

<b>Prüfbericht-Nr.:</b> <i>Test report no.:</i>	<b>DE25TSMD 001</b>	<b>Auftrags-Nr.:</b> <i>Order no.:</i>	300102912	Seite 1 von 23 Page 1 of 23
<b>Kunden-Referenz-Nr.:</b> <i>Client reference no.:</i>	2667149	<b>Auftragsdatum:</b> <i>Order date:</i>	2025-06-25	
<b>Auftraggeber:</b> <i>Client:</i>	WORLDICHEM KİMYASAL ÜRÜNLER VE TEM. MALZ GIDA TUR.SAN. TİC. LTD. ŞTİ., Fatih Mah. 1191. Sk. No:11, 35410 Sarıç / Gaziemir, İZMİR			
<b>Prüfgegenstand:</b> <i>Test item:</i>	Photovoltaic (PV) module			
<b>Bezeichnung / Typ-Nr.:</b> <i>Identification / Type no.:</i>	PV-Module: TT420-108TNFB10, Cleaning Agent: MZ 222			
<b>Auftrags-Inhalt:</b> <i>Order content:</i>	Research and development project for a cleaning agent for photovoltaic (PV) modules			
<b>Prüfgrundlage:</b> <i>Test specification:</i>	Photovoltaic (PV) modules IEC 61215-1:2021; IEC 61215-1-1:2021; IEC 61215-2:2021;			
<b>Wareneingangsdatum:</b> <i>Date of sample receipt:</i>	2025-06-20			
<b>Prüfmuster-Nr.:</b> <i>Test sample no.:</i>	see page 6			
<b>Prüfzeitraum:</b> <i>Testing period:</i>	2025-06-26 - 2025-10-14			
<b>Ort der Prüfung:</b> <i>Place of testing:</i>	Am Grauen Stein, 51105 Köln, Germany			
<b>Prüflaboratorium:</b> <i>Testing laboratory:</i>	TÜV Rheinland Solar GmbH			
<b>Prüfergebnis*:</b> <i>Test result*:</i>	Siehe Sonstiges / See Other			
<b>geprüft von:</b> <i>tested by:</i>	<input checked="" type="checkbox"/>  Datum: <i>Date:</i> 16.10.2025 Signiert von: Louis Hoffarth	<b>genehmigt von:</b> <i>authorized by:</i>	<input checked="" type="checkbox"/>  16.10.2025 Signiert von: Johannes Stang	
<b>Datum:</b> <i>Date:</i>		<b>Ausstellungsdatum:</b> <i>Issue date:</i>		
<b>Stellung / Position:</b>	Expert	<b>Stellung / Position:</b>	Authorizer	
<b>Sonstiges /</b> <i>Other:</i>	This is a research and development project for which no pass or fail criteria are applicable			
<b>Zustand des Prüfgegenstandes bei Anlieferung:</b> <i>Condition of the test item at delivery:</i>	Prüfmuster vollständig und unbeschädigt <i>Test item complete and undamaged</i>			
* Legende:	P(ass) = entspricht o.g. Prüfgrundlage(n)	F(ail) = entspricht nicht o.g. Prüfgrundlage(n)	N/A = nicht anwendbar	N/T = nicht getestet
* Legend:	P(ass) = passed a.m. test specification(s)	F(ail) = failed a.m. test specification(s)	N/A = not applicable	N/T = not tested
<p><b>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.</b></p> <p><i>This test report only relates to the above mentioned test sample. 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 test mark.</i></p>				

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**Anmerkungen**  
*Remarks*

1	<p>Alle eingesetzten Prüfmittel waren zum angegebenen Prüfzeitraum gemäß eines festgelegten Kalibrierungsprogramms unseres Prüfhauses kalibriert. Sie entsprechen den in den Prüfprogrammen hinterlegten Anforderungen. Die Rückverfolgbarkeit der eingesetzten Prüfmittel ist durch die Einhaltung der Regelungen unseres Managementsystems gegeben.</p> <p>Detaillierte Informationen bezüglich Prüfkonditionen, Prüfequipment und Messunsicherheiten sind im Prüflabor vorhanden und können auf Wunsch bereitgestellt werden.</p> <p><i>The equipment used during the specified testing period was calibrated according to our test laboratory calibration program. The equipment fulfils the requirements included in the relevant standards. The traceability of the test equipment used is ensured by compliance with the regulations of our management system.</i></p> <p><i>Detailed information regarding test conditions, equipment and measurement uncertainty is available in the test laboratory and could be provided on request.</i></p>
2	<p>Wie vertraglich vereinbart, wurde dieses Dokument nur digital unterzeichnet. Der TÜV Rheinland hat nicht überprüft, welche rechtlichen oder sonstigen diesbezüglichen Anforderungen für dieses Dokument gelten. Diese Überprüfung liegt in der Verantwortung des Benutzers dieses Dokuments. Auf Verlangen des Kunden kann der TÜV Rheinland die Gültigkeit der digitalen Signatur durch ein gesondertes Dokument bestätigen. Diese Anfrage ist an unseren Vertrieb zu richten. Eine Umweltgebühr für einen solchen zusätzlichen Service wird erhoben. Informationen zur Verifizierung der Authentizität unserer Dokumente erhalten Sie auf folgender Webseite: <a href="https://go.tuv.com/digital-signature">go.tuv.com/digital-signature</a></p> <p><i>As contractually agreed, this document has been signed digitally only. TUV Rheinland has not verified and unable to verify which legal or other pertaining requirements are applicable for this document. Such verification is within the responsibility of the user of this document. Upon request by its client, TUV Rheinland can confirm the validity of the digital signature by a separate document. Such request shall be addressed to our Sales department. An environmental fee for such additional service will be charged. For information on verifying the authenticity of our documents, please visit the following website: <a href="https://go.tuv.com/digital-signature">go.tuv.com/digital-signature</a></i></p>
3	<p>Prüfklausel mit der Note * wurden an qualifizierte Unterauftragnehmer vergeben und sind unter der jeweiligen Prüfklausel des Berichts beschrieben.</p> <p>Abweichungen von Prüfspezifikation(en) oder Kundenanforderungen sind in der jeweiligen Prüfklausel im Bericht aufgeführt.</p> <p><i>Test clauses with remark of * are subcontracted to qualified subcontractors and described under the respective test clause in the report.</i></p> <p><i>Deviations of testing specification(s) or customer requirements are listed in specific test clause in the report.</i></p>
4 a	<p>Die Entscheidungsregel für Konformitätserklärungen basierend auf numerischen Messergebnissen in diesem Prüfbericht basiert auf der "Null-Grenzwert-Regel" und der "Einfachen Akzeptanz" gemäß ILAC G8:2019 und IEC Guide 115:2023, es sei denn, in der auf Seite 1 dieses Berichts genannten angewandten Norm ist etwas anderes festgelegt oder vom Kunden gewünscht. Dies bedeutet, dass die Messunsicherheit nicht berücksichtigt wird und daher auch nicht im Prüfbericht angegeben wird. Zu weiteren Informationen bezüglich des Risikos durch diese Entscheidungsregel siehe ILAC G8:2019.</p> <p><i>The decision rule for statements of conformity, based on numerical measurement results, in this test report is based on the "Zero Guard Band Rule" and "Simple Acceptance" in accordance with ILAC G8:2019 and IEC Guide 115:2023, unless otherwise specified in the applied standard mentioned on Page 1 of this report or requested by the customer. This means that measurement uncertainty is not taken in account and hence also not declared in the test report. For additional information to the resulting risk based of this decision rule please refer to ILAC G8:2019.</i></p>
4 b	<p>Wenn auf dem Bericht kein Akkreditierungshinweis aufgebracht ist, wurde der Bericht nicht im akkreditierten Bereich erstellt und ist folglich auch nicht vom EA MLA abgedeckt. Unabhängig davon wurde der Bericht auf Basis der allgemeinen Regeln der ISO/IEC 17000er Reihe erstellt. Mit "#" gekennzeichnete Prüfungen sind nicht Bestandteil der Akkreditierung D-PL-22040-01-00.</p> <p><i>If there is no accreditation notice on the report, the report has not been produced in the accredited area and is consequently not covered by the EA MLA. Regardless of this, the report has been prepared based on the general rules of the ISO/IEC 17000 series. Tests marked with "#" are not covered by the accreditation D-PL-22040-01-00.</i></p>

