Electronic Supplementary Material (ESI) for Journal of Materials Chemistry A.

Supporting Information

Red-Emissive Carbon Quantum Dots Enable High Efficiency Luminescent Solar Concentrators

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Supporting Figures

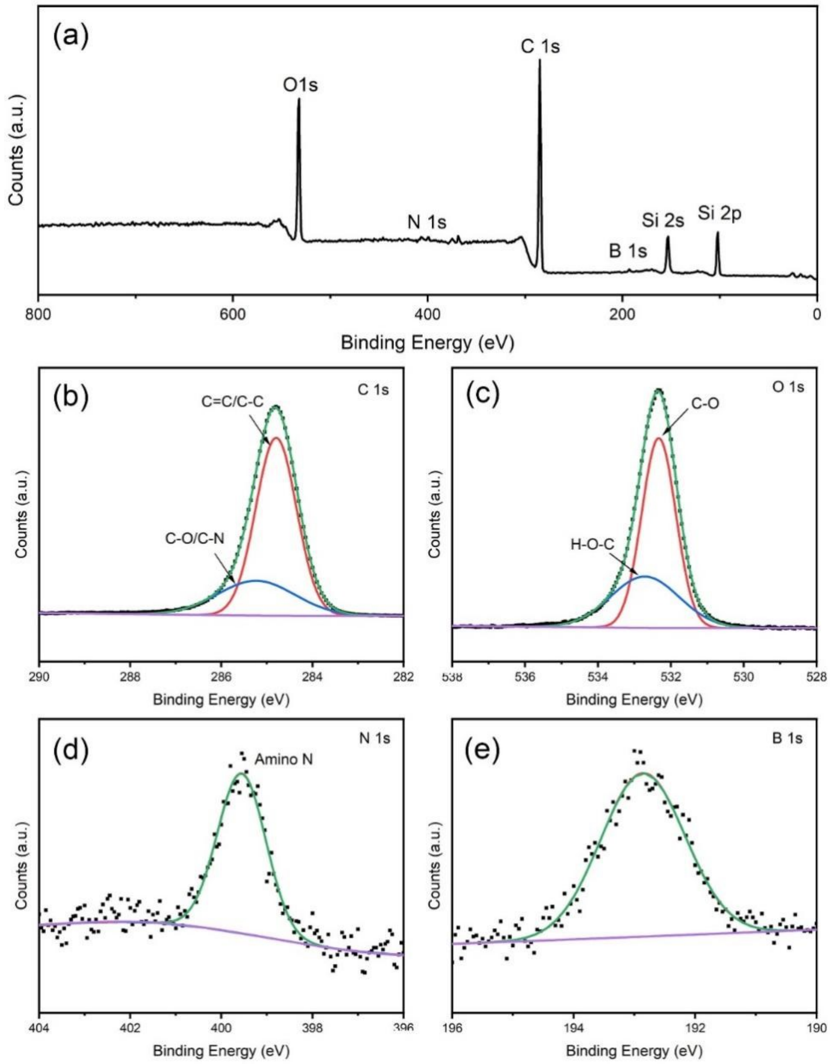

Fig. S1 XPS full survey spectrum of the C-dots (a) and high resolution XPS spectra for C 1s (b), O 1s (c), N 1s (d) and B 1s (e).

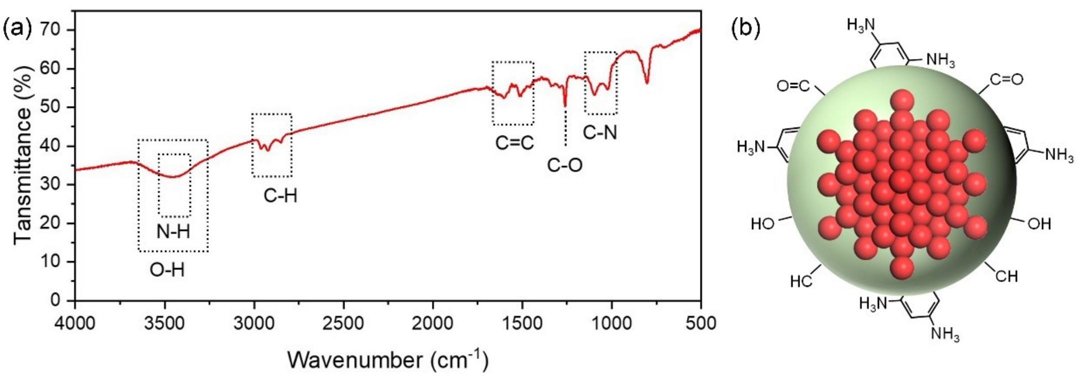

Fig. S2 (a) FT-IR spectrum of the red-emissive C-dots. (b) Schematic diagram of the structure of C-dots.

