TÜV Rheinland Taiwan Ltd.
Solar/Fuelcell Technology
Photovoltaic Laboratory

Test Report

Test of potential induced degradation (PID)

TÜV Report No. 11030426 002

Daya, October 2012

Produkte
Products

TÜVRheinland®

Prüfbericht - Nr.: 11030426 002
Test Report No.:

Auftraggeber: *Client:*	Shanghai BYD Co., Ltd. No. 999 Xiangjing Road, Songjiang, 201611 Shanghai, P.R. China		
Gegenstand der Prüfung: *Test item:*	Photovoltaic (PV) Module(s)		
Bezeichnung: *Identification:*	BYD240P6-30 BYD240P6C-30	**Serien-Nr.:** *Serial No.:*	Please see page 3 for sample list.
Wareneingangs-Nr.: *Receipt No.:*	113160426 (order no.)	**Eingangsdatum:** *Date of receipt:*	29 Aug. 2012 (order open date)
Zustand des Prüfgegenstandes bei Anlieferung: **Condition of test item at delivery:**	Test item complete and undamaged		
Prüfort: *Testing location:*	**TÜV Rheinland Taiwan Ltd.** No. 9, Ln. 36, Sec. 3, Minsheng Rd., Daya District, Taichung City 428, Taiwan, R.O.C.		
Prüfgrundlage: *Test specification:*	**See page 3**		
Prüfergebnis: *Test Result:*	**Der Prüfgegenstand entspricht oben genannter Prüfgrundlage(n).** *The test item passed the test specification(s).*		
Prüflaboratorium: *Testing Laboratory:*	**TÜV Rheinland Taiwan Ltd., Taichung Branch, Photovoltaic Laboratory**		

geprüft / *tested by:*

Frank Wang

12 Oct. 2012 — Frank Wang / Project Engineer, TÜV Rheinland Taiwan Ltd.

Datum *Date*	Name/Stellung *Name/Position*	Unterschrift *Signature*

kontrolliert/ *reviewed by:*

R. Struwe

12. Oct. 2012 — Robert Struwe / TC

Datum *Date*	Name/Stellung *Name/Position*	Unterschrift *Signature*

Sonstiges/ *Other Aspects:*

The report of 11030426 001 is replaced by 11030426 002. The value of initial relative humidity during the test is added to 11030426 002. The report of 11030426 001 is no longer valid.

Abkürzungen:				*Abbreviations:*			
	P(ass)	=	*entspricht Prüfgrundlage*		*P(ass)*	=	*passed*
	F(ail)	=	*entspricht nicht Prüfgrundlage*		*F(ail)*	=	*failed*
	N/A	=	*nicht anwendbar*		*N/A*	=	*not applicable*
	N/T	=	*nicht getestet*		*N/T*	=	*not tested*

Dieser Prüfbericht bezieht sich nur auf das o.g. Prüfmuster und darf ohne Genehmigung der Prüfstelle nicht auszugsweise vervielfältigt werden. Dieser Bericht berechtigt nicht zur Verwendung eines Prüfzeichens.

This test report relates to the a. m. test item. Without permission of the test center this test report is not permitted to be duplicated in extracts. This test report does not entitle to carry any safety mark on this or similar products.

TÜVRheinland®
Precisely Right.

Setting of tasks

According to the inquiry of the customer following measurements on the below listed crystalline PV modules shall be performed:

- Visual inspection according to IEC 61215:2005 (6 PV modules)
- Initial measurement of the IV curve at standard test conditions (STC) according to IEC 60904-1:2006 and IEC 60904-3:2008 (6 PV modules)
- Initial recording of electroluminescence images (4 PV modules)
- Full-area coverage of the module's front surface with aluminum foil (4 PV modules)
- Expose modules to -1000V for 168h in the temperature 25℃ condition / initial relative humidity 54% condition (4 PV modules)
- Re-Measurement of the IV curve at standard test conditions (STC) according to IEC 60904-1:2006 and IEC 60904-3:2008 (6 PV modules)
- Final recording of electroluminescence images (4 PV modules)

Remarks:

The relevance to real outdoor stress conditions is not proven.

The pass criteria is defined as $\Delta P_{Max,STC} < 5\%$ degradation of initial and final value of the nominal Power $P_{Max,STC}$.

PV modules

Module type	BYD240P6-30	
Cell type	Poly crystalline	
Sample number		Serial number
1	S1209-099-01	SH120727P630ES75-056
2	S1209-099-05	SH120727P630ES75-060
3	S1209-099-06	SH120727P630ES75-058
Supplementary information: Glass- Dongguan CSG Solar Glass Co.,Ltd / Tempered glass 3.2 mm Cell- BYD COMPANY LIMITED / BYD 156P EVA- Bridgestone Corporation / S11 Back sheet- Fa.SFC Co.,Ltd / TPE-34		

Module type	BYD240P6C-30	
Cell type	Poly crystalline	
Sample number		Serial number
1	S1209-099-02	SH120727P630ES75C053
2	S1209-099-03	SH120727P630ES75C052
3	S1209-099-04	SH120727P630ES75C054
Supplementary information: Glass- Xinyi Ultraclear Photovoltaic Glass (Dongguan) Co.,Ltd / ARC glass 3.2 mm Cell- BYD COMPANY LIMITED / BYD 156P EVA- Bridgestone Corporation / S11 Back sheet- Fa.SFC Co.,Ltd / TPE-34		

Visual inspection

Test Date [DD/MM/YYYY]	18/09/2012
Sample #	Nature and position of findings
S1209-099-01	No visual defects
S1209-099-02	No visual defects
S1209-099-03	No visual defects
S1209-099-04	No visual defects
S1209-099-05	No visual defects
S1209-099-06	No visual defects
Supplementary information:	

Electroluminescence images

Electroluminescence images are recorded before and after the stress test in order to detect the occurrence of PID-effect and to locate affected cells.

