Product Service

TEST REPORT

pr IEC 62716

TÜV SÜD Test report for ammonia corrosion testing of photovoltaic (PV) modules

Report reference No. ..... :	70.406.11.103.04 part 2 of 2
Date of issue ..... :	2012-04-09
Project handler ..... :	Dipl.-Ing. Alexander Krenz
Testing laboratory ..... :	Jiangsu TÜV Product Service Ltd., Shanghai Branch
Address ..... :	No. 88 Heng Tong Road, 200070 Shanghai, P.R. China
Testing location ..... :	See page 3
Client ..... :	ZN Shine PV-tech Co., Ltd.
Client number ..... :	73899
Address ..... :	No. 1 Zhixi Industry Zone 213251,Jintan Jiangsu, P.R. China
Contact person	Yang Jian
Standard ..... :	This TÜV SÜD test report form is based on the following requirements: pr IEC 62716
TRF originated by ..... :	TÜV SÜD Product Service GmbH, Dipl.-Ing. Alexander Krenz
Copyright blank test report ..... :	This test report is based on the content of the standard (see above). The test report considered selected clauses of the a.m. standard(s) and experience gained with product testing. It was prepared by TÜV SÜD Product Service GmbH. TÜV SÜD Group takes no responsibility for and will not assume liability for damages resulting from the reader's interpretation of the reproduced material due to its placement and context.
Test procedure ..... :	☐ GS, ☐ TÜV Mark, ☐ EU-Directive, ☒ without certification
Non-standard test method ..... :	N/A
National deviations ..... :	N/A
Number of pages (Report) ..... :	16
Number of pages (Attachments) ..... :	0
Compiled by ..... : Dipl.-Ing. Alexander Krenz	Approved by .... : Wang Jianhui
(+ signature)	(+ signature)

Product Service

Test sample……...:	ZX190(37)MS
Type of test object ..... :	Mono-crystalline Silicon Photovoltaic (PV) Module(s)
Trademark ..... :	ZNSHINESOLAR
Model and/or type reference ..... :	ZX190(37)MS
Rating(s) ..... :	See label
Manufacturer..... :	ZN Shine PV-tech Co., Ltd.
Manufacturer number…..... :	73899
Address ..... :	No. 1 Zhixi Industry Zone 213251,Jintan Jiangsu, P.R. China
Sub-contractors/ tests (clause)..... :	See under summary of testing. Page 3
Name..... :	See under summary of testing. Page 3
Order description… ..... :	☒ Complete test according to TRF
	☐ Partial test according to manufacturer's specifications
	☐ Preliminary test
	☐ Spot check
Date of order……..... :	2011-11-15
Date of receipt of test item ..... :	2011-12-28
Date(s) of performance of test..... :	2012-01-03 – 2012-03-07
Test item particulars: according to standard	
Attachments: N/A	

Product Service

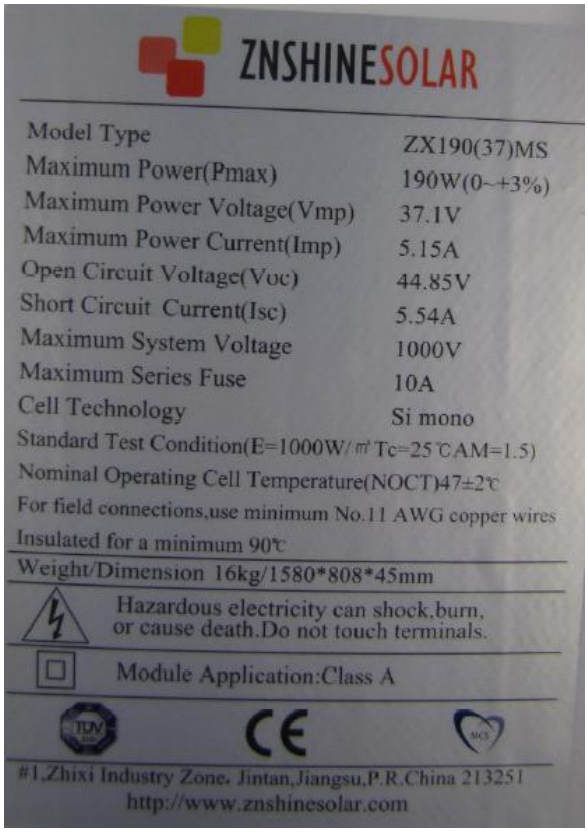
Summary of testing:

