

Solar Cells Reporting Summary

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► Experimental design

Please check: are the following details reported in the manuscript?

1. Dimensions

Area of the tested solar cells	☒ Yes	15.6 cm x 15.6 cm
	☐ No	
Method used to determine the device area	☒ Yes	The area is provided by certificate test center
	☐ No	

2. Current-voltage characterization

Current density-voltage (J-V) plots in both forward and backward direction	☐ Yes	Forward direction is enough for our silicon cells
	☒ No	
Voltage scan conditions <i>For instance: scan direction, speed, dwell times</i>	☒ Yes	Forward direction from -0.1 V to 0.78 V; 100 points; integral time 5 ms; delay time 5 ms
	☐ No	
Test environment <i>For instance: characterization temperature, in air or in glove box</i>	☒ Yes	Room temperature in air
	☐ No	
Protocol for preconditioning of the device before its characterization	☐ Yes	Explain why this information is not reported/not relevant.
	☒ No	
Stability of the J-V characteristic <i>Verified with time evolution of the maximum power point or with the photocurrent at maximum power point; see ref. 7 for details.</i>	☒ Yes	Fig. 4, Supplementary Fig. 11, Supplementary Fig. 12, Supplementary Fig. 13
	☐ No	

3. Hysteresis or any other unusual behaviour

Description of the unusual behaviour observed during the characterization	☐ Yes	Silicon cells do not exhibit hysteresis under standard conditions
	☒ No	
Related experimental data	☐ Yes	Silicon cells do not exhibit hysteresis under standard conditions
	☒ No	

4. Efficiency

External quantum efficiency (EQE) or incident photons to current efficiency (IPCE)	☐ Yes	Explain why this information is not reported/not relevant.
	☒ No	
A comparison between the integrated response under the standard reference spectrum and the response measure under the simulator	☐ Yes	Certificate reports do not contains this comparison
	☒ No	
For tandem solar cells, the bias illumination and bias voltage used for each subcell	☐ Yes	They are not tandem solar cells
	☒ No	

5. Calibration

Light source and reference cell or sensor used for the characterization	☒ Yes	A NREL cell in 'Methods'
	☐ No	
Confirmation that the reference cell was calibrated and certified	☒ Yes	A certified NREL reference cell
	☐ No	

Calculation of spectral mismatch between the reference cell and the devices under test	☐ Yes ☒ No	Certificate report does not contains this mismatch comparison
6. Mask/aperture		
Size of the mask/aperture used during testing	☒ Yes ☐ No	The cell tested in ISFH is measured using a designated-area mode. An aperture mask (ISFH identifier FN018) shadowing the cell's edges. The test areas are larger than 226 cm ² .
Variation of the measured short-circuit current density with the mask/aperture area	☐ Yes ☒ No	We did not request a full-area test in the certificate center
7. Performance certification		
Identity of the independent certification laboratory that confirmed the photovoltaic performance	☒ Yes ☐ No	Extended Data Figs. 6 and 7. Full reports are found as source data along with the publication
A copy of any certificate(s) <i>Provide in Supplementary Information</i>	☒ Yes ☐ No	Full reports are found as source data along with the publication
8. Statistics		
Number of solar cells tested	☒ Yes ☐ No	78 cells and many other cells encapsulated in large-scale modules
Statistical analysis of the device performance	☒ Yes ☐ No	Fig. 3c
9. Long-term stability analysis		
Type of analysis, bias conditions and environmental conditions <i>For instance: illumination type, temperature, atmosphere humidity, encapsulation method, preconditioning temperature</i>	☒ Yes ☐ No	Fig. 4: bending cycles, thermal cycles, violent storm impact; Supplementary Fig. 14: Operation in the Antarctic Pole