Supplementary Information

Eco-friendly quantum dots for liquid luminescent solar concentrators

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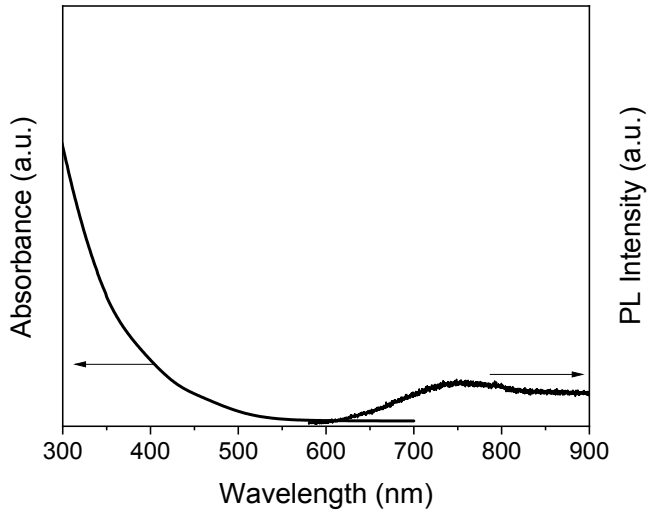

FigS1. Absorption and PL emission spectra of ZISe QDs

Table S1. Detailed PL properties of ZISe QDs under different nominal Cu dopant ratios

Samples	Peak/nm	FWHM/nm	PL QY/%
ZISe	753	475	-
5%CZISe	677	123	22±5%
10%CZISe	702	118	25±5%
15%CZISe	718	115	27±5%
5%CZISe/ZSe	644	136	63±5%

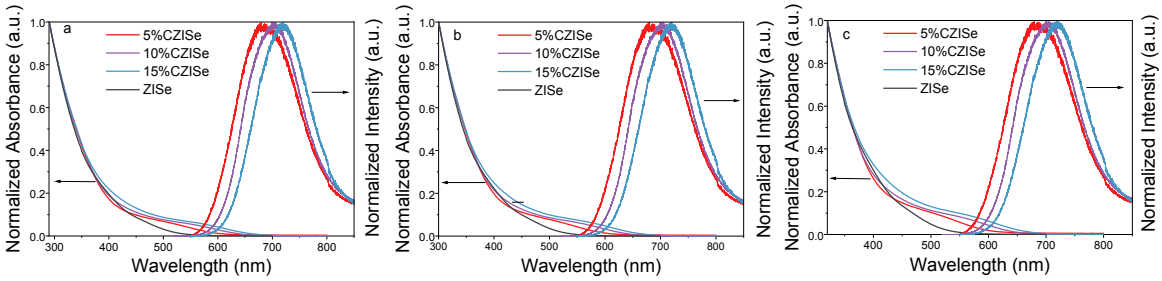

Fig S2. Normalized absorption spectra and emission spectra of as-prepared QDs for overlap area, assumed absorption peak as the maximum intensity for normalization:(a) 290nm, (b) 300nm, (c) 320nm

Table S2. Integrated overlap areas between normalized absorption spectra and PL emission spectra for as-prepared QDs

	290nm*	300nm	320nm
5%CZISe	1.34	1.50	1.91
10%CZISe	1.81	2.00	2.44
15%CZISe	2.17	2.40	2.94

* Assumed absorption peak as the maximum intensity for normalization.