Tests performed (name of test and test clause):	**Testing location:**
Initial measurements:	
Preconditioning	PI Photovoltaik- Institut Berlin AG
MST 01: Visual inspection	Wrangelstraße 100
10.2: Maximum power determination	D-10997 Berlin, Germany
MST 16: Dielectric withstand test	(Performed initial and final measurements)
10.15: Wet leakage current test	
MST 13: Ground continuity test	TechnoLab
Ammonia resistance test	Am Borsigturm 46
in accordance with ISO 6988	D-13507 Berlin, Germany
Final measurements:	(Performed ammonia corrosion test)
MST 01: Visual inspection	
10.2: Maximum power determination	
MST 16: Dielectric withstand test	
10.15: Wet leakage current test	
MST 13: Ground continuity test	
Bypass diode functionality test	

Summary of compliance with National Differences:

N/A

Copy of marking plate:



Product Service

Test item particulars.....:	
Accessories and detachable parts included in the evaluation .....:	N/A
Option included .....:	N/A

Possible test case verdicts:

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

Abbreviations used in the report:

STC – Standard Test Conditions	Vmp – Maximum power voltage
Imp – Maximum power current	Voc – Open circuit voltage
Isc – Short circuit current	WL – Wet leakage current
Pmp – Maximum power	

General remarks:

The test results presented in this report relate only to the object tested.
This report shall not be reproduced, except in full, without the written approval of the Issuing testing laboratory.
"(see Enclosure #)" refers to additional information appended to the report.
"(see appended table)" refers to a table appended to the report.

Throughout this report a point is used as the decimal separator.
Summary of contents provided on the last page of this report.

General product information and considerations:

Product Electrical Ratings:

Type or model number	ZX190(37)MS
Voc (Vdc)	44.85
Vmp (Vdc)	37.1
Imp (Adc)	5.15
Isc (Adc)	5.54
Pmp (W)	190
Deviation of Pmp at STC or Minimum value of Pmp (for thin film module) (%)	0 ~ + 3
Maximum system voltage (V)	1000Vdc
Maximum over-current protection rating (A)	10
Application Class	A

Information for testing sample:

Sample #	Type	Series number
1	ZX190(37)MS	1226255128290785
2	ZX190(37)MS	1226255128290779
3	ZX190(37)MS	1226255128290780_reference

Description of module construction:
(Manufactories and part numbers, unless otherwise specified)

Sample ..... :	Random sampling from production ☒ Prototype submitted by client ☐
Module	
Front Cover..... :	Tempered glass; t= 3.2mm; Xinyi PV Products (Anhui) Holdings Ltd.
Rear Cover ..... :	PET; type: VPEW; t= 50/100/120; Dai Nippon Printing Co., Ltd.
Encapsulation material..... :	EVA; type: SV-15296; Shenzhen Sveck Technology Co., Ltd.
Frame..... :	Anodized aluminum alloy, 6063-T5; Changzhou Yihe Aluminum Industry Co., Ltd.
Dimensions (l x w x h) [mm] ..... :	1580 x 808 x 45
Module area [m²]..... :	1.277
Adhesives (junction box) ..... :	Type: SMG533; Guangzhou Baiyun Chemical Industry Co., Ltd.
Minimum distance between current-carrying parts and module edge [mm]	18mm
Cell	
Cell (include type) ..... :	Mono-Si
Cells (l x w) [mm] ..... :	125 x 125
Cell thickness [µm]..... :	200 ± 30
Cell area [cm²] ..... :	154.8
Number of cells..... :	72
Components	
Cells per bypass diode..... :	24
Type of bypass diode..... :	10SQ050; Yangzhou Yangjie Electronic Technology Co., Ltd.
No. of bypass diodes ..... :	3
Cell- and string connectors..... :	Cell: 1.8 x 0.2mm; string 5 x 0.25mm; JiangSu Youngs Photovoltaic Technology Co., Ltd.
Junction box ..... :	Ningbo Free Trade Zhonghuan Electronic Technology Co., Ltd.; PV- ZH008

