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Supporting Information

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Supplementary Materials

Optical Fiber/Nanowire Hybrid Structures for Efficient Three-Dimensional Dye-Sensitized Solar Cells**

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Figure S1. SEM images of ZnO nanowires grown on the surfaces of a rectangular fiber, showing uniform coating around its surfaces. The nanowires are well aligned with diameters of 50-100 nm and heights 4 um, both of which can be controlled experimentally.

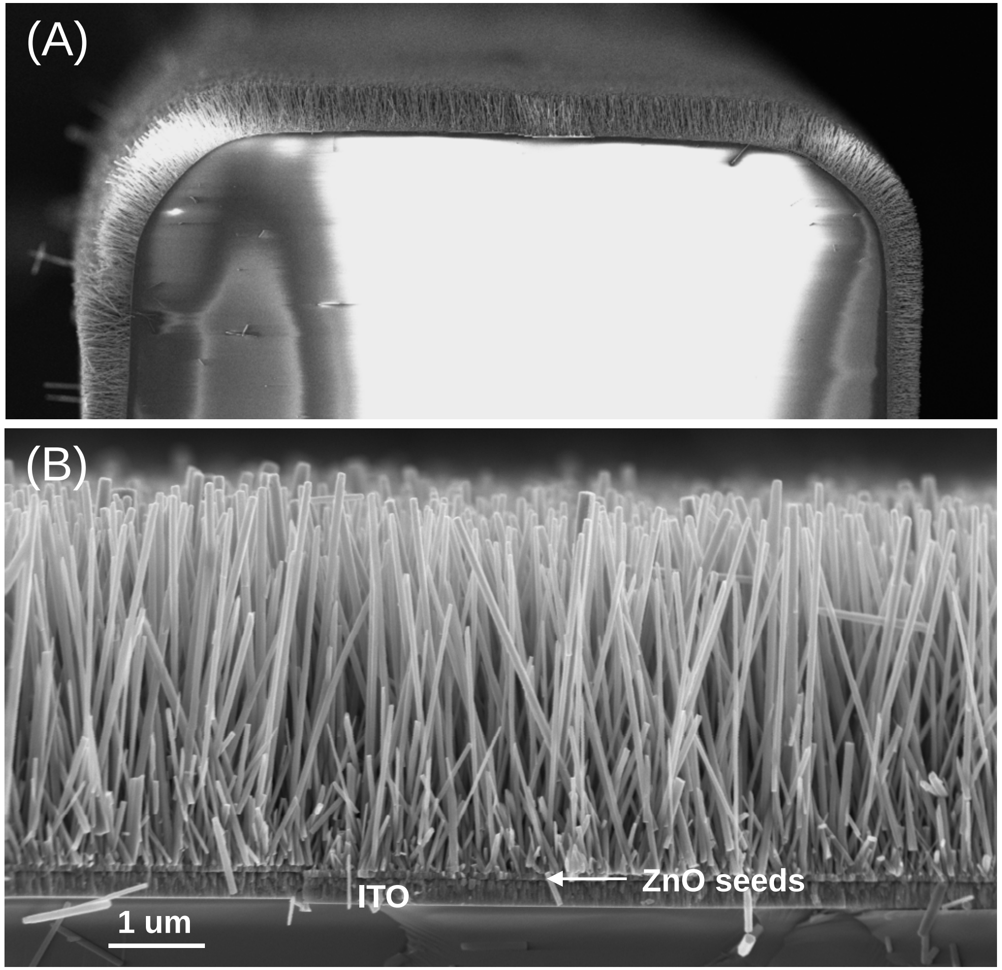


Figure S2. (A) Optical image of a rectangular fiber with ZnO NWs grown on the surface. (B) Optical image of a fiber after dye loading on NW surfaces. (C) SEM image of the fiber with NWs grown on surface before dye loading.

