

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 ☐ No	Please see the method part.
Method used to determine the device area	☒ Yes ☐ No	Please see the method part.

2. Current-voltage characterization

Current density-voltage (J-V) plots in both forward and backward direction	☒ Yes ☐ No	Please see the manuscript Fig.4.
Voltage scan conditions <i>For instance: scan direction, speed, dwell times</i>	☒ Yes ☐ No	Please see the method part.
Test environment <i>For instance: characterization temperature, in air or in glove box</i>	☒ Yes ☐ No	Please see the method part.
Protocol for preconditioning of the device before its characterization	☒ Yes ☐ No	Please see the method part.
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 ☐ No	Please see the manuscript Fig.4.

3. Hysteresis or any other unusual behaviour

Description of the unusual behaviour observed during the characterization	☒ Yes ☐ No	Please see the manuscript Fig.4.
Related experimental data	☒ Yes ☐ No	Please see the manuscript Fig.4.

4. Efficiency

External quantum efficiency (EQE) or incident photons to current efficiency (IPCE)	☒ Yes ☐ No	Please see the Supporting Information Fig.S8.
A comparison between the integrated response under the standard reference spectrum and the response measure under the simulator	☒ Yes ☐ No	Less than 5%.
For tandem solar cells, the bias illumination and bias voltage used for each subcell	☐ Yes ☒ No	N/A

5. Calibration

Light source and reference cell or sensor used for the characterization	☒ Yes ☐ No	Please see the method part.
Confirmation that the reference cell was calibrated and certified	☒ Yes ☐ No	Please see the method part.

Calculation of spectral mismatch between the reference cell and the devices under test	☒ Yes ☐ No	Please see the method part.
6. Mask/aperture		
Size of the mask/aperture used during testing	☒ Yes ☐ No	Please see the method part.
Variation of the measured short-circuit current density with the mask/aperture area	☐ Yes ☒ No	N/A
7. Performance certification		
Identity of the independent certification laboratory that confirmed the photovoltaic performance	☒ Yes ☐ No	We have the certification by the Shanghai Institute of Microsystem and Information Technology (SIMIT), Chinese Academy of Sciences, and National Photovoltaic Industry Metrology and Testing Center (NPVM)
A copy of any certificate(s) <i>Provide in Supplementary Information</i>	☒ Yes ☐ No	Please see the Supplementary Fig. 20-23.
8. Statistics		
Number of solar cells tested	☒ Yes ☐ No	Please see the manuscript part.
Statistical analysis of the device performance	☒ Yes ☐ No	Please see the manuscript part.
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	Please see both the manuscript and supporting information part.