Cable ..... :	Ningbo Zhonghuan Sunter PV Technology Co. Ltd.; PV1-F; 4mm^2
Connectors ..... :	Ningbo Free Trade Zhonghuan Electronic Technology Co., Ltd; PV- ZH202
Adhesives (frame)..... :	Type: SMG533; Guangzhou Baiyun Chemical Industry Co., Ltd.
Potting material (junction box) ..... :	N/A
Receiver	
Type ..... :	N/A
Dimension (l x w x h) [mm] ..... :	N/A
Front Cover..... :	N/A
Rear Cover ..... :	N/A
Encapsulation material..... :	N/A
Mirror	
Type ..... :	N/A
Dimension (l x w) [mm]..... :	N/A
Other	
Others..... :	N/A

Product Service

pr IEC 62716			
Clause	**Requirement + Test**	**Result--Remark**	**Verdict**
3	**Samples**		
	– Three identical samples of the model of PV module or assembly of interest must be subjected to any of the testing sequences included in Figures 1, 2, or 3, depending on the PV technology considered, namely crystalline silicon, thin-film or concentrator photovoltaic (CPV) respectively.	Three samples evaluated	P
	– Full-size sample or representative sample	Full size samples	P
	– PV module provided with means for grounding then they constitute a part of the test sample.	With grounding	P
4	**Test procedures**		
4.1	– All tests included in Figures 1, 2 or 3, except the bypass diode functionality test, are fully described in the IEC standards.	Performed accordingly	P
4.2	Bypass Diode Functionality Test	Performed accordingly	P
5	**Preconditioning**		
	– All test samples must be preconditioned with either global or direct normal sunlight according to the specifications given in the applicable Design Qualification and Type Approval IEC standard applicable.	Performed accordingly	P
6	**Initial Measurements**		
6.1	Crystalline silicon		
	– Tests according to IEC 61215		
	a) 10.2: Maximum power determination	See table 6-b)	P
	b) 10.15: Wet leakage current test	See table 6-d)	P
	– Tests according to IEC 61730-2		
	c) MST 01: Visual inspection	See table 6-a)	P
	d) MST 13: Ground continuity test	See table 6-e)	P
	e) MST 16: Dielectric withstand test	See table 6-c)	P
6.2	Thin-film technologies		
	– Tests according to IEC 61646		
	a) 10.2: Maximum power determination	See table 6-b)	N/A
	b) 10.15: Wet leakage current test	See table 6-d)	N/A
	– Tests according to IEC 61730-2		
	c) MST 01: Visual inspection	See table 6-a)	N/A

TÜV®

Product Service

pr IEC 62716			
Clause	**Requirement + Test**	**Result--Remark**	**Verdict**
	d) MST 13: Ground continuity test	See table 6-e)	N/A
	e) MST 16: Dielectric withstand test	See table 6-c)	N/A
7	**Ammonia resistance test**		
7.1	Testing facility and material		—
	As described in section 3 of ISO 6988	See table 7	P
7.2	Test condition and execution	See table 7	P
	─ specimen position: the inclination to the vertical of the face of the module normally exposed to solar irradiance shall be 15° to 30° inside the climatic chambers.	Inclination of 30°C respected. See photo documentation	P
8	**Cleaning and recovery**		
	─ After the ammonia test all samples must be washed to remove the adherent salt using running tap water for a maximum time of 5 minutes per square meter of area of the sample.	Performed accordingly	P
	─ The temperature of the water used for washing shall not exceed 35 °C.	Performed accordingly	P
	─ During cleaning or drying the use of cloths, gauzes or any other woven material shall be avoided and no scraping is allowed	Performed accordingly	P
9	**Final Measurements**		
	After the ammonia test the test samples shall be subjected to the following tests depending on the PV module technology.		—
9.1	Crystalline silicon		—
	─ Tests according to IEC 61215		—
	a) 10.2: Maximum power determination	See table 9-b)	P
	b) 10.15: Wet leakage current test	See table 9-d)	P
	─ Tests according to IEC 61730-2		—
	c) MST 01: Visual inspection	See table 9-a)	P
	d) MST 13: Ground continuity test	See table 9-e)	P
	e) MST 16: Dielectric withstand test	See table 9-c)	P
	─ Tests according to this standard:		
	f) Bypass diode functionality test	See table 9-g)	P
9.2	Thin-film technologies		N/A