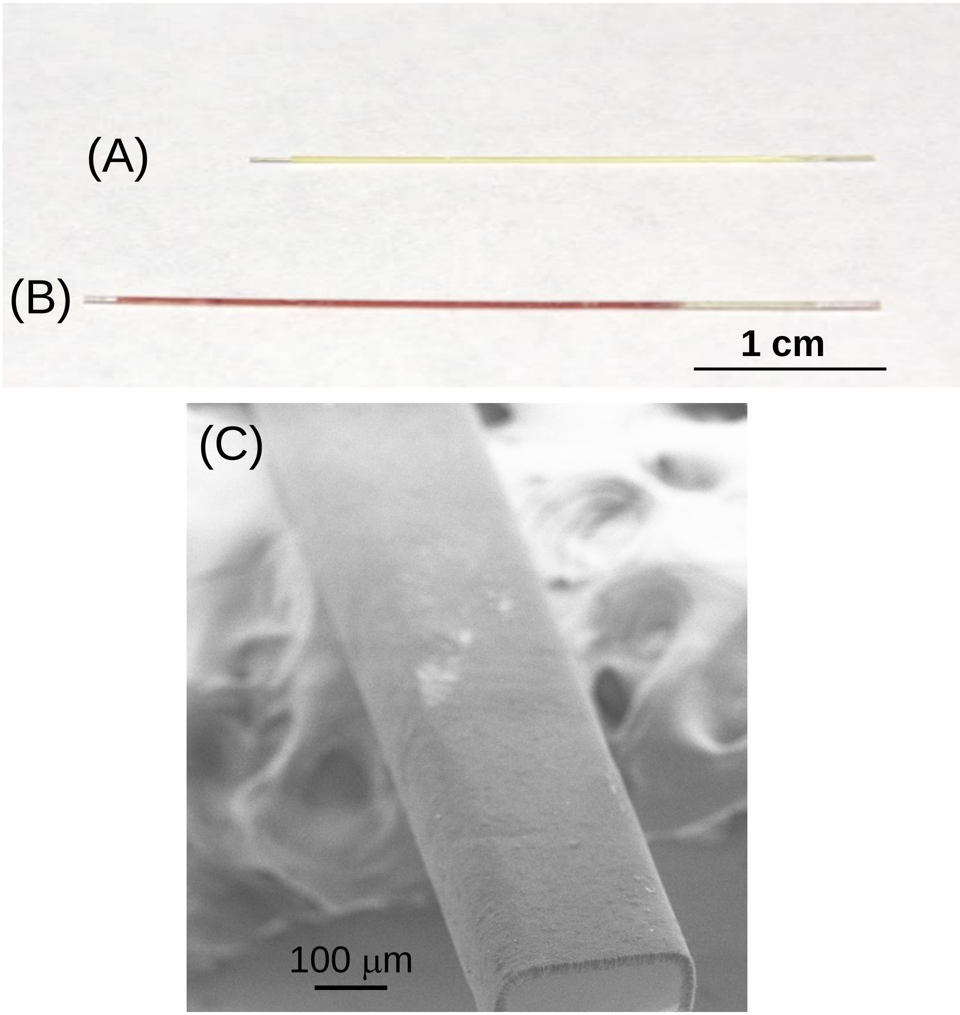


Figure S3. Characterization of decay of light as a function of fiber length. This set of measurements was carried out for a circular fiber with a diameter of 1.5 mm. No filter was applied. For the cladding coated fiber (A), the decay is very slow. For the fiber with cladding (B), the light decays twice as faster as the one with cladding. For the fiber with ITO coating and ZnO NWs grown on surfaces, the light vanishes within 10 cm of its length.

