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Electronic Supplementary Information (ESI)

A Highly Efficient and Transparent Luminescent Solar Concentrator Based on a Nanosized Metal Cluster Luminophore-Anchored on Polymer

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Table S1: The color coordinates (x, y), and the color rendering index (CRI) for samples with different concentrations and thicknesses calculated using CIE 1931 color space chromaticity diagram of the prepared LSCs with different concentrations and thicknesses.

Luminophores	Luminophores Concentration (mg/ml)	Thickness (mm)	Color Coordinates		CRI
			x	y	
pure-PMMA	0.0	3	0.334	0.334	100
$(dMDAEMA)_2[Mo_6Cl_{14}]$-PMMA	1.0	3	0.344	0.351	99
$(dMDAEMA)_2[Mo_6I_{14}]$-PMMA	0.25	3	0.354	0.359	98
	0.50	3	0.432	0.441	80
	1.0	1	0.378	0.386	91
		2	0.416	0.428	81
		3	0.459	0.454	79

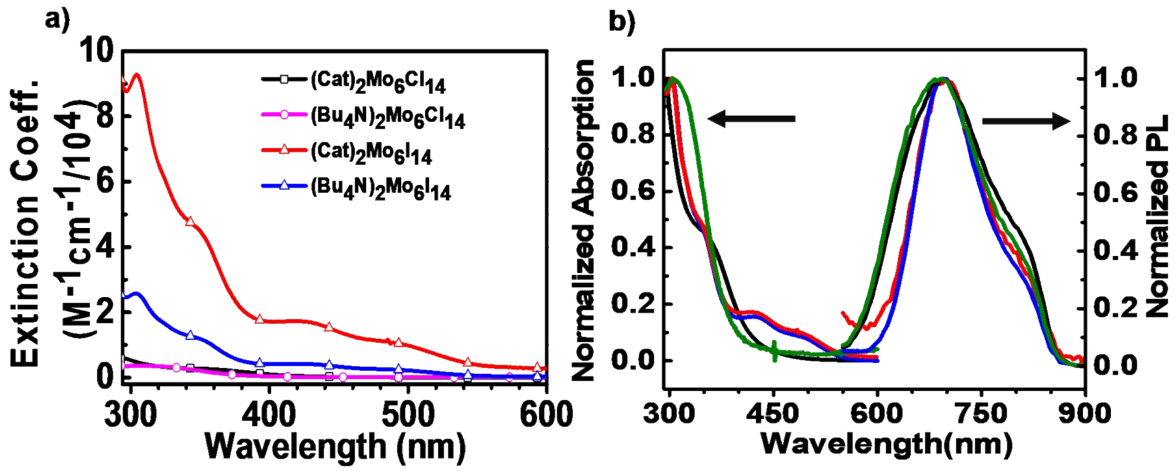

Figure S1. (a) Extinction coefficient of $(dMDAEMA)_2Mo_6I_{14}$ (red line), $(Bu_4N)_2[Mo_6I_{14}]$ (blue line), $(dMDAEMA)_2[Mo_6Cl_{14}]$ (dash black line) and $(Bu_4N)_2Mo_6Cl_{14}$ (pink line) in acetonitrile solvent. $(dMDAEMA)_2[Mo_6I_{14}]$ (blue line) has ~20 times larger extinction coefficient than that of $(Bu_4N)_2Mo_6Cl_{14}$. **(b)** Absorption and PL spectra of $(dMDAEMA)_2Mo_6Cl_{14}$ (black line), $(Bu_4N)_2Mo_6Cl_{14}$ (green line), $(Bu_4N)_2[Mo_6I_{14}]$ (red line) and $(dMDAEMA)_2Mo_6I_{14}$ (blue line) in acetonitrile solution.