Test Date [DD/MM/YYYY]		18/09/2012
Sample #	Reverse current rating [A]	Attributes
S1209-099-03	8.57	-
S1209-099-04	8.57	-
S1209-099-05	8.57	-
S1209-099-06	8.57	-
Supplementary information: Please see the EL images in Annex 3.		

Re-test Date [DD/MM/YYYY]		26/09/2012
Sample #	Reverse current rating [A]	Attributes
S1209-099-03	8.57	-
S1209-099-04	8.57	-
S1209-099-05	8.57	-
S1209-099-06	8.57	-
Supplementary information: Please see the EL images in Annex 3.		

TÜVRheinland®
Precisely Right.

Measurement at STC

The IV-curve measurements were performed before and after the stress test at standard test conditions (STC) with a flash light solar simulator class AAA acc. to IEC 60904-9:2007. The measurements are performed in order to detect the occurrence of PID-effect and to quantify the performance loss of the tested specimens.

Initial test Date [DD/MM/YYYY] ..... :			18/09/2012			—
Module temperature [°C]..... :			Corrected to 25 °C			—
Irradiance [W/m²]..... :			1000*			—
Sample #	Pmpp [W]	Umpp [V]	Impp [A]	Uoc [V]	Isc [A]	FF [%]
S1209-099-01	243.2	30.18	8.059	37.74	8.608	74.9
S1209-099-05	242.6	30.20	8.034	37.70	8.557	75.2
S1209-099-06	242.7	30.23	8.028	37.71	8.597	74.9
* A pulse solar simulator class AAA conforming to the requirements of IEC-60904-9 is used.						
Supplementary information:						

Re-Test date: ..... :				26/09/2012				—
Module temperature [°C]..... :				Corrected to 25 °C				—
Irradiance [W/m²]..... :				1000*				—
Sample #	Pmpp [W]	Umpp [V]	Impp [A]	Uoc [V]	Isc [A]	FF [%]	Degradation [%]	Verdict
S1209-099-01	243.2	30.27	8.036	37.76	8.606	74.9	+0.0	—
S1209-099-05	242.7	29.93	8.109	37.71	8.573	75.1	+0.0	P
S1209-099-06	242.7	29.93	8.109	37.69	8.612	74.8	+0.0	P
* A pulse solar simulator class AAA conforming to the requirements of IEC-60904-9 is used.								
Supplementary information: The change in the performance is within the maximum allowable degradation. The modules pass the test criteria of $\Delta P_{Max,STC}$ <5%. (refer to annex 4)								

TÜVRheinland®
Precisely Right.

Initial test Date [DD/MM/YYYY] ..... :			18/09/2012			—
Module temperature [°C]..... :			Corrected to 25 °C			—
Irradiance [W/m²]..... :			1000*			—
Sample #	Pmpp [W]	Umpp [V]	Impp [A]	Uoc [V]	Isc [A]	FF [%]
S1209-099-02	246.7	30.20	8.170	37.76	8.718	74.9
S1209-099-03	247.2	30.24	8.175	37.76	8.760	74.7
S1209-099-04	248.7	30.59	8.131	37.77	8.771	75.1
* A pulse solar simulator class AAA conforming to the requirements of IEC-60904-9 is used.						
Supplementary information:						

Re-Test date: ..... :			26/09/2012			—
Module temperature [°C]..... :			Corrected to 25 °C			—
Irradiance [W/m²]..... :			1000*			—
Sample #	Pmpp [W]	Umpp [V]	Impp [A]	Uoc [V]	Isc [A]	FF [%]	Degradation [%]	Verdict
S1209-099-02	247.9	30.27	8.192	37.76	8.777	74.8	+0.5	—
S1209-099-03	248.7	30.31	8.207	37.74	8.825	74.7	+0.6	P
S1209-099-04	249.2	30.29	8.227	37.76	8.812	74.9	+0.2	P
* A pulse solar simulator class AAA conforming to the requirements of IEC-60904-9 is used.								
Supplementary information: The change in the performance is within the maximum allowable degradation. The modules pass the test criteria of $\Delta P_{Max,STC}$ <5%. (refer to annex 4)								

Annex 1: Statement of the estimated uncertainty of the test verdicts

- Electrical performance rating is outside the scope of IEC 61215:2005 qualification testing. The verdicts of performance rating are only related to the test samples that were subjected to the tests. They cannot be generalised to the modules from the series production.
- The calibration to STC was performed with a class AAA solar simulator. The extended measurement uncertainty is (as % of measurement value):
  - $2\sigma\ P_{mpp}$ = ± 2.8 %
  - $2\sigma\ I_{SC}$ = ± 2.3 %
  - $2\sigma\ V_{OC}$ = ± 1.4 %
- Relative measurements were performed with a flash type solar simulator.
- The reproducibility of measurements with the solar simulator is less than ±1%.

