

TÜV Rheinland (Shanghai) Co., Ltd.
Solar/ Fuelcell Technology

Test Report

Photovoltaic Module Tests
according to Client's Requirements

TÜV Report No. 15104057.001

Shanghai, May 2017

Test report No.: 15104057.001

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Prüfbericht - Nr.:

Client
(Customer No. + address): **RenewSys India Pvt. Ltd.**
Auftraggeber Plot No. 06, Survey # 114/P, Srinagar Village, Maheshwaram Mandal
(Kunden-Nr. + Adresse): Rangareddy Distric t. Telangana-501359, India.

Test Item: Photovoltaic (PV) Module(s) **Date of receipt:** 03/03/2017
Gegenstand der Prüfung: Eingangsdatum:

Identification:
Bezeichnung: DESERV 3M6-315

Order No.: 154226745 **Quotation No.:** 52187459
Auftragsnummer: Angebotsnummer:

Place of testing:
Ort der Prüfung: China Telecommunication Technology Labs

Testing laboratory:
Prüflaboratorium: TÜV Rheinland (Shanghai) Co., Ltd.

Test specification: IEC 60068-2-68:1994, etc
Prüfgrundlage: Refer to details on page 4.

Test Result: Refer to the verdict of the test report
Prüfergebnis:

tested by / geprüft:

reviewed by / kontrolliert:

22.05.2017 Project Engineer/
Date Title/Name Stan Liu
Datum Titel/Name

Signature
Unterschrift

22.05.2017 Technical Reviewer/
Date Title/Name Victor Feng
Datum Titel/Name

Signature
Unterschrift

Other Aspects / Sonstiges:

N/A

Abkürzungen: P(ass) = entspricht Prüfgrundlage
F(ail) = entspricht nicht Prüfgrundlage
N/A = nicht anwendbar
N/T = nicht getestet

Abbreviations: P(ass) = passed
F(ail) = failed
N/A = not applicable
N/T = not tested

This test report relates to the listed test samples. Without permission of the test centre 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.

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

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General Information

Date(s) of performance of tests : From 13/04/2017 to 25/04/2017

Reference standard are as follows:

- IEC 60068-2-68:1994 Environmental testing for electric and electronic products-Part 2: Test methods-Test L: Dust and sand.
- IEC 61215:2005 Crystalline silicon terrestrial photovoltaic (PV) modules – Design qualification and type approval.
- IEC 61730-2:2004+A1+A2 Photovoltaic (PV) module safety qualification – Part 2: Requirements for testing.
- IEC 61701:2011 Salt mist corrosion testing of PV modules.

Abbreviations used in the report:

Pmax	– Maximum power point	Vmpp	– Maximum power point voltage
Imp	– Maximum power point current	Voc	– Open circuit voltage
Isc	– Short circuit current	FF	– Fill factor
MPD	– Maximum Power determination	EL	– Electroluminescence imaging

Possible test case verdicts:	
Test case does not apply to the test object.....:	N/A
Test object does meet the requirement	Pass (P)
Test object does not meet the requirement	Fail (F)

Further Remarks

- All tests were performed at China Telecommunication Technology Labs.
- The test verdicts presented in this report relate only to the test specimen.
- This report shall not be reproduced, except in full, without the written approval of the Issuing testing laboratory.
- IV curves are only included in the report if they show any deviations. If required, other IV curves will be provided upon request.
- Any question regards the report, please contact to TÜV Rheinland (Shanghai) within one week after report issued.

