

# Analysis of the degradation of amorphous Si mini-modules under a severe sequential UV/DH test

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## Abstract

This study presents the results of severe accelerated tests carried out on four encapsulated amorphous silicon (a-Si) mini-modules. All the a-Si mini-modules were exposed to a 85°C and 85% relative humidity damp heat (DH) prolonged treatment for 5000 hours representing five times the duration specified by the IEC 61215 standards for qualification tests. For two of the four mini-modules, the DH test was preceded by a severe UV preconditioning, applying 30 times the dose of 15 kWh/m<sup>2</sup> at a temperature of 50°C prescribed by the IEC61215 standards, so as to enhance the degradation during the following DH test and to reduce the overall testing time.

I-V curves were plotted with a time step of 100 hours in standard test conditions (STC) using a class A solar simulator and a sourcemeter in order to monitor the degradation throughout both the tests. A visual inspection with photographic capturing was also performed at each stage to detect the apparent defects. Corrosion observed after 2000 hours (Fig. 1) due to the ingress of humidity is explained here by two possible infiltration paths in the layers of the mini-modules. Delamination occurred after 5000 hours for the PV mini-modules which underwent the extended DH test. After 5000 hours of damp heat testing, the degradation of the maximal power ( $P_{max}$ ) is found to be slightly accelerated for the a-Si mini-modules that were previously exposed to a severe UV preconditioning, with a value reaching 80% of its initial value, whereas, for the others that were solely subjected to the prolonged DH test, the maximal power remained above 80% of its initial value (Fig. 2). In all cases, the mini-modules seem highly reliable with no failure after 5000 hours of accelerated testing, and, based on an equivalent time of 20 years for 1000 hours of accelerated test, they would exhibit a degradation rate of 0.2%/year in outdoor field conditions.

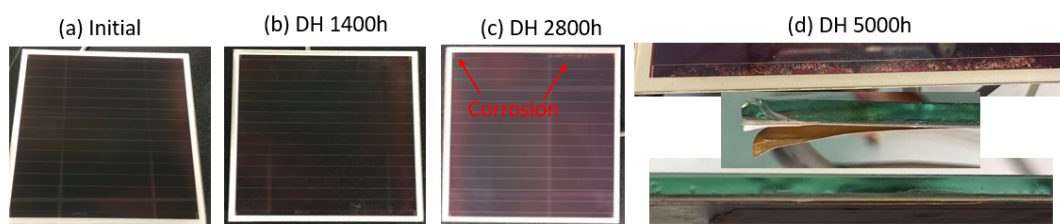


Fig. 1 : Evolution of the state of a-Si PV mini-modules under DH time.

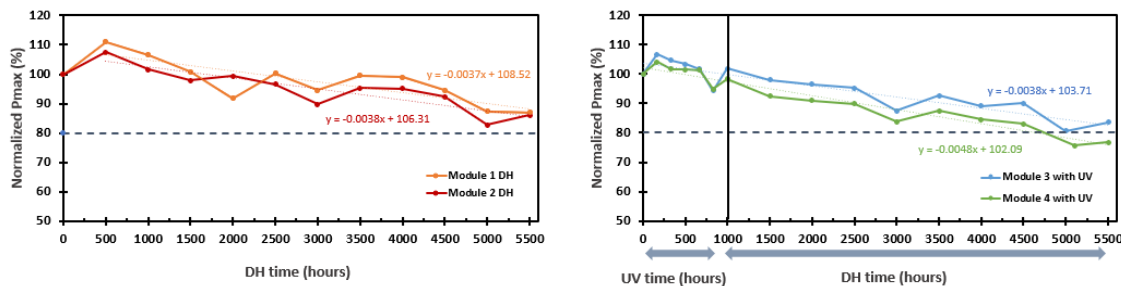


Fig. 2 : Degradation of  $P_{max}$  for a-Si mini-modules during the extended DH test and the sequential UV/DH test.

**Keywords** : photovoltaic, amorphous silicon mini-modules, accelerated test, corrosion.