7.10 FIELD PERFORMANCE OF MODULES

7.10.1 Lifetime

Long lifetime is claimed as one of the main virtues of PV and some manufacturers currently offer warranty for more than 20 years, with 30-year lifetime being the objective for short-term development. This should mean that for this period of time the module will keep working, that is, producing electrical power with an efficiency similar to the starting efficiency and without deterioration that compromises the safety or the visual appearance. Two factors determine lifetime: reliability, that refers to premature failure of the product, and durability, that attends to slow degradation that eventually decreases production to unacceptable levels. Cost effectiveness, energy payback balance and public acceptance of photovoltaic energy strongly rely on the reliability and the long lifetime of modules.

PV systems worldwide have been working for more than 20 years, and this allows us to gather information concerning degradation mechanisms. Modules in the field are subjected to static and dynamic mechanical loads, thermal cycling, radiation exposure, ambient humidity, hail impact, dirt accumulation, partial shading and so on. Common failure modes [124, 141] are related to the action of weather agents in combination with deficiencies in fabrication.

Location-dependent steady degradation of module output is also observed, with short-circuit current and fill factor being the most affected parameters. In many cases, this has been proved to correlate with degradation of EVA encapsulation [127]. EVA, like most polymers, is known to undergo photothermal degradation: UV radiation breaks molecular chains. Diffusion of chemical species is also relatively easy through it, so that moisture and corroding agents can enter while absorbers and stabilizers can out-diffuse.

Yellowing or browning of EVA reduces its optical transmission affecting module current. For this reason, EVA incorporates UV absorbers in its formulation. Cerium-containing glasses alleviate this problem. Degradation also decreases the strength of the encapsulant, leading to loss of adhesion to the cells and even detachment of the layer (delamination). This is promoted by the shear stress that accompanies different expansion coefficients upon diurnal thermal cycles. Delamination brings about optical and thermal degradation. Besides, the degraded encapsulant can be penetrated more easily by moisture and chemicals. Among these, sodium from the glass and phosphorus from the cell emitter are known to precipitate at the cell surface, corroding solder joints and increasing series resistance [141]. Encapsulant formulations are being continuously improved to address these problems.

7.10.2 Qualification

Several organisms, such as the International Electrotechnical Commission (IEC), the Institute of Electrical and Electronic Engineers (IEEE) and so on, have designed tests aimed at guaranteeing the quality of PV products [142]. Test procedures have been defined that, if successfully passed by a product, should guarantee the reliability of the PV module.

Manufacturers voluntarily submit their products for qualification tests in an accredited laboratory. These include verification of the module performance claimed in the datasheets as well as reliability tests. The certifications obtained are intended as a quality assurance for the customer.