Sampling and Test Assignment

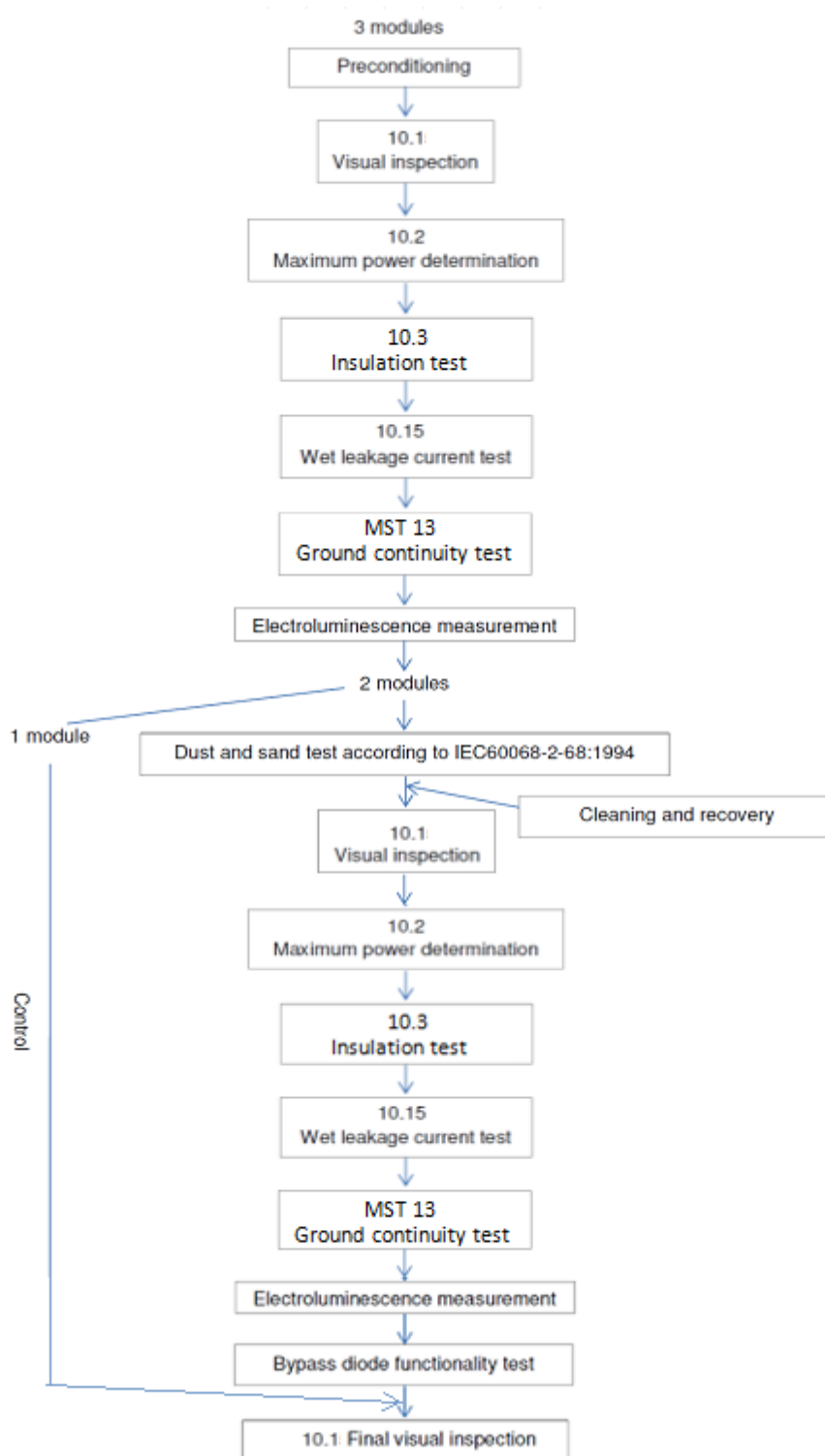
Sampling procedure

☐	Random sampling from production (e.g. during factory audit (FA) or inline inspection)
☐	Random sampling from the warehouse, container or transportation boxes
☒	Modules have been submitted by the manufacturer/ client without random sampling by TÜV Rheinland

