

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 The active solar cell area (0.2 cm²) is given in Results and Discussion of the Manuscript Page 8, line 3.
- Method used to determine the device area Yes No The average surface area was determined using ImageJ to count the pixels from a photocopy. Supplementary Information Section 2.10. Page 37.

2. Current-voltage characterization

- Current density-voltage (J-V) plots in both forward and backward direction Yes No We recorded the backward scan direction for DSSCs under study, see Supporting Information Section 2.2. Page 20. We checked the similarity in scanning in the forward direction and backward direction. No hysteresis was observed, see Supporting Information Section 2.3. Supplementary Figure 16, Page 23.
- Voltage scan conditions Yes No The 5 mV s⁻¹ scan rate and 0.488 s dwell times and more can be found in Supporting Information Section 2.2. Page 20.
For instance: scan direction, speed, dwell times
- Test environment Yes No Ambient conditions. See Supporting Information Section 2.2. Page 21.
For instance: characterization temperature, in air or in glove box
- Protocol for preconditioning of the device before its characterization Yes No No preconditioning of the solar cells was performed. Supplementary Information Section 2.1. Page 19.
- Stability of the J-V characteristic Yes No See Supplementary Information Section 2.5. Supplementary Figure 19, Page 27.
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 The solar cells under study do not suffer from capacitive issues as they are DSSCs. Due to long settling time (0.448 s) hysteresis should not be a problem. We checked the similarity in scanning in the forward direction and backward direction, showing no difference. No hysteresis was observed. See Supporting Information Section 2.3. Figure 16 Page 23.
- Related experimental data Yes No We envisioned that this would not be the case for this type of Solar Cell (Dye Sensitized Solar Cells).

4. Efficiency

- External quantum efficiency (EQE) or incident photons to current efficiency (IPCE) Yes No Manuscript, Figure 3b.
- A comparison between the integrated response under the standard reference spectrum and the response measure under the simulator Yes No IPCE is measured from 414–723 nm and the integrated photocurrent gives 2.10 mA cm⁻² while the J-V curve gives 1.97 mA cm⁻². See Supplementary Information Section 2.4. Page 25.
- For tandem solar cells, the bias illumination and bias voltage used for each subcell Yes No Not applicable.

5. Calibration

- Light source and reference cell or sensor used for the characterization Yes No See Supporting Information Section 2.2. Page 21.
- Confirmation that the reference cell was calibrated and certified Yes No See Supporting Information Section 2.2. Page 21. Certificates can be found in Supporting Information Supplementary Section 4. Page 50.
- Calculation of spectral mismatch between the reference cell and the devices under test Yes No Spectral Mismatch correction factor $M = 0.996 \pm 0.004$, See Supporting Information Section 2.4. Page 25.

6. Mask/aperture

- Size of the mask/aperture used during testing Yes No There was minimal variance of surface area between the screen printed devices as can be found in Supporting Information Section 2.10. Supplementary Figure 30, Page 37. Photocurrents measured for cells with and without masks vary very little (7%). As the DSSCs under study are extremely sensitive towards oxygen and required immediate measurement no masks were used in this study.
- Variation of the measured short-circuit current density with the mask/aperture area Yes No There was minimal variance of surface area between the screen printed devices as can be found in Supporting Information Section 2.10. Supplementary Figure 31 Page 37.

7. Performance certification

- Identity of the independent certification laboratory that confirmed the photovoltaic performance Yes No No records are reported, as this is not applicable for our study. The performance of the DSSCs in this study are compared with each other.
- A copy of any certificate(s)
Provide in Supplementary Information Yes No Not applicable.

8. Statistics

- Number of solar cells tested Yes No A total of 9 solar cells were studied for Pstation and P1 and 5 solar cells for PPEG4 Manuscript Page 17, Table 2.
- Statistical analysis of the device performance Yes No See Supporting Information Section 2.5. Table 7 and Table 8 Page 26, 27.

9. Long-term stability analysis

- Type of analysis, bias conditions and environmental conditions
For instance: illumination type, temperature, atmosphere humidity, encapsulation method, preconditioning temperature Yes No See Supporting Information Section 2.5. Table 9 and Figure 19 Page 27.