Supplementary Information

Incident-Angle-Controlled Semitransparent Colored Perovskite Solar Cells with Improved Efficiency Exploiting a Multilayer Dielectric Mirror

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Keyword: perovskite solar cells, multilayers, dielectric mirrors, photonic crystals, semitransparent

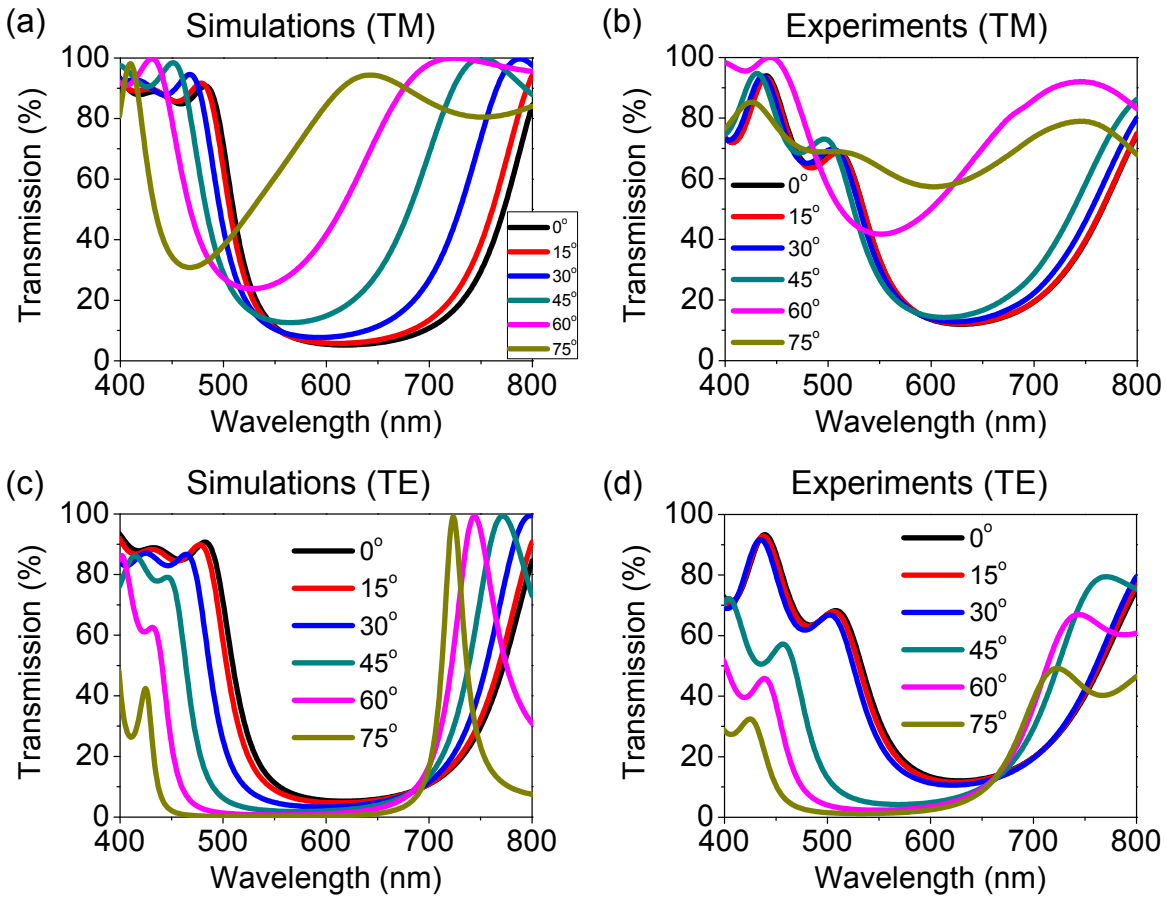


Fig. S1 Simulated and measured transmission spectra of a multilayer dielectric mirror for (a) – (b) TM and (c) – (d) TE polarizations.

