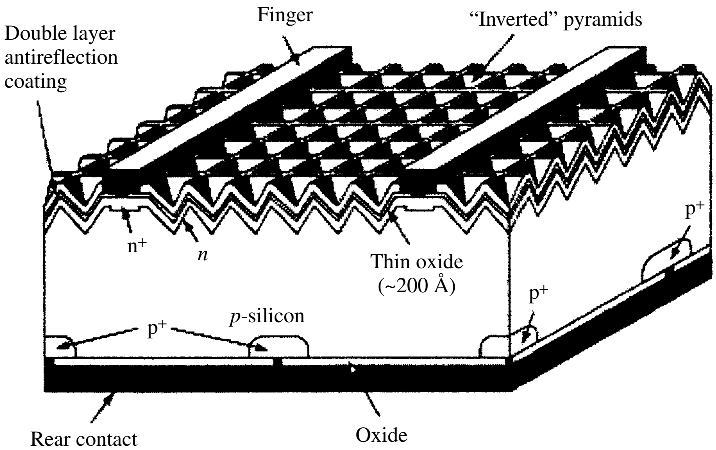

Figure 8.6 Structure of the test cells whose parameters are given in Table 8.1

due to oxide stress. The third device is also a PERL cell, but was fabricated on a 400-μm FZ wafer, and its device structure is similar to the 47-μm device. Figure 8.6 shows the structure of these devices. They include excellent passivation and light-trapping using the PERL process and inverted pyramids, respectively. The performance of the 44-μm n^+pp^+ cell is considerably lower than that of the other two cells, primarily due to inadequate passivation. Chapter 7 further discusses Si wafer–based solar cell technology. The results shown in Table 8.1 clearly demonstrate the potential of thin Si cells.

The table shows that light-trapping in the 47-μm cell can yield a J_{SC} that is only 3.3 mA/cm^2 lower than that of the 400-μm cell. Comparing the two PERL cells shows that it is possible to reduce the thickness by a factor of 10, and yet reduce the efficiency only by 10% (23.5% vs. 21.5%). It is interesting to note that the J_{SC} values of these cells are very close to the theoretical values, indicating very efficient light-trapping and carrier collection. From Figure 8.3, it is seen that inverted pyramids can produce J_{SC} values of 38 and 39 mA/cm^2 for cells having thicknesses of 44 and 47 μm, respectively. It is also seen that beyond a 250 μm cell thickness, the J_{SC} saturates at about 42 mA/cm^2.

Another cell that illustrates the high performance capability of thin cells was fabricated on a crystalline Si film made by zone-melting recrystallization (ZMR) [28]. Figure 8.7 illustrates the structure and processing sequence for ZMR cells. To minimize substrate issues, a single-crystalline Si wafer was used as a support. A thin layer of SiO_2 was deposited on the Si substrate as a stopping layer for impurity diffusion, and then a 60-μm-thick layer of poly-Si was deposited by a chemical vapor deposition (CVD) technique. The sample was then heated in vacuum by a line-shaped carbon strip, located just above the sample, to about 1200°C to recrystallize the poly-Si layer. A (100)-dominated surface was obtained with a growth speed of 0.2 mm/s, and grain sizes of millimeter to centimeter were reached. They achieved a high conversion efficiency of more than 14% for a 10 × 10-cm cell with $V_{OC} = 608$ mV, $J_{SC} = 30$ mA/cm^2, and $FF = 78.1\%$, and 16% for a 2 × 2-cm^2 cell with $V_{OC} = 608$ mV, $J_{SC} = 35.1$ mA/cm^2, and $FF = 77.1\%$. These results are quite impressive for solar cells fabricated on the poly-Si thin film obtained by ZMR technology.