Carrier Concentration and Fermi Levels

RECALL

$$n = N_c e^{-\frac{E_c - E_F}{kT}}$$

$$p = N_v e^{-\frac{E_F - E_v}{kT}}$$

For an intrinsic semiconductor, $n = p = n_i$; $E_F = E_{f_i}$

$$n_i = N_c e^{-\frac{E_c - E_{f_i}}{kT}}$$

$$n_i = N_v e^{-\frac{E_{f_i} - E_v}{kT}}$$

$$N_c = n_i e^{\frac{E_c - E_{f_i}}{kT}}$$

$$N_v = n_i e^{\frac{E_{f_i} - E_v}{kT}}$$

$$np = N_c N_v e^{\frac{E_v - E_c}{kT}}$$

$$= N_c N_v e^{-\frac{E_g}{kT}}$$

$$n_i = \sqrt{N_c N_v} e^{-\frac{E_g}{2kT}}$$

$$n = n_i e^{\frac{E_F - E_{f_i}}{kT}}$$

$$p = n_i e^{\frac{E_{f_i} - E_F}{kT}}$$

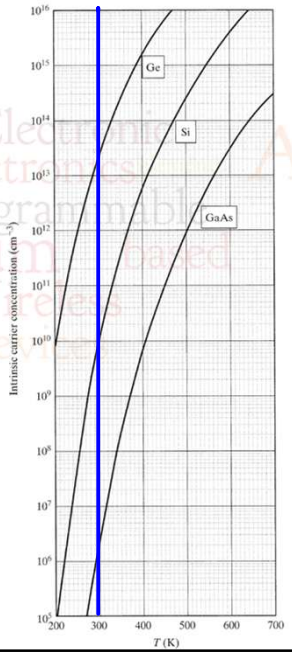
$np = n_i^2$ ← Law of Mass Action

Si

T (°C)	n_i (cm^{-3})
0	8.86×10^8
5	1.44×10^9
10	2.30×10^9
15	3.62×10^9
20	5.62×10^9
25	8.60×10^9
30	1.30×10^{10}
35	1.93×10^{10}
40	2.85×10^{10}
45	4.15×10^{10}
50	5.97×10^{10}
300 K	1.00×10^{10}

GaAs

T (°C)	n_i (cm^{-3})
0	1.02×10^5
5	1.89×10^5
10	3.45×10^5
15	6.15×10^5
20	1.08×10^6
25	1.85×10^6
30	3.13×10^6
35	5.20×10^6
40	8.51×10^6
45	1.37×10^7
50	2.18×10^7
300 K	2.25×10^6



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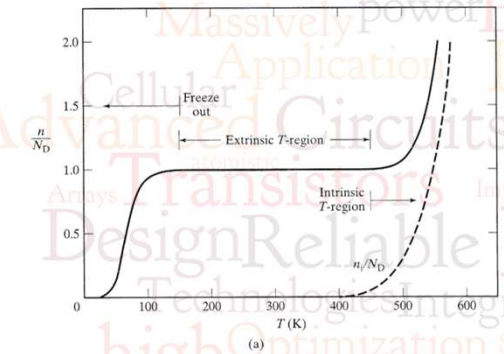
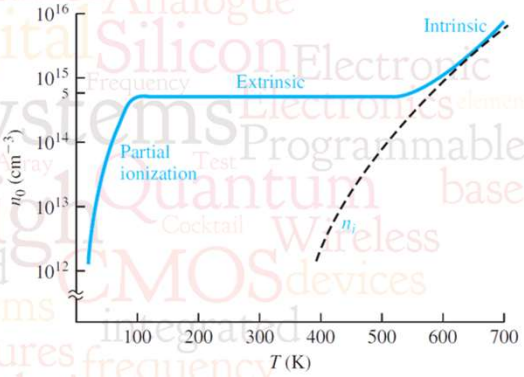
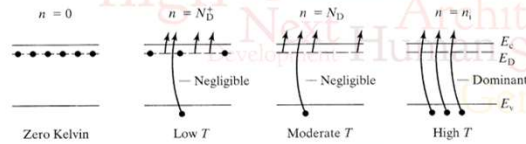
Carrier Concentration with temperature







RECALL

$$E_F - E_{f_i} = kT ln\left(\frac{N_D}{n_i}\right) \quad E_{f_i} - E_F = kT ln\left(\frac{N_A}{n_i}\right)$$

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