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Eco-friendly Luminescent solar concentrator with high photon transport efficiency based on Bi-doped $Cs_2Na_{0.6}Ag_{0.4}InCl_6$ quantum dots

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PL QY calculations for Bi-doped $Cs_2Na_{0.6}Ag_{0.4}InCl_6$ DP QDs

The *PL QY* of Bi-doped $Cs_2Na_{0.6}Ag_{0.4}InCl_6$ QDs was measured with the integrating sphere and then directly calculated by the following equation,

$$PLQY = \frac{N_{PL}}{N_{abs}} = \frac{\int \left(I_{sample}(\lambda) - I_{reference}(\lambda)\right) d\lambda}{\int \left(E_{sample}(\lambda) - E_{reference}(\lambda)\right) d\lambda}, \qquad \text{(S1)}$$

where I_{sample} and E_{sample} are the intensity of the emission and excitation light after correction for the QD samples, respectively. $I_{\text{reference}}$ and $E_{\text{reference}}$ are the intensity of the emission and excitation light after correction for the reference samples (pure n-hexane solution) in a quartz cuvette, respectively. The $\eta_{\text{LSC,PL}}$ of LSCs (by encapsulating the QDs in the PDMS) was characterized in the same way as that of the QDs solution.

The haze of LSC

Total transmission (T_t) and diffusion transmission (T_d) data in Fig.S7. a are used to calculate the haze of LSC in visible light. A double-beam Shimadzu UV-3600 spectrophotometer with the integrating sphere is used to measure the T_t and T_d. These measurements are taken over the wavelength range from 250 nm to 800 nm. The haze is calculated as follows:

$$Haze = \frac{T_d}{T_t}. \qquad \text{(S2)}$$

The external quantum efficiency (η_{ext}) of LSC

The η_{ext} can be calculated as:

$$\eta_{\text{ext}} = \eta_{\text{abs}} \times \eta_{\text{int}} = (1-R)\frac{\int_0^\infty AM1.5G(\lambda)(1-e^{-\alpha(\lambda)d})d\lambda}{\int_0^\infty AM1.5G(\lambda)\lambda} \times \eta_{\text{int}},$$

where η_{abs} is the absorption efficiency of LSC, AM1.5G(λ) is the solar radiation intensity obtained using a solar simulator AM1.5G, α(λ) is the absorption coefficient of the LSC, *d* is the thickness of the LSC (0.5 cm), *R* is reflectivity (0.03 in this work).

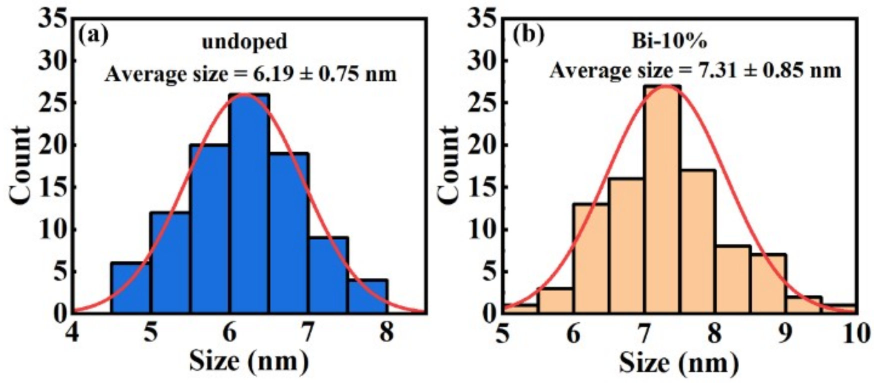

Fig. S1 Histogram of the size distribution of (a) undoped and (b) Bi-doped $Cs_2Na_{0.6}Ag_{0.4}InCl_6$ QDs.

