Temperature Dependence

The temperature-dependent variables in the models developed so far include the: Fermi potential, PHI, EG, bulk junction potential of the source-bulk and drain-bulk junctions, PB, the reverse currents of the pn junctions, I_S, and the dependence of mobility upon temperature. The temperature dependence of most of these variables is found in the equations given previously or from well-known expressions. The dependence of mobility upon temperature is given as

$$\mathrm{UO}(T) = \mathrm{UO}(T_0)\left(\frac{T}{T_0}\right)^{\mathrm{BEX}}$$

where BEX is the temperature exponent for mobility and is typically -1.5.

$$v_{therm}(T) = \frac{KT}{q}$$

$$\mathrm{EG}(T) = 1.16 - 7.02 \cdot 10^{-4} \cdot \left[\frac{T^2}{T + 1108.0}\right]$$

$$\mathrm{PHI}(T) = \mathrm{PHI}(T_0) \cdot \left(\frac{T}{T_0}\right) - v_{therm}(T)\left[3 \cdot \ln\left(\frac{T}{T_0}\right) + \frac{\mathrm{EG}(T_0)}{v_{therm}(T_0)} - \frac{\mathrm{EG}(T)}{v_{therm}(T)}\right]$$

$$v_{bi}(T) = v_{bi}(T_0) + \frac{\mathrm{PHI}(T) - \mathrm{PHI}(T_0)}{2} + \frac{\mathrm{EG}(T_0) - \mathrm{EG}(T)}{2}$$

$$\mathrm{VT0}(T) = v_{bi}(T) + \mathrm{GAMMA}\left[\sqrt{\mathrm{PHI}(T)}\right]$$

$$\mathrm{PHI}(T) = 2 \cdot v_{therm} \ln\left(\frac{\mathrm{NSUB}}{n_i(T)}\right)$$

$$n_{i(T)} = 1.45 \cdot 10^{16} \cdot \left(\frac{T}{T_0}\right)^{3/2} \cdot \exp\left[\mathrm{EG} \cdot \left(\frac{T}{T_0} - 1\right) \cdot \left(\frac{1}{2 \cdot v_{therm}(T_0)}\right)\right]$$

For drain and source junction diodes, the following relationships apply.

$$\mathrm{PB}(T) = \mathrm{PB} \cdot \left(\frac{T}{T_0}\right) - v_{therm}(T)\left[3 \cdot \ln\left(\frac{T}{T_0}\right) + \frac{\mathrm{EG}(T_0)}{v_{therm}(T_0)} - \frac{\mathrm{EG}(T)}{v_{therm}(T)}\right]$$

$$I_S(T) = \frac{I_S(T_0)}{\mathrm{N}} \cdot exp\left[\frac{\mathrm{EG}(T_0)}{v_{therm}(T_0)} - \frac{\mathrm{EG}(T)}{v_{therm}(T)} + 3 \cdot \ln\left(\frac{T}{T_0}\right)\right]$$

where N is diode emission coefficient. The nominal temperature, T_0, is 300 K.