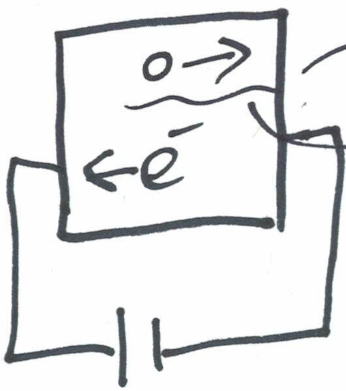
P_p n_p n_n P_n n_i
- conc. of electrons and holes
- intrinsic silicon
- cm^3
- at a certain temperature
- $n_i = 1.5 \times 10^{10}/cm^3$ at room temp

①



→ piece of silicon

→ the drift current

$V_{p\text{-drift}} = \mu_p \cdot E$ → intensity of the electric field

μ_p → mobility of the holes

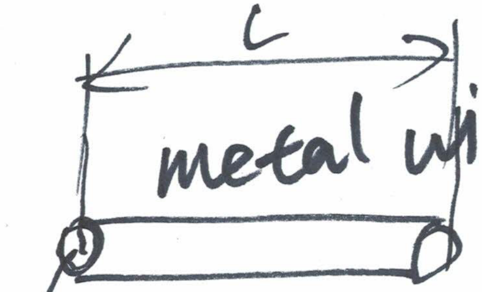
$V_{n\text{-drift}} = \mu_n \cdot E$

$\mu_n > \mu_p$

①

② $\rho = \dfrac{1}{q(\mu_n \cdot n + \mu_p \cdot p)}$

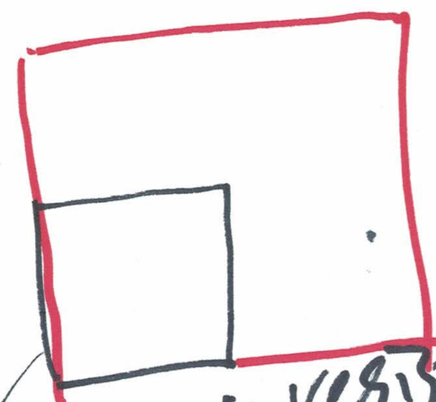
- ρ → resistivity
- q → magnitude of electron charge $= 1.6 \times 10^{-19}$ Coulomb
- n → conc. of electrons
- p → conc. of holes



$A = \pi r^2$

$R = \rho \dfrac{L}{A}$

A → cross-sectional Area

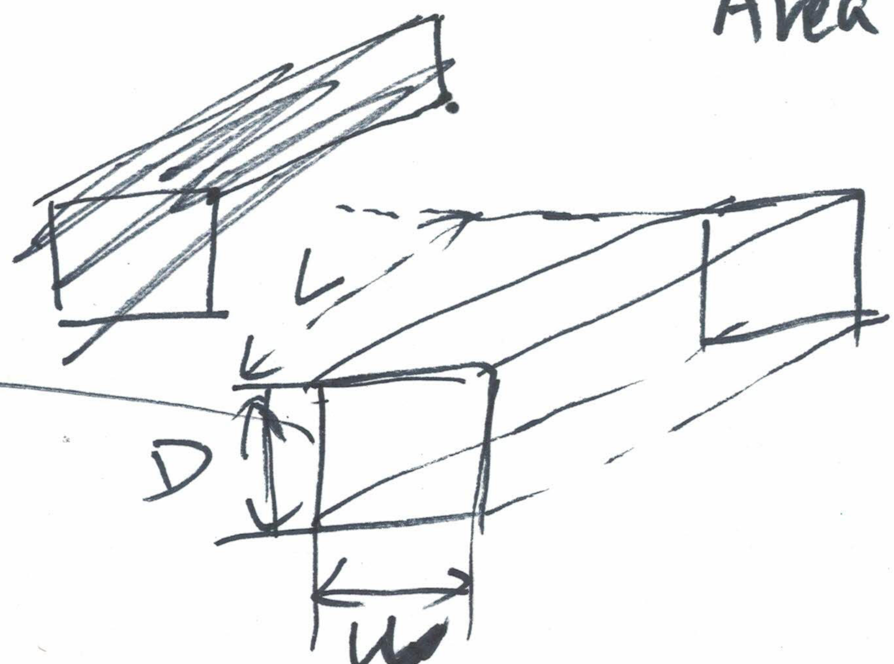


Sheet resistance

300Ω

$R_{n\text{-}well} = \rho \dfrac{L}{A} = \rho \dfrac{L}{W \cdot D}$

$= \rho \cdot \dfrac{L \times 2}{W \times 2} \cdot \dfrac{1}{D}$



③ $\sigma = \frac{1}{\rho} = q(\mu_n \cdot n + \mu_p \cdot p)$

Example:

Given: $p = n = n_i = 1.5 \times 10^{10} / cm^3$

$\mu_n = 1350\ cm^2/V \cdot s$

$\mu_p = 480\ cm^2/V \cdot s$

what is ρ?

$$\rho = \frac{1}{q(\mu_n \cdot n + \mu_p \cdot p)}$$

unit: $\Omega \cdot cm$ (ρ)

q: $1.6 \times 10^{-19}\ C$

Example:

p-type, $N_A = 10^{16}/cm^3$, $\mu_n = 1110\ cm^2/V \cdot s$

$\mu_p = 400\ cm^2/V \cdot s$, what is ρ ? (at room temp)

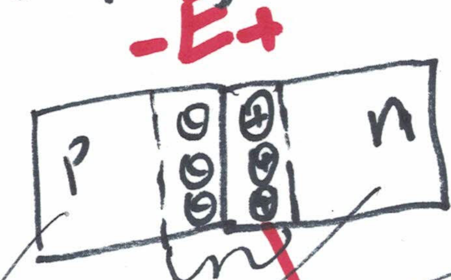
$$N_A = P_p = 10^{16}/cm^3$$

$$P_p \cdot n_p = n_i^2$$

$$n_p = \frac{n_i^2}{P_p} = \frac{(1.5\times10^{10})^2}{10^{16}} = \frac{2.25\times10^{20}}{10^{16}}$$

$$= 2.25\times10^{4}/cm^3$$

④ The pn juction



← I_S

→ I_D — $I_S = I_D$ at equlibrium

depletion region

electrically neutral

charge movement stops at a specific thickness of the depletion region

⑤ current driven by the Electric field : I_S (drifting current)

- - - - - - - concentration gradient : I_D (diffusion current)

⑤

⑥ E / V_0 : built-in voltage, Barrier voltage.

Si : 0.6 – 0.9 V at room temp