One Donor and One Acceptor for n-type semiconductor

Since the electron concentration $n(T)$ is described as

$$n(T) = \frac{N_\mathrm{D}}{1 + g\exp\left(\frac{\Delta E_\mathrm{D} - \Delta E_\mathrm{F}}{kT}\right)} - N_\mathrm{A}\,, \tag{1}$$

the following relation is obtained:

$$\frac{n(T) + N_\mathrm{A}}{N_\mathrm{D} - [n(T) + N_A]} = \frac{1}{g}\exp\left(-\frac{\Delta E_\mathrm{D}}{kT}\right)\exp\left(\frac{\Delta E_\mathrm{F}}{kT}\right) \tag{2}$$

On the other hand, since

$$n(T) = N_\mathrm{C}(T)\exp\left(-\frac{\Delta E_\mathrm{F}}{kT}\right), \tag{3}$$

the following relation is obtained:

$$\exp\left(\frac{\Delta E_F}{kT}\right) = \frac{N_C(T)}{n(T)}. \tag{4}$$

Therefore, substituting Eq. (4) to Eq. (2) gives

$$\frac{n(T)[n(T) + N_\mathrm{A}]}{N_\mathrm{D} - [n(T) + N_\mathrm{A}]} = \frac{N_\mathrm{C}(T)}{g}\exp\left(-\frac{\Delta E_\mathrm{D}}{kT}\right). \tag{5}$$

Since

$$N_\mathrm{C}(T) = 2\left(\frac{2\pi m^* kT}{h^2}\right)^{3/2} M_\mathrm{C}\,, \tag{6}$$

we obtain the following relationship:

$$\frac{1}{T^{3/2}} \cdot \frac{n(T)[n(T) + N_\mathrm{A}]}{N_\mathrm{D} - [n(T) + N_\mathrm{A}]} = \frac{1}{g}\left[2\left(\frac{2\pi m^* k}{h^2}\right)^{3/2} M_\mathrm{C}\right]\exp\left(-\frac{\Delta E_\mathrm{D}}{kT}\right). \tag{7}$$