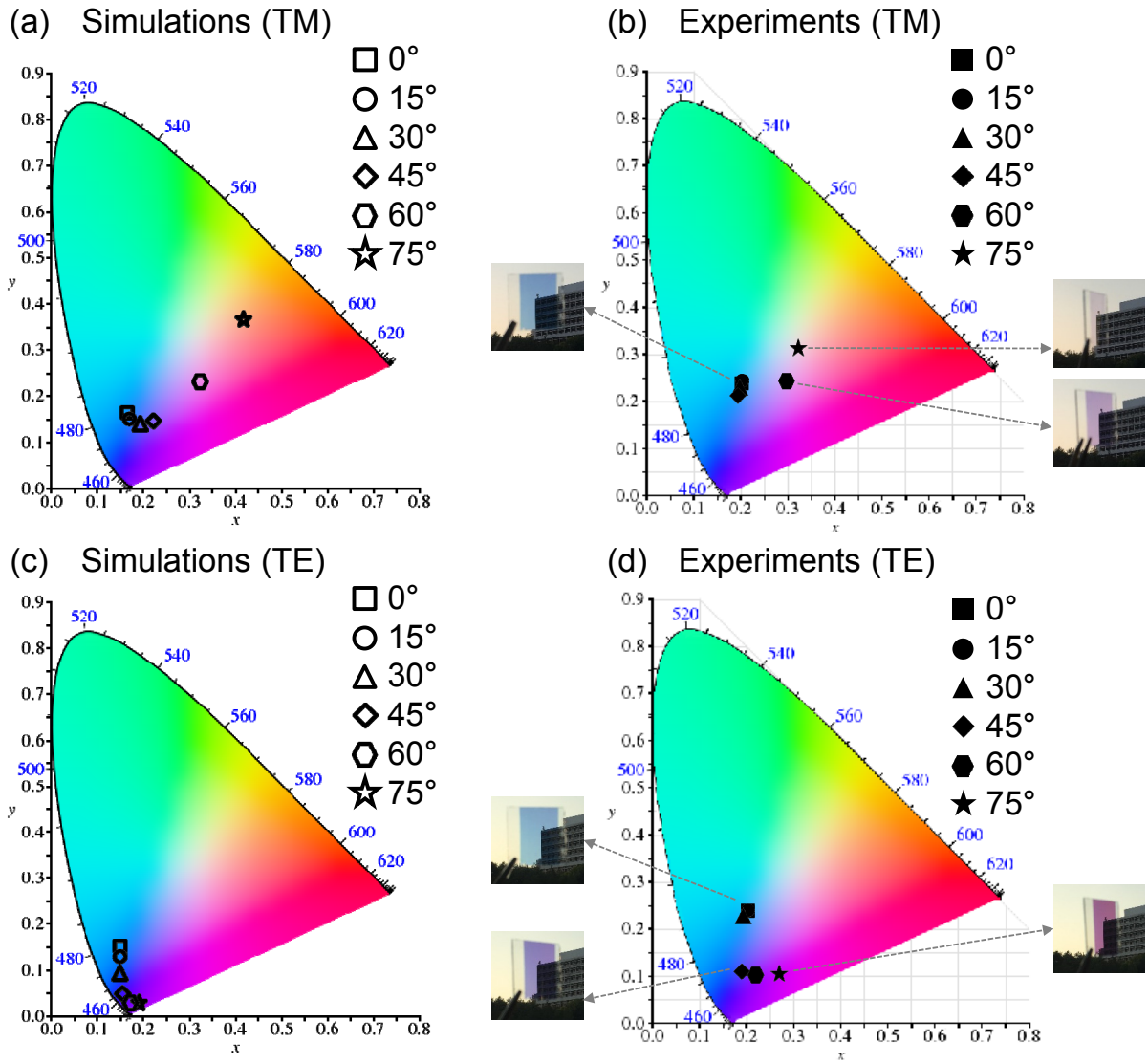


Fig. S2 Color coordinates of the multilayer dielectric mirror calculated from simulated and measured transmission spectra, illustrated on the CIE 1931 chromaticity diagram for (a) – (b) TM and (c) – (d) TE polarizations. The corresponding optical images are inserted to (b) and (d) for TM and TE polarizations, respectively.

