forward-current mechanisms other than thermionic emission.

$$J = J_0 \exp[(V - JR)/AkT] - J_{SC} + V/r \tag{14.1}$$

For the illuminated $J-V$ curves of the record-efficiency CdTe cell, the prefactor J_0 is 1×10^{-9} A/cm^2, the series resistance R is 1.8 Ω-cm^2, the diode quality factor A is 1.9, and the shunt resistance r is 2500 Ω-cm^2. The values for R and A were found using the technique described in Reference [161].

The forward-current ($J + J_{SC}$) data for the record-efficiency CdTe cell is replotted in Figure 14.21 using a logarithmic scale, and the analogous data of a high-efficiency GaAs cell [162] is shown for comparison. Since CdTe and GaAs have nearly the same band gap, they should ideally have the same lower limit to J_0 and same V_{OC} and $J-V$ characteristic, if they were both limited by band-to-band recombination. Both curves have had small corrections for series and shunt resistances (R and r). Since the absorber materials have similar band gaps, the CdTe and GaAs cells should have similar $J-V$ curves. The V_{OC} difference shown, however, is nearly 200 mV. At maximum power (MP), the voltage difference is larger yet, approaching 300 mV, because the CdTe A-factor is 1.9 compared to 1.0 for the GaAs. The physical difference is due to the additional recombination-current paths for the CdTe junction. This excess forward current for the CdTe cell is roughly two orders of magnitude greater than that of the GaAs cell under normal operating conditions. The implication is that there is considerable room for improvement of V_{OC} in CdTe cells through reduction in such recombination. Referring to the band diagrams in Figure 14.20, it is apparent that for sufficiently high density of midgap states, low doping levels in CdTe will enhance recombination current. Further, low doping levels and the resulting field profiles are expected to reduce minority transport, resulting in more pronounced voltage-dependent collection, reducing J_{MP}.

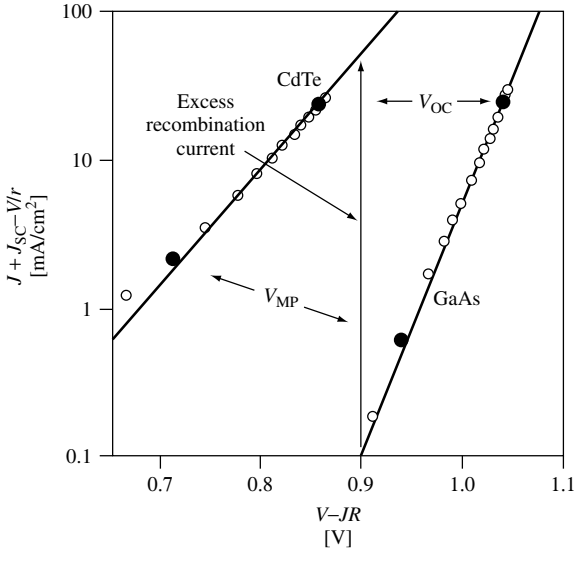

Figure 14.21 Comparison of high-efficiency CdTe and GaAs-illuminated $J-V$ data on a log plot, corrected for resistive effects