Exploring highly accelerated aging on c-Si modules

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As a PV power plant operator and investor we are interested in rapid quality control of modules.

Today, it seems that the typical accelerated aging tests are not very representative of outdoor failures, and they are also particularly long and therefore expensive to use, especially for quality control. The results presented here shows attempts to thermally accelerate the damp heat test of crystalline silicon modules.

For this study we applied 2 different damp heat conditions :

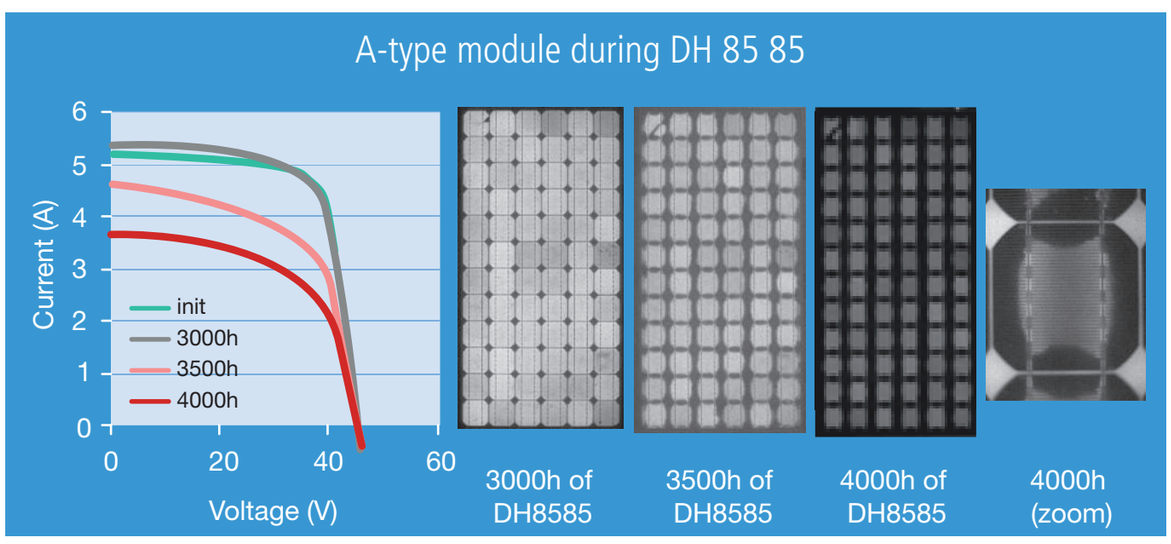
- DH 85°C 85% RH, as required by the IEC 61215 standard,
- DH 95°C 85% RH.

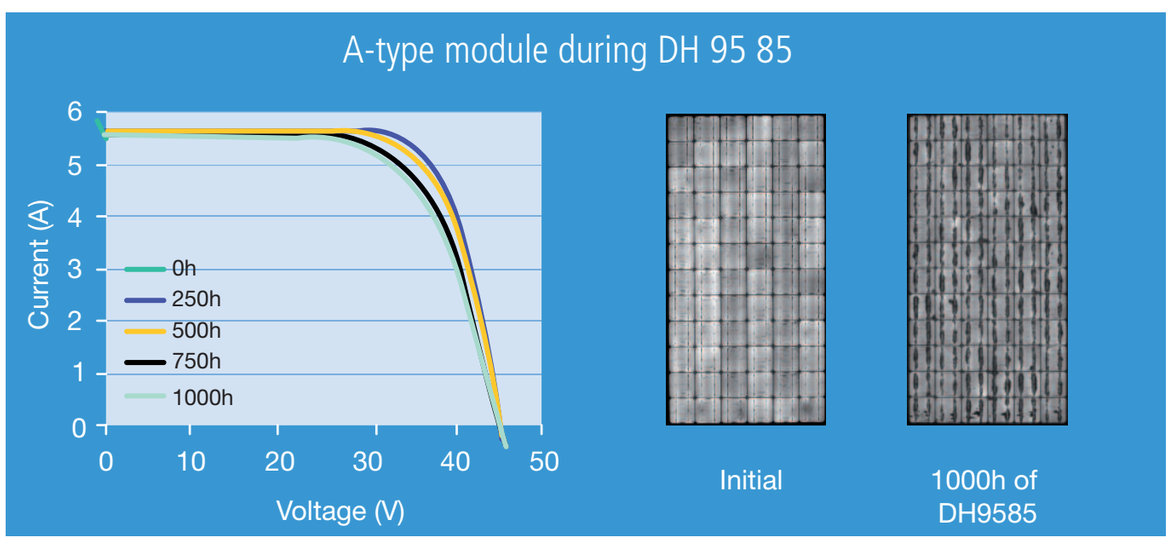
2 different types of commercially available modules have been tested:

- A-type modules are mono-crystalline,
- B-type modules are poly-crystalline from a different supplier.

At each test, 3 modules per type have been aged, while one extra module is kept for reference. For each test, the 3 modules showed about the same behaviour. Some tests have been completed until failure of the module, while others are still on-going, in order to reach a significant power loss.

In the following, we show I-V curves measured at STC (25°C, 1000W/m², AM1.5) with a PASAN flasher of AAA quality, and electro-luminescence images obtained with a basic setup, which allows to get complementary information not accessible by visual inspection.

