normalized by the nominal "defect-free" current for each component device. A finite-element computer code, written in Microsoft Excel, is used to analyze the network.

$$V_{ij} =$$

$$\frac{F_{\text{phi}j}I_{\text{phnom}} - [A_{ij}I_{01nom}(e^{V_{ij}/akT} - 1) + B_{ij}I_{02nom}(e^{V_{ij}/bkT} - 1)] + (V_{\text{neighbors}})/R_s}{N/R_s}$$

(8.3)

where $\quad$ V_{ij}: Voltage at a node ij

$F_{\text{phi}j}$: Fraction of short-circuit current at the node compared to nominal defect-free short circuit current (<1)

I_{01nom}, I_{02nom}: Nominal short-circuit current per node

A_{ij}, B_{ij}: Fraction of dark currents at the node (>1)

$V_{\text{neighbors}}$: Voltage of the nearest-neighbor cells

N: Number of nearest-neighbor cells

R_s: Electrical resistance between cells.

This above network model allows the synthesis of the I–V characteristics of the total cell. Here we will use this model to illustrate the influence of crystal defects on the cell performance. We first consider a spatially uniform, defect-free solar cell; the cell performance is limited by the material properties such as impurity content and the minority-carrier lifetime. The values of various current components are assumed to be: $J_{\text{ph}} = 35$ mA/cm^2, $J_{01} = 3.6 \times 10^{-6}$ mA/cm^2, $J_{02} = 4.5 \times 10^{-10}$ mA/cm^2. Because this cell is uniform, all device elements in the network model of this cell are identical. Figure 8.21 shows the I–V curve (dotted line) of the total cell. The parameters of the total cell are $V_{\text{OC}} = 650$ mV, $J_{\text{SC}} = 34.5$ mA/cm^2, $FF = 81\%$, and Efficiency = 18.4%. Now, we consider another cell with same material properties but having 20% of the area covered by heavily dislocated regions. The network model of this cell consists of two kinds of device elements. One similar to those of the defect-free cell, and the other representing defected regions. The parameters for the defected device elements are determined from
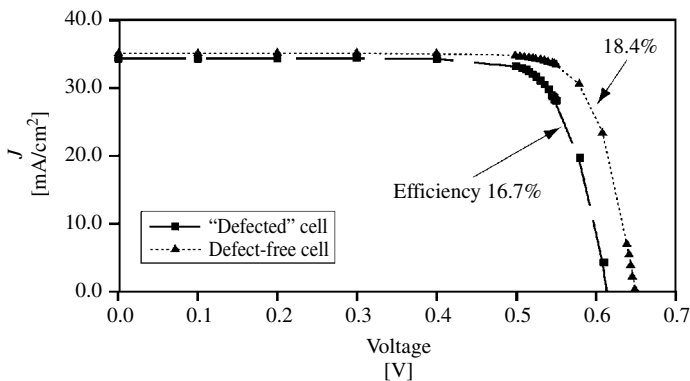

Figure 8.21 Calculated I–V curves of defect-free and defected cells (20% area with defects) showing degradation due to defected regions