Product Service

pr IEC 62716			
Clause	**Requirement + Test**	**Result--Remark**	**Verdict**
	– Tests according to IEC 61646		
	a) 10.2: Maximum power determination at STC after light soaking	See table 9-b)	N/A
	b) 10.15: Wet leakage current test	See table 9-d)	N/A
	c) 10.19: light soaking	See table 9-f)	N/A
	– Tests according to IEC 61730-2		
	d) MST 01: Visual inspection	See table 9-a)	N/A
	e) MST 13: Ground continuity test	See table 9-e)	N/A
	f) MST 16: Dielectric withstand test	See table 9-c)	N/A
	– Tests according to this standard:		
	g) Bypass diode functionality test	See table 9-g)	N/A
10	**Requirements**		
10.1	Crystalline silicon		
	– After the ammonia test, no evidence of major visual defects as described in IEC 61730-2.	See table 9-a)	P
	– After the ammonia test the maximum power shall not decrease by more than 5% of the initial value.	See table 9-b)	P
	– All pass fail criteria corresponding to tests 10.15, MST 13 and MST 16 must be fulfilled.	MST16 see table 9-c) 10.15 see table 9-d) MST13 see table 9-e)	P
	– The requirement for the bypass diode functionality test must be also fulfilled.	See table 9-g)	P
10.2	Thin-film technologies		
	– After the ammonia test, no evidence of major visual defects as described in IEC 61730-2.	See table 9-a)	N/A
	– After the light soaking the maximum power at STC shall not be less than 90% of the minimum value specified by the manufacturer in the marking of the PV module.	See table 9-b)	N/A
	– All pass fail criteria corresponding to tests 10.15, 10.19, MST 13 and MST 16 must be fulfilled.	MST16 see table 9-c) 10.15 see table 9-d) MST13 see table 9-e) 10.19 see table 9-f)	N/A
	– The requirement for the bypass diode functionality test must be also fulfilled.	See table 9-g)	N/A

6-a)	TABLE: Visual inspection (Initial)	P
Test Date [MM/DD/YYYY]……..…:	01-12-2012	—

Sample No.	Nature and position of initial findings – comments or attach photos	Verdict
1	No major visual defects	P
2	No major visual defects	P
3	No major visual defects	P

Supplementary information:

6-b)	TABLE: I-V characteristic (Initial)	P
Test Date [MM/DD/YYYY]……..…:	01-12-2012	—
Radiant Source……..…:	☒ Solar simulator ☐ Natural Sunlight	
Module temperature [°C] ……..…:	Corrected to 25	—
Irradiance [W/m^2] ……..…:	Corrected to 1000	—

Sample No.	Voc [V]	Vmp [V]	Isc [A]	Imp [A]	Pmp [W]	Pr [%]
1	44.78	36.55	5.533	5.208	190.4	N/A
2	44.63	36.34	5.543	5.200	189	N/A
3	44.78	36.48	5.471	5.536	190	N/A

Supplementary information:
T_{coeff} V_{oc}: -0.334 %/K
T_{coeff} I_{sc}: 0.038 %/K

6-c)	Table: Insulation test (initial)	P
Test Date [YYYY-MM-DD]…… :	2012-01-13	—
Test Voltage applied [V] …… :	6000/1000	—

Sample #	Measured	Required	Dielectric breakdown		Result
	MΩ	MΩ	Yes (description)	No	
1	>1000	31.25		X	P
2	>1000	31.25		X	P
3	>1000	31.25		X	P