Module test assignment

Module manufacturer	Module type	Remarks / constructional characteristics							
Renewsys India Pvt Ltd	DESERV 3M6-315	6" poly c-Si module, 72 pcs							
Sample #		1	2	3					
Setting of tasks		Serial number							
Test item	Test specification	R1000003171238073	R1000003171238063	R1000003171238066					
Reference module		x							
Initial visual inspection	IEC61215:2005, 10.1	x	x	x					
Initial maximum power determination	IEC61215:2005, 10.2	x	x	x					
Initial insulation test	IEC61215:2005, 10.3	x	x	x					
Initial wet leakage test	IEC61215:2005, 10.15	x	x	x					
Initial ground continuity test	IEC61730-2:2004, MST 13	x	x	x					
Initial EL-images		x	x	x					
Dust and sand test	IEC 60068-2-68:1994		x	x					
Final visual inspection	IEC61215:2005, 10.1	x	x	x					
Final maximum power determination	IEC61215:2005, 10.2	x	x	x					
Final insulation test	IEC61215:2005, 10.3	x	x	x					
Final wet leakage test	IEC61215:2005, 10.15	x	x	x					
Final ground continuity test	IEC61730-2:2004, MST 13	x	x	x					
Final bypass diode functionality test			x	x					
Final EL-images		x	x	x					
Legend:									
x Selected sample for test									

Test sequence and test sample requirement



Tables

Visual inspection (according to IEC61215:2005, 10.1)

Test Date [DD-MM-YYYY]	13/04/2017	—
Sample #	Nature and position of initial findings	Verdict
1	No visual defect found	P
2	No visual defect found	P
3	No visual defect found	P
Supplementary information: N/A		

Initial maximum power determination (according to IEC61215:2005, 10.2)

Test Date [DD-MM-YYYY] :			13/04/2017			—
Test method :			☒ indoor		☐ outdoor	—
Irradiance [W/m²]..... :			1000			—
Module temperature [°C] :			Corrected to 25			—
Sample #	Pmpp [W]	Vmpp [V]	Impp [A]	Voc [V]	Isc [A]	FF [%]
1	318.9	37.42	8.522	45.75	8.998	77.5
2	319.7	37.51	8.523	45.72	9.014	77.6
3	320.6	37.51	8.547	45.75	8.997	77.9
Supplementary information: N/A						

Initial insulation test (according to IEC61215:2005, 10.3)

Test Date [DD/MM/YYYY] :				14/04/2017		—
Maximum system voltage [VDC] :				1000		—
High voltage applied [VDC] :				6000		—
Insulation resistance measured at [VDC] :				1000		—
Sample #	Measured	Area	Result*	Dielectric breakdown		Verdict
	GΩ	m²	GΩ * m²	Yes (description)	No	
1	>9.90	1.99	>19.70	-	No	P
2	>9.90	1.99	>19.70	-	No	P
3	>9.90	1.99	>19.70	-	No	P
*Minimum requirement acc. to the standard is 0.04 GΩ × m².						
Supplementary information: The maximum resistance measurement range is 9900 MΩ.						

Initial wet leakage current test (according to IEC61215:2005, 10.15)

Test Date [DD/MM/YYYY] :	14/04/2017			—
Insulation resistance measured at [VDC] :	1000			—
Solution resistivity [Ω cm] :	< 3500			—
Solution temperature [°C]..... :	22 ± 3			—
Sample #	Measured	Area	Result*	Verdict

	GΩ	m ²	GΩ * m ²	
1	4.98	1.99	9.91	P
2	5.34	1.99	10.63	P
3	5.37	1.99	10.69	P
* Minimum requirement acc. to the standard is 40 MΩ × m ² .				
Supplementary information: N/A				

Initial ground continuity test (refer to IEC61730-2:2004, MST 13)

Test date [DD/MM/YYYY]	14/04/2017	—
Maximum over-current protection rating [A]	20	—
Current applied [A]	37.5	—
Location of designated grounding point	Grounding point of the long edge	—
Location of second contacting point	The greatest physical displacement of adjacent side	—
Sample No	Voltage [V]	Resistance [Ω]
1	0.049	0.0013
2	0.050	0.0013
3	0.062	0.0017
Supplementary information: N/A		

EL-images (Initial)

Test date [DD/MM/YYYY]	14/04/2017	—
Forward bias current [A]	9.0	—
Sample No	Remarks	—
1	One cracked cell as marked in EL picture.	—
2	One cracked cell as marked in EL picture.	—
3	One cracked cell as marked in EL picture.	—
Supplementary information: Refer to Appendix 3: EL-images of the appendix for more details.		

