Two tabs per cell are employed thus providing redundancy that allows current to flow in case electrical continuity is broken because of some failure [124]. Besides, the effective length of grid fingers is one-fourth the cell side and series resistance is alleviated. Tabs provide a nonrigid link between cells that allow thermal expansions to be accommodated.

Series interconnection of strings by soldering the tabs to the rear side of another cell follows (Figure 7.17b). The strings are interconnected with auxiliary tabs to form the cell matrix. This can consist of a single series string or several strings (Figure 7.17c). If the strings are not internally paralleled, their terminals are brought outside the module to permit flexible circuit configuration.

A common module configuration uses 36 series-connected cells, which, under operating conditions, would produce around 15 V at maximum power, appropriate for 12 V battery charging [125]. As building-integrated, grid-connected applications grow, modules with different electrical configurations enter the market.

A few years ago these operations were performed manually, but current factories use sophisticated equipment that performs most of the operations automatically. Both throughput and yield benefit from automation since the connected cells are very fragile and difficult to handle.

7.8.2 The Layers of the Module

The array of cells must be properly encapsulated for reliable outdoor operation for more than 20 years, paying attention to factors like rigidity to withstand mechanical loads, protection from weather agents and humidity, protection from impacts, electrical isolation for the safety of people and so on.

The different layers that the module is made up of are then stacked. A common structure is sketched in Figure 7.18.

A 2- to 3-mm thick soda lime glass is used as a superstrate that provides mechanical rigidity and protection to the module while allowing light through. It must have low iron content or otherwise the light transmission will be low. Modern modules use glass with cerium that absorbs UV radiation to enhance reliability [126]. Tempered glass must be employed to increase the resistance to impacts.

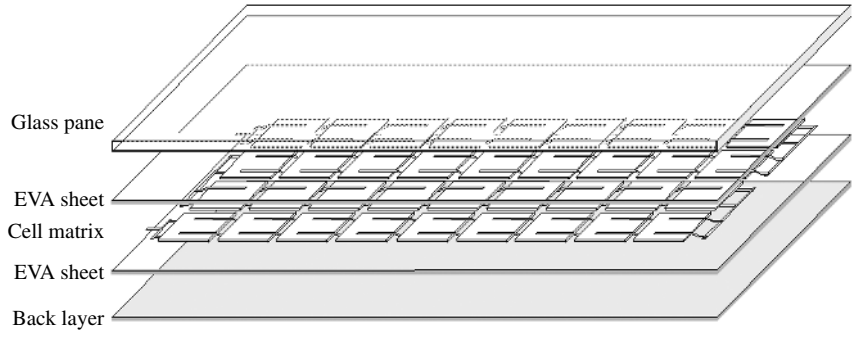

Figure 7.18 Stack of materials to be laminated