Experimental Section

Synthesis of PEG-*m*-CQDs

2 g of glucose was heated at 195 ± 5 ^{o}C using a heating mantle for 6 min until the liquid was changed from colorless to orange. Subsequently, the resultant was dissolved in 50 mL of deionized water for future use. 0.2 g of PEG (M_W = 4000) was added into 30 mL of above-mentioned solution, and stirred until dissolved completely. Then the solution was transferred into a Teflon lined autoclave and heated at 170 ^{o}C for 6 h. After cooling to room temperature, the solution was subjected to filtered, centrifuged (8000 rpm) and dialyzed in a dialysis bag (3500 D) for three days and the pure PEG-*m*-CQDs aqueous solution with the property of down- and up-conversion was obtained.

Synthesis of transparent CoSe CE

A mixing aqueous solution consisting of 2 mM SeO_2 ultrafine powers, 2 mM $CoCl_2$ and 100 mM LiCl in deionized water. Subsequently, the CoSe alloy CE on cleaned FTO glass was built on a traditional CHI660E setup comprising a CE of platinum sheet, an Ag/AgCl reference electrode, and a working electrode of FTO substrate. A cyclic voltammetry method was realized by depositing CoSe. The potential range, scan rate and scanning number were controlled at -1.0 to 0.4V, 10 mV s^{-1} and 1 cycle, respectively.

Synthesis of transparent CQDs-CoSe CE

The above-mentioned CoSe electrode was used as a new work electrode, the pure PEG-*m*-CQDs aqueous solution was a electrolyte. A cyclic voltammetry method was realized by depositing PEG-*m*-CQDs on the surface of CoSe substrate. The fluorescent CE was prepared by scanning from -0.8 to 0.4 V at a scan rate of 10 mV s^{-1} for 10 cycle.

Assembly of DSSCs and photovoltaic measurements

The N719 dye-sensitized TiO_2 photoanode with an active area of 0.25 cm^2 was prepared according to our previous report.[S1] Each DSSC device was fabricated by sandwiching the redox electrolyte between a dye-sensitized TiO_2 anode and a CoSe or CQDs-CoSe transparent alloy CE. A liquid redox electrolyte consists of 0.1 M tetraethylammonium iodide, 0.1 M tetramethylammonium iodide, 0.1 M tetrabutylammonium iodide, 0.1 M NaI, 0.1 M KI, 0.1 M LiI, 0.05 M I_2 and 0.05 M 4-tert-butyl-pyridine in acetonitrile. The photocurrent density-voltage (*J-V*) curves of various solar cells were recorded on a CHI660E electrochemical work station under irradiation of simulated solar light from an intensity controlled to 100 mW cm^{-2} xenon arc lamp.