Dust and sand test (according to IEC 60068-2-68:1994)

Test Date [DD/MM/YYYY / DD/MM/YYYY]	17/04/2017 – 20/04/2017	—
Sample No	2, 3	—
Cell interconnection circuit	☒ S ☐ SP ☐ SPS	—
Chamber temperature [°C]	40-44	—
Chamber relative humidity [%]	4-7	—
Method Lc1 or Lc2	Lc1	—
Dust/sand type and composition	Quartz, 95% SiO ₂	—
Particle size	Average 0.5mm	—
Dust/sand concentration [g/m ³]	4.8-5.3	—
Wind speed [m/s]	18.3-20.7	—
Duration [min]	240 min for front side+240 min for rear side	—
Supplementary information: N/A		

Visual inspection after dust and sand test (according to IEC61215:2005, 10.1)

Test Date [DD-MM-YYYY]	21/04/2017	—
Sample #	Nature and position of initial findings	Verdict
1	No visual defect found	P
2	No visual defect found	P
3	No visual defect found	P
Supplementary information: N/A		

Maximum power determination after dust and sand test (according to IEC61215:2005, 10.2)

Test Date [DD/MM/YYYY] :				21/04/2017				—
Module temperature [°C] :				Corrected to 25				—
Irradiance [W / m²]..... :				1000				—
Sample #	Pmpp [W]	Vmpp [V]	Impp [A]	Voc [V]	Isc [A]	FF [%]	Degradation [%]	—
1	318.9	37.41	8.524	45.75	9.002	77.4	0.00	P
2	311.2	37.53	8.291	45.70	8.994	75.7	-2.66	P
3	313.6	37.91	8.271	45.73	8.937	76.7	-2.20	P
Supplementary information: N/A								

Insulation test after dust and sand test (according to IEC61215:2005, 10.3)

Test Date [DD/MM/YYYY] :				21/04/2017		—
Maximum system voltage [VDC] :				1000		—
High voltage applied [VDC] :				6000		—
Insulation resistance measured at [VDC] :				1000		—
Sample #	Measured	Area	Result*	Dielectric breakdown		Verdict
	GΩ	m²	GΩ * m²	Yes (description)	No	
1	>9.90	1.99	>19.70	-	No	P
2	>9.90	1.99	>19.70	-	No	P
3	>9.90	1.99	>19.70	-	No	P
*Minimum requirement acc. to the standard is 0.04 GΩ × m².						
Supplementary information: Insulation tester can measure up to 9900.0 MΩ.						

Wet leakage current test after dust and sand test (according to IEC61215:2005, 10.15)

Test Date [DD/MM/YYYY] :	21/04/2017			—
Insulation resistance measured at [VDC] :	1000			—
Solution resistivity [Ω cm] :	< 3500			—
Solution temperature [$^{\circ}$ C]..... :	22 $\pm$ 3			—
Sample #	Measured	Area	Result*	Verdict
	G Ω	m ²	G Ω * m ²	
1	5.31	1.99	10.57	P

2	5.34	1.99	10.63	P
3	5.28	1.99	10.51	P
* Minimum requirement acc. to the standard is 40 MΩ × m ² .				
Supplementary information: N/A				

Ground continuity test after dust and sand test (refer to IEC61730-2:2004, MST 13)

Test date [DD/MM/YYYY]	24/04/2017	—
Maximum over-current protection rating [A]	20	—
Current applied [A]	50.0	—
Location of designated grounding point	Grounding point of the long edge	—
Location of second contacting point	The greatest physical displacement of adjacent side	—
Sample No	Voltage [V]	Resistance [Ω]
1	0.048	0.0013
2	0.051	0.0014
3	0.050	0.0013
Supplementary information: N/A		

Bypass diode functional test

Test Date [DD/MM/YYYY]	24/04/2017	—		
Number of diodes in junction box	3			
Diode manufacturer	—			
Diode type designation	—			
Max. permissible junction temperature T _{jmax} [°C] (according to diode datasheet)	200			
Sample No.	Diode 1	Diode 2	Diode 3	—
2	Functional	Functional	Functional	P
3	Functional	Functional	Functional	P
Supplementary information: N/A				

EL-images (Final)

Test date [DD/MM/YYYY]	25/04/2017	—
Forward bias current [A].....:	9.0	—
Sample No	Remarks	—
1	One cracked cell as marked in EL picture.	—
2	One cracked cell as marked in EL picture.	—
3	One cracked cell as marked in EL picture.	—
Supplementary information: Refer to Appendix 3: EL-images of the appendix for more details.		

