Solution of the Semiconductor Equations — II

As for the continuity and transport equations for the carriers, e.g., electrons, one finds

\[- \text{div}\ J_n = G - U - \frac{\partial n}{\partial t} \quad \Rightarrow \quad - \text{div}\ S = C,\]

\[J_n = q D_n \, \text{grad}\ n - q D_n \, \text{grad}(\sigma) \, n \quad \Rightarrow \quad S = a \, \text{grad}\ u + b \, u,\]

with \( S = J_n, \) \( C = G - U - \partial n/\partial t, \) \( a = q D_n, \) \( \sigma = q \varphi/(k_B T_L), \) \( b = -a \, \text{grad}\ \sigma, \) \( u = n. \) It is assumed that the electric potential is known from a previous iteration. As before, the integration over the \( i \)th cell of the continuity equation in one dimension yields

\[S_i - S_{i+1} \simeq \Omega_i C_i.\]

The transport equation is more suitably recast in the self-adjoint form \( S \, \exp(-\sigma) = a \, d \left[ u \, \exp(-\sigma) \right]/dx. \) Then, \( S \) and \( a \) are approximated as piecewise-constant functions over each element; considering, e.g., \( h_i, \) the integration of the self-adjoint expression over it, letting \( Y_i = \int_{h_i}^{0} \exp(-\sigma) \, dx, \) yields

\[S_i \, Y_i \simeq a_i \left[ u_i \, \exp(-\sigma_i) - u_{i-1} \, \exp(-\sigma_{i-1}) \right].\]