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**Zusammenfassung der Prüfung**  
*Summary of testing*

- 5** All tests were carried out in accordance with the standards IEC 61215 and were successfully passed. However, it is important to note that this test program serves only research and development purposes and does not provide qualification according to this standard.
- The goal of this project was to demonstrate that the cleaning agent MZ 222, produced by Worldchem, has no influence on the performance of a PV module. Therefore, four modules of type TT420-108TNFB10 (provided by Worldchem) underwent the following test sequences. Two modules were cleaned by TÜV Rheinland using the cleaning agent MZ 222 in accordance with the manufacturer's instructions. Each test sequence included one cleaned (treated) module and one uncleaned (untreated) module.
- Test sequence:  
Test Sequences: The test program was defined at the customer's request as follows:  
Two Modules Test sequence 1: Initial measurements, Damp heat tests (1000 h), Final measurements  
Two Modules Test sequence 2: Initial measurements, Thermal cycling test (50 cycles), Humidity freeze test (10 cycles), Final measurement
- Initial measurements include stabilization with 5 kWh/m<sup>2</sup> per cycle, performance measurement at STC and electroluminescence recording.  
Final measurements include Performance measurement at STC and electroluminescence recording.
- No insulation or wet leakage current tests were performed.
- Result:  
The final Performance measurement shows no negative influence on the performance of the PV modules caused by cleaning agent MZ 222.

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**Produktbeschreibung**  
*Product description*

6	<b>Produktdetails</b> <i>Product details</i>	TT420-108TNFB10
7	<b>Verwendete Materialien</b> <i>Used materials</i>	PV: Module: TT420-108TNFB10 Cleaning Agent: MZ 222
8	<b>Sonstiges</b> <i>Other</i>	-
9	<b>Prüfmusterbereitstellung</b> <i>Test sample obtaining</i>	<input checked="" type="checkbox"/> Sending by customer <input type="checkbox"/> Sampling by TÜV Rheinland Group <input type="checkbox"/> Others: -
10	<b>Anschrift(en) der Produktionsstätte(n)</b> <i>Address(es) of the manufacturing site(s)</i>	PV: Module: N/A Cleaning Agent: WORLDCHEM KİMYASAL ÜRÜNLER VE TEM. MALZ GIDA TUR.SAN. TİC. LTD. ŞTİ. Fatih Mah. 1191. Sk. No:11 35410 Sarnıç / Gaziemir İZMİR (no Factory Inspection performed)

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**Prüfgrundlagen**  
 Test specification

<b>11</b>	<b>Test specification</b>		
	IEC 61215-1:2021 Terrestrial photovoltaic (PV) modules – Design qualification and type approval – Part 1: Test requirements	applicable	
	IEC 61215-1-1:2021 Terrestrial photovoltaic (PV) modules - Design qualification and type approval - Part 1-1: Special requirements for testing of crystalline silicon photovoltaic (PV) modules	applicable	—
	IEC 61215-2:2021 Terrestrial Photovoltaic (PV) Modules - Design Qualification and Type Approval - Part 2: Test procedures	applicable	

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**Prüfmusterliste**  
*List of test samples*

<b>12</b>	<input type="checkbox"/> The modules tested were taken at random from a production batch and subjected to manufacturer's normal quality control and inspection for safety testing			
	<input checked="" type="checkbox"/> The modules tested were prototypes of a new design and not taken from a production batch.			
	Sample no.	Sample SN	Test seq.	Remarks
	113416300960	HV2025001873	1	
	113416300986	HV2025001874	1	cleaned
	113416305456	HV2025001875	2	cleaned
113416300992	HV2025001876	2		