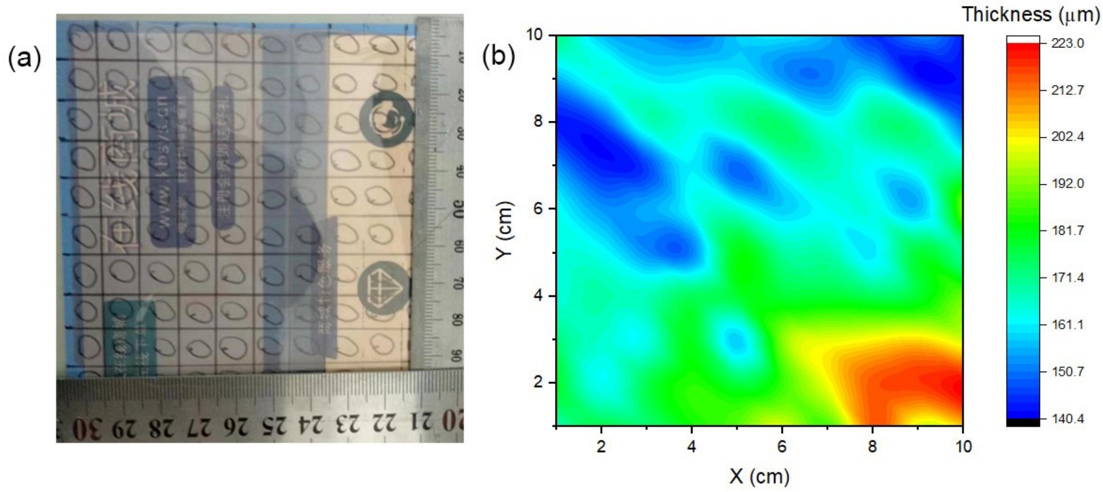

Fig. S3 (a) photograph of the 10×10 cm^2 sized LSC based on C-dots/PMMA film. (b) 2D thickness distribution map of the LSC film.

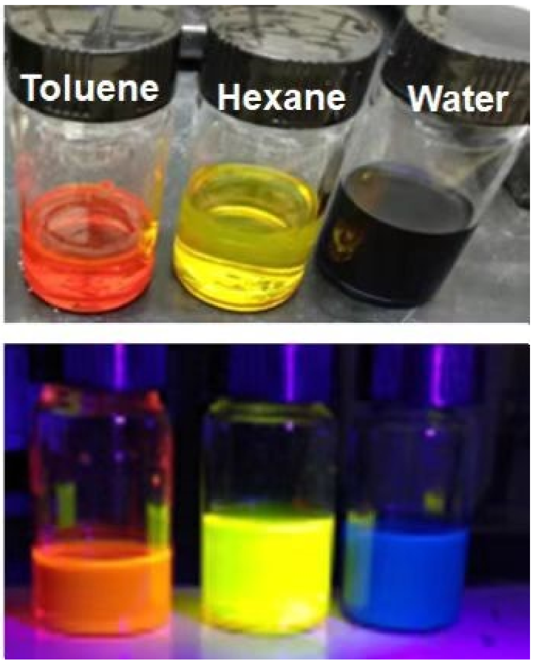

Fig. S4 The photograph of the C-dots dispersed in different solution under indoor sunlight (top) and 365 nm UV light (bottom) irradiation.

