

Solar Cells Reporting Summary

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ü Experimental design

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

1. Dimensions

Area of the tested solar cells	☒ Yes	0.16 cm ² . See "Device fabrication" in Methods section.
	☐ No	
Method used to determine the device area	☒ Yes	Defined by a non-reflective mask.
	☐ No	

2. Current-voltage characterization

Current density-voltage (J-V) plots in both forward and backward direction	☒ Yes	See Figure 4b.
	☐ No	
Voltage scan conditions <i>For instance: scan direction, speed, dwell times</i>	☒ Yes	In "Solar cell performance testing" section.
	☐ No	
Test environment <i>For instance: characterization temperature, in air or in glove box</i>	☒ Yes	In "Solar cell performance testing" section.
	☐ No	
Protocol for preconditioning of the device before its characterization	☐ Yes	No preconditioning, see "Solar cell performance testing" section.
	☒ 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	See Figure 4c.
	☐ No	

3. Hysteresis or any other unusual behaviour

Description of the unusual behaviour observed during the characterization	☒ Yes	Negligible hysteresis. See Figure 4b.
	☐ No	
Related experimental data	☒ Yes	See Figure 4b.
	☐ No	

4. Efficiency

External quantum efficiency (EQE) or incident photons to current efficiency (IPCE)	☒ Yes	See Figure 4d.
	☐ No	
A comparison between the integrated response under the standard reference spectrum and the response measure under the simulator	☒ Yes	The integrated J _{sc} values are consistent with those from J-V measurements. see Figure 4c and 4d.
	☐ No	
For tandem solar cells, the bias illumination and bias voltage used for each subcell	☐ Yes	Not relevant to this work.
	☒ No	

5. Calibration

Light source and reference cell or sensor used for the characterization	☒ Yes	In "Solar cell performance testing" section.
	☐ No	
Confirmation that the reference cell was calibrated and certified	☒ Yes	Si-reference cell was certificated by NREL. See "Solar cell performance testing" section.
	☐ No	

Calculation of spectral mismatch between the reference cell and the devices under test	☐ Yes ☒ No	The Si-reference cell with KG3 window has a similar spectral corresponding range with that of PSC in our work, so we used mismatched factor of 1 for all devices.
6. Mask/aperture		
Size of the mask/aperture used during testing	☒ Yes ☐ No	0.096 cm ² . See "Solar cell performance testing" section.
Variation of the measured short-circuit current density with the mask/aperture area	☐ Yes ☒ No	The short-circuit current density doesn't vary with the mask/aperture area.
7. Performance certification		
Identity of the independent certification laboratory that confirmed the photovoltaic performance	☐ Yes ☒ No	This work mainly focuses on the mechanical reliability of PSCs.
A copy of any certificate(s) <i>Provide in Supplementary Information</i>	☐ Yes ☒ No	This work mainly focuses on the mechanical reliability of PSCs.
8. Statistics		
Number of solar cells tested	☒ Yes ☐ No	About 15 devices for each type of solar cell.
Statistical analysis of the device performance	☒ Yes ☐ No	See supplementary Figure 2.
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	See "Solar cell stability testing" section.