Annex 2: Photos of modules
Module type: BYD240P6-30

Fig. 1: Front view of test sample

Fig. 2: Rear view of test sample

Fig. 3: Detail view of closed junction box

Fig. 4: Detail view of type label

Module type: BYD240P6C-30

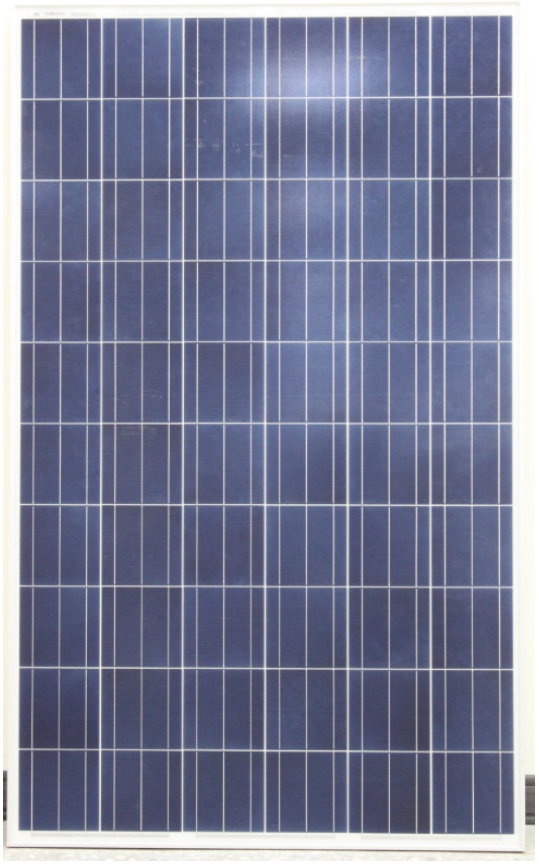

Fig. 5: Front view of test sample