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Clause	Anforderungen - Prüfungen / Requirements - Tests	Measuring results - Remarks	Result
II	IEC 61215-1:2021 and IEC 61730-1:2023 – Requirements for design construction		
13	Classification, application and intended use (Clause 5 of IEC 61730-1:2023)		N/A
14	Requirements for design and construction (Clause 6 of IEC 61730-1:2023 and Clause 5 of IEC 61215-1:2021)		N/A
15	Pass criteria (Clause 7 of IEC 61215-1:2021)		
15.1	Output power and electric circuitry (Clause 7.2 of IEC 61215-1:2021)		
15.1.1	Verification of rated label values (Gate #1) (STC) (Clause 7.2.1 of IEC 61215-1:2021)		N/A
15.1.2	Maximum power degradation during type approval testing (Gate #2) (STC) (Clause 7.2.2 of IEC 61215-1:2021)		
	At the end of each test sequence, each test sample shall meet: $P_{\max}(\text{Lab\_Gate \#2}) \geq 0.95 \times P_{\max}(\text{Lab\_Gate \#1}) \cdot \left(1 - \frac{r}{100}\right)$	$r = 0.5$ See table "Gate #2 evaluation"	P
	$r =$ reproducibility		—
15.1.3	Electrical circuitry (Clause 7.2.3 of IEC 61215-1:2021)		
	Samples are not permitted to exhibit an open-circuit during the tests.	No open-circuit during tests	P
15.2	Visual defects (Clause 7.3 of IEC 61215-1:2021)		
	There is no visual evidence of a major defect.	No major visual defect	P
15.3	Electrical safety (Clause 7.4 of IEC 61215-1:2021)		
	The insulation test (MQT 03) requirements are met at the beginning and the end of each sequence.	See tables below	N/A
	The wet leakage current test (MQT 15) requirements are met at the beginning and the end of each sequence.	See tables below	N/A
	Specific requirements of the individual tests are met.	See tables below	P
Supplementary information: -			

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<b>III</b>	<b>IEC 61215-2:2021 and IEC 61730-2:2023 – Test procedures</b>
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<b>16</b>	<b>Overview of tests and test results</b>
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<b>Initial examination</b>	—	—
Visual inspection (MQT 01)	See table 16.1	P
Initial stabilization (MQT 19.1)	See table 16.2	P
Performance at STC (MQT 06.1)	See table 16.3	P
Electroluminescence recordings	See Appendix C	N/A

<b>Sequence 1</b>	—	—
Damp heat test (MQT 13)	See table 16.4	P

<b>Sequence 2</b>	—	—
Thermal cycling test (50 cycles) (MQT 11)	See table 16.5	P
Humidity-freeze test (MQT 12)	See table 16.6	P

<b>Final measurements</b>	—	—
Performance at STC (MQT 06.1)	See table 16.7	P
Electroluminescence recordings	See Appendix C	N/A

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Clause	Anforderungen - Prüfungen / Requirements - Tests	Measuring results - Remarks	Result

<b>16.1</b>	<b>Visual inspection (initial) – MQT 01</b>		
Test date (dd/mm/yyyy)	25/07/2025		—
Sample no.	Requirement	Nature and position of initial findings	—
HV2025001873	No major visual defects	No visual defects	P
HV2025001874		No visual defects	P
HV2025001875		No visual defects	P
HV2025001876		No visual defects	P
Supplementary information: -			

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Clause	Anforderungen - Prüfungen / Requirements - Tests	Measuring results - Remarks	Result

16.2	Initial stabilization – MQT 19.1
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Simulator  Natural sunlight  Other stabilization procedures

Test date (dd/mm/yyyy)		04/08/2025 – 21/08/2025			—
Irradiance [W/m <sup>2</sup> ]		800 - 1000			
Module temperature [°C]		50 ± 10			
Sample no.	Test	Integrated irradiation [kWh/m <sup>2</sup> ]	P <sub>max</sub> [W]	Stabilization [%] *	
HV2025001873	Initial	—	414.8	—	P
	Light-soaking 1	5	419.3		
	Light-soaking 2	5	414.9	0.3	
	Light-soaking 3	5	416.0		
	Light-soaking 4	5	415.8		
HV2025001874	Initial	—	413.0	—	P
	Light-soaking 1	5	417.3	0.8	
	Light-soaking 2	5	413.8		
	Light-soaking 3	5	414.2		
HV2025001875	Initial	—	414.6	—	P
	Light-soaking 1	5	421.5	0.1	
	Light-soaking 2	5	416.2		
	Light-soaking 3	5	416.8		
	Light-soaking 4	5	416.2		
HV2025001876	Initial	—	414.1	—	P
	Light-soaking 1	5	420.4	0.2	
	Light-soaking 2	5	414.9		
	Light-soaking 3	5	415.6		
	Light-soaking 4	5	415.3		

Supplementary information:

\* Stabilization criterion:  $(P_{\max} - P_{\min}) / P_{\text{avg}} \leq 1\%$  for three consecutive measurements.

Initial measurement corresponds to MQT 02 of IEC 61215-2:2021.

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<b>16.3</b>	<b>Performance at STC (initial) – MQT 06.1</b>						
Test date (dd/mm/yyyy)	21/08/2025 – 13/10/2025						—
Test method	<input checked="" type="checkbox"/> Simulator <input type="checkbox"/> Natural sunlight						
Ambient temperature [°C]	25 ± 2						
Irradiance [W/m²]	1000 ± 10						
Module temperature [°C]	25 ± 2						
Sample no.	P <sub>max</sub> [W]	V <sub>mpp</sub> [V]	I <sub>mpp</sub> [A]	V <sub>oc</sub> [V]	I <sub>sc</sub> [A]	FF [%]	
HV2025001873	415.8	32.88	12.65	38.71	13.29	80.8	P
HV2025001874	395.8	31.90	12.41	38.69	13.15	77.8	P
HV2025001875	415.0	32.89	12.62	38.74	13.28	80.7	P
HV2025001876	415.3	32.82	12.65	38.70	13.33	80.5	P
Supplementary information: -							

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<b>16.4</b>	<b>Damp heat test – MQT 13</b>		
Test date (dd/mm/yyyy)	29/08/2025 – 13/10/2025		—
Total duration [h]	1012		
Sample no.	—		
HV2025001873	—		P
HV2025001874	—		P
Supplementary information: A single 5N weight was attached to the electrical termination leads / junction box.			