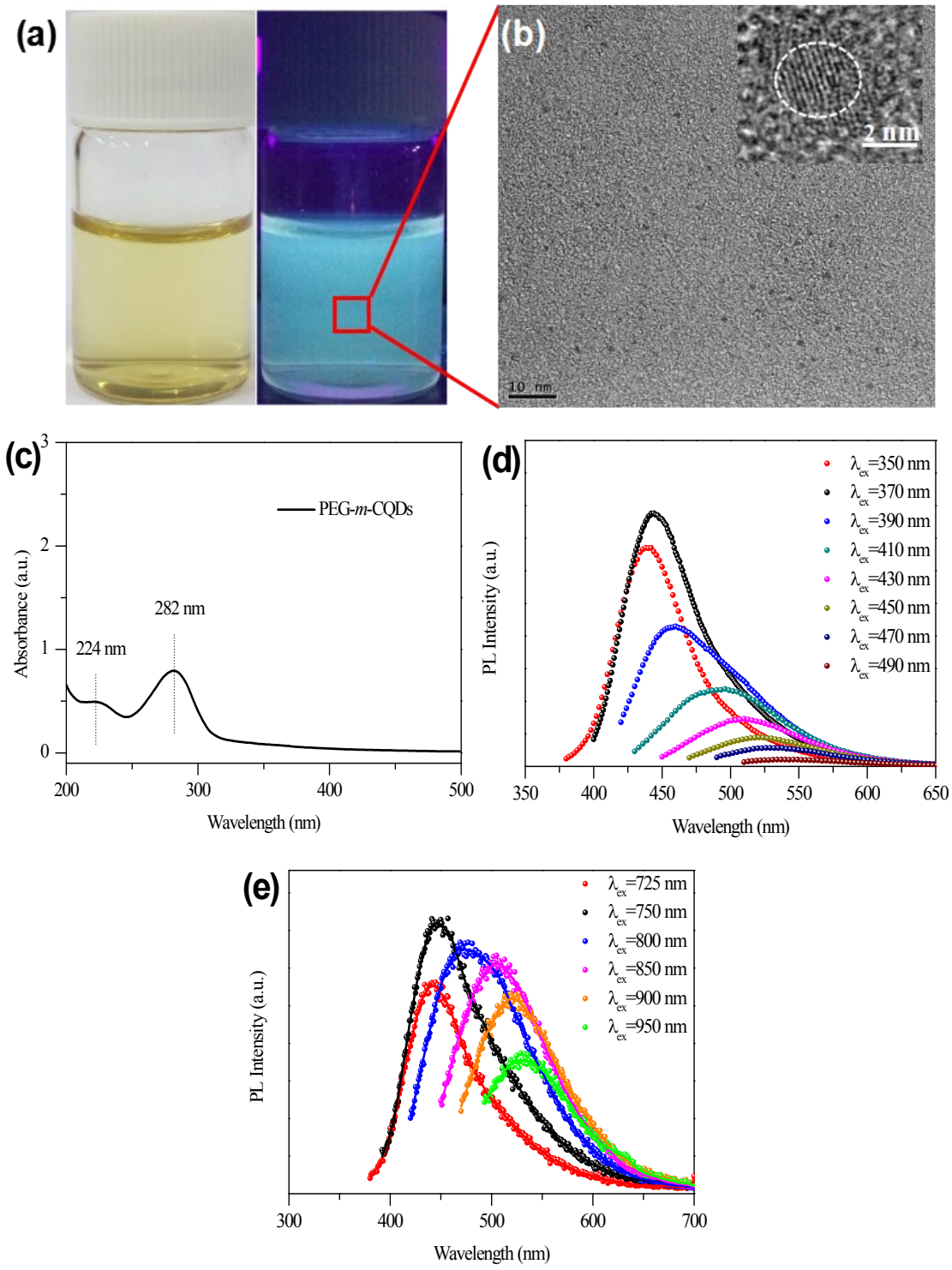

Fig. S1. (a) The photographs of the PEG-*m*-CQDs taken under visible light (left) and 365 nm UV lamp irradiation (right). (b) TEM image of the PEG-*m*-CQDs (insert is the HRTEM image). (c) UV-vis absorption of PEG-*m*-CQDs. PL emission spectra of the PEG-*m*-CQDs under excitation in the range of (d) 350-490 nm and (e) 725-950 nm.

Table S1. The electrochemical parameters extracted from CV, EIS and Tafel characterizations.

CEs	J_{Red1} (mA cm^{-2})	E_{pp} (V)	R_s (Ω cm^2)	R_{ct} (Ω cm^2)	J_{lim} (mA cm^{-2})	J_0 (mA cm^{-2})
CoSe, dark	-6.304	0.510	16.13	13.26	1.264	0.768
CoSe, light	-6.421	0.502	16.21	13.18	1.298	0.616
CQDs-CoSe, dark	-6.592	0.502	12.69	13.83	1.461	0.588
CQDs-CoSe, light	-7.127	0.451	12.82	9.543	1.624	0.590

[1] Y. Duan, Q. Tang, B. He, Z. Zhao, L. Zhu and L. Yu, *J. Power Sources*, 2015, **284**, 349-354.