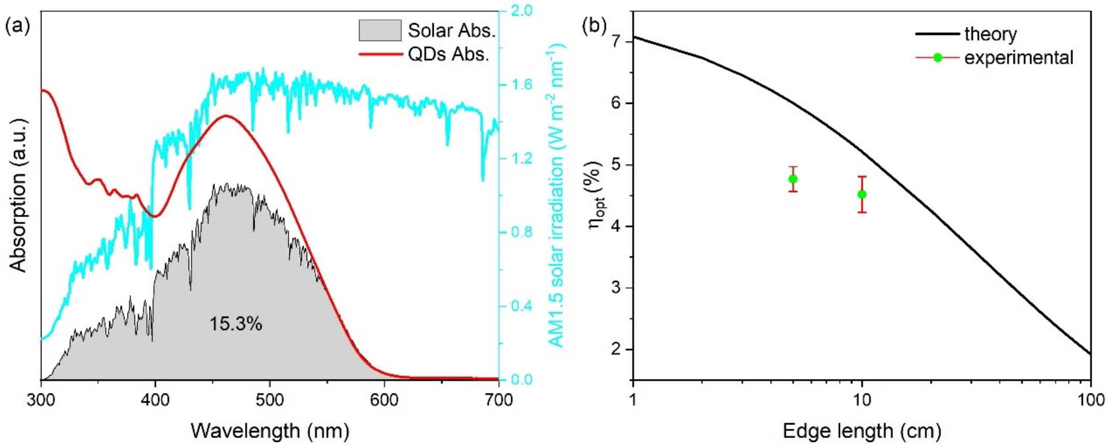

Fig. S5 (a) Absorption spectrum of red-emissive C-dots used in LSC along with the AM 1.5 G solar spectrum. (b) Theoretical external optical efficiency (η_{opt}) of the LSCs with different size under AM 1.5G sunlight illumination and the experimental η_{opt} of the LSCs (10×10×0.5 cm^3 and 5×5×0.5 cm^3).

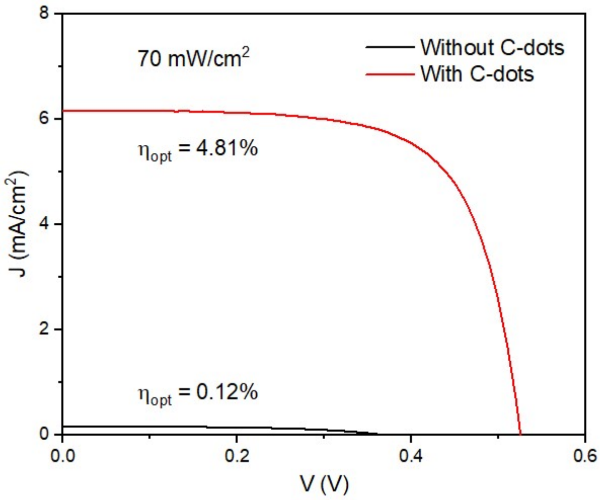

Fig. S6 J-V curves of the LSC-solar cell with and without red-emissive C-dots under 70 mW/cm^2 sunlight illumination. The LSC dimension is 100 cm^2.

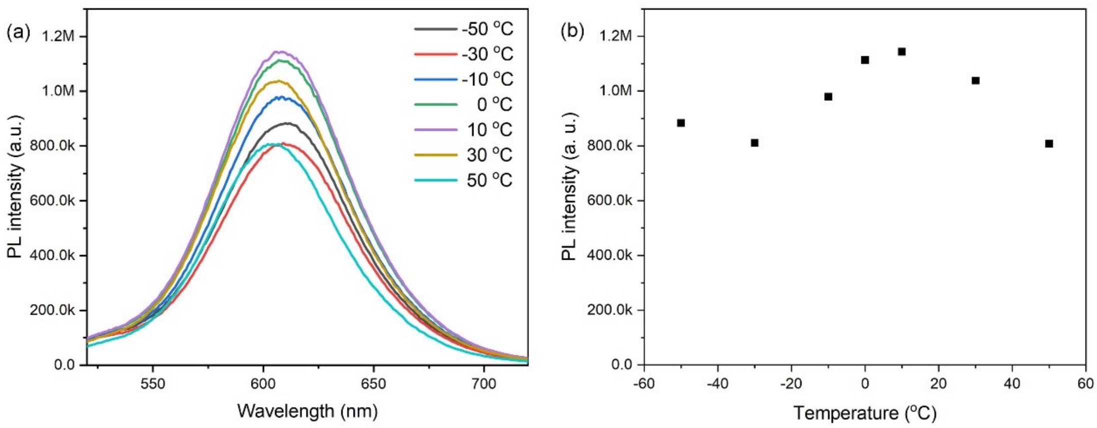

Fig. S7 (a) Temperature dependent PL spectra for red-emissive C-dots based LSC. (b) The change of PL intensity under different temperature.

