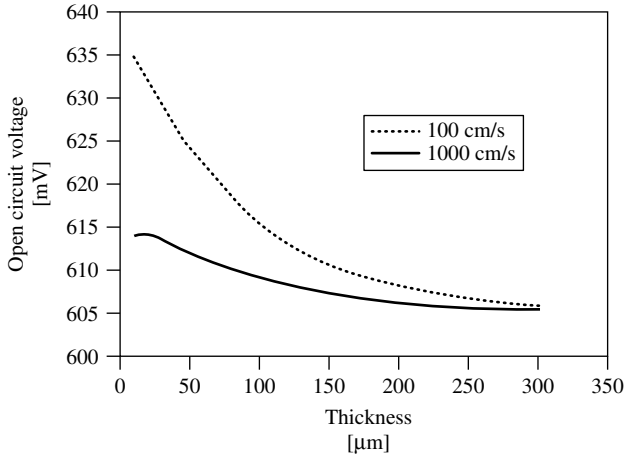

Figure 8.2 V_{OC} of a Si solar cell as a function of thickness for high and low surface-recombination velocities. These calculations were performed with PC1D

One approach to simultaneously accomplish these demands is to use thinner wafers. Thinner wafers conserve material and also offer a performance advantage by decreasing the bulk-carrier recombination within the solar cell. Hence, for a given material quality of the substrate, a reduction in the cell thickness can result in improving the open-circuit voltage (V_{OC}) and the fill factor (FF) of the solar cell. However, as the cell thickness is reduced, the surface recombination becomes an increasingly important component of the total recombination. In particular, surface recombination can severely degrade V_{OC}. This can be seen in Figure 8.2, which shows V_{OC} as a function of thickness (for a rather simple solar cell) for two different values of surface-recombination velocity, $S = 100$ cm/s and $S = 1000$ cm/s. In the calculations for Figure 8.2, we have used a front-textured cell with $S_f = S_b$, where S_f and S_b are the recombination velocities at the front and back surfaces, respectively. The important conclusion is that although a reduction in thickness can lead to an increase in V_{OC}, it can have the opposite effect if surface recombination is not reduced simultaneously. Clearly, the full advantage of reducing the volume recombination by thinner wafers can be achieved only if the device has built-in features to generate and reflect minority carriers away from interfaces using electronic reflectors (such as high–low fields), and optical reflectors. These are important considerations for thin solar cells.

Thus, thinner cells can yield higher voltages and higher fill factors if the surface recombination demands are met. However, they may suffer a loss in the photocurrent unless the optical losses associated with thickness reduction are compensated through superior light-trapping design. If these conditions are met, thinner cells can be more efficient than their thicker counterparts. Thin-film cells can also offer a direct cost advantage associated with the use of less Si and by employing thin-film technologies that (in principle) are deemed to be low-cost methods. It is clear that thinner cells can offer significant reduction in the PV energy cost. The photovoltaic industry is planning to reduce the wafer thickness incrementally from its current value of about 350 μm to less than 100 μm within