Fig. 6: Rear view of test sample

Fig. 7: Detail view of closed junction box

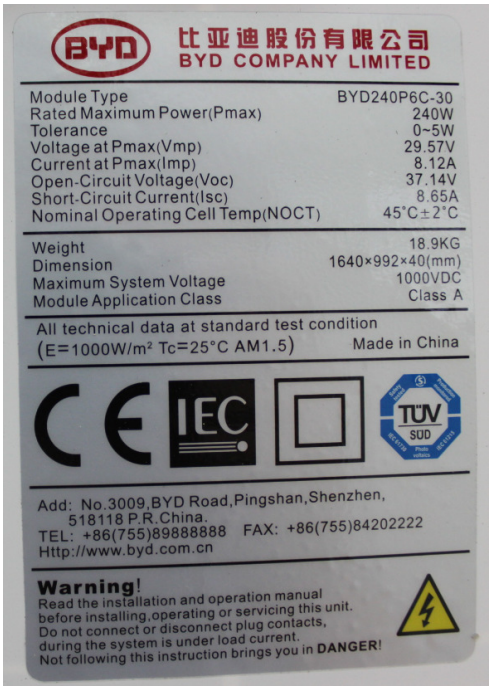

Fig. 8: Detail view of type label

Annex 3: Electroluminescence images
Module type: BYD240P6-30

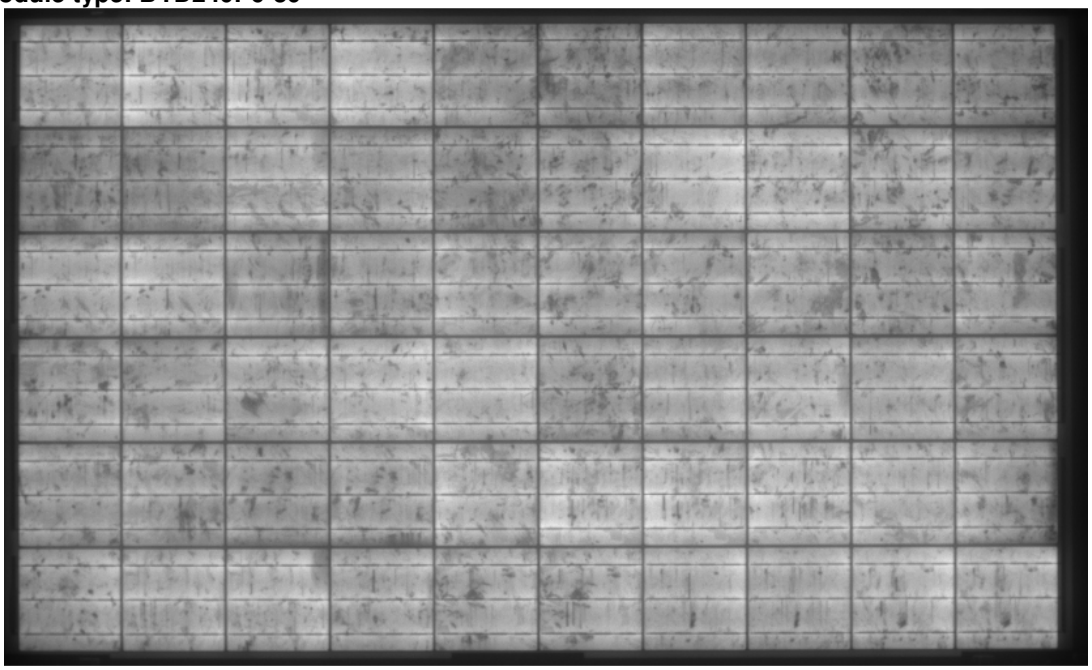

Fig. 9: Initial EL, Sample # S1209-099-05