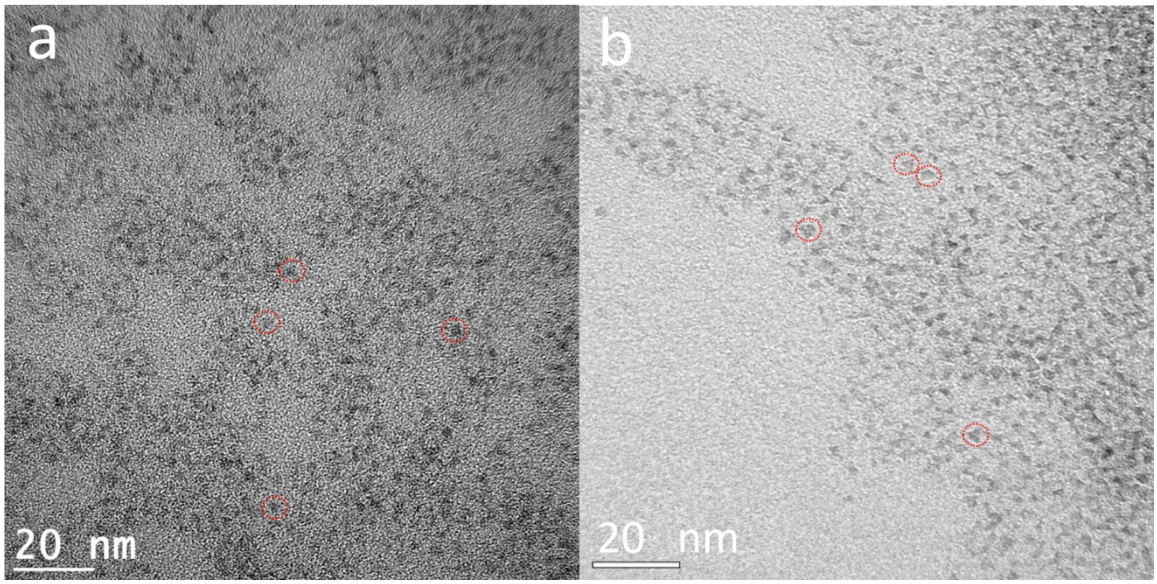

Fig S3. TEM images of as-prepared QDs: (a)ZISe, (b) 15%CZISe

Table S3. Elemental contents in Cu doped ZISe QDs determined by ICP-OES.

Samples	Ion concentration/ppm			Atomic ratio	
	Cu	Zn	In	In/Zn	Cu/(Zn+In)
ZISe	0	1.20	4.30	2.03	0
5%CZISe	0.39	2.19	7.58	1.97	0.062
10%CZISe	0.26	0.73	2.67	2.08	0.118
15%CZISe	0.73	1.39	5.06	2.07	0.175

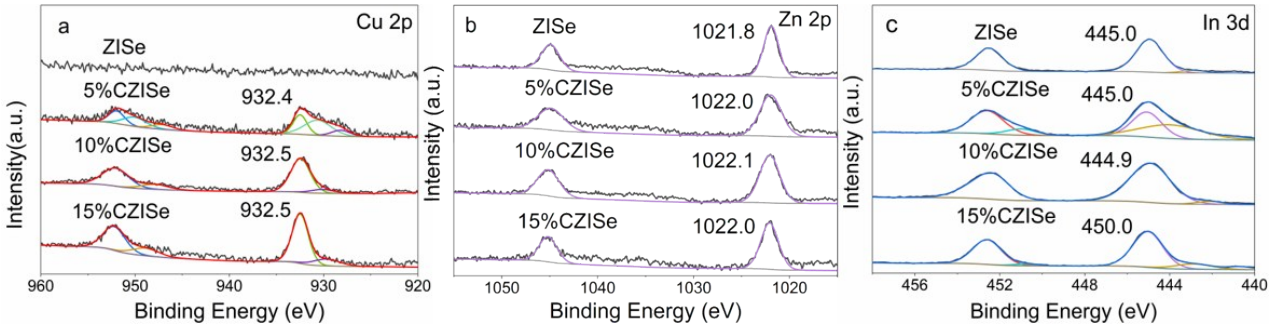

Fig S4. XPS spectra of element (a) Cu, (b) Zn, and (c) In of as-prepared ZISe and CZISe QDs

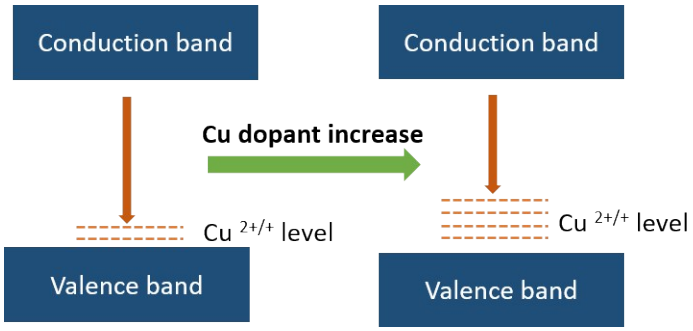

Fig S5 Schematic illustration of the possible energy states of Cu in Zn-In-Se nanocrystal

Table S4. The cost of Liquid LSC and polymer LSC for mass production*

Raw Materials	Liquid LSC	Polymer LSC (based on PMMA)
QDs synthesis	3.1$/m^2	3.1$/m^2
Solvent	2.5$/m^2	0.3$/m^2
Waveguide	12.0$/m^2	9.6$/m^2 (glass 6$, polymer 3.6$)
Total	17.7$/m^2	13$/m^2

