 \times 10^{-14} * 0.63}{1.6 \times 10^{-19}}\left(\frac{1 \times 10^{16} + 9 \times 10^{14}}{1 \times 10^{16} * 9 \times 10^{14}}\right)}$$

$$W = 0.999\mu m$$