

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.

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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 Methods section
- Method used to determine the device area Yes No Methods section

2. Current-voltage characterization

- Current density-voltage (J-V) plots in both forward and backward direction Yes No Figure 3d
- Voltage scan conditions Yes No Methods section
For instance: scan direction, speed, dwell times
- Test environment Yes No Main text and Methods section
For instance: characterization temperature, in air or in glove box
- Protocol for preconditioning of the device before its characterization Yes No No preconditioning was involved before test
- Stability of the J-V characteristic Yes No Figure 3e, Figure 4a, 4c-4e
Verified with time evolution of the maximum power point or with the photocurrent at maximum power point; see ref. 7 for details.

3. Hysteresis or any other unusual behaviour

- Description of the unusual behaviour observed during the characterization Yes No No unusual behavior was observed
- Related experimental data Yes No No unusual behavior was observed

4. Efficiency

- External quantum efficiency (EQE) or incident photons to current efficiency (IPCE) Yes No Supplementary Figure 21
- A comparison between the integrated response under the standard reference spectrum and the response measure under the simulator Yes No Characterization section
- For tandem solar cells, the bias illumination and bias voltage used for each subcell Yes No No tandem solar cells were reported in our manuscript

5. Calibration

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

Calculation of spectral mismatch between the reference cell and the devices under test	<input type="checkbox"/> Yes <input checked="" type="checkbox"/> No	The light spectrum used for measurements matches well with the reference cell and AM1.5.
6. Mask/aperture		
Size of the mask/aperture used during testing	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No	Methods section
Variation of the measured short-circuit current density with the mask/aperture area	<input type="checkbox"/> Yes <input checked="" type="checkbox"/> No	We measured all devices with identical mask
7. Performance certification		
Identity of the independent certification laboratory that confirmed the photovoltaic performance	<input type="checkbox"/> Yes <input checked="" type="checkbox"/> No	No new record efficiency is claimed. The focus of our manuscript is on the long-term stability of the devices.
A copy of any certificate(s) <i>Provide in Supplementary Information</i>	<input type="checkbox"/> Yes <input checked="" type="checkbox"/> No	No new record efficiency is claimed. The focus of our manuscript is on the long-term stability of the devices.
8. Statistics		
Number of solar cells tested	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No	Supplementary Figure 19, Figure 4a, 4c and 4d, Supplementary Table 7, Supplementary 25a, Supplementary Figure 29
Statistical analysis of the device performance	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No	Main text, Supplementary Figure 19, Figure 4a, 4c and 4d
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>	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No	Main text, Methods section