SUPPORTING INFORMATION

Dual-band luminescent solar converter-coupled dye-sensitized solar cells for high performance semi-transparent photovoltaic device

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Table S1. Comparison of various type of LSC integrated solar cells.

LSC materials	Solar cell type	Abs. (nm)	ΔJ_{SC} [mA/cm^2]	Note	Ref.
$YVO_4:Eu^{3+}$	DSSC	300-350	0.6		[1]
$LiYF_4:Yb^{3+}$, Er^{3+}	PSC	>800	~ 1	7-8 sun	[2]
Rubrene/PQ4PdNA	a-Si	650-700	0.3	19 sun	[3]
Perylene/PdTPBP	DSSC	600-650	0.6		[4]

PSC: Perovskite solar cell

DSSC: Dye-sensitized solar cell

Table S2. Photovoltaic parameter values and efficiency extracted from J-V curves in DSSC, DS/DSSC, and DS/DSSC/UC samples.

	J_{SC} [mA/cm^2]	V_{OC} [V]	FF	η [%]
DSSC	14.62 ± 0.11	0.70 ± 0.01	0.72 ± 0.03	7.36 ± 0.08
DS DSSC	15.22 ± 0.03	0.71 ± 0.01	0.71 ± 0.03	7.68 ± 0.02
DS/DSSC/UC	15.26 ± 0.06	0.72 ± 0.01	0.71 ± 0.03	7.80 ± 0.05

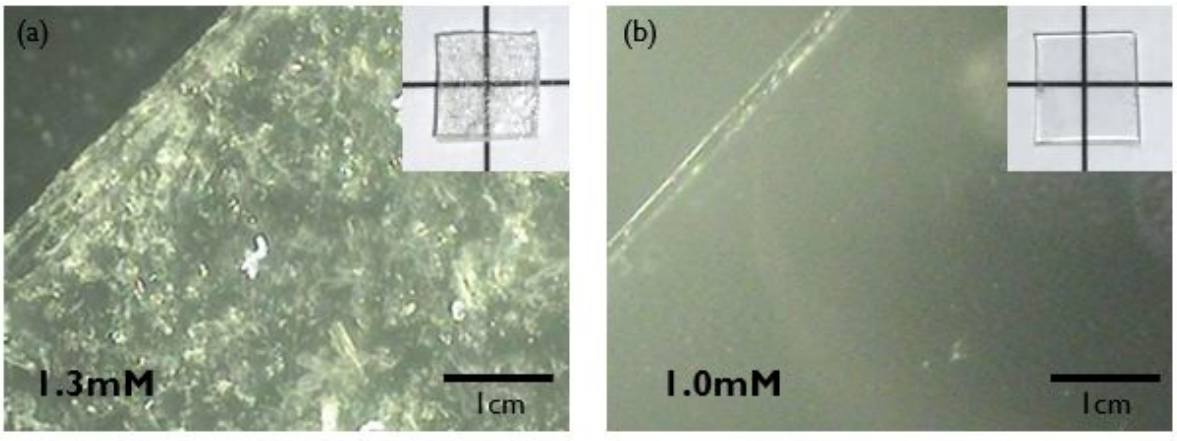

Figure S1. Microscopic images of DS LSC panels (a) with and (b) without excessive concentration of anthracene in polymer matrix.

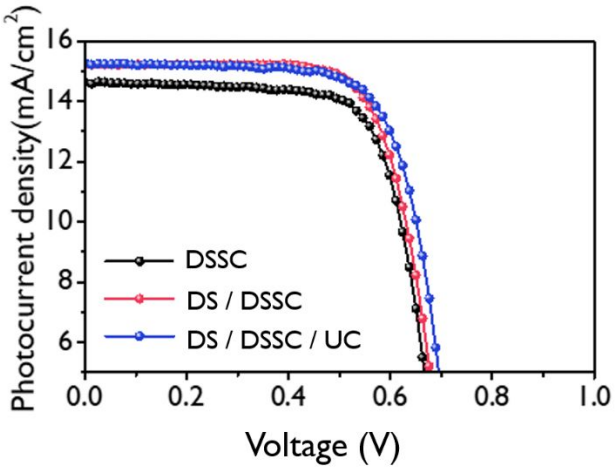

Figure S2. J-V curves on DSSC, DS / DSSC, and DS / DSSC / UC samples.

Supplementary note

Single-point measurement was used to determine the fluorescence quantum yield. the quantum yield of DS process is calculated using

$$\Phi_{DS} = 2\Phi_{ref}(\frac{A_{ref}}{A_{DS}})(\frac{I_{UC}}{I_{ref}})\left(\frac{\eta_{UC}}{\eta_{ref}}\right)^2$$

where Φ is fluorescence quantum yield, A is the optical density (absorption), I is the integrated fluorescence intensity, and n is the refractive index of solvent (or host matrix). The subscript "ref" refers to the reference sample which used 0.01mM ethanol solution of anthracene with a fluorescence quantum yield of 27% which excited at 366nm wavelength of light.[5] The UC quantum yield was calculated using the following formula,

$$\Phi_{UC} = 2\Phi_{ref}(\frac{A_{ref}}{A_{UC}})(\frac{I_{UC}}{I_{ref}})\left(\frac{\eta_{UC}}{\eta_{ref}}\right)^2$$

The multiplicative factor 2 for this formula should be considered because the absorption of 2 photon is required for the observation of 1 upconverted photon.[6-8] The reference sample for up-conversion was used 10^{-3}mM ethanol solution of methylene blue with a fluorescence quantum yield of 4% which excited at 633nm wavelength of light.[9]

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