<b>16.4.1</b>	<b>Visual inspection after Damp heat test – MQT 01</b>		
Test date (dd/mm/yyyy)	13/10/2025		—
Sample no.	Requirement	Nature and position of findings	
HV2025001873	No major visual defects	No visual defects	
HV2025001874		No visual defects	P
Supplementary information: -			

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<b>16.5</b>	<b>Thermal cycling test (50 cycles) – MQT 11</b>		
Test date (dd/mm/yyyy)	29/08/2025 – 08/09/2025		—
Total number of cycles	66		
Actual dwell duration at high and low temperatures	Minimum 10 min / Minimum 10 min		
Sample no.	Open circuits (yes/no)		
HV2025001875	No		P
HV2025001876	No		P
Supplementary information: A single 5N weight was attached to the electrical termination leads / junction box.			

<b>16.5.1</b>	<b>Visual inspection after Thermal cycling test (50 cycles) – MQT 01</b>		
Test date (dd/mm/yyyy)	08/09/2025		—
Sample no.	Requirement	Nature and position of findings	
HV2025001875	No major visual defects	No visual defects	
HV2025001876		No visual defects	P
Supplementary information: -			

<b>16.6</b>	<b>Humidity-freeze test – MQT 12</b>		
Test date (dd/mm/yyyy)	12/09/2025-06/10/2025		—
Total number of cycles	10		
Sample no.	Open circuits (yes/no)		
HV2025001875	No		P
HV2025001876	No		P
Supplementary information: -			

<b>16.6.1</b>	<b>Visual inspection after Humidity-freeze test – MQT 01</b>		
Test date (dd/mm/yyyy)	22/09/2025 – 06/10/2025		—
Sample no.	Requirement	Nature and position of findings	
HV2025001875	No major visual defects	No visual defects	
HV2025001876		No visual defects	P
Supplementary information: -			

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<b>16.7</b>	<b>Performance at STC (final) – MQT 06.1</b>						
Test date (dd/mm/yyyy)	01/10/2025 – 13/10/2025						
Test method	<input checked="" type="checkbox"/> Simulator <input type="checkbox"/> Natural sunlight						
Ambient temperature [°C]	25 ± 2						
Irradiance [W/m <sup>2</sup> ]	1000 ± 10						
Module temperature [°C]	25 ± 2						
Sample no.	P <sub>max</sub> [W]	V <sub>mpp</sub> [V]	I <sub>mpp</sub> [A]	V <sub>oc</sub> [V]	I <sub>sc</sub> [A]	FF [%]	Degradation [%]
HV2025001873	397.9	31.92	12.47	38.71	13.23	77.7	-4.31
HV2025001874	396.4	31.92	12.42	38.69	13.16	77.9	0.15
HV2025001875	409.4	32.58	12.57	38.77	13.29	79.5	-1.35
HV2025001876	408.9	32.54	12.57	38.70	13.32	79.4	-1.54
Supplementary information: Negative degradation means power loss.							

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**ZUSATZ-DOKUMENTATION**  
*ADDITIONAL DOCUMENTATION*

**Appendix A: Abbreviations used in the report**

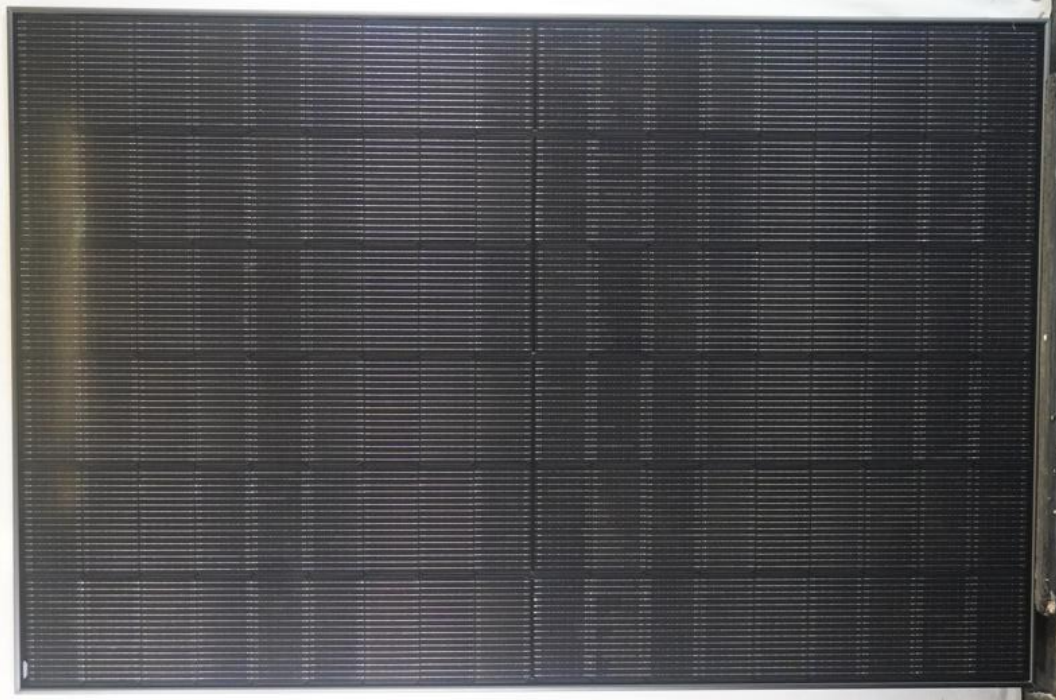
<b>STC</b>	Standard Test Conditions
<b>P<sub>max</sub></b>	Maximum power
<b>I<sub>mpp</sub></b>	Maximum power point current
<b>V<sub>mpp</sub></b>	Maximum power point voltage
<b>I<sub>sc</sub></b>	Short circuit current
<b>V<sub>oc</sub></b>	Open circuit voltage
<b>FF</b>	Fill factor
<b>α</b>	Current temperature coefficient
<b>β</b>	Voltage temperature coefficient
<b>γ</b>	Power temperature coefficient
<b>S</b>	Series connection
<b>SP</b>	Series-parallel connection
<b>PS</b>	Parallel-series connection
<b>R<sub>iso</sub></b>	Electrical insulation resistance
<b>A</b>	Module area

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**FOTO-DOKUMENTATION**  
*PHOTO DOCUMENTATION*

**Appendix B: Photos**



*Fig. 1: front view of test sample*



*Fig. 2: rear view of test sample*

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FOTO-DOKUMENTATION  
PHOTO DOCUMENTATION

