

Solar Cells Reporting Summary

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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 | Area of the tested solar cells is provided in Methods section. |
| Method used to determine the device area | ☒ Yes
☐ No | Calibrated Nikon visible light microscope is used to determine the device areas. |

2. Current-voltage characterization

- | | | |
|--|--|--|
| Current density-voltage (J-V) plots in both forward and backward direction | ☒ Yes
☐ No | The forward and reverse scans with different delay times can be found in supporting information. |
| Voltage scan conditions
<i>For instance: scan direction, speed, dwell times</i> | ☒ Yes
☐ No | Voltage scan conditions are provided in Methods section. |
| Test environment
<i>For instance: characterization temperature, in air or in glove box</i> | ☒ Yes
☐ No | Ambient air with below 30% relative humidity level |
| Protocol for preconditioning of the device before its characterization | ☐ Yes
☒ No | No preconditioning of the devices were used in our study. |
| 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
☐ No | MPPT is provided in the manuscript, Fig. S21 in SI |

3. Hysteresis or any other unusual behaviour

- | | | |
|---|--|--|
| Description of the unusual behaviour observed during the characterization | ☐ Yes
☒ No | Hysteresis as a common characteristic of perovskite solar cells is also observed in this work. The hysteresis indexes calculated for different voltage delay time/sweep rates are presented in supporting information. |
| Related experimental data | ☐ Yes
☒ No | We did not observe any unusual behavior in our PVs. |

4. Efficiency

- | | | |
|---|--|--|
| External quantum efficiency (EQE) or incident photons to current efficiency (IPCE) | ☐ Yes
☒ No | EQE data is not included as EQE is not relevant to the diffusion physics discussion presented in our work. |
| A comparison between the integrated response under the standard reference spectrum and the response measure under the simulator | ☐ Yes
☒ No | These measurements have not been performed as they are not relevant to this study. |
| For tandem solar cells, the bias illumination and bias voltage used for each subcell | ☐ Yes
☒ No | We did not report any tandem devices in this study. |

5. Calibration

- | | | |
|---|--|---|
| Light source and reference cell or sensor used for the characterization | ☒ Yes
☐ No | The information regarding the light source and reference cell is provided in Methods section. |
| Confirmation that the reference cell was calibrated and certified | ☒ Yes
☐ No | This information is provided in Methods section. |

Calculation of spectral mismatch between the reference cell and the devices under test	☒ Yes ☐ No	This information is provided in Methods section.
6. Mask/aperture		
Size of the mask/aperture used during testing	☒ Yes ☐ No	The mask size during testing is provided in Methods section.
Variation of the measured short-circuit current density with the mask/aperture area	☐ Yes ☒ No	These measurements have not been performed as we did not aim to develop new devices or claim record-efficiency.
7. Performance certification		
Identity of the independent certification laboratory that confirmed the photovoltaic performance	☐ Yes ☒ No	The photovoltaic performance of our PV devices has not been confirmed from independent certification laboratories, as we did not aim to claim record-efficiency.
A copy of any certificate(s) <i>Provide in Supplementary Information</i>	☐ Yes ☒ No	N/A
8. Statistics		
Number of solar cells tested	☒ Yes ☐ No	At least ten devices have been tested for each system.
Statistical analysis of the device performance	☒ Yes ☐ No	We have included the average and standard deviation of power conversion efficiency in Table S3-S5.
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	The information regarding to the type of the stability measurement and environmental conditions is provided in the Methods section.