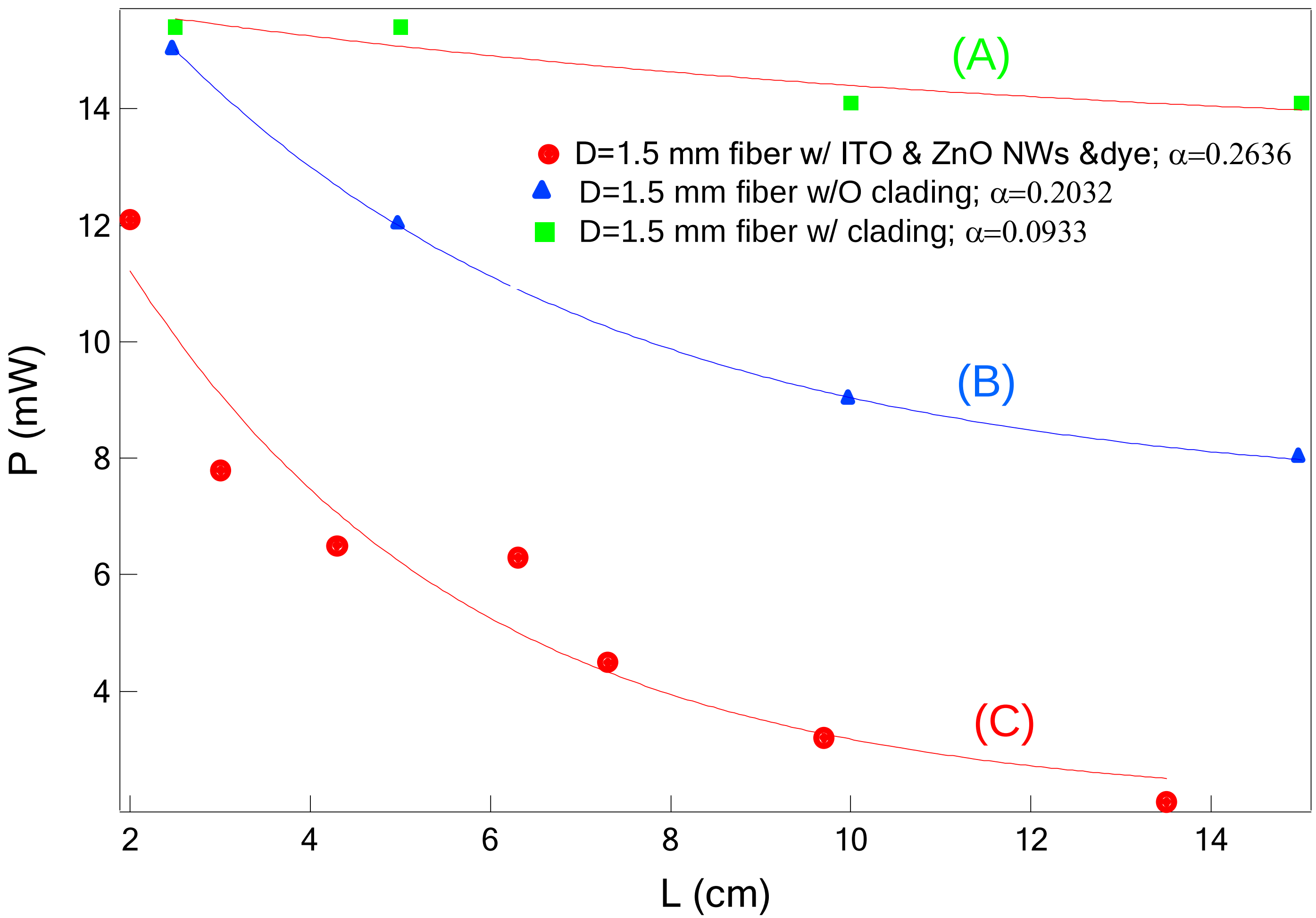