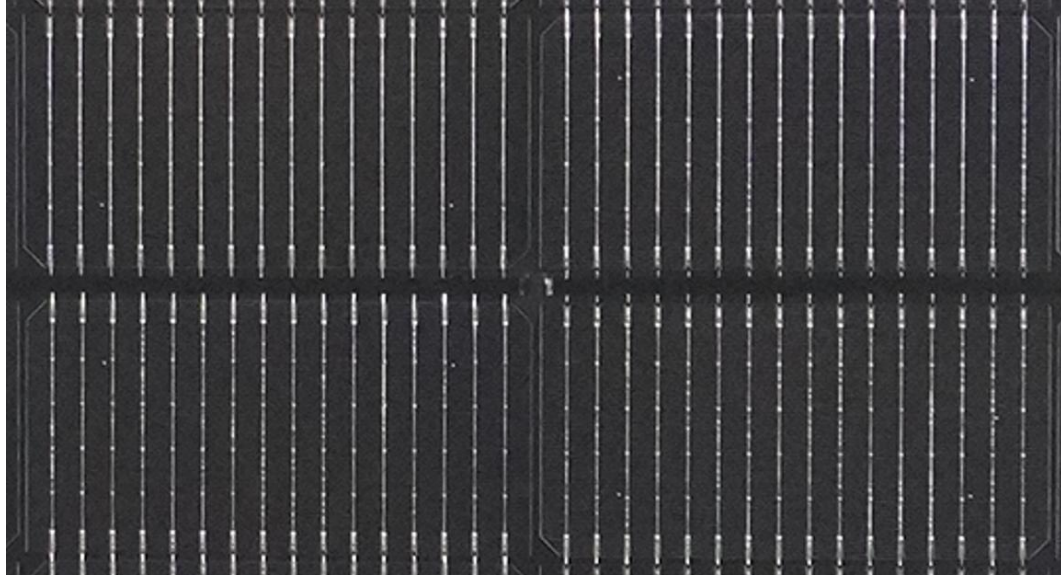


Fig. 3: detail view of solar cell

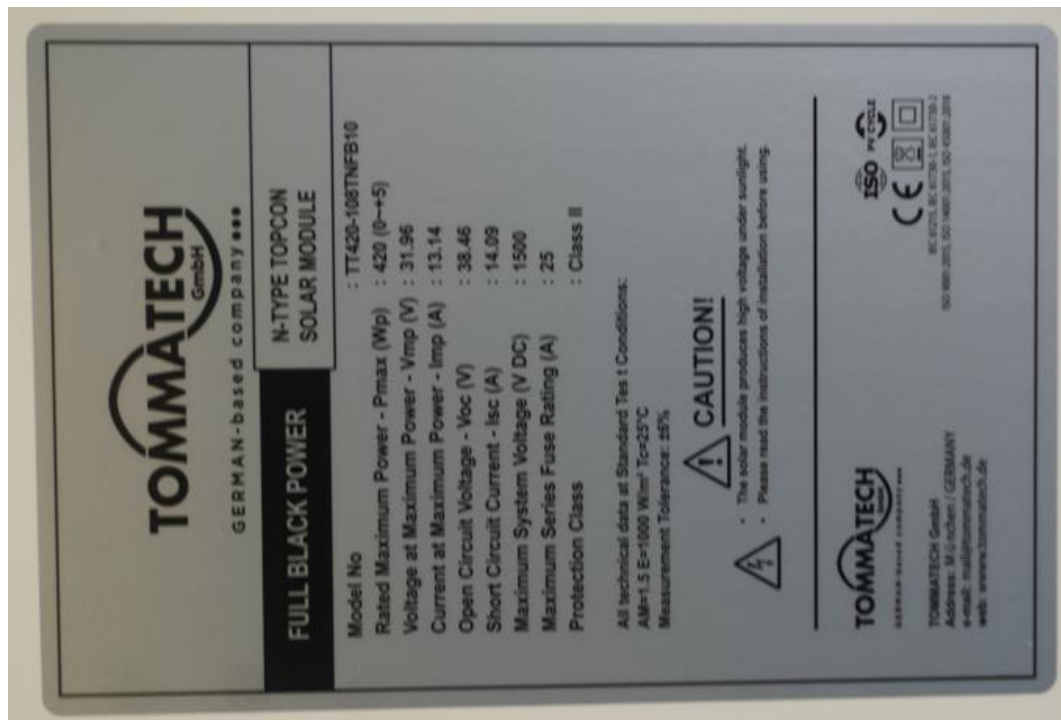


Fig. 4: detail view of type label

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**FOTO-DOKUMENTATION**  
**PHOTO DOCUMENTATION**



*Fig. 5: detail view of closed junction box*



*Fig. 6: detail view of connector*

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*PHOTO DOCUMENTATION*



*Fig. 7: detail view of cable*



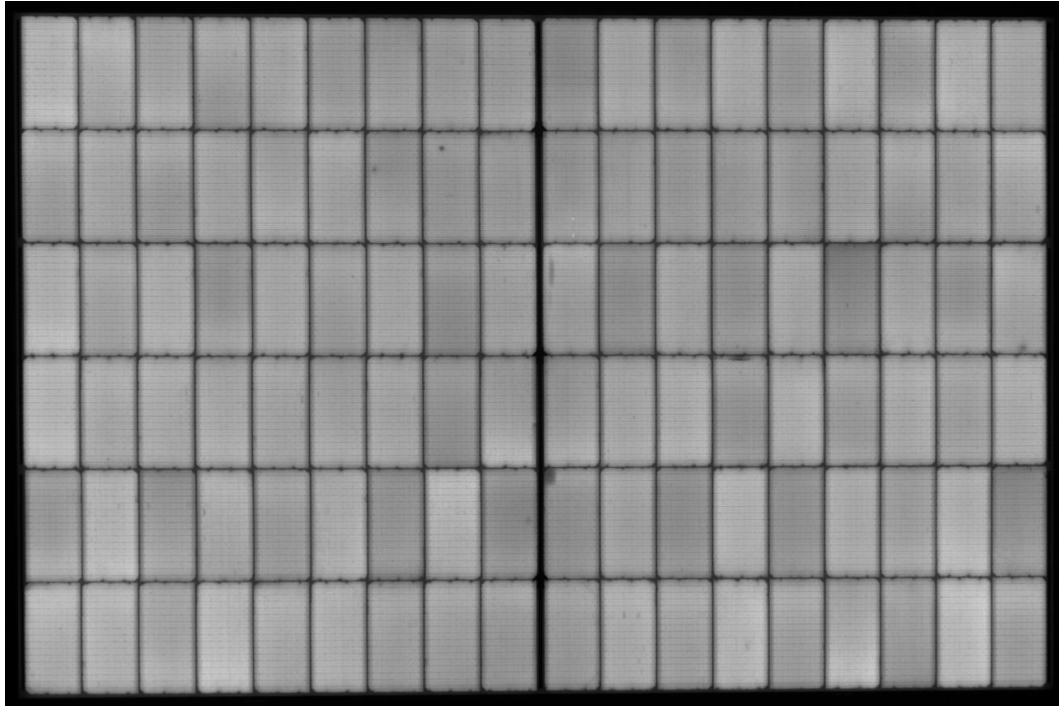
*Fig. 8: detail view of equipotential bonding hole and symbol*