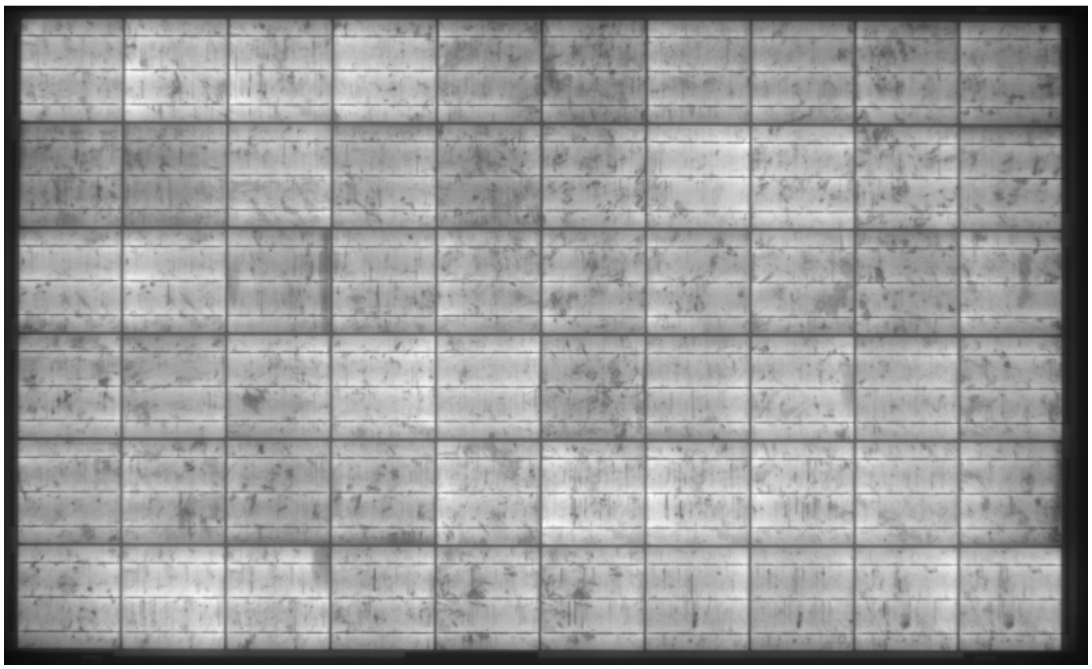

Fig.10: Final EL, Sample # S1209-099-05

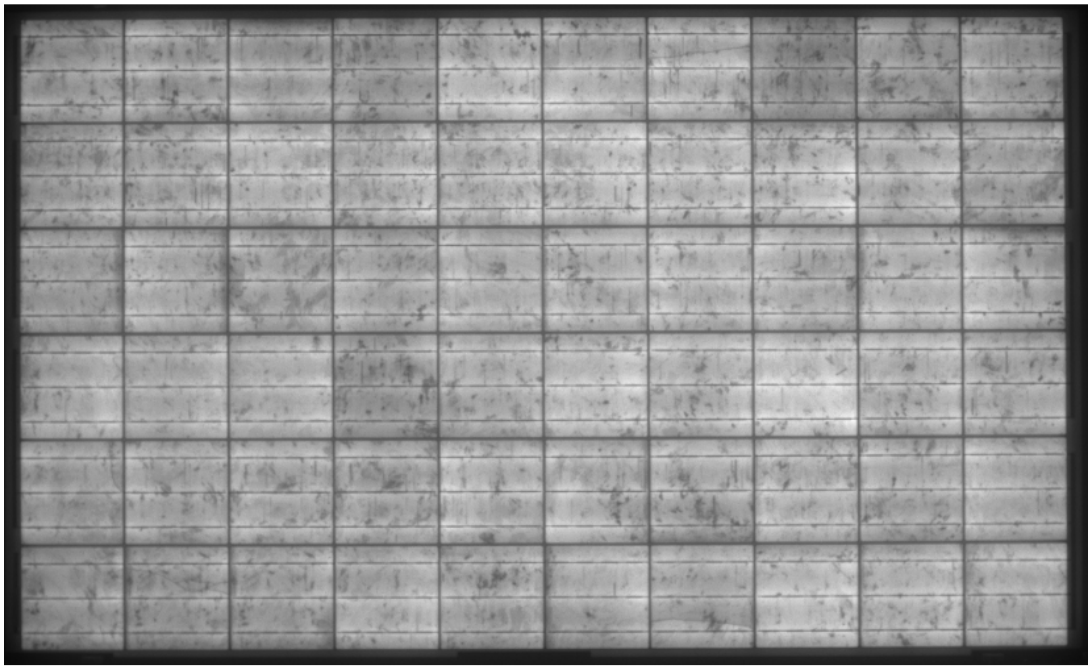

Fig.11: Initial EL, Sample # S1209-099-06

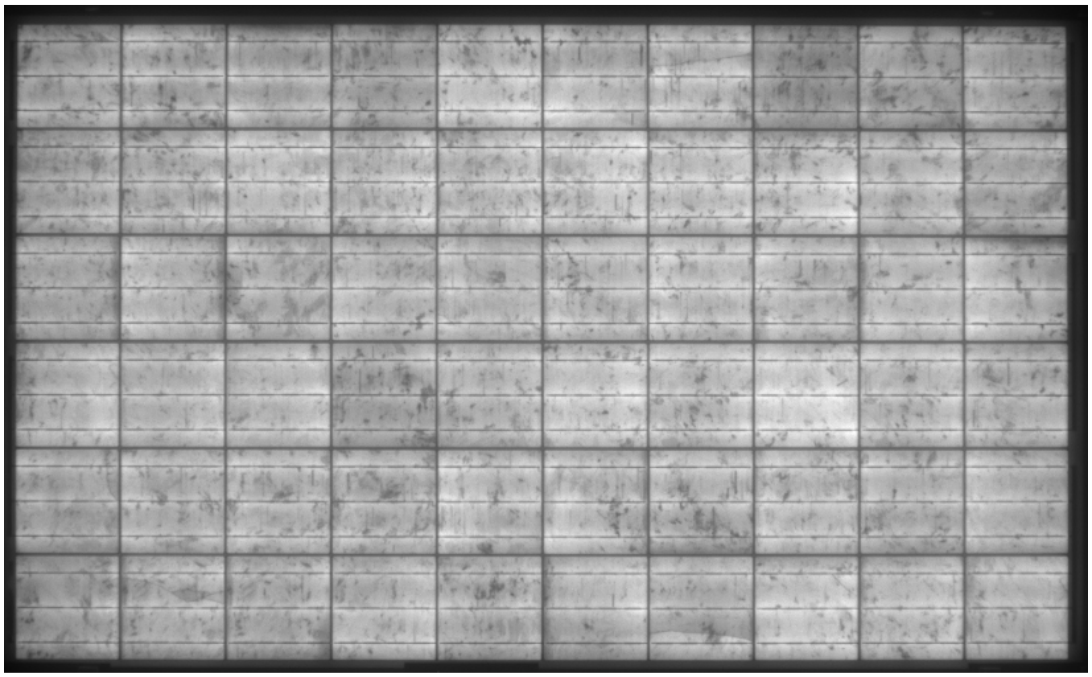

Fig.12: Final EL, Sample # S1209-099-06

Module type: BYD240P6C-30

