IMPACT OF ENCAPSULATION OVER PERFORMANCE STABILITY AND RELIABILITY TESTING OF PEROVSKITE SOLAR CELLS

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ABSTRACT

In comparison with traditional c-Si, hybrid organic-inorganic metal halide perovskite cells (OHPSCs) contain chemically active compounds, secondary bonds, and soft/ionic interactions. Therefore, they are more prone to react under the exposure of external (ambient & operational) as well as internal stressors such as light, heat, moisture, oxygen and electric biasing. For instance, it has been reported in literature several photo/thermal-induced decomposition into volatile compounds and phase segregations of cation or halides mainly at grain boundaries and interfaces of the Perovskite, which ends in transient ion/vacancies migration that modulates shallow traps formation and additional non-radiative recombination. The later, causing hysteresis ("preconditioning memory effect") on the performance of the device. In that sense, besides protecting from external degradation factors or containing decomposition products, an effective encapsulation would be responsible for ensuring a higher intrinsic stability on the device. For which, glass-to-glass encapsulation has been reported as one of the best option, when trying to comply with reliability testing standards (such as ICE 61215). Therefore, the current project has the aim of studying the requirements to perform proper JV characterization and reliability testing protocols on encapsulated OHPSCs at L'Institut Photovoltaïque d'Ile-de-France (IPVF). In concrete, it seeks: (i) to address the impact of encapsulation (mostly temperature effects) over the stability of the device and (ii) to evaluate which procedure to put in place for ensuring performance and stability measurements in a reproducible way before and after aging tests. For which, a rough estimate of the initial temperature stabilization time under light soaking was measured for the JV characterization of cells fully encapsulated with Polyisobutylene (PIB) and/or Polyolefin (PO). Furthermore, biasing at maximum power point (MPP) or at a fixed voltage closer to MPP were identified as the most appropriate ways (closer to real conditions and reduced hysteresis index evolution) to assess the operational stability and characterize OHPSCs in comparison to light JV series without bias preconditioning. Additionally, a set of dark JV characterizations were performed to evaluate potential leakage currents on the cells and more accurately estimate the series and shunt resistance. Finally, it is proposed the evolution of the hysteresis index as a figure of merit to evaluate any enhancement on performance stability, or for identifying interface defects passivation and self-healing behaviours during the JV characterization of encapsulated OHPSCs under light/dark cycling.

Key words: Intrinsic & extrinsic degradation, ion-migration, hysteresis index, operational stability, defects passivation, dark/light JV characterization, reliability testing.