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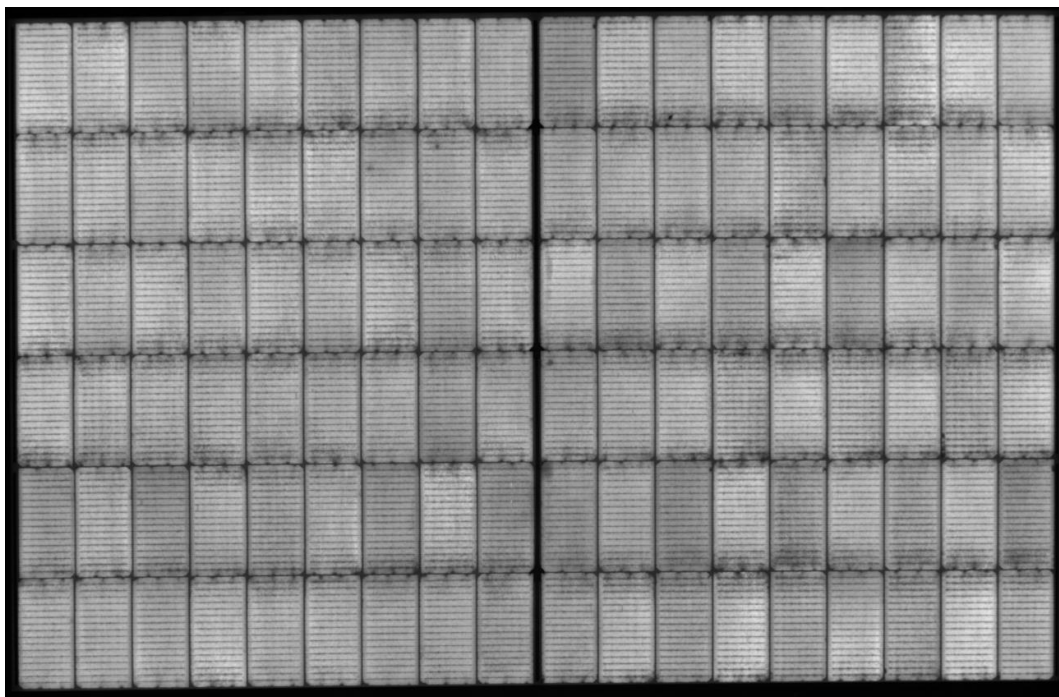
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**Elektrolumineszenz-Aufzeichnungen**  
*Electroluminescence recordings*

