1.7 GLOBAL TRENDS IN PERFORMANCE AND APPLICATIONS

Figure 1.8 shows the trends in efficiency achieved over the past 20 years for all the major PV technologies. These results are for small area "champion cells", the one-of-a-kind result that establishes the potential of a given material system and device technology. The highest efficiency is for the most expensive and complex devices, based on III–V technologies like GaAs and GaInP, consisting of multiple devices with different optical and electrical properties, grown on top of each other. They are discussed in Chapter 9. These multijunction (MJ) cells outperform other cell technologies for three reasons. They are made from very perfect and high-purity crystalline materials, they can capture either a wider range of the solar spectrum or the same range more efficiently than other devices, and they are operated with high concentration factors, using lenses, which increases the efficiency for reasons discussed in Chapter 3. Not surprisingly, they are also extremely expensive.

The workhorse of the PV industry is still Si as discussed in Chapters 5, 6, and 7. Si wafers in the form of either single crystal Si or multicrystalline (also called polycrystalline) Si accounts for 90% of the PV market. Although champion single crystal (c-Si) and multicrystalline Si (multi-Si) cells have been recorded with 25% and 20% efficiency, respectively (both made at UNSW in Australia), the difference in module performance between the two Si-wafer technologies is much smaller. They have typically 14% and 12% efficiency in commercial modules, respectively. Despite three decades of research and manufacturing, clever scientists and engineers are still finding ways to improve the performance of Si-wafer photovoltaics. They are also finding ways of reducing the cost.

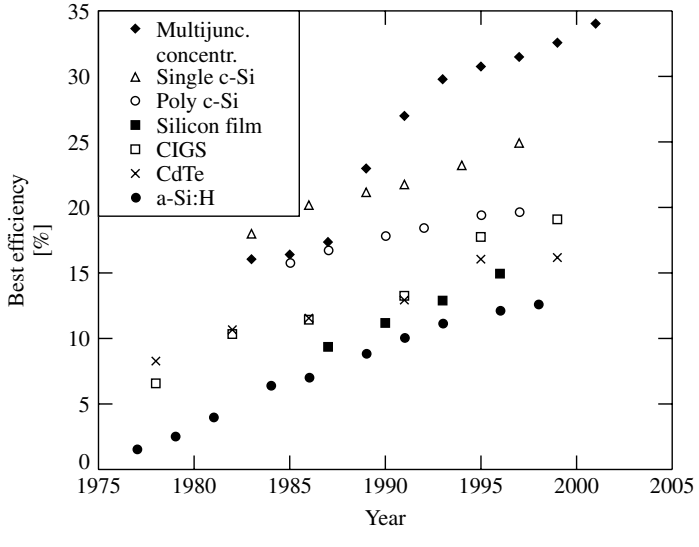

Figure 1.8 Best small area (0.5–5 cm^2) efficiency for various cell technologies measured under standard laboratory test conditions. MJ concentrators are double junctions before 1995, and triple junctions after. a-Si represents stabilized efficiency after extended light soaking and are MJ after 1990 (see Chapter 12)