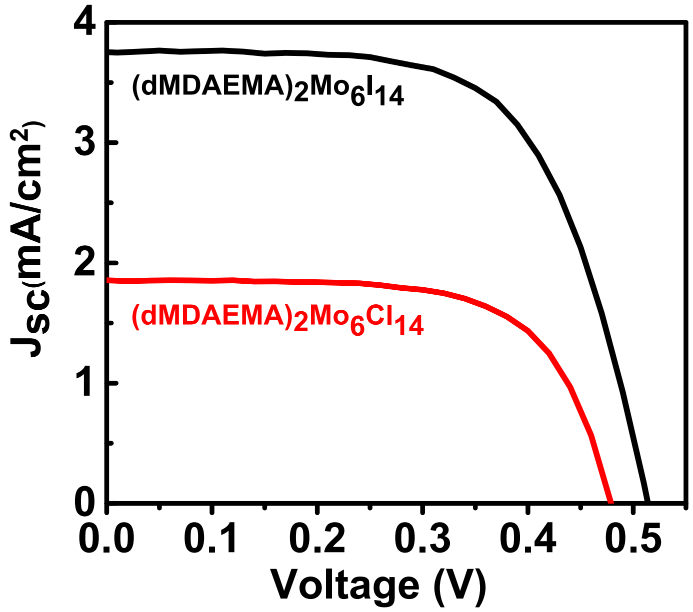

Figure S2. The J-V curves of LSC device at concentration C=1mg/ml and thickness of d= 3mm with different halide ligands contained dyes, $(dMDAEMA)_2[Mo_6I_{14}]$ (black line) and $(dMDAEMA)_2[Mo_6Cl_{14}]$ (red line).

Table S2. Photovoltaic parameters obtained from PCE measurements of LSC encapsulated with $(dMDAEMA)_2[Mo_6Cl_{14}]$ and $(dMDAEMA)_2[Mo_6I_{14}]$ films with 1mg/ml and dimensions of 2.0 x 2.0 x 0.3 cm^3.

Samples	J_{sc} (mA/cm^2)	V_{oc} (V)	FF	PCE (%)
$(dMDAEMA)_2[Mo_6I_{14}]$	3.79	0.51	0.64	1.24
$(dMDAEMA)_2[Mo_6Cl_{14}]$	1.86	0.48	0.66	0.59

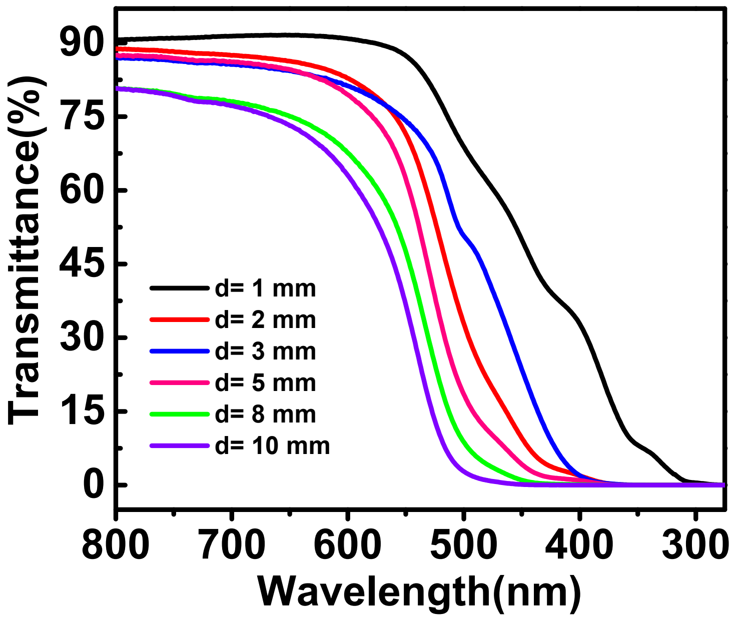

Figure S3. Transmittance of the synthesized $(dMDAEMA)_2[Mo_6I_{14}]$-PMMA hybrid with dye concentration of C=1 mg/ml at various thickness: d=1 mm (black line), d=2 mm (red line), d=3 mm (blue line), d=5 mm (pink line), d=8 mm (green line) and d=10 mm (violet line).

Table S3. PCEs of LSC with various thicknesses fabricated with a luminophore concentration of 1 mg/mL and dimensions of 2.0 cm × 2.0 cm × *x* cm (*x*=0.1, 0.2, 0.3, 0.5, 0.8, 1.0).

Thickness (cm)	G	J_{sc} (mA/cm^2)	V_{oc} (V)	FF	PCE (%)
0.1	5.00	3.71	0.39	0.41	0.59
0.2	2.50	4.46	0.51	0.35	0.80
0.3	1.67	3.79	0.51	0.64	1.24
0.5	1.00	2.33	0.42	0.59	0.58
0.8	0.63	2.07	0.46	0.63	0.60
1.0	0.50	1.49	0.44	0.59	0.39

Table S4: Summary of optical properties and PCEs of similar inorganic-organic salts contained LSCs.