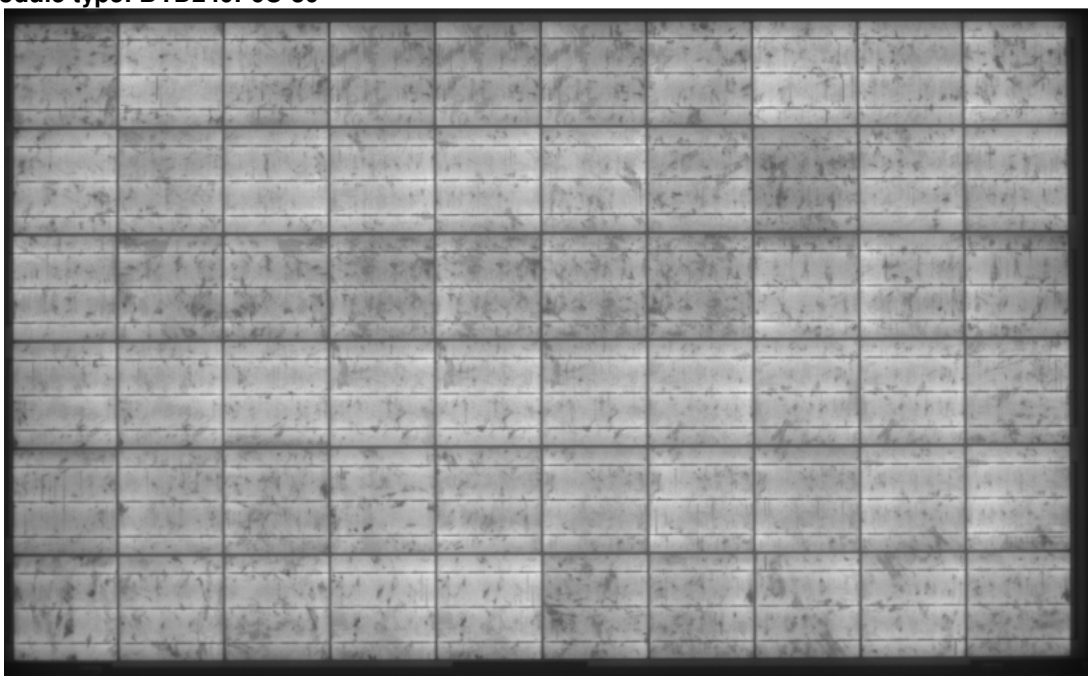

Fig.13: Initial EL, Sample # S1209-099-03

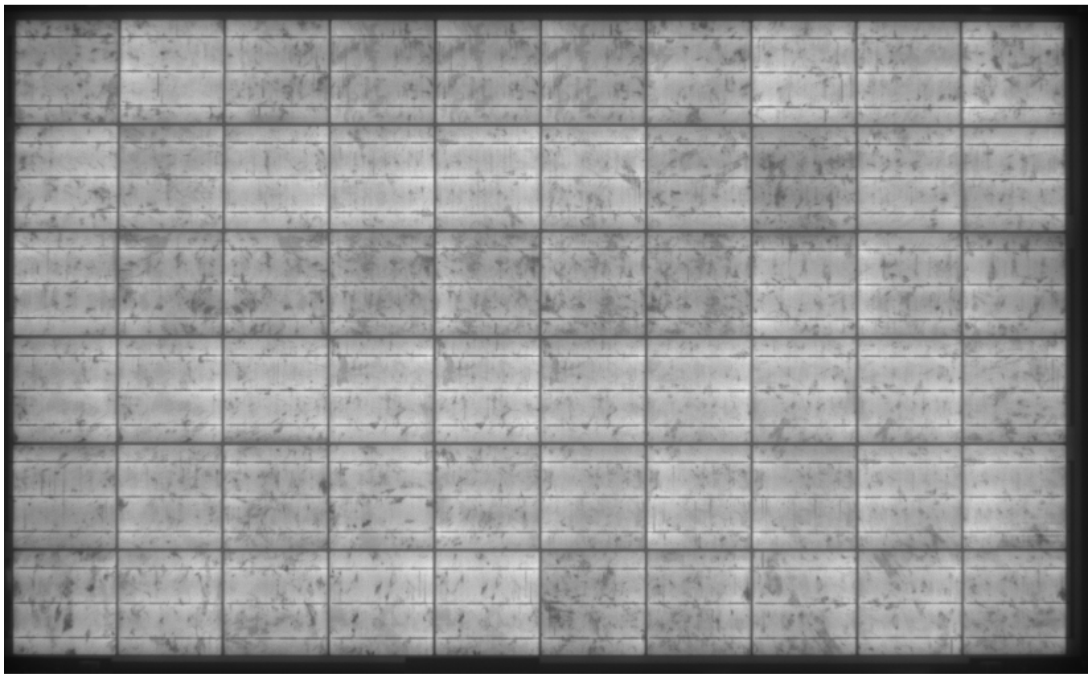

Fig.14: Final EL, Sample # S1209-099-03

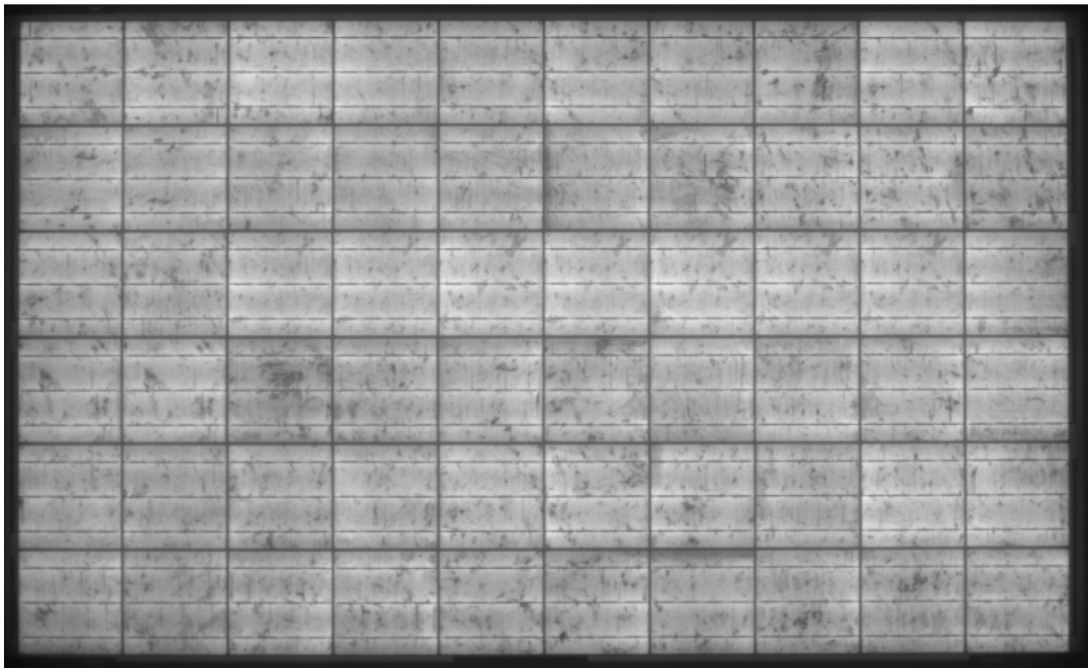

Fig.15: Initial EL, Sample # S1209-099-04

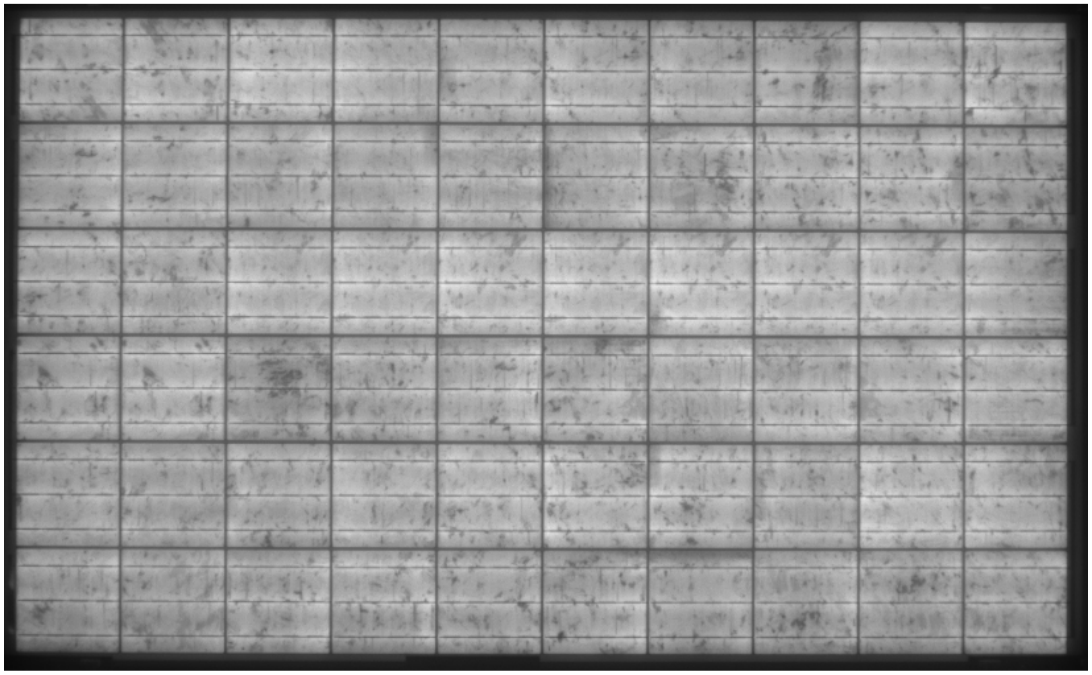

