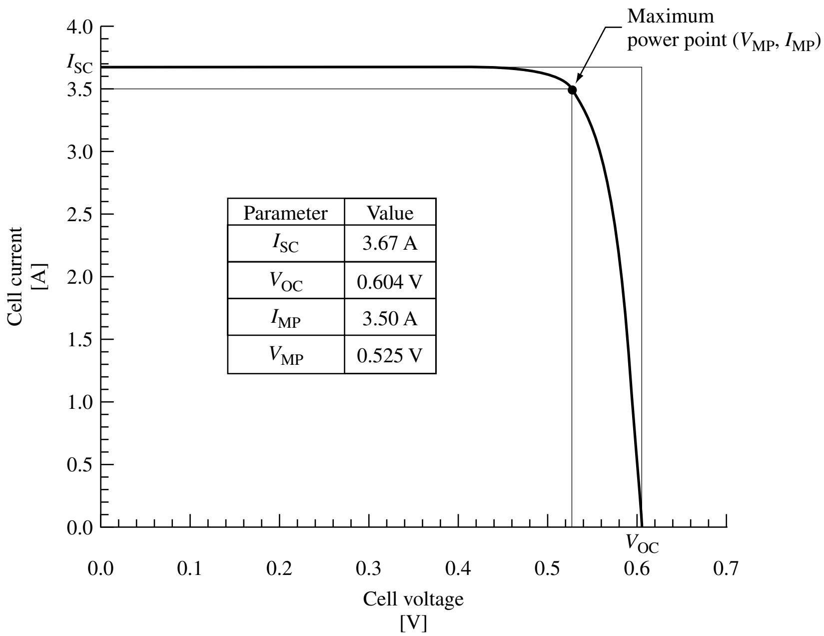

Figure 3.16 Current–voltage characteristic of the silicon solar cell defined by Table 3.2

The current–voltage ($I-V$) characteristic of a typical silicon solar cell is plotted in Figure 3.16 for the parameter values given in Table 3.2. For simplicity, the dark current due to the depletion region (diode 2) has been ignored (a reasonable and common assumption for a good silicon solar cell, especially at larger forward biases). It illustrates several important figures of merit for solar cells – the short-circuit current, the open-circuit voltage, and the fill factor. At small applied voltages, the diode current is negligible and the current is just the short-circuit current, I_{SC}, as can be seen when V is set to zero in equation (3.130). When the applied voltage is high enough so that the diode current (recombination current) becomes significant, the solar cell current drops quickly.

Table 3.2 shows the huge asymmetry between the n-emitter and the p-base in a typical solar cell. The emitter is ~1000 times thinner, 10 000 times more heavily doped, and its diffusion length is ~100 times shorter than the corresponding quantities in the base.

At open circuit ($I = 0$), all the light-generated current, I_{SC}, is flowing through diode 1, so the open-circuit voltage can be written as

$$V_{OC} = \frac{kT}{q} \ln \frac{I_{SC} + I_{o1}}{I_{o1}} \approx \frac{kT}{q} \ln \frac{I_{SC}}{I_{o1}}, \tag{3.131}$$

where $I_{SC} \gg I_{o1}$.

Of particular interest is the point on the $I-V$ curve where the power produced is at a maximum. This is referred to as the *maximum power point* with $V = V_{MP}$ and $I = I_{MP}$. As seen in Figure 3.18, this point defines a rectangle whose area, given by $P_{MP} = V_{MP}I_{MP}$, is the largest rectangle for any point on the $I-V$ curve. The maximum