Compound	Extinction coefficient ($M^{-1}cm^{-1}$)	Absorption peak (nm)	Emission peak (nm)	Downshift (nm)	QY (%)	PCE (%)
$(Bu_4N)_2[Mo_6I_{14}]$	$2.6\cdot10^4$	305	695 (730[23], 738 [24])	390	12[23], 10 [24]	-
$(Bu_4N)_2[Mo_6Cl_{14}]$	$3.4\cdot10^3$	307	690 (744 [23])	383	15 [23], 19 [25] 75[15]	0.44 [15]
$(dMDAEMA)_2[Mo_6I_{14}]$	$9.3\cdot10^4$	305	695	390	81.6*	1.24
$(dMDAEMA)_2[Mo_6Cl_{14}]$	$6.0\cdot10^3$	305	690	385	-	0.59

*QY of this work at an excitation wavelength (λ_{ex}) of 330 nm

23 Ref quantum yield estimated by comparison with cresyl violet as a reference in deaerated acetonitrile at λ_{ex} = 440 nm.

24 Ref absolute quantum yield measured in deaerated acetonitrile at λ_{ex}=380 nm.

25 Ref quantum yield estimated by comparison with $Ru(bpy)_3^{2+}$ in acetonitrile solution at 300K at λ_{ex}=436 nm.

15 Ref absolute quantum yield measured in acetonitrile under flowing high-purity nitrogen at λ_{ex}= 325 nm.

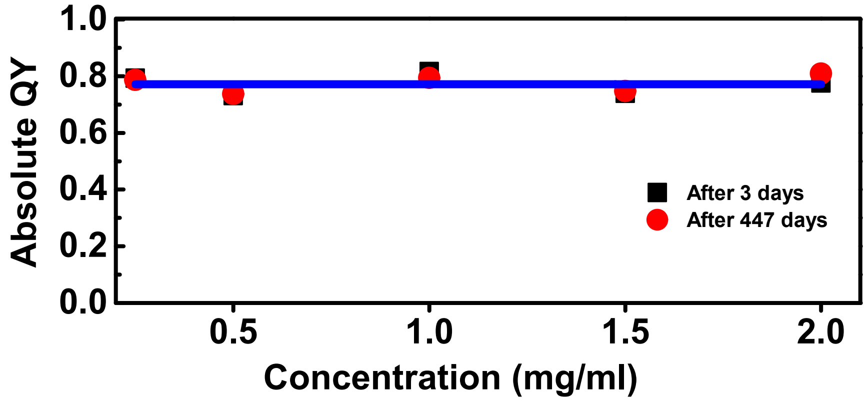

Figure S4. The absolute QY of the hybrid LSC plate after three days (black square) and 15 months after the fabrication (red circle) with various dye concentrations. The unchanged QY suggests that the LSC device made from the hybrid is stable against moisture and light.

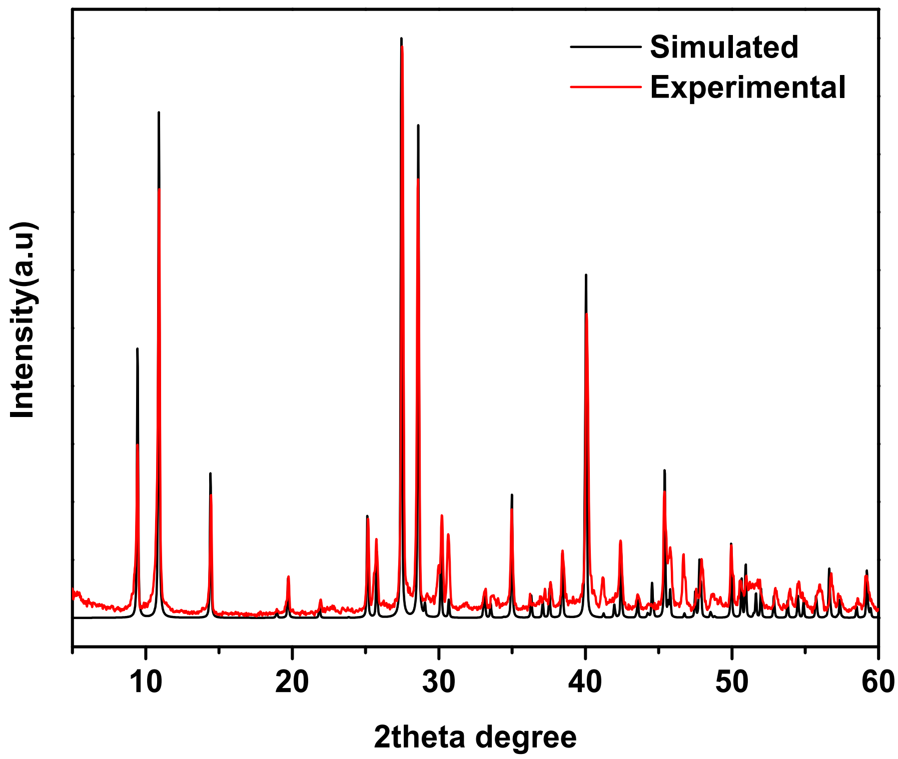

Figure S5. Comparison of experimental and simulated XRD patterns of $Cs_2Mo_6I_{14}$.The powder X-ray pattern of $Cs_2Mo_6I_{14}$ perfectly matched with the calculated pattern from single crystal data.

