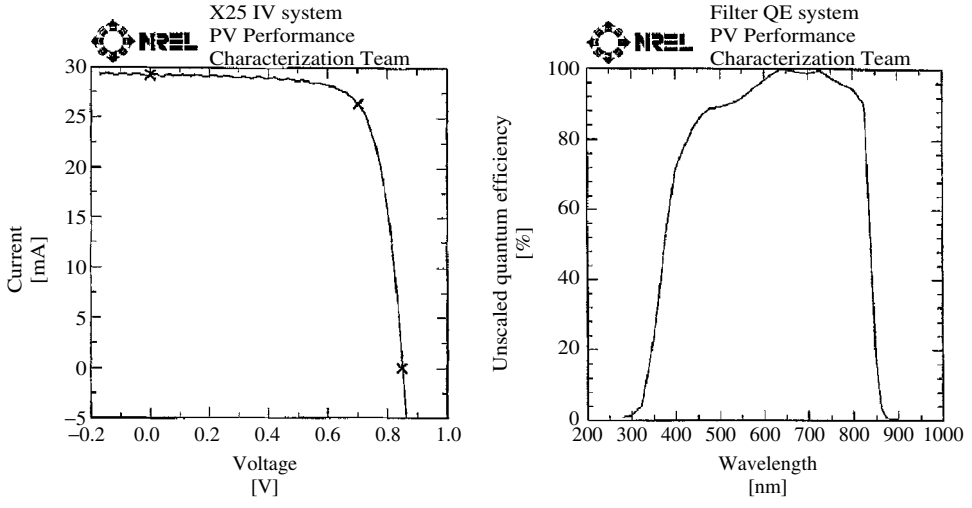

Figure 14.2 Current–voltage and relative quantum efficiency curves for 16.4%-efficient CdTe/CdS thin-film solar cell [37]

to date is 16.5% with $V_{OC} = 845$ mV, $J_{SC} = 25.9$ mA/cm^2, and $FF = 75.5\%$ [37]. The $J-V$ and quantum efficiency (QE) characteristics of this cell are shown in Figure 14.2.

Superstrate polycrystalline thin-film CdTe/CdS solar cells have received significant R&D attention and have achieved the highest performance among CdTe-based solar cell configurations. Consideration of the cell parameters obtained by devices in all configurations suggests that $V_{OC} = 900$ mV, $J_{SC} = 26$ mA/cm^2, and $FF = 80\%$, and efficiency approaching 19% are reasonable expectations without major breakthroughs. Translating high-efficiency cells to high-efficiency module fabrication, however, will require the additional understanding of processing tolerances, the effects of thermal and chemical nonuniformities in processing large-area devices, and the effects of cell-area delineation, interconnections, and encapsulants.

14.2 CdTe PROPERTIES AND THIN-FILM FABRICATION METHODS

This section summarizes the fundamental properties of CdTe and describes methods for depositing polycrystalline CdTe thin films. CdTe is unique among the II^B-VI^A compounds, such as ZnS, CdSe, and HgTe, in that it exhibits the highest average atomic number, the least negative formation enthalpy, the lowest melt temperature, the largest lattice parameter, and the highest ionicity. Electronically, CdTe exhibits amphoteric semiconducting behavior, making it possible to intrinsically and extrinsically dope CdTe n and p-type. All these factors complement its nearly ideal optical band gap and absorption coefficient for terrestrial photovoltaic devices, making it a forgiving material to deposit and control in the thin-film form. Table 14.1 presents pertinent physical and optoelectronic data for CdTe.

The synthesis of II^B-VI^A compounds is facilitated by the large negative formation enthalpies (ΔH_f) and correspondingly low vapor pressures (p_{sat}) of the compounds compared to their constituent elements: for CdTe, $\Delta H_f = -22.4$ kcal/mol and $p_{sat}(400°C) =$