* From Alibaba and Ref. 1

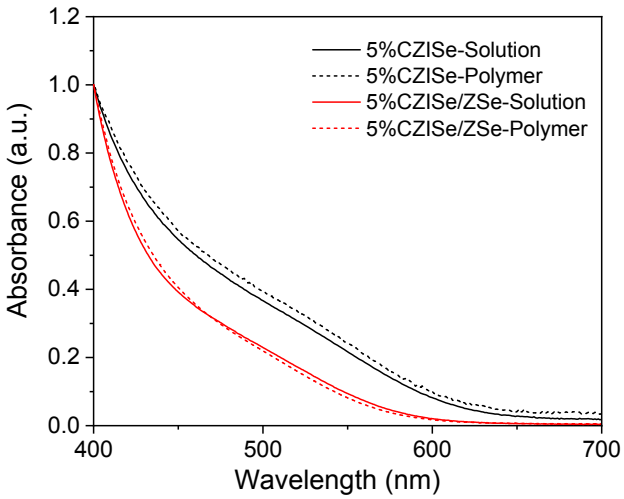

Fig S6. Absorption spectra of 5%CZISe QDs and 5%CZISe/ZSe QDs in solution and in polymer

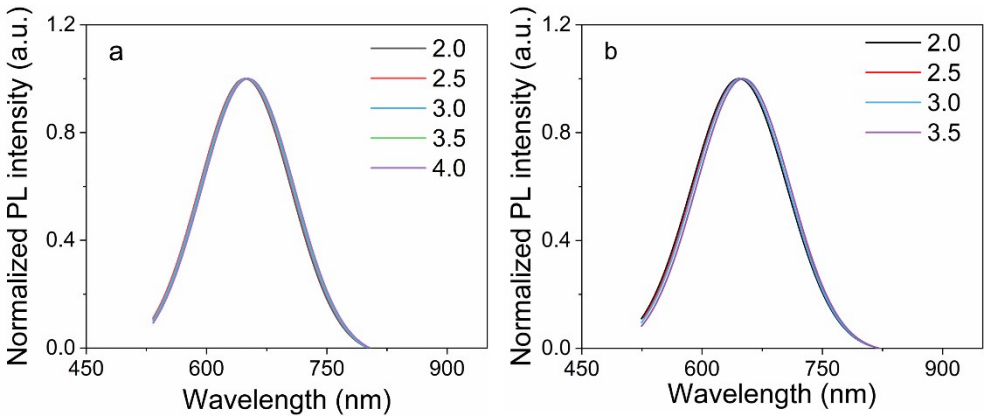

Fig S7. Normalized PL spectra of 5% CZISe/ZSe based LSCs measured at different optical paths for the samples (a) Liquid LSC, (b) Polymer LSC

Table S5. PL dynamics parameters of as-prepared samples in solution and Polymer

Samples	**A_1**	**τ_1/ns**	**A_2**	**τ_2/ns**	**A_3**	**τ_3/ns**	**τ_{ave}/ns**
5%CZISe-Solution	0.15	37.6	0.82	163.0	0.03	9.0	157.7
5%CZISe-Polymer	0.16	38.8	0.82	165.3	0.02	6.1	159.5
5%CZISe/ZSe-Solution	0.10	43.5	0.89	174.4	0.01	7.4	170.6
5%CZISe/ZSe-Polymer	0.08	43.3	0.91	180.0	0.01	8.1	176.8

Table S6. Photovoltaic parameters of Si solar cell coupled with different LSCs (G=15)

Samples	J_{sc}/mA cm^{-1}	V_{oc}/V	FF	PCE/%	η_{opt} /%
Only Si solar cell	23.56	0.54	0.51	6.60	-
Blank polymer	1.99	0.18	0.26	0.10	0.56
Blank quartz cell	2.81	0.24	0.27	0.18	0.80
Blank quartz cell with toluene	3.20	0.26	0.28	0.23	0.90
5%CZISe-Solution	9.30	0.45	0.38	1.63	2.63
5%CZISe-Polymer	2.50	0.21	0.27	0.15	0.70
5%CZISe/ZSe-Solution	9.80	0.46	0.39	1.75	2.77
5%CZISe/ZSe-Polymer	3.44	0.27	0.29	0.28	0.97

Table S7. Optical efficiency of bare liquid LSC and LSCs with matching fluids

Bare LSCs (test No.)	1	2	3	4			Average
Optical efficiency (%)	2.24	2.06	2.23	2.22			2.19
LSCs with matching fluids (test No.)	1	2	3	4	5	6	Average
Optical efficiency (%)	2.18	1.93	2.78	2.09	2.30	2.98	2.38

Reference

1. H. Li, K. Wu, J. Lim, H.-J. Song and V. I. Klimov, *Nat. Energy*, 2016, **1**, 1-9.