Supplementary information: Size of module 1.28 m²

6-d)	TABLE: Wet leakage current test (Initial)	P
Test Date [MM/DD/YYYY]……..…:	2012-01-17	—
Test voltage applied [V] ……..…:	1000	—
Module maximum system voltage rating (V, DC)…… :	1000	—
Solution resistivity [Ω cm], < 3,500 Ω cm at 22 ± 3 ℃…… :	Within limits	—

Sample No.	Measured [MΩ]	Limit [MΩ]	Result
1	3780	31.25	P
2	533	31.25	P

3	472	31.25	P
Supplementary information: Size of module 1.28 m²			

6-e)	**MST 13 – ground continuity test (Initial)**			P
	Maximum over-current protection rating (A) .....:	10		—
	Current applied (A) ..... :	25		
	Location of designated grounding point.....:	On the middle of the longest frame side		—
	Location of second contacting point.....:	Adjacent frame side		—
Sample No.	Position in test sequence:	Voltage (V)	Resistance (Ω)	
1	Measurement 1	0.1639	0.0066	P
	Measurement 2	0.1598	0.0064	P
2	Measurement 1	0.1031	0.0041	P
	Measurement 2	0.0824	0.0033	P
3	Measurement 1	0.1405	0.0056	P
	Measurement 2	0.0837	0.0034	P
Supplementary information:				

7	**TABLE: Ammonia resistance test procedure**			P
Cycles	1 test section	Hours	8 including heating up	—
		NH3 - Concentration	6.667 ppm	—
		Temperature	40°C ± 3°C	—
		Rel. Humidity	100%, saturation	—
	2 test section	Hours	16 including cooling	—
		NH3 - Concentration	0 ppm	—
		Temperature	18 to 28 °C	—
		Rel. Humidity	75% max.	—
Duration……..……..:			20 cycles (480 hours)	—
Supplementary information:				

9-a)	**TABLE: Visual inspection (final)**		P
Test Date [MM/DD/YYYY]……..…..:	02-16-2012		—
Sample No.	Nature and position of initial findings – comments or attach photos		Verdict
1	Corrosion of frame and data label		P
2	Corrosion of frame and data label		P
Supplementary information:			

9-b)	**TABLE: Maximum power determination (final)**	P
Test Date [MM/DD/YYYY] start-end .....:	02-16-2012	—

Product Service

Module temperature [°C] low-high .....:			Corrected to 25					—
Irradiance [W/m2] low-high.....:			Corrected to 1000					—
Sample #	Voc [V]	Vmp [V]	Isc [A]	Imp [A]	Pr [%]	Pmp [W]	Degradation [%]	Limit [%]
1	44.79	36.58	5.545	5.203	N/A	190.3	0.0016	- 5%
2	44.76	36.58	5.542	5.183	N/A	189.6	-0.0021	- 5%
Supplementary information: Crystalline silicon module: Pmp degradation after this test ≤ 5% Thin film module: minimum value of Pmp at STC after this test ≥ 90% of minimum value of marking CPV module: The relative power degradation under natural sunlight after this test ≤ 7% or under solar simulator after this test ≤ 5%								

9-c)	**Table: Insulation test (final)**				P
Test Date [YYYY-MM-DD]..... :			2012-02-17		—
Test Voltage applied [V] ..... :			6000/1000		—
Sample #	Measured	Required	Dielectric breakdown		Result
	MΩ	MΩ	Yes (description)	No	
1	>10,000	31.25		x	P
2	>10,000	31.25		x	P
Supplementary information: Size of module 1.28 m²					

9-d)	**TABLE: Wet leakage current test (final)**			P
Test Date [MM/DD/YYYY]……..:		02-29-2012		—
Test voltage applied [V] ……..:		1000		—
Module maximum system voltage rating (V, DC)..... :		1000		—
Solution resistivity [Ω cm], < 3,500 Ω cm at 22 ± 3 ℃..... :		Within limits		—
Sample No.	Measured [MΩ]		Limit [MΩ]	Verdict
1	1939		31.25	P
2	275		31.25	P
Supplementary information:				