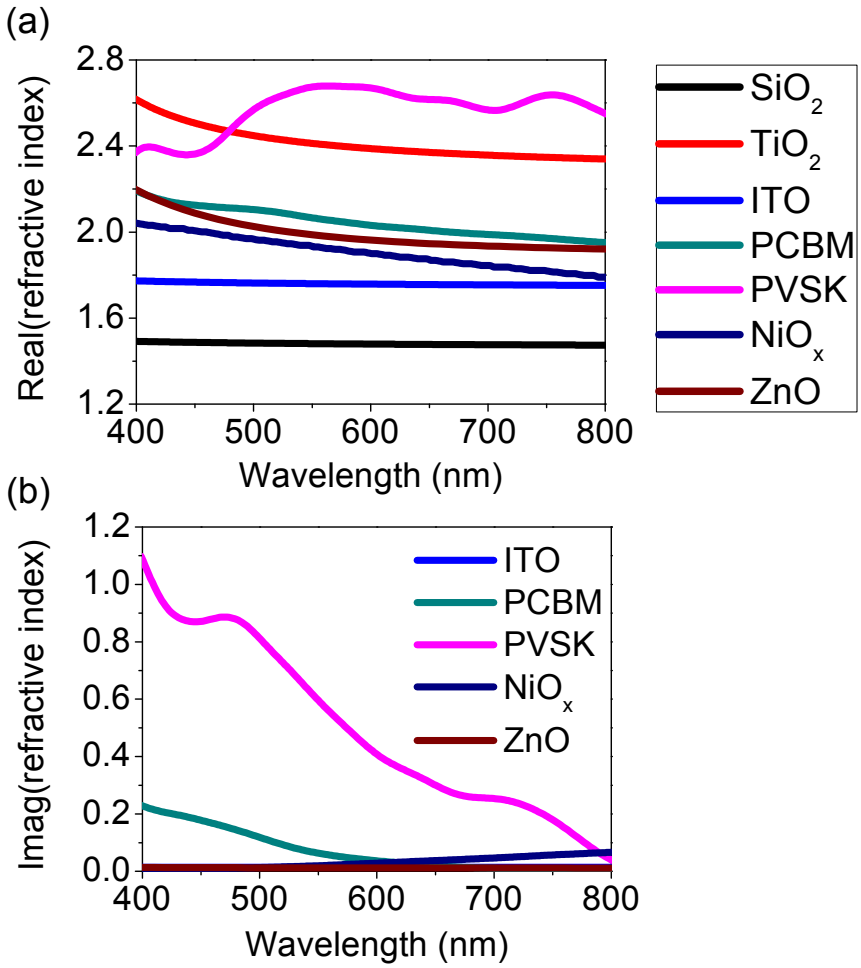


Fig. S3 (a) Real and (b) imaginary part of refractive index of the materials, measured by a spectroscopic ellipsometer (Elli-SE, Ellipso Technology Co.).