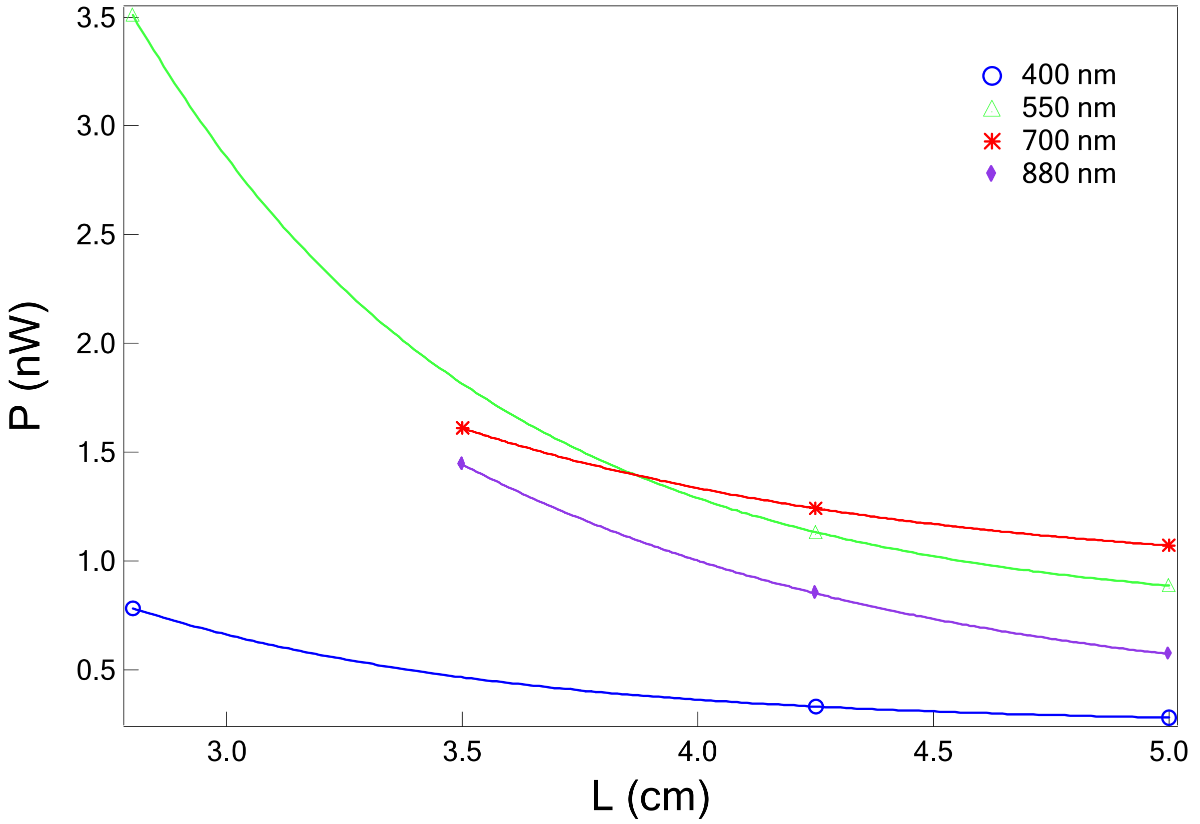