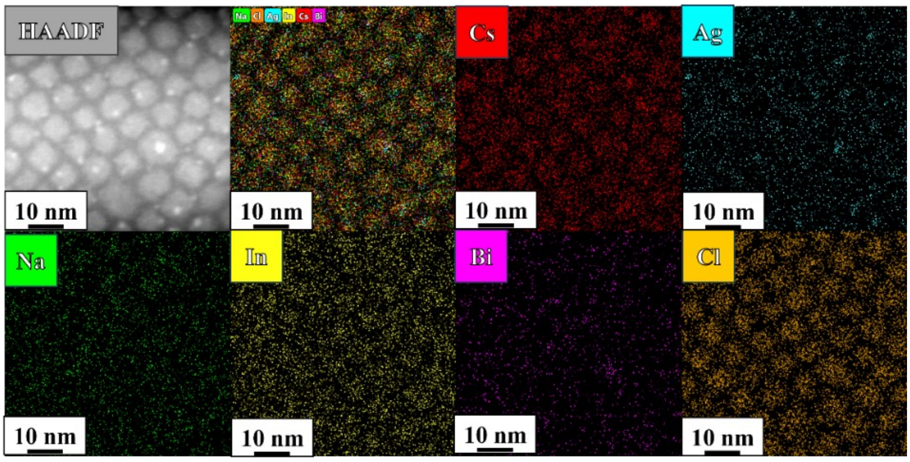

Fig. S2 TEM-EDX elemental images of Bi-doped $Cs_2Na_{0.6}Ag_{0.4}InCl_6$ QDs.

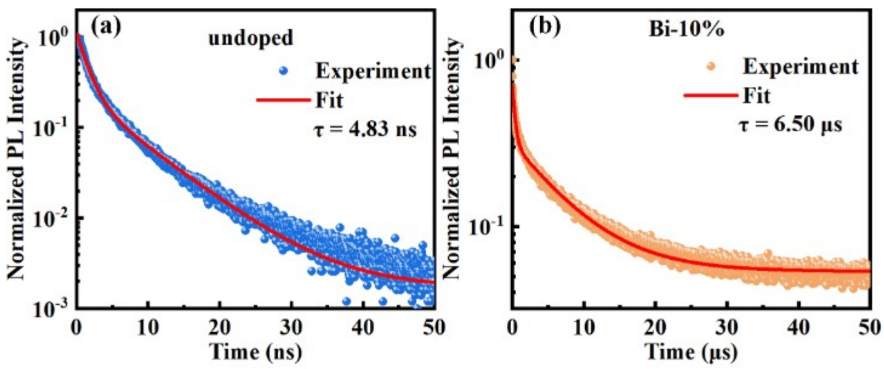

Fig. S3 PL decay curves of (a) undoped and (b) Bi-doped $Cs_2Na_{0.6}Ag_{0.4}InCl_6$ QDs.

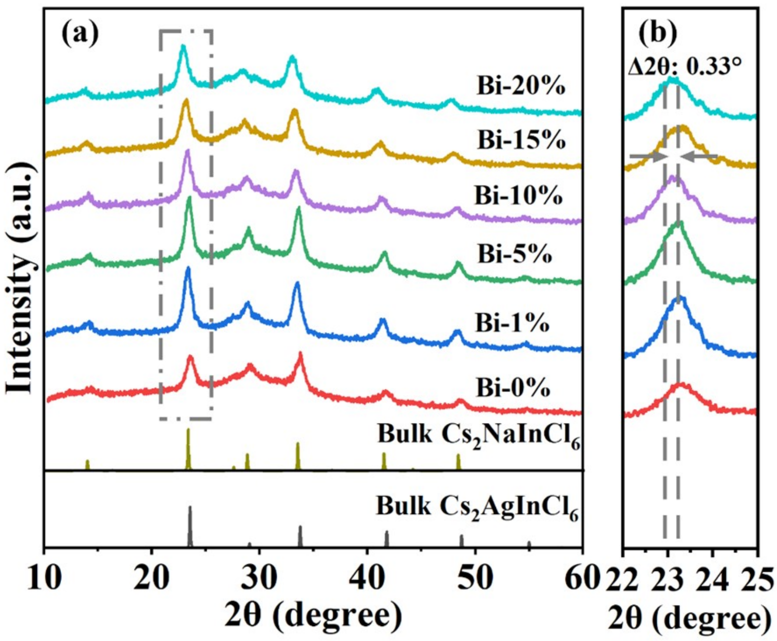

Fig. S4 XRD pattern of Bi-doped $Cs_2Na_{0.6}Ag_{0.4}InCl_6$ QDs with Bi^{3+} cation concentration.