**Appendix C: Electroluminescence recordings**



*Fig. 9: HV2025001873 initial (not cleaned)*

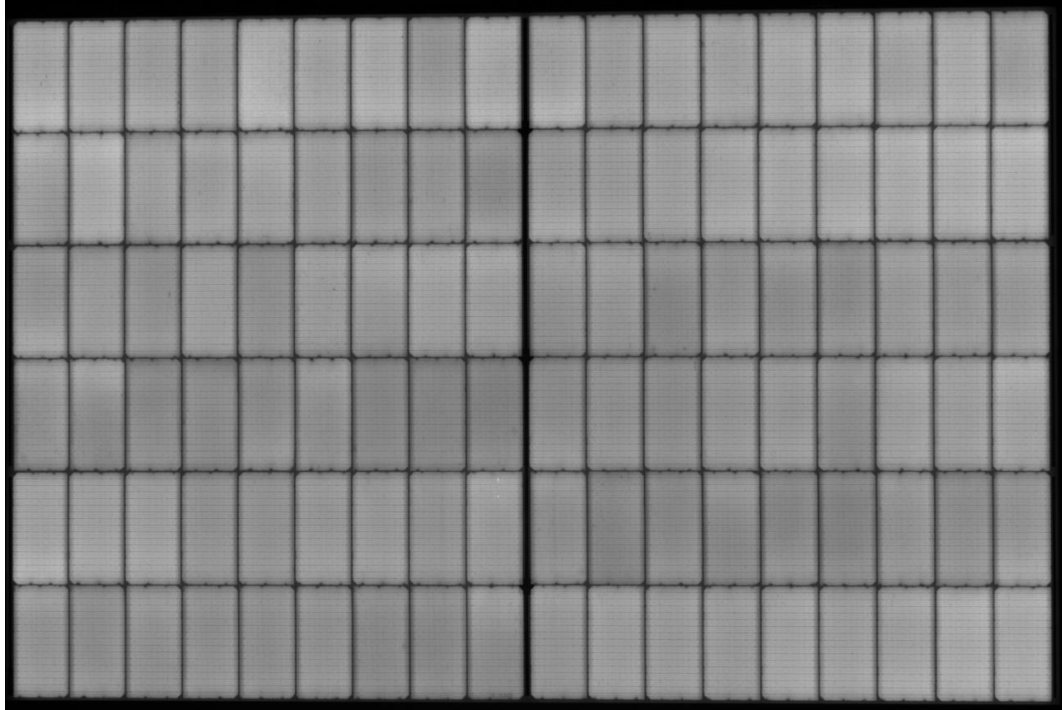


*Fig. 10: HV2025001873 final (not cleaned)*

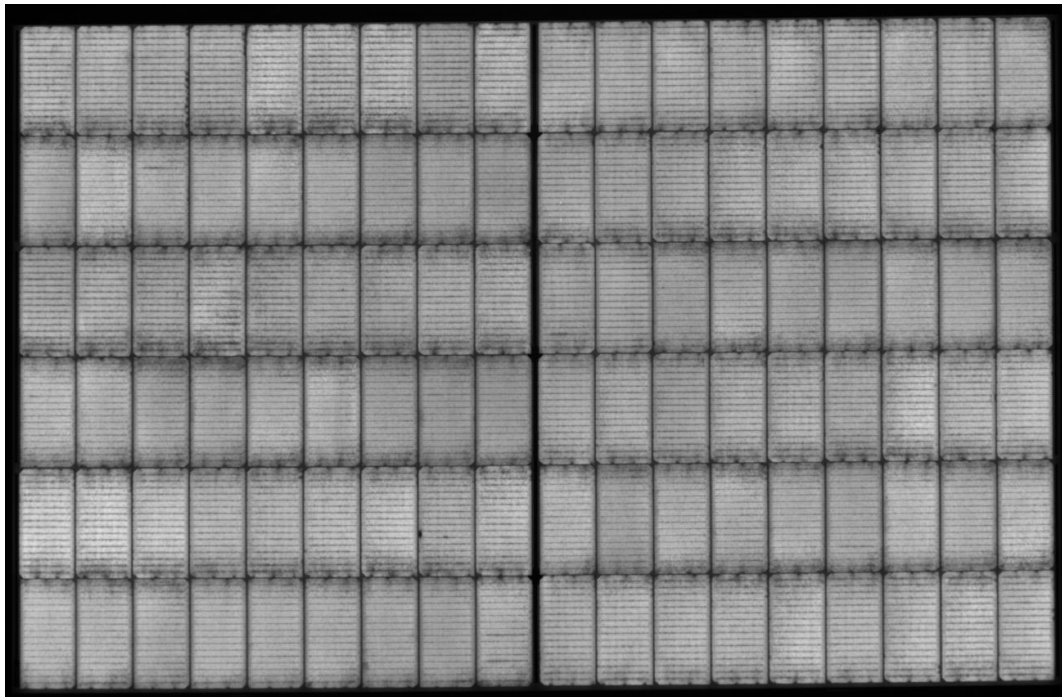
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**Elektrolumineszenz-Aufzeichnungen**  
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*Fig. 11: HV2025001874 initial (cleaned)*

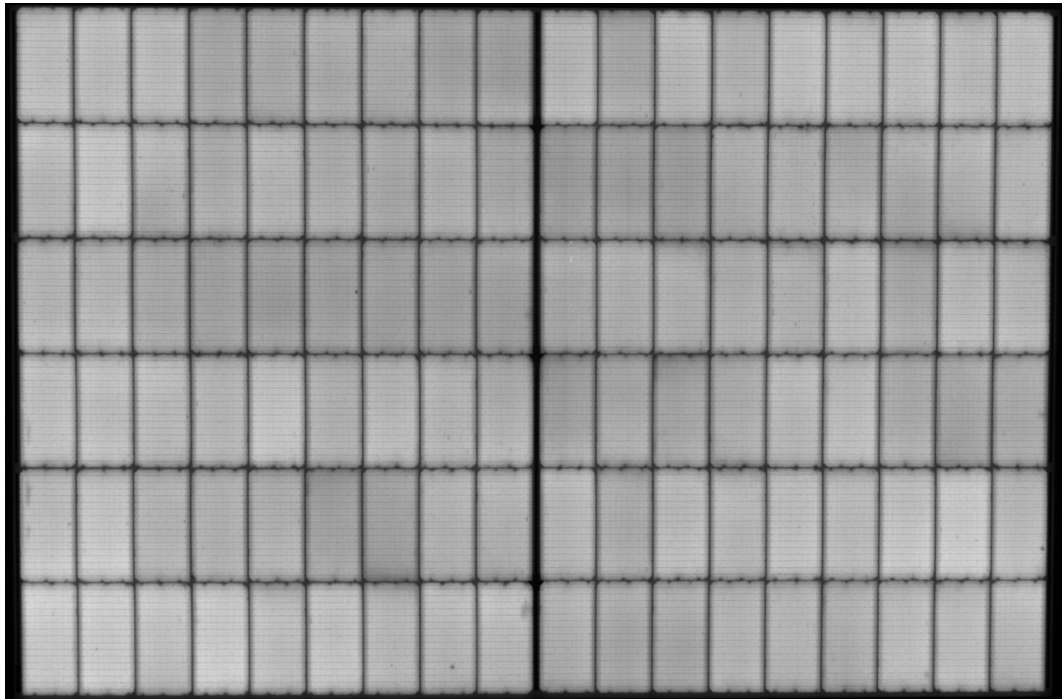


*Fig. 12: HV2025001874 final (cleaned)*

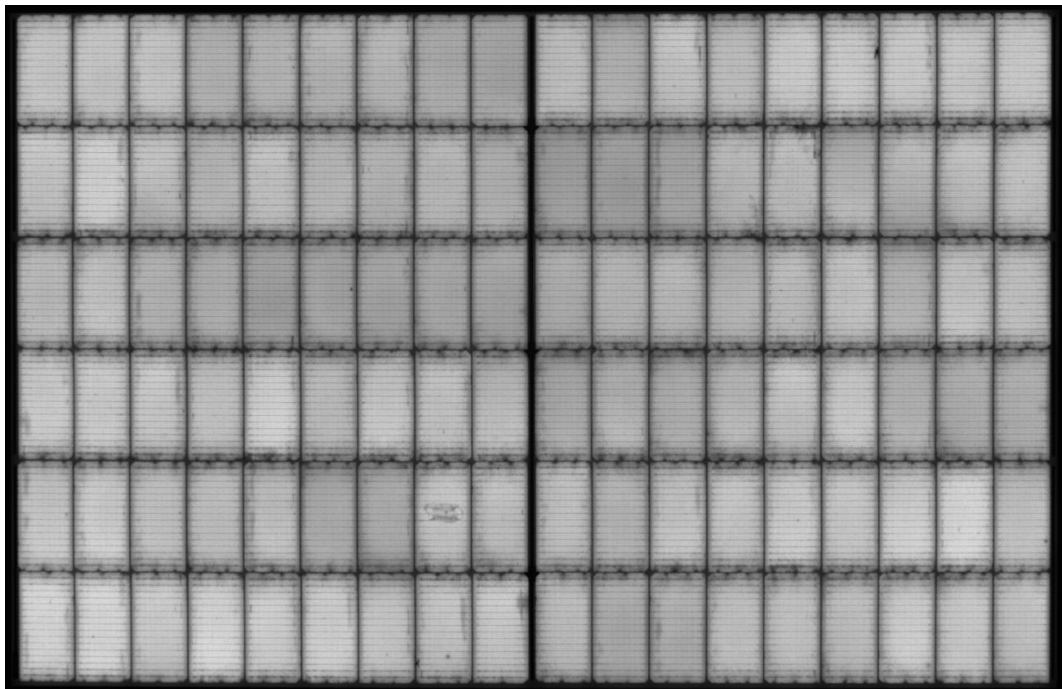
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**Elektrolumineszenz-Aufzeichnungen**  
*Electroluminescence recordings*



