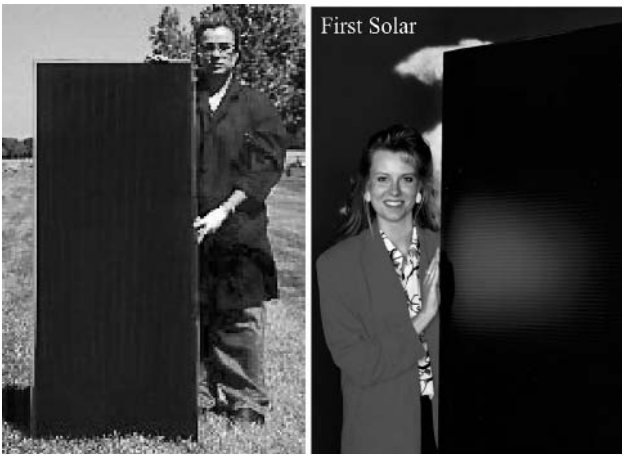

Figure 14.27 CdTe modules made by (a) BP Solar and (b) First Solar. (BP Solar photograph courtesy of D. Cunningham. First Solar photograph courtesy D. Rose)

modules are formed on tin oxide–coated soda lime glass made by Libby Owens Ford. The production line is reported to be capable of 2.9 m^2 per minute throughput [191]. A photograph showing a First Solar module is shown in Figure 14.27(b).

The BP Solar module utilizes electrodeposited CdTe films and overcomes throughput issues associated with low growth rate by simultaneous batch deposition of many modules. The plant has eight identical reaction chambers, or tanks. Each tank is capable of handling 40, 0.55 m^2 ($14'' \times 61''$) substrates or 24, 0.94 m^2 ($24'' \times 61''$) substrates [192]. A photograph of a BP Solar module is shown in Figure 14.27(a).

The Antec module utilizes CSS deposition of the CdTe layer, with a patented source diffuser to improve spatial uniformity during deposition. Spatial uniformity in CSS deposition is an issue because the source and substrate have the same area and are in static relation to each other.

Issues confronting manufacturers of thin-film CdTe solar cells are maintaining small-area efficiencies at the module scale, control of uniformity during growth, reproducibility, and product certification with respect to expected lifetime. Module performance and spatial uniformity are linked to the CdS film thickness; thick CdS films improve processing latitude but reduce light-generated current. With the ultrathin CdS films used to obtain state-of-the-art performance in small-area cells, spatial variations in CdTe-film microstructure can affect the diffusion of CdS into CdTe and the resulting junction structure. Incorporating buffer layers into the window-layer side of the structure, refining the postdeposition treatments, and developing in-line sensing diagnostic tools are viable pathways for widening the tolerance window needed to raise the current density in modules.

14.5 THE FUTURE OF CdTe-BASED SOLAR CELLS

The future of CdTe thin-film photovoltaic devices in energy production and optical sensing is assured by the material properties, laboratory-scale device performance, and photovoltaic module implementation. Enhancing the viability of CdTe/CdS for terrestrial