9-e)	**MST 13 – ground continuity test (final)**			P
	Maximum over-current protection rating (A) .....:		10	—
	Current applied (A) ..... :		25	
	Location of designated grounding point.....:		On the middle of the longest frame side	—
	Location of second contacting point.....:		Adjacent frame side	—
Sample No.	Position in test sequence:		Voltage (V)	Resistance (Ω)
1	Measurement 1		0.0754	0.003	P
	Measurement 2		0.0881	0.0035	P
2	Measurement 1		0.1081	0.0043	P

TÜV®

	Measurement 2	0.0918	0.0037	P
Supplementary information:				

9-f)	TABLE: Light soaking								N/A
Abbreviation: Regarding light source “S” for Solar simulator and “N” for Natural sunlight									
Sample #		Test Date (MM/DD/YYYY) start/end							
Test cycle	Light source	Irradiance applied (kWh/m2)	Average irradiance (W/m2)	Module temperature during test (°C)			Pmp(W) at the end of cycle	Change in Pmp in the cycle (%)	
				min	max	avg			
Initial	—	—	—	—	—	—		—	
1									
2									
Supplementary information:									
Sample #		Test Date (MM/DD/YYYY) start/end							
Test cycle	Light source	Irradiance applied (kWh/m2)	Average irradiance (W/m2)	Module temperature during test (°C)			Pmp(W) at the end of cycle	Change in Pmp in the cycle (%)	
				min	max	avg			
Initial	—	—	—	—	—	—		—	
1									
2									
Supplementary information:									

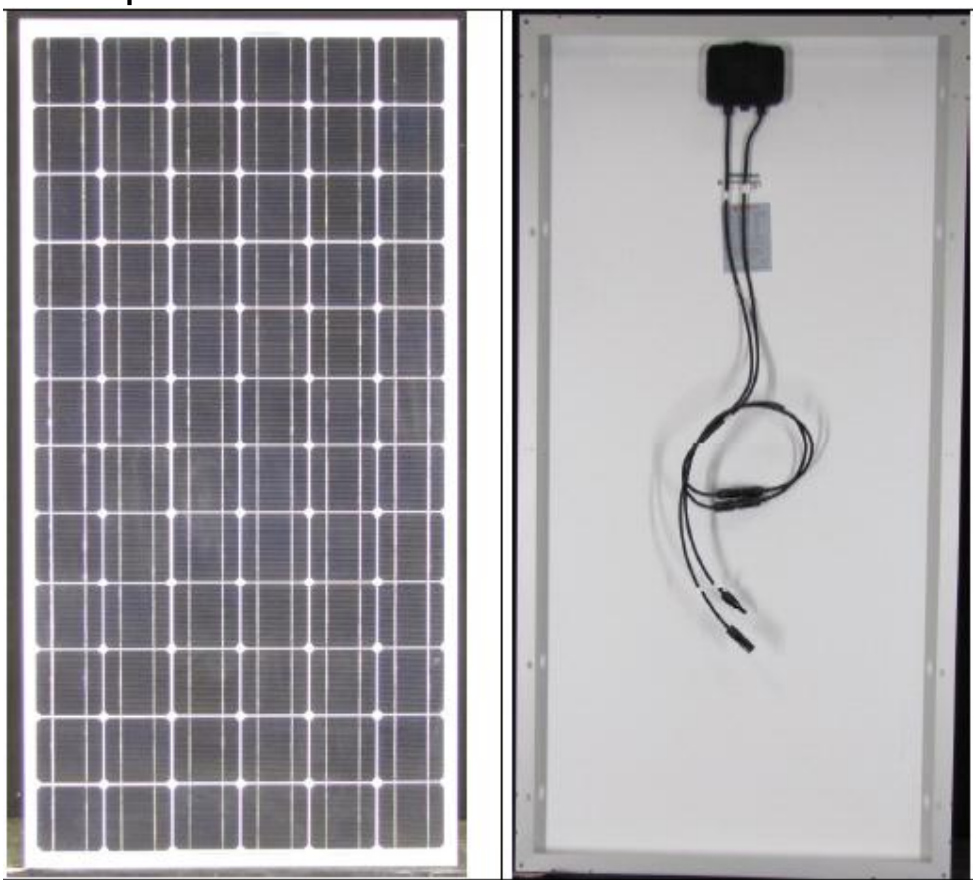
9-g)	TABLE: Bypass diode functionality test							P
Sample No.	1							—
Test Date [MM/DD/YYYY].....:	03-06-2012							—
Module temperature [°C]..... :	26.5							—
Number of diodes in junction box..... :	3							—
Diode manufacturer..... :	Yangzhou Yangjie Electronic Technology Co., Ltd.							—
Diode type designation ..... :	10SQ050							—
Rated STC short-circuit current [A]..... :	5.54							—
Current flow (1.25 * Isc) [A] ..... :	6.93							P
Test duration (hour)	1							P
	D1	D2	D3	D4	D5	D6	Result	
Diode functional? yes/no..... :	yes	yes	yes	N/A	N/A	N/A	P	
Sample No.	2							—
Test Date [MM/DD/YYYY].....:	03-07-2012							—
Module temperature [°C]..... :	26.5							—
Number of diodes in junction box..... :	3							—
Diode manufacturer..... :	Yangzhou Yangjie Electronic Technology							—