Appendix 1: Main measuring equipment and used software

Measuring equipment

Test equipment	Equipment type	ID-No.	Next calibration
Solar simulator	PasanIIIb	PAA0352	2017.12.22
Dielectrometer	TOS5051A	NG001602	2017.11.03
Reference cell	CH-2000	10-0118-11	2017.12.15
Infrared thermometer	RAYST60XBAP	17200075	2018.01.04
Power supply	62150H-600S	GK451	—
Blowing sand test chamber	SC-GF-01	HJ-15-3	2017.11.29
Multimeter	FLUKE289C	33650010	2017.10.31
DC clamp	HIOKI 3287	130912099	2017.05.16

Appendix 2: Photos of the modules



Fig. 1: front view of test module



Fig. 2: rear view of test module



Fig. 3: rating label of test module



Fig. 4: junction box of test module

Appendix 3: EL-images

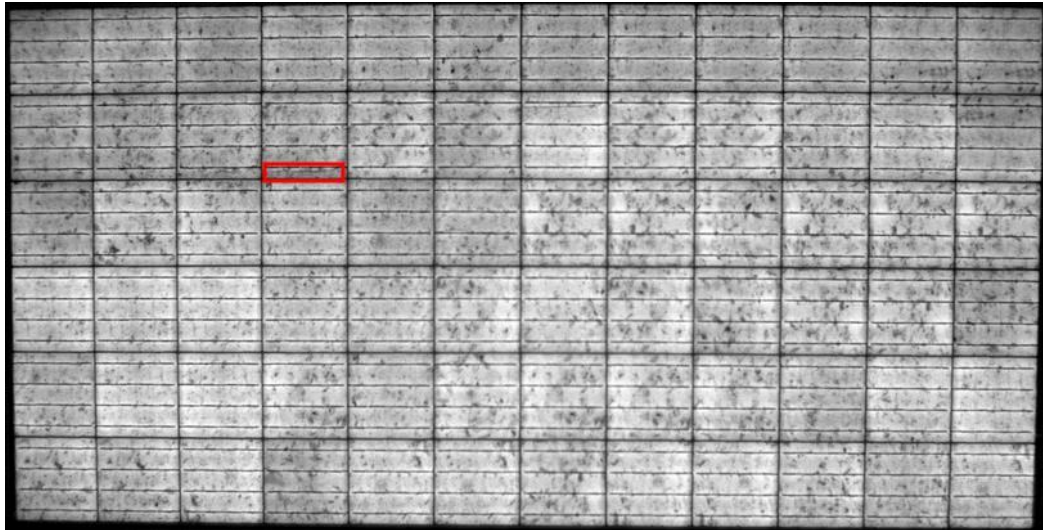


Fig. 5: EL-image of sample R1000003171238073 (initial)

