Investigation of Preconditioning Procedures for Thin Film Modules

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Abstract/Summary:

The maximum power of thin film modules (a-Si, CdTe and CIGS) is strongly dependent on the module history and measurement type. The power of CIGS and CdTe modules may increase when they are exposed to radiation and decrease when they are stored in the dark. The power of a-Si modules from production decreases under light and increases with increasing temperature. For an indoor power measurement at STC which corresponds to the outdoor value it is necessary to define a preconditioning procedure which is specific for the technology under test. Here a bias preconditioning is compared to the standard light soaking and to the methods suggested from the producers. For a final determination of the most reliable preconditioning procedure, the resulting maximum power is compared with outdoor power measurements at STC. The capacitive effects of the modules are also investigated.

For more Information on the topic please contact the R&D Team of PI Berlin.

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PHOTOVOLTAIK-INSTITUT BERLIN

INVESTIGATION OF PRECONDITIONING PROCEDURES FOR THIN FILM MODULES

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➡ Introduction & Approach

a-Si, a-Si tandem, CIS and CdTe modules exhibit a meta-stable behavior. This means that the measured Pmpp depends on the specific thermal and radiation condition the module is exposed to prior to the measurement. Because of this characteristic, thin film modules need to be subjected to preconditioning before the performance measurements.
In this work different preconditioning procedures are compared on a-Si, a-Si tandem, CIS and CdTe modules. One purpose is to test if the bias preconditioning is comparable to the standard light soaking procedure. Another aim is to check if the preconditioning procedure proposed from the producer is suitable for the prediction of the stabilized outdoor power once the modules are installed in the field. The time scale of the preconditioning effect is also investigated.
Finally the capacitive effects of the modules are tested by comparing direct (Isc->Voc) and reverse (Voc->Isc) I-V curve measurements.

Module Testing Sequence

The following testing sequence is applied to CIS, CdTe, a-Si and a-Si tandem modules:

1. Direct and reverse I-V curve measurement
2. 5 sec biasing at 3/2 Isc
3. I-V curve measurement after 5 sec the biasing
4. I-V curve measurement after 1 hour
5. Preconditioning
6. Direct and reverse I-V curve measurement within 1 hour of preconditioning
7. 5 sec biasing at 3/2 Isc
8. I-V curve measurement after 5 sec the biasing
9. I-V curve measurements 1 h, 3 h, 6 h, 22 h, 3 days, 7 days after point 8 (during storage)
10. Direct and reverse I-V curve measurement 28 days after point 8
11. 5 sec biasing at 3/2 Isc
12. I-V curve measurement after 5 sec the biasing

Preconditioning Procedures

Preconditioning procedures (point 5) tested:

LS: 20 kWh/m² in the light soaker
B: 22 hours biasing at Impp
O: two weeks outdoor exposure
P: 10 kWh + 5 sec bias at 3/2 Isc (proposed by CIS manufacturer)

The I-V curve measurements are performed under Standard Test Conditions at a flasher light sun simulator class AAA. The module temperature was 25±2 °C and the I-V curve sweep time 8 ms.

In the Figures 1 to 6 are the results of the direct I-V curve measurements. The deviations of Pmpp with respect to the initial values are plotted. In each figure different preconditioning procedures are compared.

Testing Sequence Results

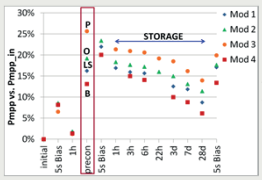

Fig. 1: CIS mod. Producer B – LS is comparable to the B preconditionig. The procedure P strongly deviates from O.

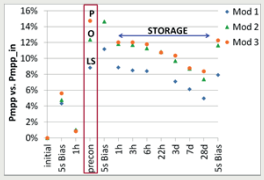

Fig. 2: CIS mod. Producer B – The results for procedure P are higher than for O.

After the 5 sec biasing following the preconditioning the Pmpp deviation is close to the deviation after outdoor exposure.

Testing Sequence Results

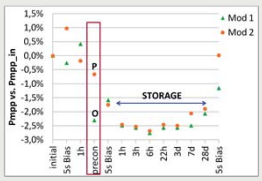

Fig. 3: CIS mod. Producer C – The results for procedure P are higher than for O.

