

Solar Cells Reporting Summary

Nature Research wishes to improve the reproducibility of the work that we publish. This form is intended for publication with all accepted papers reporting the characterization of photovoltaic devices and provides structure for consistency and transparency in reporting. Some list items might not apply to an individual manuscript, but all fields must be completed for clarity.

For further information on Nature Research policies, including our [data availability policy](#), see [Authors & Referees](#).

► Experimental design

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

1. Dimensions

Area of the tested solar cells	☒ Yes	Methods
	☐ No	
Method used to determine the device area	☒ Yes	Methods
	☐ No	

2. Current-voltage characterization

Current density-voltage (J-V) plots in both forward and backward direction	☒ Yes	Figure 3 ,Figure 5
	☐ No	
Voltage scan conditions <i>For instance: scan direction, speed, dwell times</i>	☒ Yes	Figure 3 ,Figure 5
	☐ No	
Test environment <i>For instance: characterization temperature, in air or in glove box</i>	☒ Yes	Methods
	☐ No	
Protocol for preconditioning of the device before its characterization	☒ Yes	Methods
	☐ 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	Figure 3
	☐ No	

3. Hysteresis or any other unusual behaviour

Description of the unusual behaviour observed during the characterization	☒ Yes	Figure 5
	☐ No	
Related experimental data	☒ Yes	Supplementary Figure 12,Supplementary Figure 15,Supplementary Figure 16,Supplementary Figure 18,Supplementary Figure 19
	☐ No	

4. Efficiency

External quantum efficiency (EQE) or incident photons to current efficiency (IPCE)	☒ Yes	Supplementary Figure 7
	☐ No	
A comparison between the integrated response under the standard reference spectrum and the response measure under the simulator	☒ Yes	Supplementary Figure 7
	☐ No	
For tandem solar cells, the bias illumination and bias voltage used for each subcell	☐ Yes	Explain why this information is not reported/not relevant.
	☒ No	

5. Calibration

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

Calculation of spectral mismatch between the reference cell and the devices under test	☒ Yes ☐ No	State where this information can be found in the text.
6. Mask/aperture		
Size of the mask/aperture used during testing	☒ Yes ☐ No	Methods
Variation of the measured short-circuit current density with the mask/aperture area	☒ Yes ☐ No	Methods
7. Performance certification		
Identity of the independent certification laboratory that confirmed the photovoltaic performance	☐ Yes ☒ No	No certification
A copy of any certificate(s) <i>Provide in Supplementary Information</i>	☐ Yes ☒ No	No certification
8. Statistics		
Number of solar cells tested	☒ Yes ☐ No	Figure 6
Statistical analysis of the device performance	☒ Yes ☐ No	Figure 6
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	Stability test of the devices