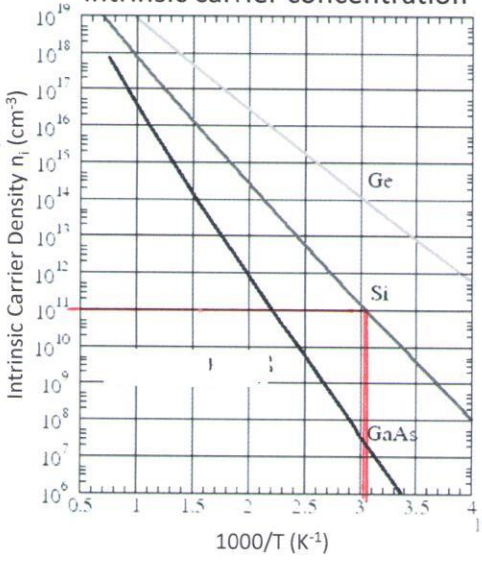
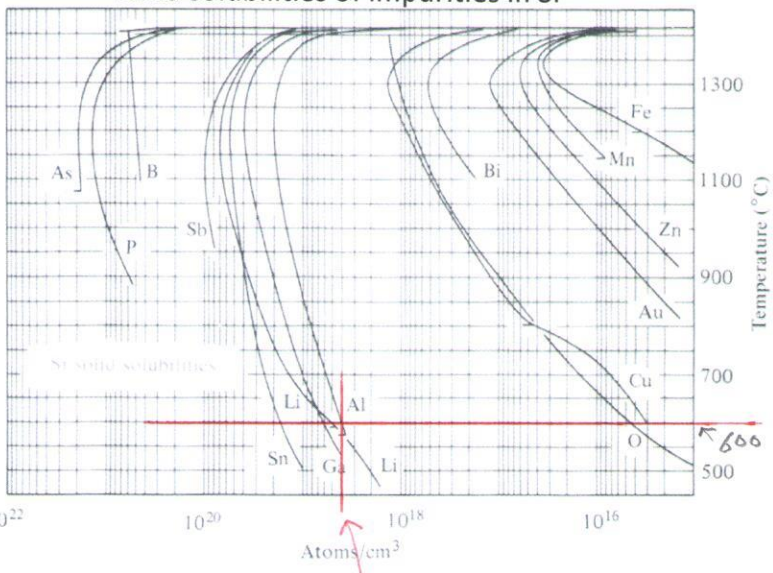
Intrinsic carrier concentration



Solid solubilities of impurities in Si



$4 \times 10^{18} / cm^3$

1) $E_{iP} - E_{FP} = ?$

$$E_{iP} - E_{FP} = kT \ln \frac{P}{n_i}$$

$k = 8.62 \times 10^{-5}$ eV/K, $T = 328$K $\Rightarrow kT = 0.0283$ eV

P = solid (Al) solubility in Si at 600°C

$= 4 \times 10^{18} / cm^3$ } from graph

$n_i = 1 \times 10^{11} / cm^3$ }

$$\Rightarrow E_{iP} - E_{FP} = 0.0283 \ln \frac{4 \times 10^{18}}{1 \times 10^{11}} = 0.495 \text{ eV}$$

2) $E_{Fn} - E_{in} = ?$

$$E_{Fn} - E_{in} = kT \ln \frac{n}{n_i}$$

$$n = 1 \times 10^{15} / cm^3$$

$$\Rightarrow E_{Fn} - E_{in} = 0.0283 \ln \frac{1 \times 10^{15}}{1 \times 10^{11}} = 0.261 \text{ eV}$$

3) Contact potential $V_{bi} = ?$

$$qV_{bi} = E_{ip} - E_{in}$$

$$E_{ip} = 0.495 + E_{FP}$$

$$E_{in} = -0.261 + E_{Fn}$$

$$\Rightarrow E_{ip} - E_{in} = 0.495 + E_{FP} + 0.261 - E_{Fn}$$

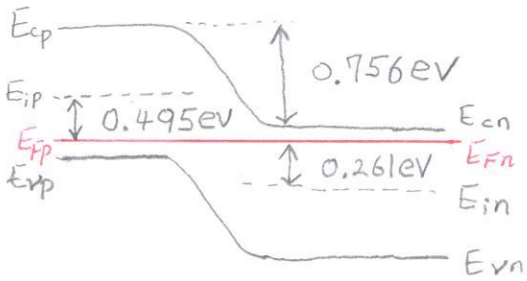
$$= 0.495 + 0.261 \quad (\because E_{FP} = E_{Fn} \text{ under equilibrium})$$

$$= 0.756 \text{ eV}$$

$$qV_{bi} = 0.756 \text{eV}$$

$$\Rightarrow V_{bi} = 0.756 \text{V}$$

4)



5) $W = x_n + x_p$

$$= \left[\frac{2 k_s \varepsilon_0 V_{bi}}{q} \left(\frac{1}{N_A} + \frac{1}{N_D} \right) \right]^{1/2}$$

$k_s = 11.8$

$\varepsilon_0 = 8.85 \times 10^{-14}$ farad / cm

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

$N_A = 4 \times 10^{18} / cm^3$

$N_D = 1 \times 10^{15} / cm^3$

$$\Rightarrow W = \left[\frac{2 \times 11.8 \times 8.85 \times 10^{-14} \times 0.756}{1.6 \times 10^{-19}} \left(\frac{1}{4 \times 10^{18}} + \frac{1}{1 \times 10^{15}} \right) \right]^{1/2}$$

$$= 9.94 \times 10^{-5} \text{ cm}$$

$$= 0.994 \, \mu m.$$