*Fig. 13: HV2025001875 initial (cleaned)*

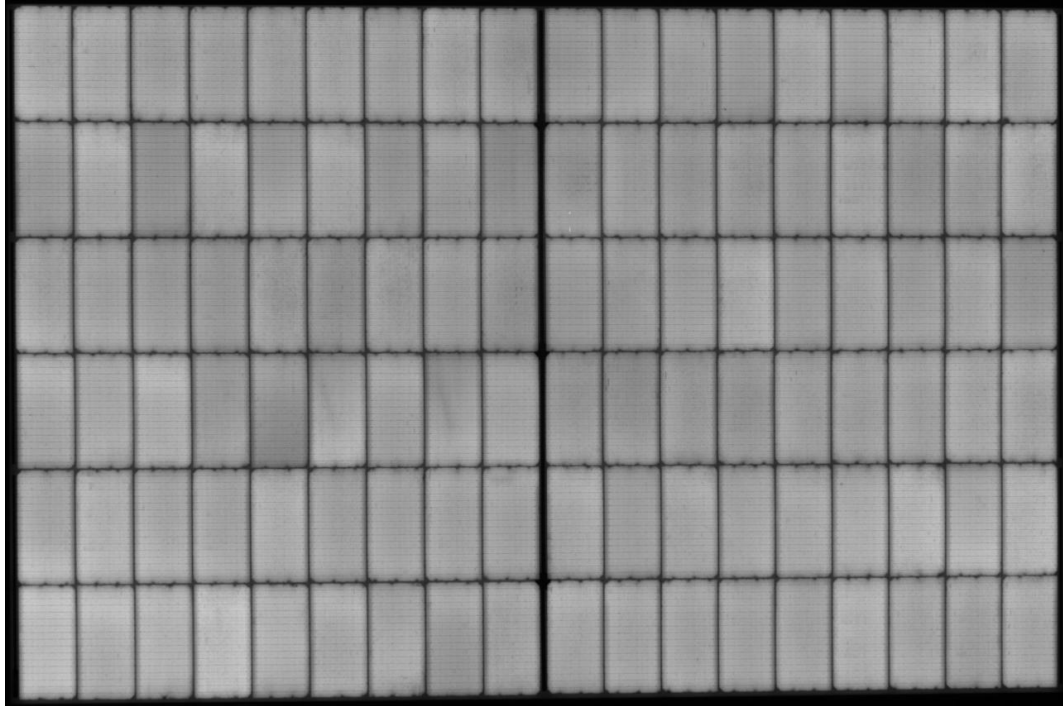


*Fig. 14: HV2025001875 final (cleaned)*

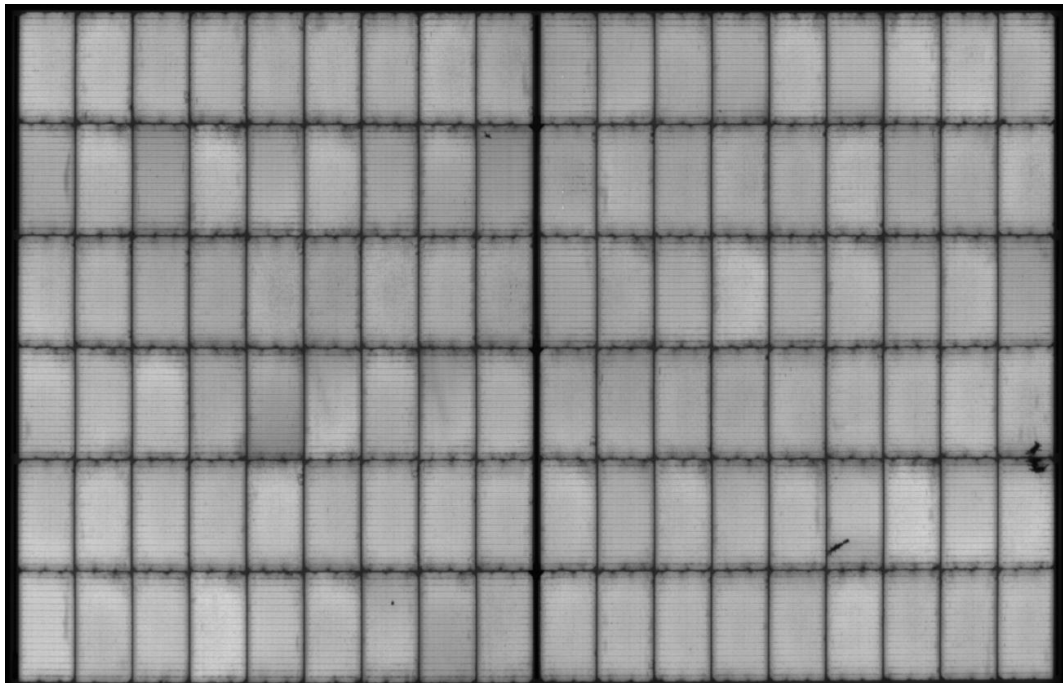
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**Elektrolumineszenz-Aufzeichnungen**  
*Electroluminescence recordings*



*Fig. 15: HV2025001876 initial (not cleaned)*



*Fig. 16: HV2025001876 final (not cleaned)*