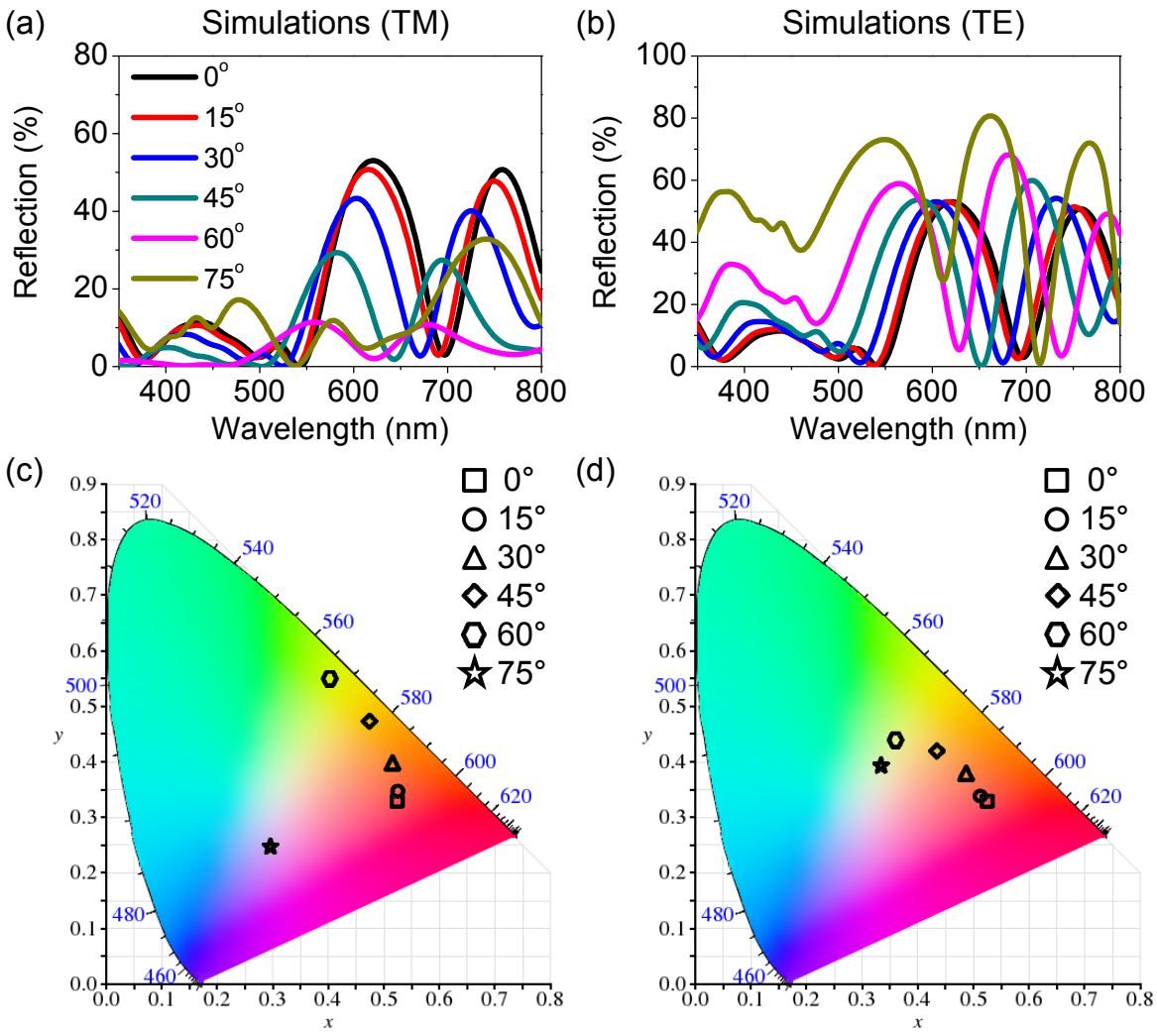


Fig. S4 Simulated angle-resolved reflection spectra for (a) TM and (b) TE polarizations. Color spaces illustrated on the CIE 1931 chromaticity diagram for (c) TM and (d) TE polarizations.