Figure S4. Characterization the decay of light transmitting along an optical fiber. With a filter, 89.6% and 96.7% incident power were absorbed within 2 cm and 3 cm along the fiber, respectively. The table shows the simulation of the data by the power decay law.



	400nm	550nm	700 nm	880 nm
p_0	0.248	0.747	0.92	0.323
p_1	19.81	124.3	24.9	37.78
α	1.29	1.36	1.026	1.005

$$p = p_0 + p_1 \exp(-\alpha l)$$

Figure S5. A rectangular fiber with NWs grown around its entire circumference, and the corresponding DSSC performance when the incident light illuminates along the axial and normal direction (magnified by x10) orientation relative to the fiber axis. The inset is the EEF for a few samples, which can be as high as 26, which is partially due to the location of the Pt electrode.

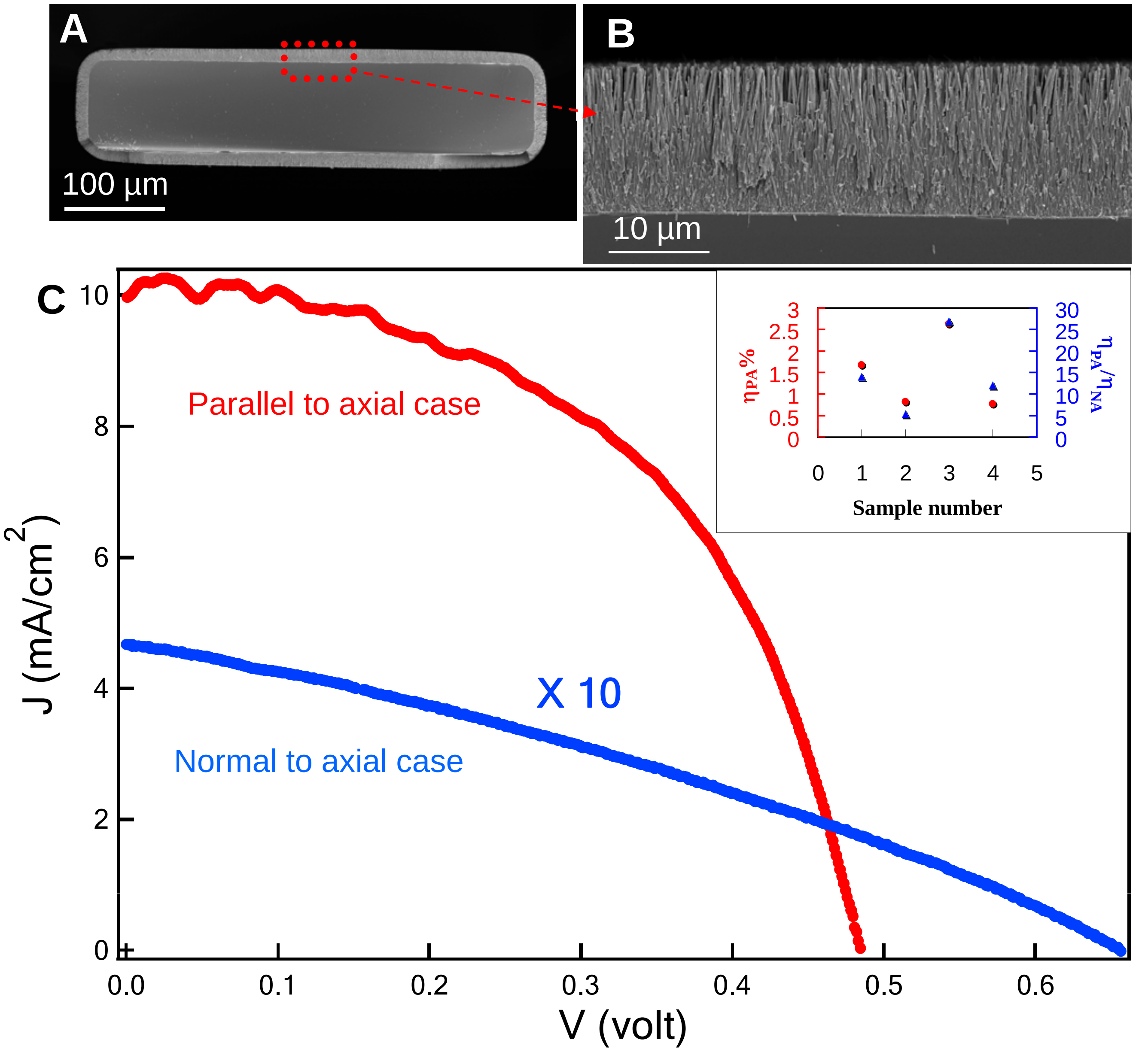


Figure S6. The measurement of short circuit current density Jsc as a function of incident light (in units of full suns) when the illumination light is parallel to optical axis, showing that the 3D DSSC works even at very strong light intensities.

