Cell protection against UV: when high cut-off encapsulants show their true colours

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High-efficiency silicon-based PV technologies such as heterojunction (HJT) cells will be increasingly used in future PV systems [1]. However, to ensure terrestrial PV development in a given climate, the study of the PV system durability in such location must be assessed as it determines critical viability indicators like levelised cost of energy (LCOE) [2].

UV light affects Si-HJT cells durability by degrading for instance their passivation [3]. A way to limit ultraviolet-induced degradation (UVID) is to use “high cut-off” encapsulation polymers that absorb most of UV photons before they reach the cell, in opposition to “low cut-off” encapsulants. Theoretically, the initial lower photogenerated current due to the lack of photoconversion in the UV region is compensated in the long run by the improved cell photoprotection. Nonetheless, these high cut-off encapsulants rely on organic UV blockers, which are additives that can be altered by photodegradation [4]. Twenty years ago, this mechanism was already related to intense PV module yellowing [5].

In this study, we investigated the degradation of UV absorbers embedded in current industrial formulations and its impact on the module performances during accelerated UV aging tests.

To this end, five different encapsulants, either low or high cut-off, have been used to produce glass-glass monocell modules with nHJT Si-cells. Ten modules have been aged in an Atlas Ci5000 weatherometer (UV irradiance: 100 W/m², sample temperature: 83°C) with a solar-like emission spectrum for 4200 hours and inspected by I-V measurements and fluorescence imaging. All modules that have been manufactured with high cut-off encapsulants showed yellowing (Fig. 1) while the others did not. The discoloration caused a notable loss of photogenerated current that translates into power drop that reach up to 8% (Fig. 2). Modules with low cut-off encapsulants only lost 2% in the first 1500 hours and then stabilised. Fluorescence shots showed that yellowing is strongly affected by the module architecture, which makes it a signature of a diffusion-reaction mechanism that impairs the module photoprotection. In current encapsulant formulations, UV screeners are thus not fitted to protect HJT cells from a long exposure to high UV irradiance.

Fig 1: Comparison of monocell modules with either low (left) or high (right) cut-off encapsulant after 4200 hours long UV aging

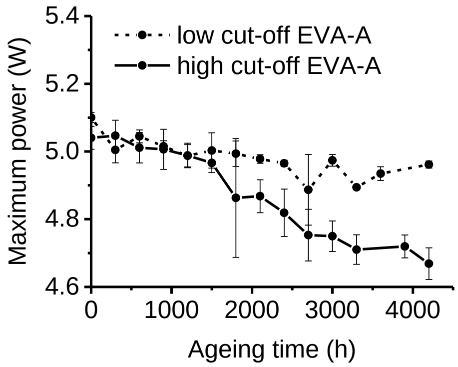

Fig 2: Evolution of the monocell modules performances during accelerated UV aging

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