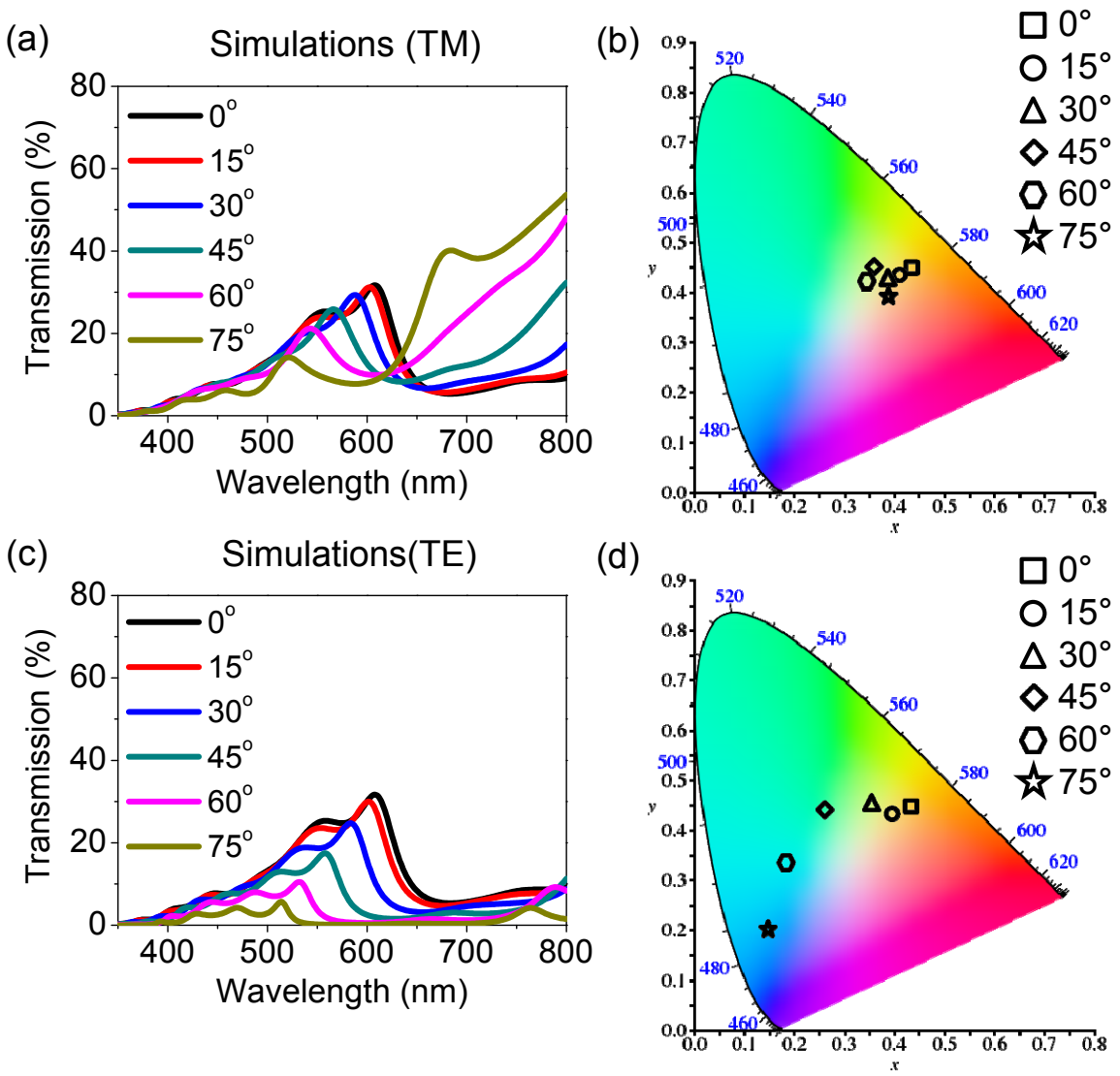
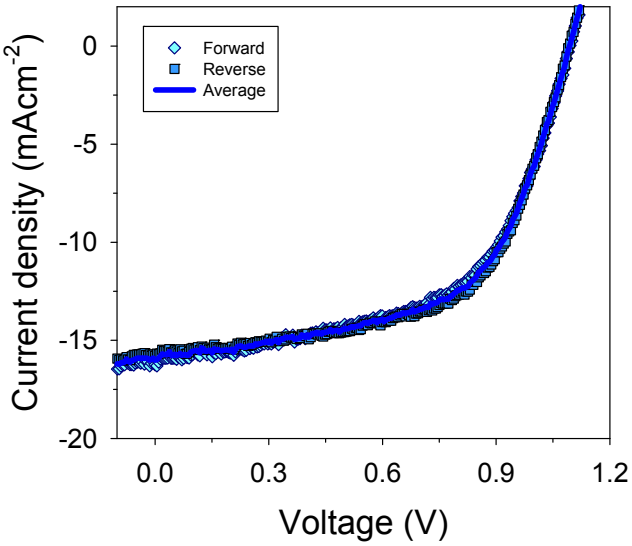


Fig. S5 (a) Simulated transmission spectra of the colored semitransparent PVSK solar cells, where the dielectric mirror consists of 80 nm-thick TiO_2 and 130 nm-thick SiO_2, and (b) the calculated color spaces described on the CIE 1931 chromaticity diagram for TM polarization. (c) – (d) The same study for TE polarization.



	V_{oc}	J_{sc} (mA/cm^2)	*FF*	PCE (%)
Forward	1.09	16.25	0.56	9.92
Reverse	1.09	15.79	0.60	10.33
Average	1.09	16.02	0.58	10.12

Fig. S6 The symbols represent experimentally measured *J*-*V* curves of the solar cell with 4 pairs dielectric mirror, scanned in forward and reverse directions. The line is average value of experimental data, obtained by scanning in forward and reverse directions. All data were measured at AM 1.5 G with an intensity of 100 mW/cm^2.

