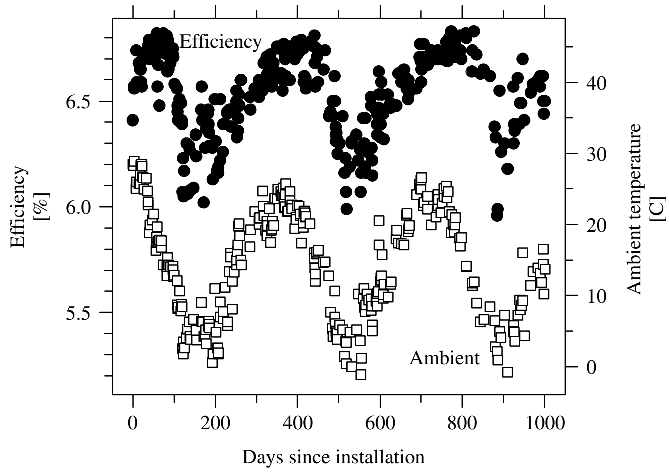


**Figure 12.6** Seasonal variations in the average conversion efficiency (solid symbols) of an amorphous silicon triple-junction module [18], along with the daily mean temperature (open symbols)

the daily average conversion efficiency and ambient temperature of a triple-junction module installation in Switzerland. The module performed best in hot weather. Up to 20°C, the relative increase in efficiency with temperature is about $+5 \times 10^{-3}$/K. It is noteworthy that there was no permanent degradation of this module over the three-year extent of the test. The conclusion that amorphous silicon modules reach a steady state after about 1000 h of steady illumination was also reached in a much larger study of modules manufactured by Advanced Photovoltaics Systems, Inc. [17].

This positive trend of efficiency with temperature is atypical of solar cells made with other materials; for example, the temperature coefficient of crystal silicon solar cells is about $-4 \times 10^{-3}$/K [19, 20]. Interestingly, if the temperature dependence of a-Si:H solar cells is measured quickly – so that there is no time for the Staebler–Wronski effect to set in – the temperature coefficient is also negative (about $-1 \times 10^{-3}$/K) [19]. The behavior of a module in the field may be understood as a competition of the slow annealing of the Staebler–Wronski effect (which yields the positive temperature coefficient) and of a smaller, intrinsic negative coefficient [21, 22]. The effects of temperature on solar cell performance are discussed in more detail in Chapters 3 and 16.

### 12.1.4 Synopsis of this Chapter

The remainder of this chapter is organized as follows. In Section 12.2 we introduce some of the fundamental physical concepts required to interpret the scientific literature about amorphous silicon and related materials (such as amorphous silicon–based alloys and, to a much lesser degree, microcrystalline silicon). Section 12.3 surveys the principal methods such as plasma deposition that are used to make amorphous silicon–based solar cells. Section 12.4 describes how the simplest, single-junction solar cell "works," by which we mean how the photoelectric behavior of the cell is related to the fundamental concepts. High-efficiency solar cells based on amorphous silicon technology are multijunction devices, and in Section 12.5 we discuss how these are made and how their