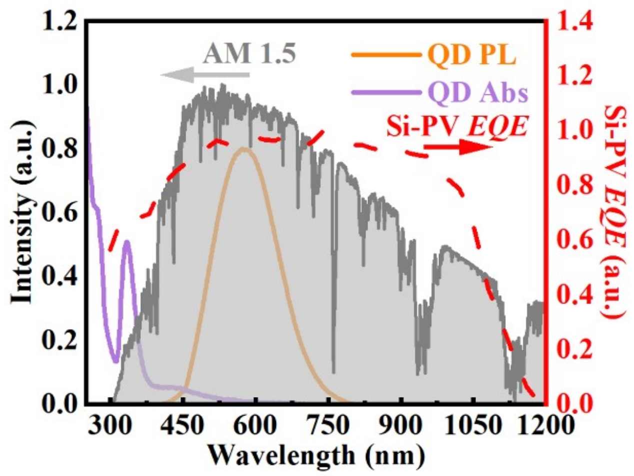

Fig. S5 Absorption (purple line) and PL (orange line) spectra of Bi-doped $Cs_2Na_{0.6}Ag_{0.4}InCl_6$ QDs. Grey shading is the AM 1.5G solar spectrum and the red-dash line is a typical Si PV cell *EQE* spectrum (the PV cell is purchased from ANGUI company of Ningbo, and its *EQE* spectrum is tested by a solar cells energy conversion system CEL-QPCE1000).

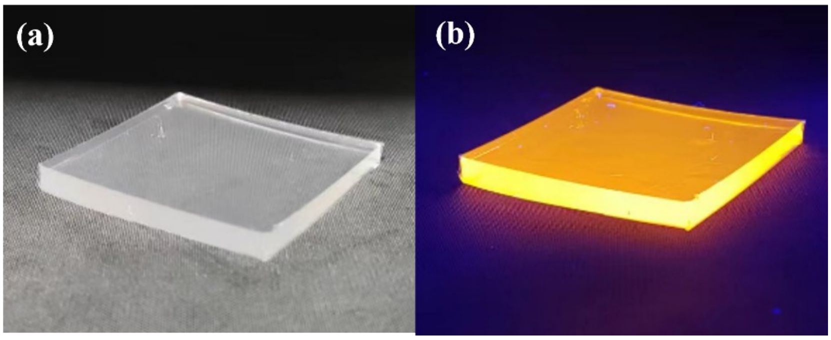

Fig. S6 The photograph of LSC with 3 mg/ml QDs under (a) ambient light; (b) UV lamp irradiation

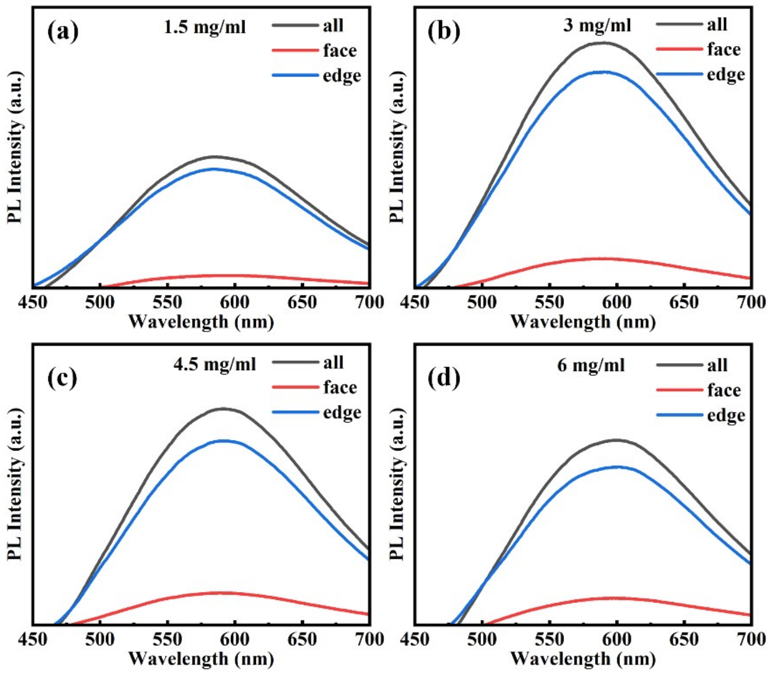

Fig. S7 (a-d) The measurements of the edge-emission efficiency (η_{edge}) of LSCs with the different Bi-doped $Cs_2Na_{0.6}Ag_{0.4}InCl_6$ QDs concentrations. The black lines are the total PL intensity from the unmasked LSCs. The red lines are the face PL intensity from the LSC with the four masked edges using black tapes. The blue line is defined as the edge PL intensity calculated as $I_{edge} = I_{all} - I_{face}$. Finally, $\eta_{edge} = I_{edge} / I_{all}$.