Fig.16: Final EL, Sample # S1209-099-04

Annex 4: IV-curves at STC-conditions
Module type: BYD240P6-30

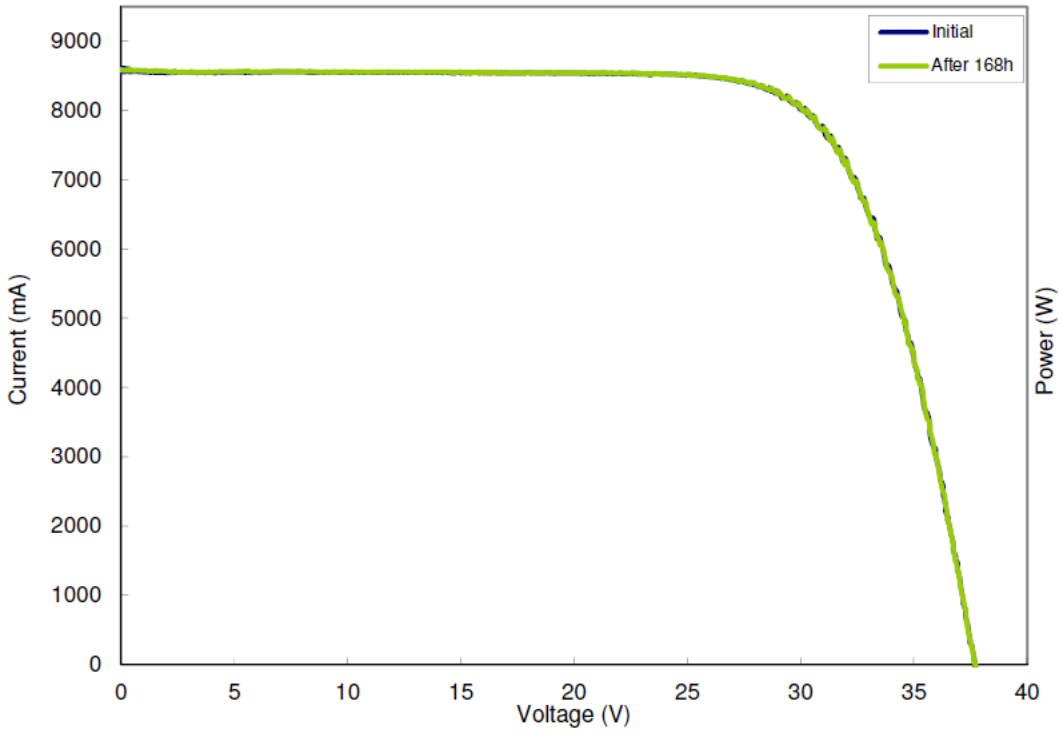

Fig. 17: Initial (blue) and final (green) IV-curves, Sample # S1209-099-05

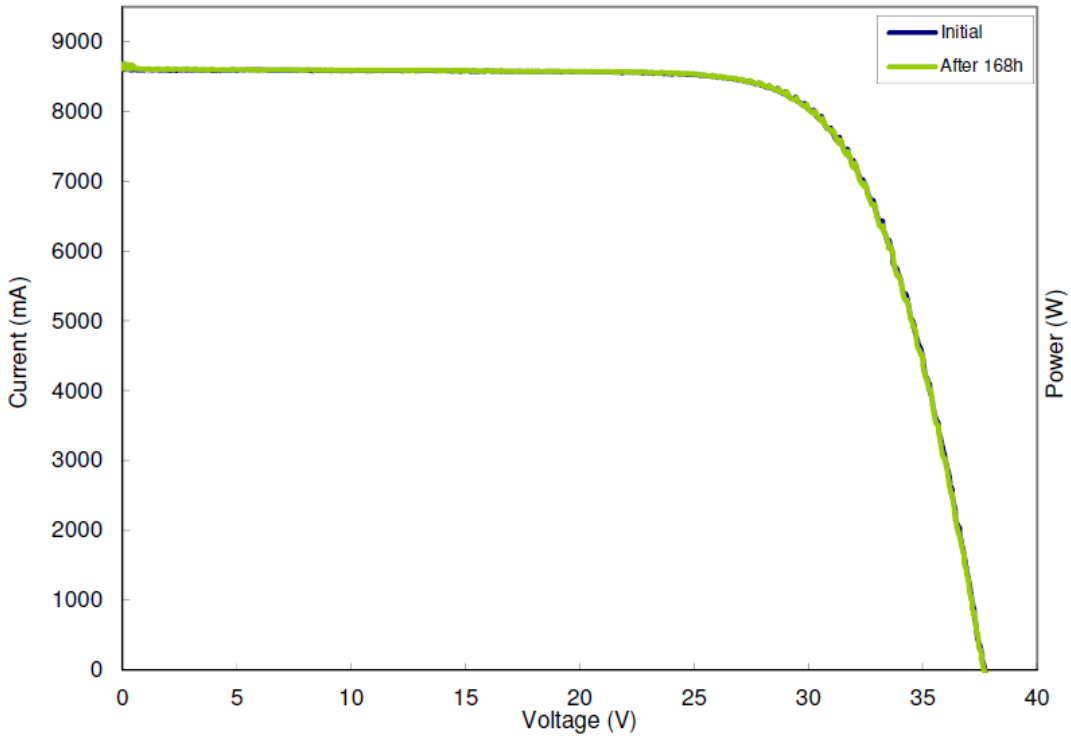

Fig.18: Initial (blue) and final (green) IV-curves, Sample # S1209-099-06