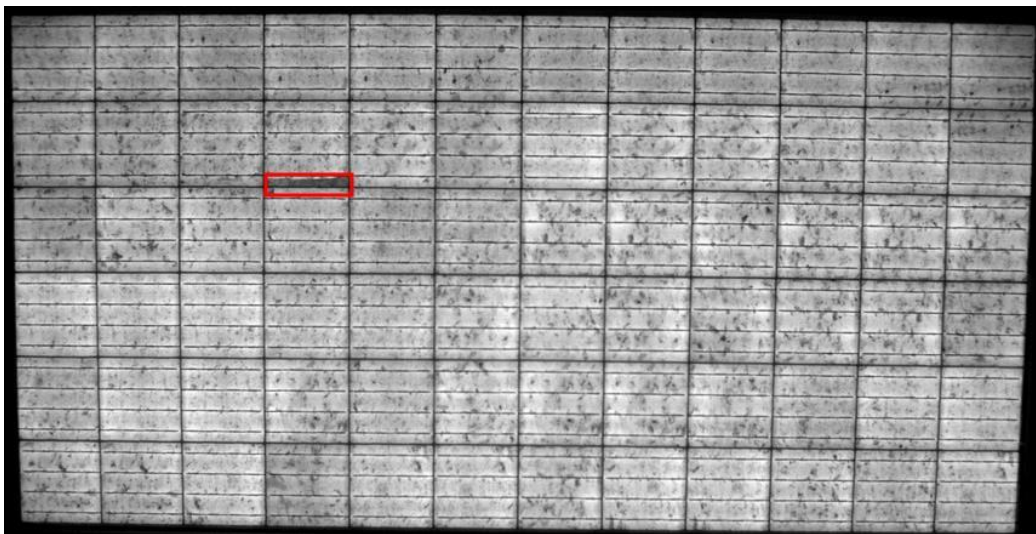


Fig. 6: EL-image of sample R1000003171238073 (final)

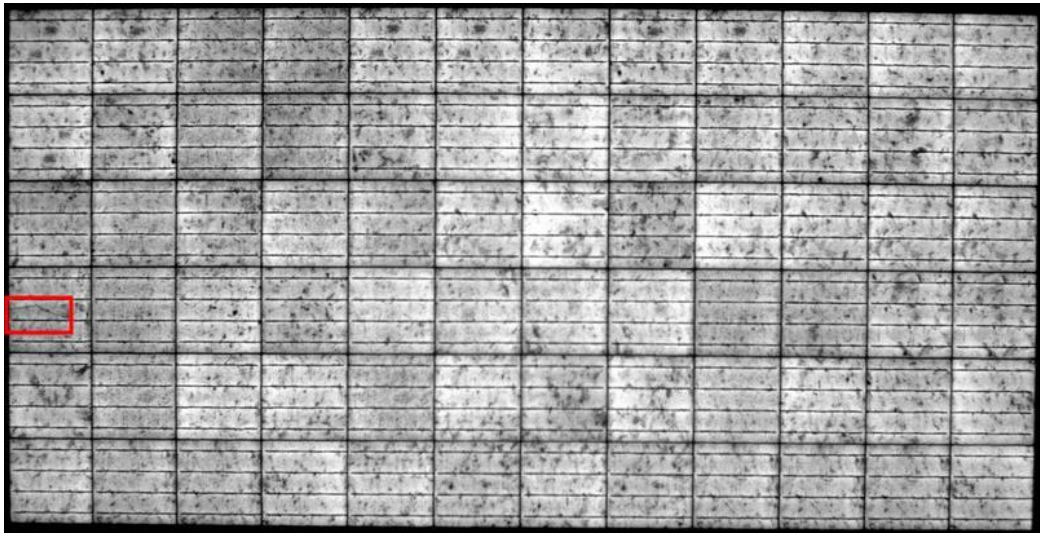


Fig. 7: EL-image of sample R1000003171238063 (initial)

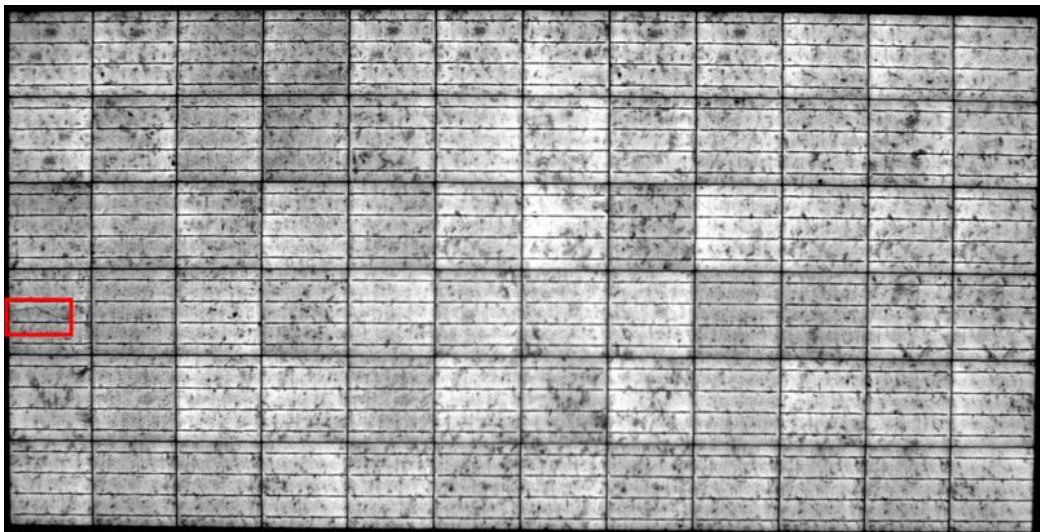


Fig. 8: EL-image of sample R1000003171238063 (final)