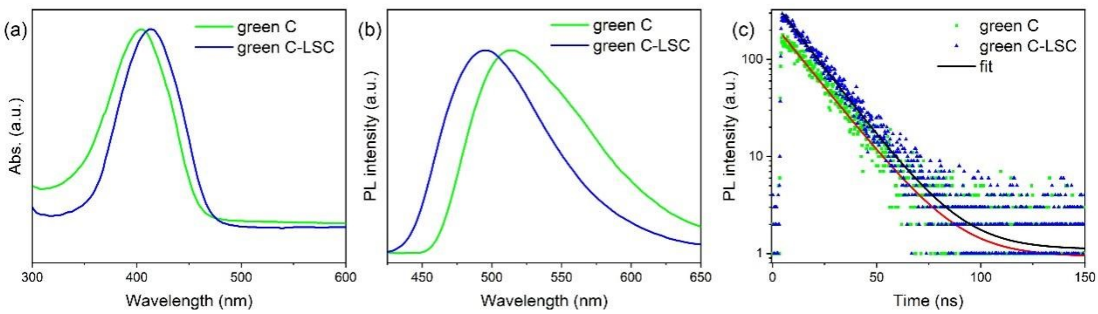

Fig. S8 (a) Absorption, (b) PL emission spectra and (c) PL decay curves of the green-emissive C-dots in methanol and LSC.

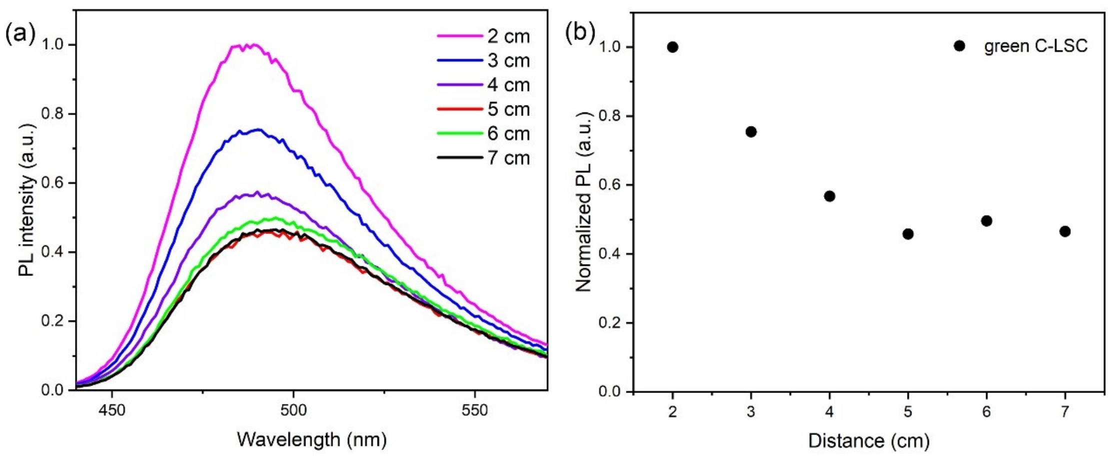

Fig. S9 (a) PL spectra for different light propagation distance between the irradiation and the edge for green-emissive C-dos LSC. (b) Total PL intensity of the LSC as a function of distance of the irradiation from the side edge.

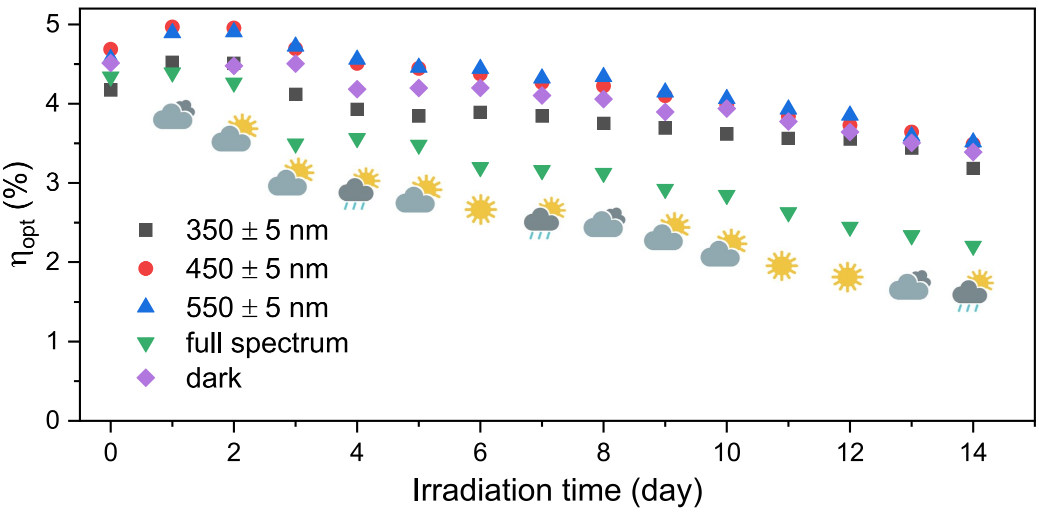

Fig. S10 The longtime stability of the LSC under different wavelength of the sunlight irradiation (350 ± 5 nm, 450 ± 5 nm, 550 ± 5 nm, full solar spectrum and dark).

