

## Solar Cells Reporting Summary

Nature Portfolio 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 the following details are reported in the manuscript, and provide a brief description or explanation where applicable.**

#### 1. Dimensions

Area of the tested solar cells	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No	0.04 cm <sup>2</sup>
		<i>Explain why this information is not reported/not relevant.</i>
Method used to determine the device area	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No	Device area is determined using optical microscope
		<i>Explain why this information is not reported/not relevant.</i>

#### 2. Current-voltage characterization

Current density-voltage (J-V) plots in both forward and backward direction	<input type="checkbox"/> Yes <input checked="" type="checkbox"/> No	OPV devices do not show notable hysteresis, so only forward scans were measured
Voltage scan conditions	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No	From -0.2 V to 1.2 V with a 20 mV step and a dwell time of 10 ms
		<i>Explain why this information is not reported/not relevant.</i>
Test environment	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No	All devices are tested in a nitrogen-filled glove box at low (~0.02 ppm) humidity at room temperature
		<i>Explain why this information is not reported/not relevant.</i>
Protocol for preconditioning of the device before its characterization	<input type="checkbox"/> Yes <input checked="" type="checkbox"/> No	<i>Provide a description of the protocol.</i>
		It has negligible effect on our J-V curves measured
Stability of the J-V characteristic	<input type="checkbox"/> Yes <input checked="" type="checkbox"/> No	<i>Provide a description of the method used. The stability of the J-V characteristic can be verified with time evolution of the maximum power point or with the photocurrent at maximum power point; see ref. 5 for details.</i>
		Stability is not the main focus of this manuscript.

#### 3. Hysteresis or any other unusual behaviour

Description of the unusual behaviour observed during the characterization	<input type="checkbox"/> Yes <input checked="" type="checkbox"/> No	<i>Provide a description of hysteresis or any other unusual behaviour observed during the characterization.</i>
		Not applicable for the scope of this manuscript
Related experimental data	<input type="checkbox"/> Yes <input checked="" type="checkbox"/> No	<i>Provide a description of the related experimental data.</i>
		Not applicable

#### 4. Efficiency

External quantum efficiency (EQE) or incident photons to current efficiency (IPCE)	<input type="checkbox"/> Yes <input checked="" type="checkbox"/> No	<i>Provide a description of the technique used.</i>
		This manuscript focused on morphology characterization of reported systems instead of exploring new systems or reporting record efficiencies
A comparison between the integrated response under the standard reference spectrum and the response measure under the simulator	<input type="checkbox"/> Yes <input checked="" type="checkbox"/> No	<i>State where this information can be found in the text.</i>
		Not applicable

For tandem solar cells, the bias illumination and bias voltage used for each subcell	<input type="checkbox"/> Yes <input checked="" type="checkbox"/> No	<input type="text" value="Provide a description of the measurement conditions."/> <input type="text" value="Not applicable"/>
<b>5. Calibration</b>		
Light source and reference cell or sensor used for the characterization	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No	<input type="text" value="Method section in the manuscript"/> <input type="text" value="Explain why this information is not reported/not relevant."/>
Confirmation that the reference cell was calibrated and certified	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No	<input type="text" value="Method section in the manuscript"/> <input type="text" value="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 <input checked="" type="checkbox"/> No	<input type="text" value="Provide a value of the spectral mismatch and/or a description of how it has been taken into account in the measurements."/> <input type="text" value="Not applicable"/>
<b>6. Mask/aperture</b>		
Size of the mask/aperture used during testing	<input type="checkbox"/> Yes <input checked="" type="checkbox"/> No	<input type="text" value="Report the size of the mask/aperture."/> <input type="text" value="No mask was used"/>
Variation of the measured short-circuit current density with the mask/aperture area	<input type="checkbox"/> Yes <input checked="" type="checkbox"/> No	<input type="text" value="Report the difference in the short-circuit current density values measured with the mask and aperture area."/> <input type="text" value="Not applicable"/>
<b>7. Performance certification</b>		
Identity of the independent certification laboratory that confirmed the photovoltaic performance	<input type="checkbox"/> Yes <input checked="" type="checkbox"/> No	<input type="text" value="Identify the independent certification laboratory."/> <input type="text" value="Not applicable"/>
A copy of any certificate(s)	<input type="checkbox"/> Yes <input checked="" type="checkbox"/> No	<input type="text" value="Certificate copies should be provided in the Supplementary information. Please state the supplementary item number."/> <input type="text" value="Not applicable"/>
<b>8. Statistics</b>		
Number of solar cells tested	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No	<input type="text" value="15 independent cells on around 5 independent substrates were measured for each condition"/> <input type="text" value="Explain why this information is not reported/not relevant."/>
Statistical analysis of the device performance	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No	<input type="text" value="For each parameter, the average and the highest values, as well as the standard deviations were provided"/> <input type="text" value="Explain why this information is not reported/not relevant."/>
<b>9. Long-term stability analysis</b>		
Type of analysis, bias conditions and environmental conditions	<input type="checkbox"/> Yes <input checked="" type="checkbox"/> No	<input type="text" value="Provide a description of the type of analysis, bias conditions and environmental conditions (e.g. illumination type, temperature, atmosphere humidity, encapsulation method, preconditioning temperature, bias) for each long-term stability analysis carried out; see ref. 7 and 8 for details."/> <input type="text" value="Not applicable for the scope of this manuscript"/>