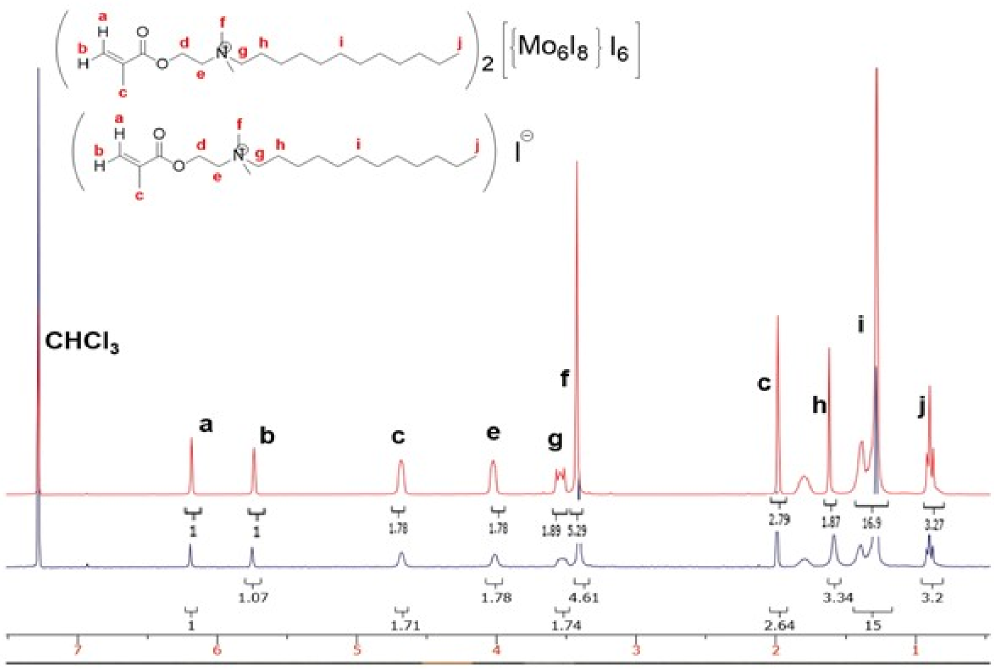

Figure S6. ^{1}H NMR (300.13 MHz) spectrum of of [2-(Methacryloyloxy) ethyl] dimethyldodecylammonium iodide (dMDAEMAI) (blue line) and $(dMDAEMA)_2[Mo_6I_8I_6]$ (red line) with integration in $CDCl_3$. The change of the I^- for $[Mo_6I_{14}]^{2-}$ leads to significant shielding of CH_2^g and CH_2^e signals due to the bulkiness of the cluster anion. ^{1}H NMR spectrum of dMDAEMA iodide and $(dMDAEMA)_2[Mo_6I_{14}]$ show the similar peaks from the cation $dMDAEMA^+$ due to no change of carbon and hydrogen in two compounds. However, the exchange of the I^- in dMDAEMAI by di-anion $[Mo_6I_8I_6]^{2-}$ led to significant shielding of CH_2^g and CH_2^e signal due to the bulkiness of cluster anion. NMR ($CDCl_3$)–δ(^{1}H): 6.15 [1H, s, CHH], 5.7 [1H, s, CHH], 4.65 [2H, m, OCH_2], 4.13 [2H, m, CH_2N], 3.62-3.58 [2H, m, NCH_2], 3.49 [6H, m, $N(CH_3)_2$], 1.94 [3H, s, CH_3], 1.67 [2H, m, N CH_2CH_2], 1.40-1.12 [18H, $(CH_2)_9$], 0.87 [3H, t, J = 6.7Hz, CH_3].

