The cell matrix is sandwiched between two layers of the encapsulant or pottant material. The most popular encapsulant is the copolymer ethylene-vinyl-acetate (EVA), a plastic composed of long molecules with a backbone of carbon atoms with single covalent bonding. EVA is a thermoplastic, that is, shape changes made under heating are reversible. It is sold in rolls of extruded film around 0.5-mm thick. Along with the polymer, the film contains (1) curing agents and (2) stabilizers whose role will be described later.

The outer layer at the nonilluminated module side is usually a composite plastic sheet acting as a barrier for humidity and corroding species. Some manufacturers use another glass, which increases protection.

7.8.3 Lamination and Curing

These steps are carried out in a laminator, a table that can be heated and furnished with a cover that closes the edges tightly. The cover has an internal chamber and a diaphragm that separates this from the chamber containing the module. Both chambers can be independently evacuated: this configuration allows the module to be kept in a vacuum while mechanical pressure is exerted on it.

In the lamination stage, both chambers are evacuated while temperature is raised above the EVA melting point at around 120°C. Vacuum is important to extract air – to prevent voids from forming – and moisture and other gases. The EVA flows and embeds the cells. After a few minutes, with the module chamber still in vacuum, the upper chamber is filled with air so that the diaphragm presses the laminate. The temperature is increased to 150°C and the curing stage begins: the curing agents induce cross-linking of the EVA chains, that is, chemical bonds are formed transversely among the long molecules that before curing are only weakly linked to one another. The plastic then acquires elastomeric, rubberlike properties and indeed the curing step is analogous to the vulcanization of rubber. This stage takes up to 60 min for standard cure EVA [127]. After cooling down, the laminates are unloaded from the laminator.

Lamination used to be a bottleneck in the module fabrication process. To improve throughput several solutions have been followed by the industry: (1) commercial fast-curing EVA formulations allow drastic reductions of curing time to less than 10 min [128], (2) performing the curing step in a separate oven decreases the residence time in the laminator and (3) a large lamination area – up to several square meters – enables simultaneous process of several modules or very large ones.

Another polymeric material, poly vinyl butyral (PVB), was used in early times of module fabrication. It is processed in a similar way to EVA and can present some advantages over EVA [129] but it requires low temperature storing. For modules using two glass panes, resin fill-in is an alternative to EVA with reliability advantages. A sealed cavity is formed between the glass panes with the cells in-between and the liquid resin is poured into it. Care must be taken to ensure that no bubbles form [125]. Resins do not require heating to cure. Silicone resins are expensive but very stable and some modules for building integration use them. Yet curing can be inhibited by the module sealant so that they are difficult to handle. Acrylic resins with UV curing are being investigated.