Module type: BYD240P6C-30

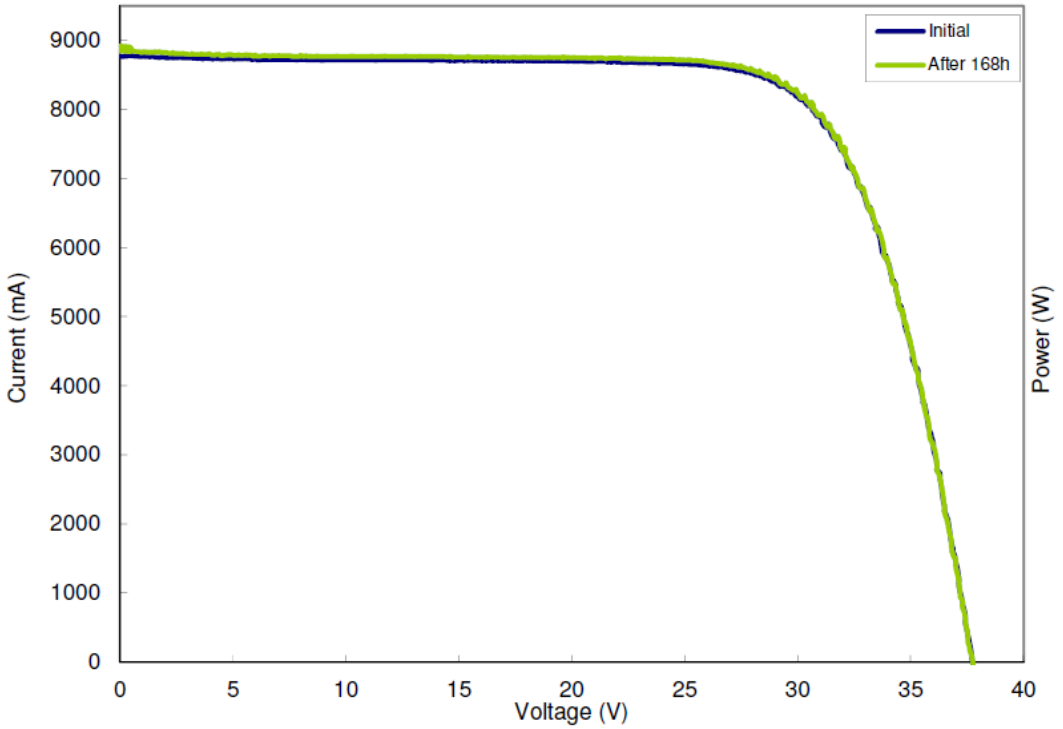

Fig.19: Initial (blue) and final (green) IV-curves, Sample # S1209-099-03

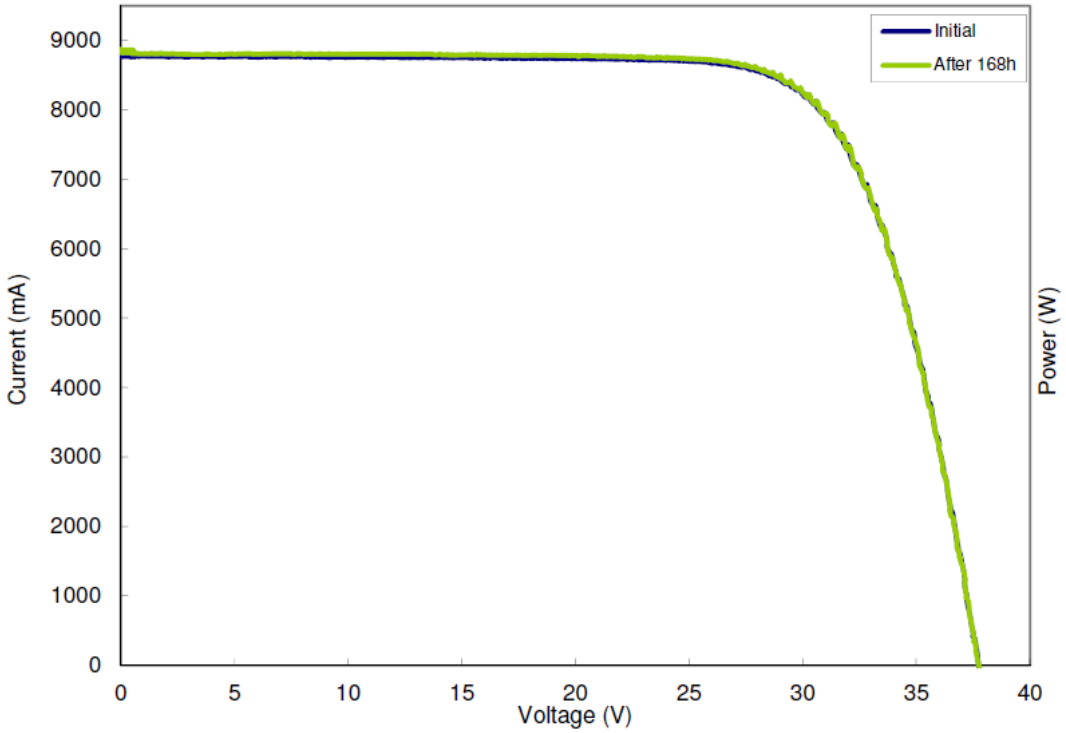

Fig. 20: Initial (blue) and final (green) IV-curves, Sample # S1209-099-04