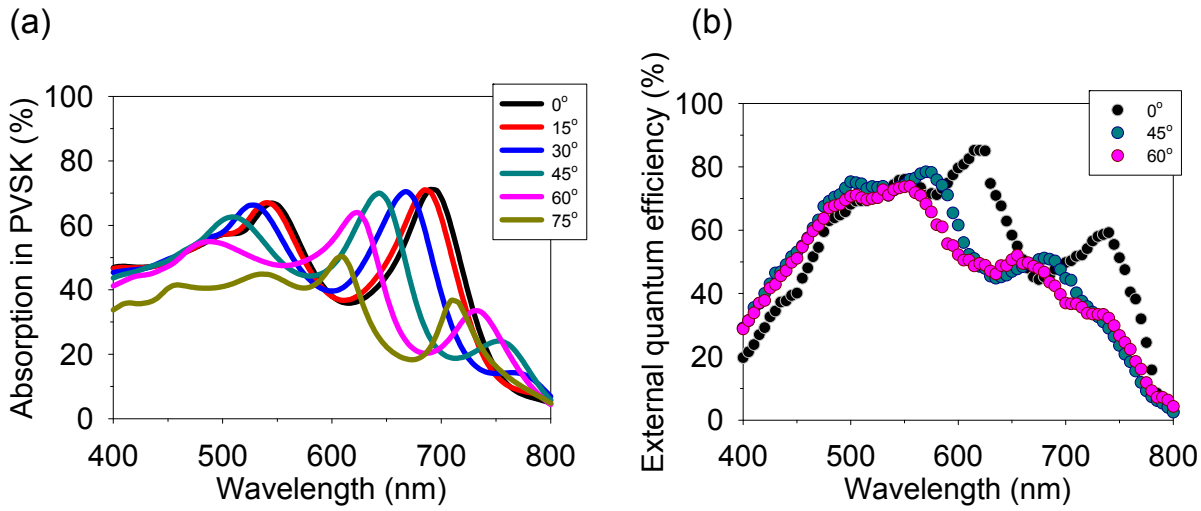


Fig. S7 (a) Simulated absorption spectra in PVSK layer and (b) measured EQE spectra of the solar cell with the dielectric mirror (4 paired) depending on the incident angle. EQE spectra were corrected by cos(incident angle) values to consider the change of effective area with the incident angle.

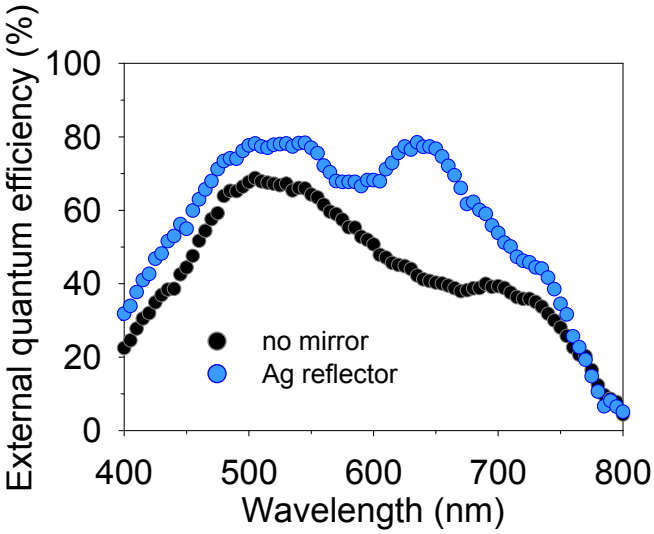


Fig. S8 Measured EQE spectra of the solar cells without dielectric mirror and with 100-nm-thick Ag reflector (glass/Ag/ITO/NiO_x/PVSK/PCBM/ZnO/ITO).

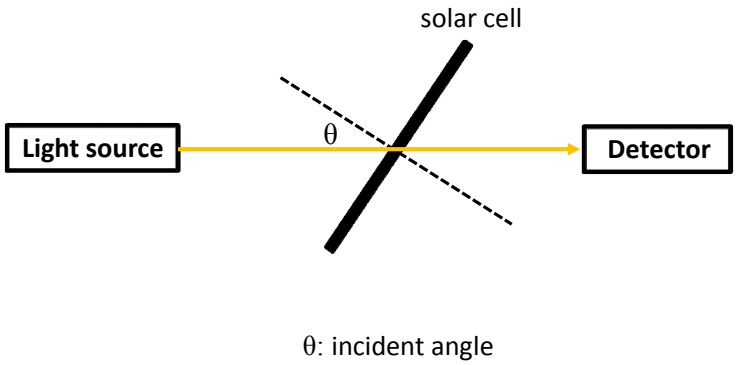


Fig S9. Experimental setup for angular dependent measurements.