UNIVERSITY OF CALIFORNIA AT BERKELEY
College of Engineering
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Discussion Notes #1

EE 105 **Spring 2007**
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1) IC Resistor – Figure 1 shows the layout of an IC Resistor and its corresponding dimensions. The resistor was doped with $N_a = 10^{16}cm^{-3}$ and $N_d = 2*10^{16}cm^{-3}$. The junction depth Xj = 450nm.

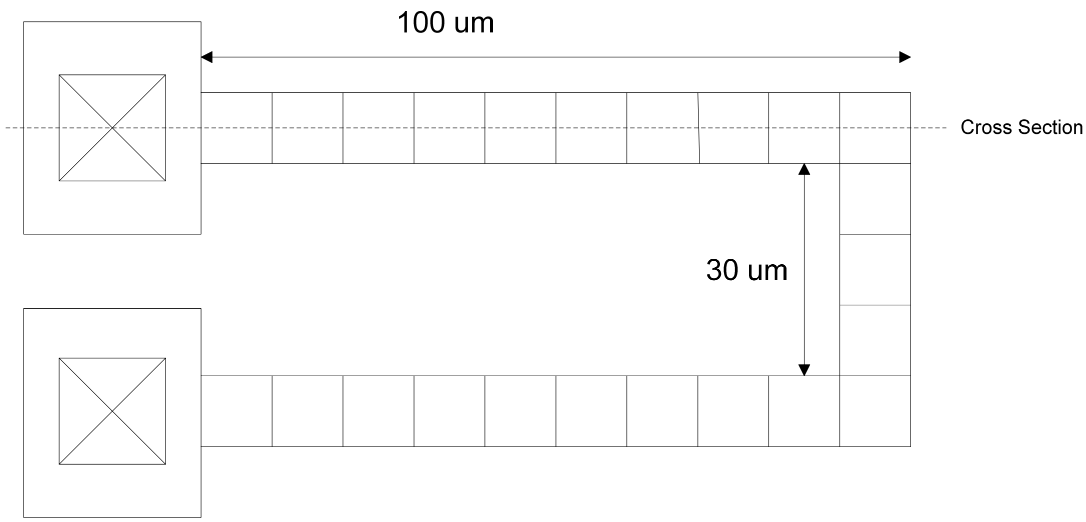


Figure 1: IC Resistor Layout

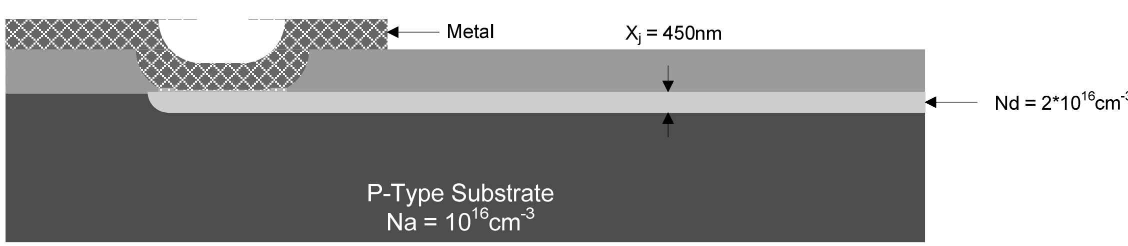


Figure 2: Cross sectional layout view of the IC Resistor.

a) Find the resistivity ρ_n

To find mobility, $N_a + N_d = 3*10^{16}cm^{-3}$. Using the mobility vs. $N_a + N_d$ plot, $U_n \approx 950\ cm^2/(V*s)$. To find the electron and hole concentrations, $n_0 = N_d - N_a = 1*10^{16}cm^{-3}$, and $p_0 = n_i^2/(n_0) = 10^4cm^{-3}$. Since $p_0 << n_0$, we can neglect the contribution from the holes in the resistivity calculation: $\rho_n = 1/(q*n_0*U_n) = 0.658\ \Omega*cm$.

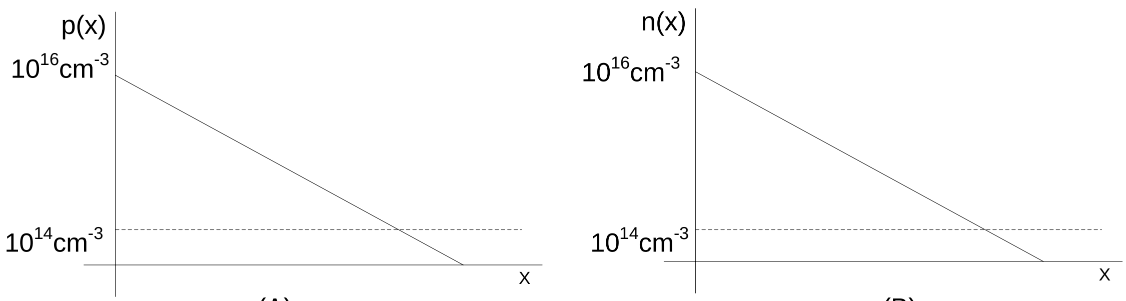
b) Find the sheet resistance $R_{\square}$.

$R_{\square} = \rho_n/X_j = 14619.883\ \Omega \approx 14.6\ k\Omega/\square$

c) Find the total resistance of the resistor.

Assuming each corner is 0.56 square, and each contact is 0.65 square, the total number of squares = 21 + (0.56)*2 + (0.65)*2 = 23.42. $R_{tot} = R_{\square}$ * (total number of squares) ≈ 342 kΩ.

2) Diffusion – Consider two separate pieces of silicon, A and B, with the following doping profiles:



(A) (B)

a) What direction do the holes diffuse in piece A? What direction do the electrons diffuse in piece B?

In piece A, the holes diffuse to the right, positive x direction. In piece B, the electrons move to the right, positive x direction.

b) What direction is the diffusion current in piece A? In piece B?

Current is defined as the direction of positive charge flow. Therefore, in piece A, the diffusion current is moving to the positive x direction. In piece B, current is flowing to the negative x direction, since the negatively charged electrons are moving in the positive x direction.

c) Calculate the diffusion coefficients D_p and D_n at room temperature.. Use $N_d = 10^{15}cm^{-3}$ and $N_a = 10^{15}cm^{-3}$.

Using $N_d = 10^{15}cm^{-3}$ and $N_a = 10^{15}cm^{-3}$, $U_p = 475\ cm^2/(V*s)$, and $U_n = 1375\ cm^2/(V*s)$. Calculating that kT/q = 26mV, we can find the coefficients: $D_n = U_n*kT/q = 12.35\ cm^2/s$, and $D_p = U_p*kT/q = 35.75\ cm^2/s$.