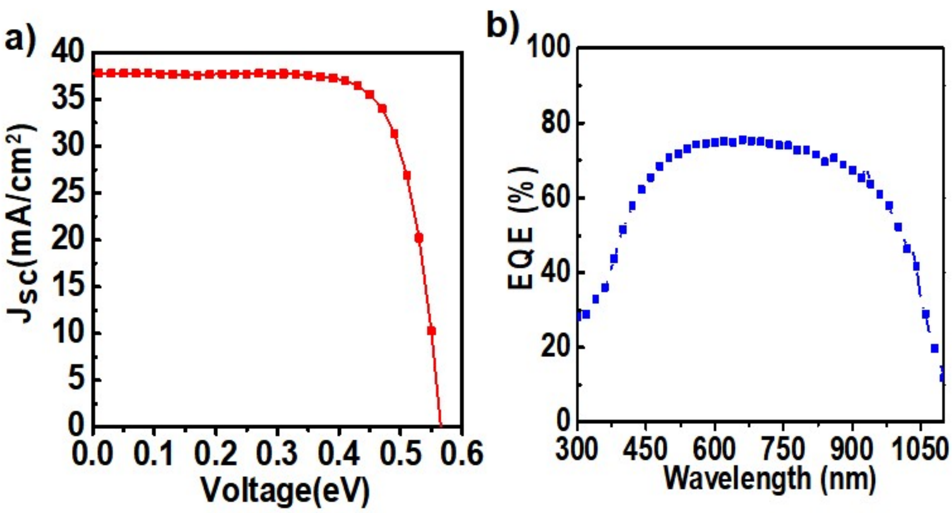

Figure S7. a) I-V curve of Si PV cell. The PCE of 16.0 ±0.1%, the short circuit current density (J_{SC}) of 37.8 ±0.1 mAcm-2, open circuit voltage (V_{OC}) of 0.565 ±0.01V, and a fill factor of 74.7 ± 0.1 % were observed. **b)** EQE of Si PV cell.

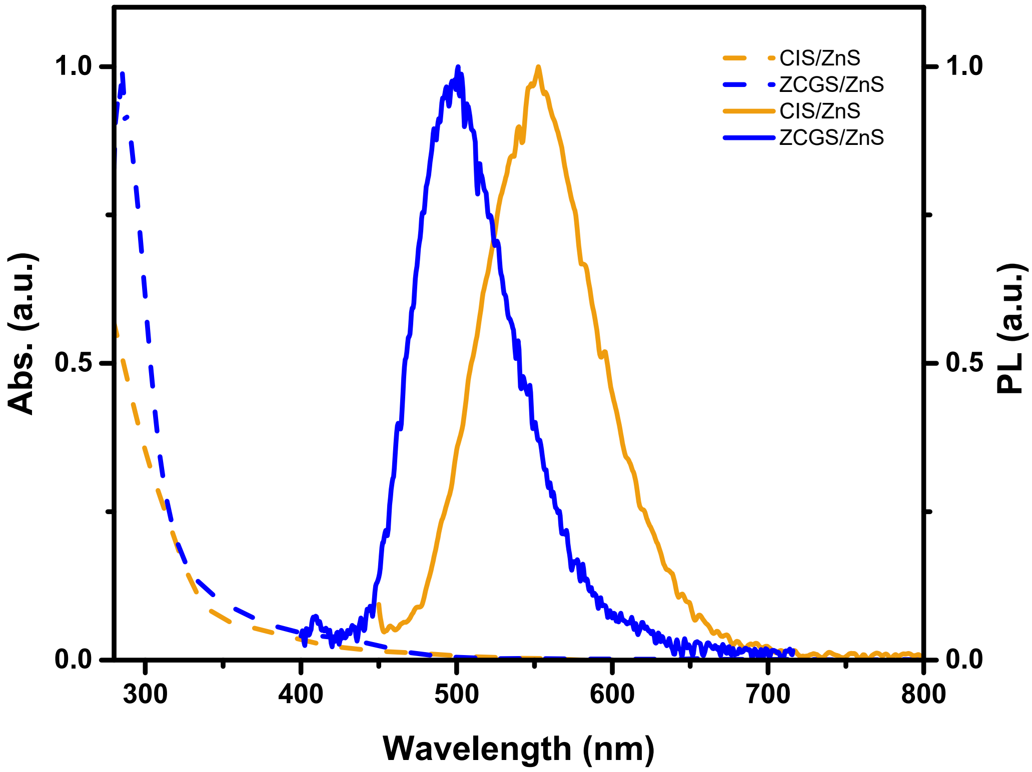

Figure S8. The absorption (dashed line) and emission (solid line) spectra of ZnCuGaS/ZnS core/shell quantum dots which used as a control in the experiment of PV response of LSCs as a function of the distance. As zinc was doped, the emission was blue shifted about 100 nm.