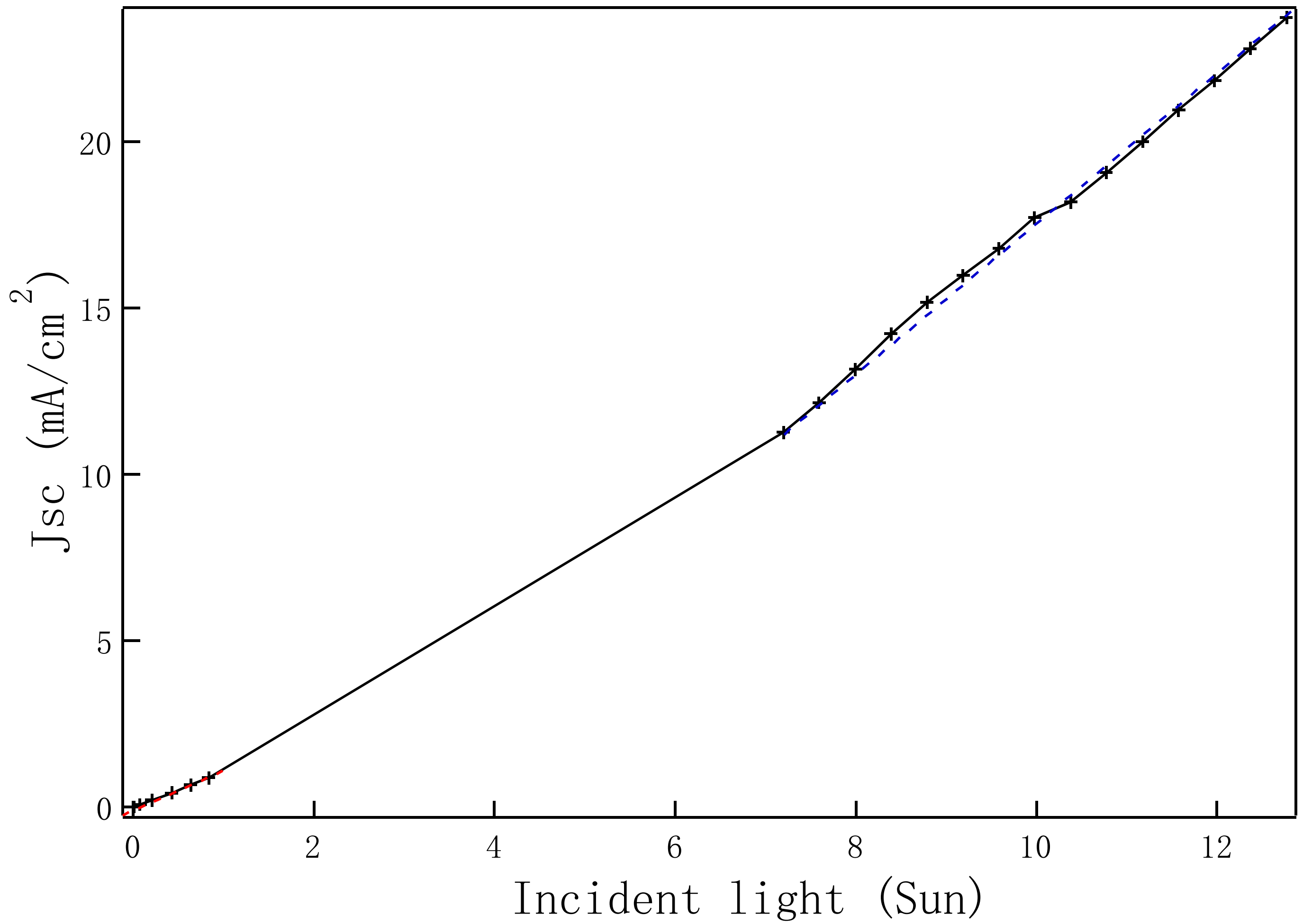


Table S1: Data used to plot Fig. 3D: Solar cell efficiency of parallel to (PA) and normal to (NA) axis configurations measured at full Sun, demonstrating large enhancement in efficiency.

η_{PA} (%)	η_{NA} (%)	EEF $= \eta_{PA}/\eta_{NA}$
1.91	0.31	6.16
3.3	0.76	4.34
2.02	0.77	2.62
1.85	0.57	3.25
1.83	0.77	2.38
1.5	0.71	2.12
1.1	0.23	4.82
1.76	0.39	4.51