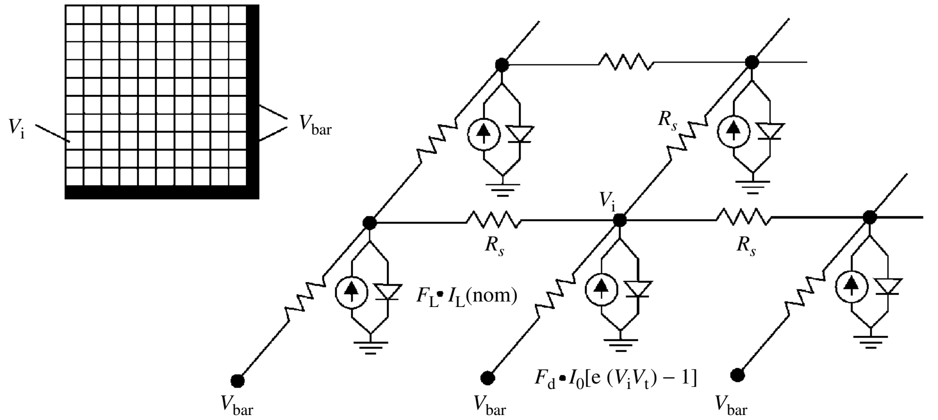

Figure 8.20 A network model of a solar cell showing voltage and current sources corresponding to dark (indicated by subscript d) and illuminated (indicated by subscript L) conditions, and the resistive components due to the sheet resistivity of the emitter

Current–voltage (I–V) curves of a cell are synthesized using diode equations for individual cells. For each cell, we can write the total current density, J, as

$$J = J_{\text{ph}} - J_{\text{dark}}(\text{V})$$

where J_{ph} and $J_{\text{dark}}(\text{V})$ are the photogenerated and the dark-current densities, respectively. The dark current of each local region of a known defect density, is described by

$$J_{\text{dark}} = J_{01}\{\exp(\text{eV}/kT - 1)\} + J_{02}\{\exp(\text{eV}/2kT - 1)\} + J_{03}\{\exp(\beta V - 1)\} \quad (8.1)$$

The first two terms in the above equation are well-known expressions for representing band-to-band and midgap defect recombination respectively in a *p-n* junction (see Chapter 3). The last term is added to include tunneling currents (as a generalized expression) that occur in heavily defected regions. These tunneling currents arise because of a carrier-hopping mechanism, which is independent of temperature; here β is a constant needed to fit the specific voltage dependence. Hence, a local cell element (i, j) in the matrix is represented by a current source comprising J_{01ij}, J_{02ij}, J_{03ij}, and a corresponding light-induced current density $J_{\text{ph},ij}$. For room temperature operation, the tunneling current can be neglected. One can represent all current components of cell elements in terms of nominal currents of defect-free devices. Accordingly,

$$J_{01ij} = J_{01} \bullet A_{ij} \bullet \exp(\text{eV}/kT - 1) \text{ and}$$
$$J_{02ij} = J_{02} \bullet B_{ij} \bullet \exp(\text{eV}/2kT - 1) \quad (8.2)$$

where J_{01} and J_{02} represent dark-saturation current densities in the nominal "defect-free" device element. A_{ij} and $B_{i'j}$ are the factors representing the ratio of dark current