14.4 CdTe MODULES

A CdTe photovoltaic module consists of electrically interconnected CdTe cells on a superstrate that serves as the mechanical support. The module's electrical output depends on individual cell output, interconnection scheme, and losses due to nongenerating areas and interconnection-resistive losses. Obtaining high cell efficiency at the module scale depends on the successful transfer of small-area batch processing steps, such as the $CdCl_2$ treatment, to either large-area batch or continuous processing, and on minimizing dead-area and resistive losses as well as optical losses due to the use of low-cost glass. In effect, the manufacturer's goal is to obtain a series-connected array of large-area CdTe/CdS diodes having spatially uniform physical and electrical properties in a high-throughput fabrication process. This manufacturing orientation is somewhat different from that of integrated-circuit manufacturers, where the challenge lies in minimizing the spatial dimension of each circuit element.

The electrical interconnections between adjacent cells can be made via external contacts or by monolithic integration during deposition and processing. For cost-effective commercial-scale modules, the principle of monolithic integration is often adopted, where the cells on a single large-area substrate or superstrate are isolated and interconnected by scribing through the deposited layers at different stages of fabrication. Scribing can be achieved by mechanical means or, preferably, by laser scribing in which the stopping point is determined by matching the absorption properties of the different layers with the appropriate wavelength and power density [180]. The first scribe isolates the TCO front contact, the second through the CdS and CdTe provides an electrical path from the TCO to the back contact of an adjacent cell, and the third isolates the back contact between cells. A monolithically interconnected module is shown in Figure 14.26. The photocurrent generated by each individual cell flows from one end of the module to the other. The module voltage is simply the sum of the voltages from the series connected individual cells. This monolithic structure and its three laser scribes are very similar to that of amorphous silicon–based PV modules. Significant design analysis of module geometry and lateral-sheet resistances, to minimize resistive and dead-area losses, has been carried out for amorphous silicon PV modules, and is applicable to CdTe PV modules [181, 182].

The structure shown in Figure 14.26 utilizes a sheet of glass as the supporting superstrate. The choice of glass is based on the cost per watt, optical loss, and thermal

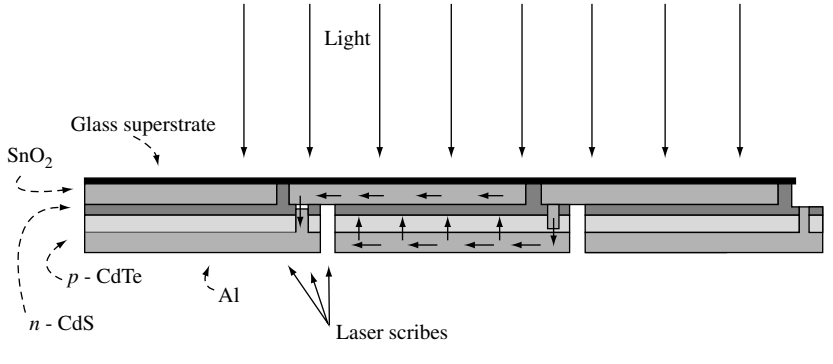

Figure 14.26 Schematic of a series-connected integrated CdTe module having three laser scribes