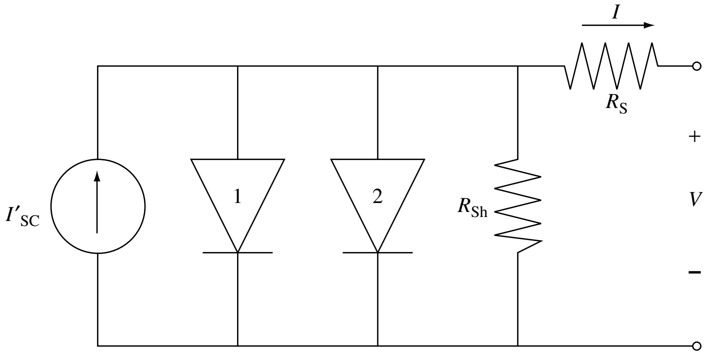

Figure 3.21 Solar cell circuit model including the parasitic series and shunt resistances

since the absorption coefficient is highest for short wavelength (high energy) photons. Conversely, removing the BSF makes it more likely that electrons created deep within the base region of the solar cell (those created by the long wavelength, low-energy photons) will recombine at the back contact and therefore, the long wavelength response is dramatically reduced.

3.5.3 Parasitic Resistance Effects

Equation (3.130) neglects the parasitic series and shunt resistances typically associated with real solar cells. Incorporating these resistances into the circuit model of Figure 3.15, as shown in Figure 3.21, yields

$$I = I'_{SC} - I_{o1}(e^{q(V+IR_S)/kT} - 1) - I_{o2}(e^{q(V+IR_S)/2kT} - 1) - \frac{(V + IR_S)}{R_{Sh}} \tag{3.149}$$

where I'_{SC} is the short-circuit current when there are no parasitic resistances. The effect of these parasitic resistances on the I–V characteristic is shown in Figures 3.22 and 3.23. As can also be seen in equation (3.149), the shunt resistance, R_{Sh}, has no effect on the short-circuit current, but reduces the open-circuit voltage. Conversely, the series resistance, R_S, has no effect on the open-circuit voltage, but reduces the short-circuit current. Sources of series resistance include the metal contacts, particularly the front grid, and the transverse flow of current in the solar cell emitter to the front grid.

It is often more convenient to rewrite equation (3.149) as

$$I = I'_{SC} - I_o(e^{q(V+IR_S)/A_okT} - 1) - \frac{(V + IR_S)}{R_{Sh}} \tag{3.150}$$

where A_o is the diode ideality (quality) factor and typically has a value between 1 and 2, with $A_o \approx 1$ for diode dominated by recombination in the quasi-neutral regions and $A_o \rightarrow 2$ when recombination in the depletion region dominates. In solar cells where the