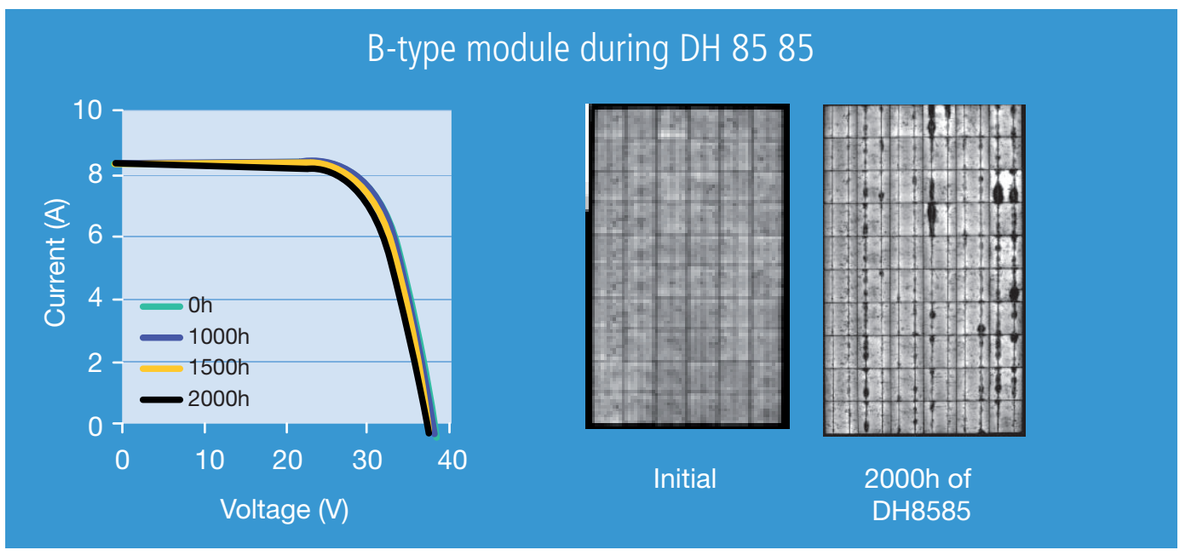


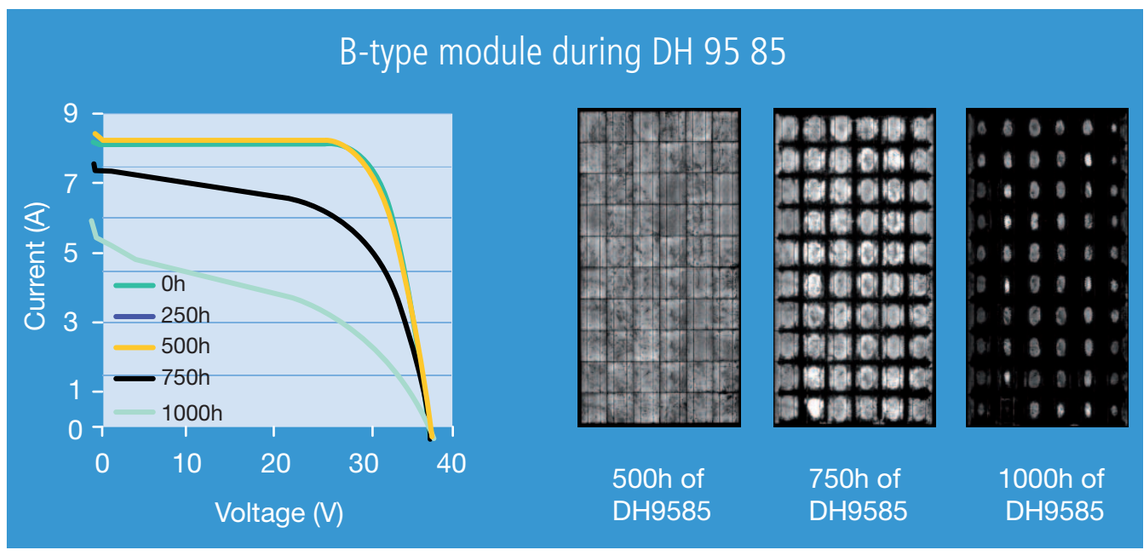


This module resisted to more than 3000 hours of DH8585, which is 3 times longer than the time required by the IEC standard. After that, we observed that the front side of the cells became inactive from their edges. We suspect that humidity entered homogeneously through the Tedlar back-sheet and further on between the cells towards the front. We suspect that the EVA encapsulation released acetic acid which is corrosive for the front contacts.

Although this module comes from the same supplier A, it's design is slightly different from the one tested at CH8585.

At the current stage (1000h of DH9585) this module has lost 13% of it's power, mainly due to series resistance increase. Soldering of the front contacts seems to be degraded. Further DH is on-going.





At this stage (2000h of DH8585) the module shown has lost 7% of it's power, mainly due to series resistance increase. Soldering of the front contacts seems to be degraded. Further DH is on-going.

This module has failed by Isc, Rs and Rsh degradation after more than 500 hours of DH9585. We suspect that humidity went through the back-sheet, came between the cells and attacked their front side from the edges.

DISCUSSION

We have tested 2 different commercially available c-Si module types A and B at 2 different damp heat temperatures : 85°C and 95°C, both at 85% relative humidity.

For both module types, increasing test temperature accelerates power degradation by a factor of 2 or 3.

However, at higher test temperatures, the failure modes changed. The observed failure modes are:

- homogeneous humidity penetration from the back-sheet, between the cells and further on towards their front surface. The cells degrade individually from their edges.
- soldering failures at the front side of the cells, which leads to increased series resistance

We suspect that the tested modules come from different production batches and therefore behave differently.

This poster does not contain any proprietary or confidential information

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