For CIS modules the Pmpp start to vary from 3 hours after the preconditioning and continues to change within one month.

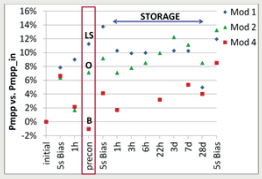

Fig. 4: CdTe mod. Producer D – Pmpp is unstable. A similar trend to higher Pmpp value is recognizible after 5 sec bias for all the modules.

Testing Sequence Results

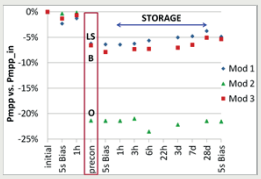

Fig. 5: a-Si mod. Producer F – The procedures LS and B are comparable.

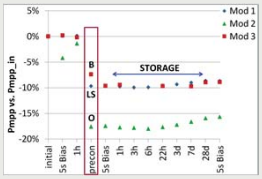

Fig. 6: a-Si tandem mod. Producer G – The procedures LS and B are comparable.

For a-si based technologies the Pmpp is rather stable within one month.

Comparison Biasing-Light Soaking

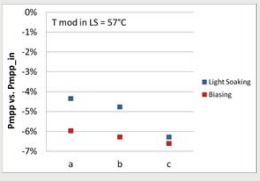

Fig. 7: a-Si mod. – Pmpp dev. wrt initial value. The procedures LS and B are comparable.

Init. Pmpp (W)	a	b	c
LS	52.7	53.6	48.8
B	55.2	56.3	48.7

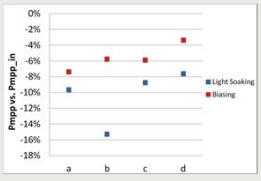

Fig. 8: a-Si tandem mod. – Pmpp dev. wrt initial value. The procedures LS and B are comparable exept for group ‚b' modules.

Init. Pmpp (W)	a	b	c	d
LS	125.2	120.7	128.7	124.2
B	127.1	112.5	127.6	122.4

Pmpp dev. rev. vs. dir. I-V curve meas.

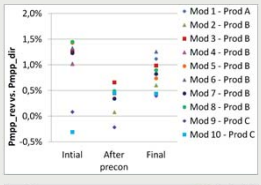

Fig. 9: CIS mod. – Pmpp dev. up to 1.5%. Capacitive effects decrease after preconditioning.

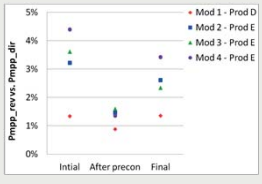

Fig. 10: CdTe mod. – Pmpp dev. up to 4%. Capacitive effects decrease after preconditioning.

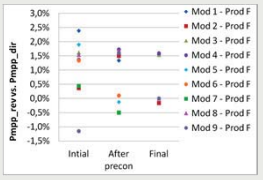

Fig. 11: a-Si mod. – Pmpp dev. Up to 2.5%. Capacitive effects decrease after preconditioning.

➡ Conclusions

Different preconditioning procedures were investigated on thin film modules of CIS, CdTe, a-Si and a-Si tandem technologies. Modules of the same technology were exposed to different preconditioning procedures and the results were compared.
For CIS, a-Si and a-Si tandem modules 22 hours of bias preconditioning at Impp resulted to be comparable to 20 kWh/m² light soaking.
By applying on the CIS modules the preconditioning procedure proposed from a producer, the Pmpp gain was found to be higher than for the modules exposed outdoor.
The performance of CIS modules resulted to change faster within one month after the preconditioning than for the a-Si and a-Si tandem modules. To check the effect of the preconditioning on CIS modules, I-V curve measurements should be performed within one hour.
The performance of CdTe modules resulted to be unstable over the time. Only after 5 sec biasing at 3/2 Isc a trend toward higher Pmpp values could be observed for all the modules.
The capacitive effects were also checked through direct and reverse I-V curve measurements. All the technologies showed initially slight capacitive effects which decreased after the preconditioning.