Product Service

	Co., Ltd.						
Diode type designation ..... :	10SQ050						—
Rated STC short-circuit current [A]..... :	5.54						—
Current flow (1.25 * Isc) [A] ..... :	6.93						P
Test duration (hour)	1						P
	D1	D2	D3	D4	D5	D6	Result
Diode functional? yes/no ..... :	yes	yes	yes	N/A	N/A	N/A	P
Supplementary information:							

TÜV®

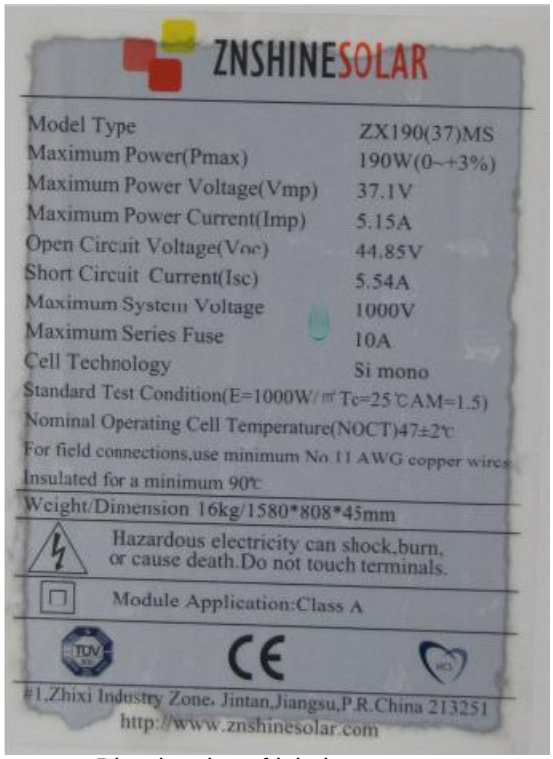
Photos of samples



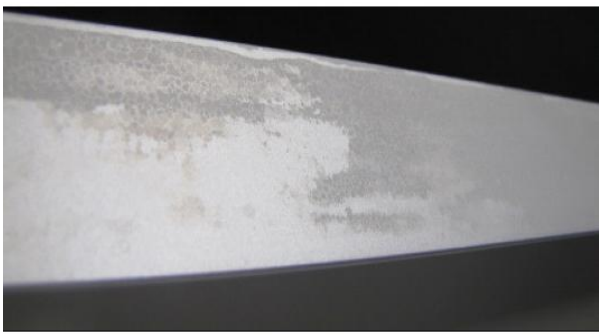
Front of sample 1 Back of sample 1

Junction box of sample 1

Sample 1 and sample 2 in ammonia test chamber



Discoloration of label



Corrosion of frame

END OF REPORT