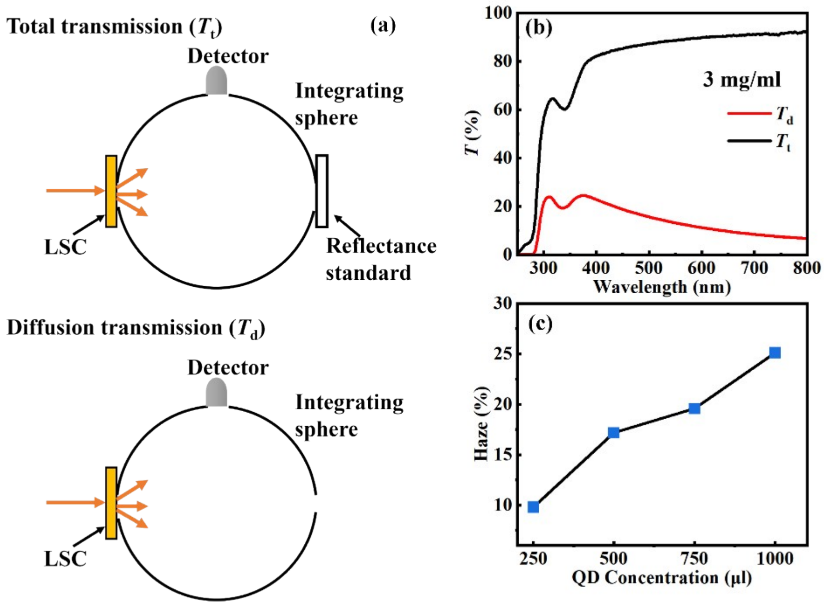

Fig. S8 (a) The schematic of the T_t and T_d measurements. (b) The T_t and T_d of the LSC with 3 mg/ml Bi-doped $Cs_2Na_{0.6}Ag_{0.4}InCl_6$ QDs. (c) The haze of as-fabricated LSCs as a function of QD concentration.

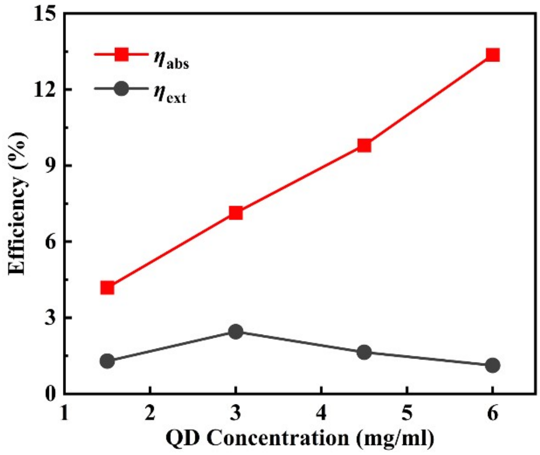

Fig. S9 η_{abs} and η_{int} of LSCs with different QD concentrations.

Table S1 Photovoltaic parameters of LSC-PV systems

QDs concentration (mg/ml)	$J_{sc\text{-}LSC}$ (mA/cm^2)	V_{oc} (V)	*FF* (%)	*PCE* (%)	η_{opt} (%)
1.5	2.41	0.50	60.08	2.30	2.34
3	2.64	0.50	60.25	2.56	2.57
4.5	2.30	0.50	60.09	2.19	2.25
6	2.30	0.50	59.92	2.19	2.23

Table S2 Aesthetic quality parameters of as-fabricated LSCs.

QD concentration (mg/ml)	**CIE1931**		**CRI**	***AVT* (%)**
	x	**y**		
1.5	0.3357	0.3356	95.6	93.68
3	0.3372	0.3369	95.5	91.55
4.5	0.3378	0.3376	95.6	88.88
6	0.3403	0.3398	95.8	85.62
Quartz glass	0.3434	0.3460	97.0	82.85