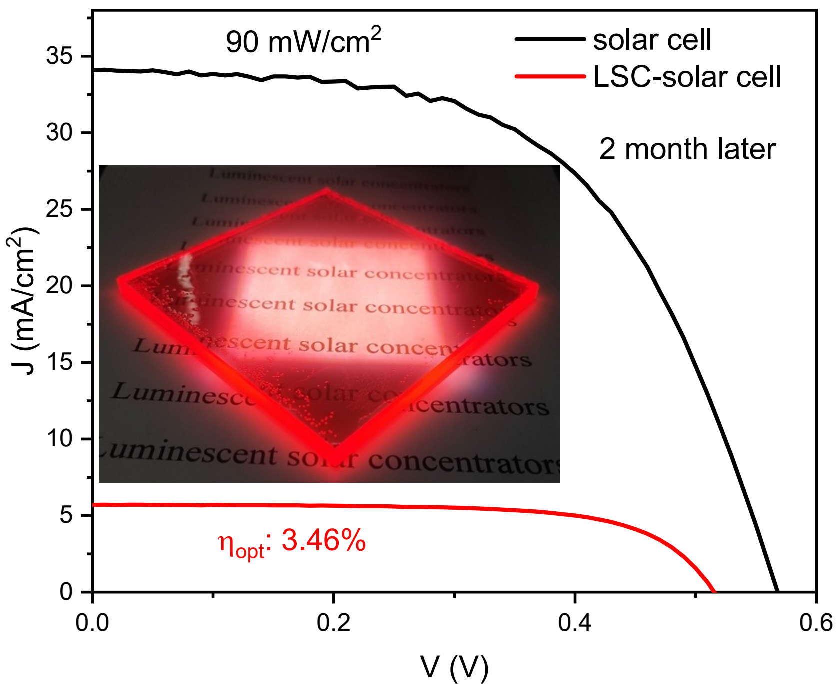

Fig. S11 J-V curve of the red C-dots based LSC-solar cell placed in a nature room for 2 months.

Table S1. External optical efficiency for the LSCs based on C-dots.

Types of luminophore	Type of LSC	External optical efficiency (%)	LSC area (cm^2)	Ref.
C-dots	Single	2.88	25	1
boric acid-graphene QDs	Single	2.5	100	2
C-dots	Single	2.7	100	3
	Single	2.2	225	
Ag40@SiO_2/C-dots	Single	0.9	25	4
organosilane-functionalized C-dots	single	3.9	9	5
N-doped C-dots	single	4.52	12.5	6
C-dots	single	5.26	25	7
N-doped C-dots	single	5.02	3.24	8
N-doped C-dots	single	12.23	4	9
C-dots	laminated	1.6	100	10
N-doped C-dots	laminated	4.75	4	11
UV C-dots and visiable C-dots	tandem	1.1	100	12
Red and yellow C-dots	tandem	4.3	100	13
Red, green and yellow C-dots	tandem	2.3	64	14
Red, green and yellow C-dots	tandem	4.03	6.25	15
C-dots $CsPb(I_xBr_{1-x})_3$ $CsPb(Cl_xBr_{1-x})_3$	tandem	3.05	100	16
Red C-dots	single	4.81	100	This work
Green C-dots	single	3.0	100	This work
Red C-dots and green C-dots	**tandem**	**6.78**	**100**	**This work**

Table S2 Stability of LSCs based on various luminophores in previously reports.

Types of luminophore	η_{opt} (%)	PCE (%)	Thermal stability	Long-term stability	Ref.
Cu-deficient CuGaAlS/ZnS core/shell QDs	/	4.29	74% (40 ℃) 50% (80 ℃)	/	17
Blue C-dots	2.61	/	287% (35 ℃)	/	18
Green C-dots	2.76		261% (35 ℃)		
Aggregation-induced emission molecules	4.2	1.4	/	70% (180 h)	19
C-dots	2.88	2.82	92% (70 ℃)	~100% (14 days)	1
Cu_4I_6(pr-ted)$_2$	3.6	3.59	64% (70 ℃)	~100% (14 days)	
Si-C-dots	7.58	6	/	83% (2 months)	20
CdSe/CdS QDs	2.3	/	80.4% (40 ℃)	/	21
Red, yellow, green C-	4.03	2.92	/	89.3 (7 days)	15

dots					
Red C-dots	4.81	2.41	89% (60 °C)	72% (2 months)	This work

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