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 Initial submission Revised version Final submission

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

State where this information can be found in the text.

 No

Explain why this information is not reported/not relevant.

Method used to determine the device area

 Yes

State where this information can be found in the text.

 No

Explain why this information is not reported/not relevant.

2. Current-voltage characterization

Current density-voltage (J-V) plots in both forward and backward direction

 Yes

State where this information can be found in the text.

 No

Explain why this information is not reported/not relevant.

Voltage scan conditions

For instance: scan direction, speed, dwell times

 Yes

State where this information can be found in the text.

 No

Explain why this information is not reported/not relevant.

Test environment

For instance: characterization temperature, in air or in glove box

 Yes

State where this information can be found in the text.

 No

Explain why this information is not reported/not relevant.

Protocol for preconditioning of the device before its characterization

 Yes

State where this information can be found in the text.

 No

Explain why this information is not reported/not relevant.

Stability of the J-V characteristic

Verified with time evolution of the maximum power point or with the photocurrent at maximum power point; see [ref. 7](#) for details.

 Yes

State where this information can be found in the text.

 No

Explain why this information is not reported/not relevant.

3. Hysteresis or any other unusual behaviour

Description of the unusual behaviour observed during the characterization

 Yes

State where this information can be found in the text.

 No

Explain why this information is not reported/not relevant.

Related experimental data

 Yes

State where this information can be found in the text.

 No

Explain why this information is not reported/not relevant.

4. Efficiency

External quantum efficiency (EQE) or incident photons to current efficiency (IPCE)

 Yes

State where this information can be found in the text.

 No

Explain why this information is not reported/not relevant.

A comparison between the integrated response under the standard reference spectrum and the response measure under the simulator

 Yes

State where this information can be found in the text.

 No

Explain why this information is not reported/not relevant.

For tandem solar cells, the bias illumination and bias voltage used for each subcell

 Yes

State where this information can be found in the text.

 No

Explain why this information is not reported/not relevant.

5. Calibration

Light source and reference cell or sensor used for the characterization

 Yes

State where this information can be found in the text.

 No

Explain why this information is not reported/not relevant.

Confirmation that the reference cell was calibrated and certified	<input type="checkbox"/> Yes	State where this information can be found in the text.
	<input type="checkbox"/> No	Explain why this information is not reported/not relevant.
Calculation of spectral mismatch between the reference cell and the devices under test	<input type="checkbox"/> Yes	State where this information can be found in the text.
	<input type="checkbox"/> No	Explain why this information is not reported/not relevant.
6. Mask/aperture		
Size of the mask/aperture used during testing	<input type="checkbox"/> Yes	State where this information can be found in the text.
	<input type="checkbox"/> No	Explain why this information is not reported/not relevant.
Variation of the measured short-circuit current density with the mask/aperture area	<input type="checkbox"/> Yes	State where this information can be found in the text.
	<input type="checkbox"/> No	Explain why this information is not reported/not relevant.
7. Performance certification		
Identity of the independent certification laboratory that confirmed the photovoltaic performance	<input type="checkbox"/> Yes	State where this information can be found in the text.
	<input type="checkbox"/> No	Explain why this information is not reported/not relevant.
A copy of any certificate(s) <i>Provide in Supplementary Information</i>	<input type="checkbox"/> Yes	State where this information can be found in the text.
	<input type="checkbox"/> No	Explain why this information is not reported/not relevant.
8. Statistics		
Number of solar cells tested	<input type="checkbox"/> Yes	State where this information can be found in the text.
	<input type="checkbox"/> No	Explain why this information is not reported/not relevant.
Statistical analysis of the device performance	<input type="checkbox"/> Yes	State where this information can be found in the text.
	<input type="checkbox"/> No	Explain why this information is not reported/not relevant.
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 type="checkbox"/> Yes	State where this information can be found in the text.
	<input type="checkbox"/> No	Explain why this information is not reported/not relevant.

► Further reading

- Shrotriya, V. *et al.* [Accurate measurement and characterization of organic solar cells](#). *Adv. Funct. Mater.* **16**, 2016–2023 (2006).
- Dennler, G. *et al.* [The value of values](#). *Mat. Today* **10**, 56 (2007).
- Cravino, A., Schilinsky, P. & Brabec, C. J. [Characterization of organic solar cells: the importance of device layout](#). *Adv. Funct. Mater.* **17**, 3906–3910 (2007).
- Reese, M. O. *et al.* [Consensus stability testing protocols for organic photovoltaic materials and devices](#). *Sol. Energ. Mat. Sol. C* **95**, 1253–1267 (2011).
- Snaith H. J. [The perils of solar cell efficiency measurements](#). *Nat. Photon.* **6**, 337–340 (2012).
- Luber, E. J. & Buriak, J. M. [Reporting performance in organic photovoltaic devices](#). *ACS Nano* **7**, 4708–4714 (2013).
- Snaith, H. J. *et al.* [Anomalous hysteresis in perovskite solar cells](#). *J. Phys. Chem. Lett.* **5**, 1511–1515 (2014).
- Grätzel M. [The light and shade of perovskite solar cells](#). *Nat. Mat.* **13**, 838–842 (2014).
- Zimmermann E. *et al.* [Erroneous efficiency reports harm organic solar cell research](#). *Nat. Photon.* **8**, 669–672 (2014).
- Beard M.C., Luther J.M. & Nozik A.J. [The promise and challenge of nanostructured solar cells](#). *Nat. Nanotech.* **9**, 951–954 (2014).
- Timmreck, R. *et al.* [Characterization of tandem organic solar cells](#). *Nat. Photon.* **9**, 478–479 (2015).

A number of international committees develop industry standards on the characterization of photovoltaic technologies (for example [ASTM-E44](#) and [IEC-TC 82](#)), which can provide guidance for academic research.