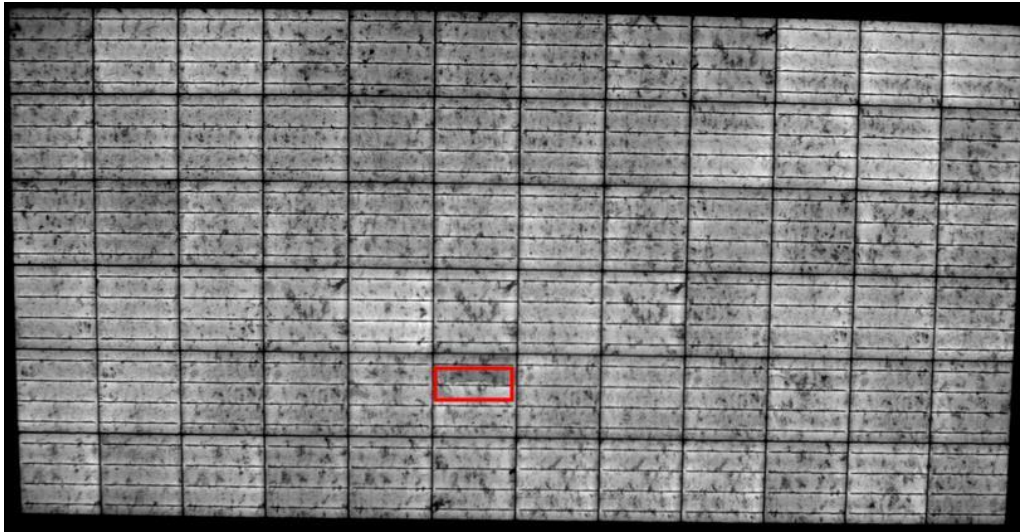


Fig. 9: EL-image of sample R1000003171238066 (initial)

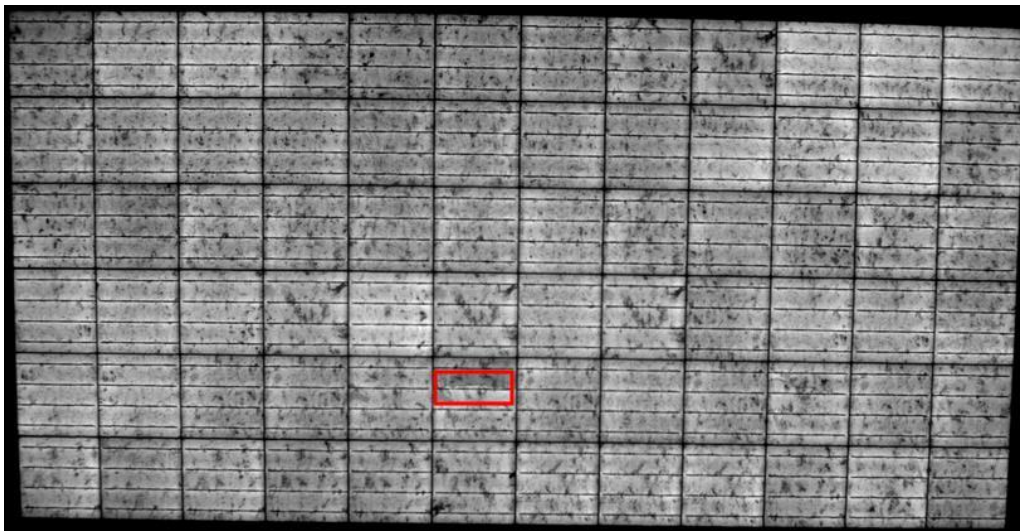


Fig. 10: EL-image of sample R1000003171238066 (final)

End of Test Report