Electronic Supplementary Information (ESI)

Performance enhancement of quantum dot sensitized solar cells by adding electrolyte additives

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Preparation of the copper sulfide counter electrode

$Cu_{2-x}S$ nanoparticles were prepared by a solvothermal method. Briefly, 9.6 mmol of thiourea were added into 30 mL of ethylene glycol followed by ultrasonicating to give transparent solutions. The ethylene glycol solution (30 mL) of $Cu(CH_3COO)_2.H_2O$ (3.2 mmol) were also obtained according to the similar method. The above solutions were then mixed together and transferred into a 100 mL teflon-lined stainless autoclave. The reaction was proceeded at 180 ^oC for 5 h. After cooling to room temperature, the precipitates were purified with ethanol and deionized water respectively three times. A total of 250 mg of the dried Cu_{2-x} S nanoparticles were added to anhydrous ethanol under continuous sonication, together with 1.0 g of terpineol and 2.3 g of 10 wt% ethyl cellulose, followed by further sonication for 5 min to get a uniform mixture. The ethanol was then removed via a rotary-evaporator. The as-prepared $Cu_{2-x}S$ pastes were screen-printed onto cleaned FTO glass.

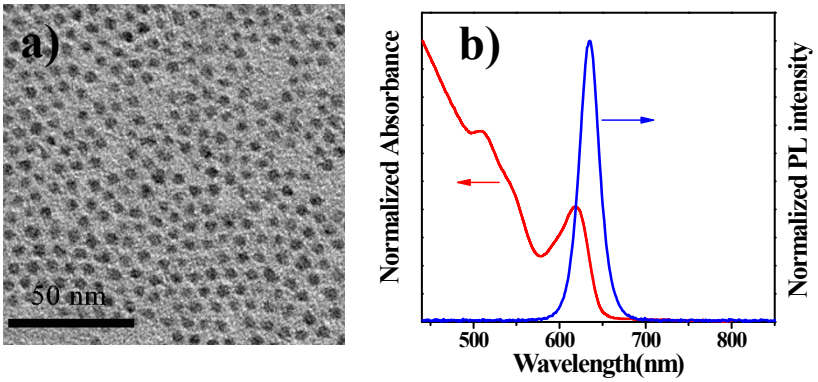

Fig. S1. TEM image (a) and UV-vis absorption (red line) and PL emission (blue line, λ_{ex} = 410 nm) spectra of pre-synthesized oil-soluble CdSe QDs.

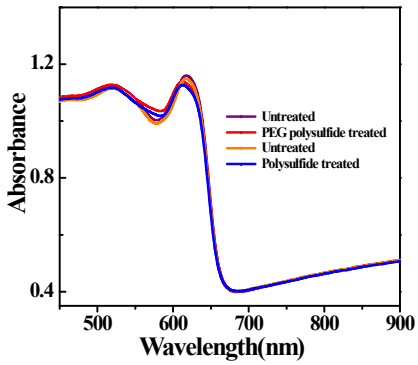

Fig. S2. Absorption spectra of the CdSe QDs films before and after with polysulfide electrolyte with(red) and without(bule) 15 wt% PEG additives treatment.

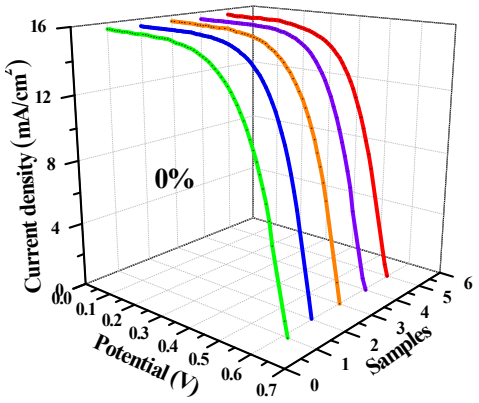

Fig. S3. *J-V* curves of polysulfide electrolyte based cell devices under the irradiation of AM 1.5G full one sun with 5 devices in parallel.

Table S1. Photovoltaic parameters for QDSCs based on polysulfide electrolyte under the irradiation of AM 1.5G full one sun with 5 devices in parallel.

PEG Concentration (wt%)	J_{sc} (mA·cm^{-2})	V_{oc} (V)	FF (%)	PCE (%)
0%	15.47	0.615	60.51	5.76
	15.71	0.598	62.08	5.83
	15.89	0.601	60.62	5.79
	15.39	0.604	63.16	5.87
	15.62	0.599	61.24	5.73
average	15.62±0.198	0.603±0.006	61.52±1.11	5.80±0.055

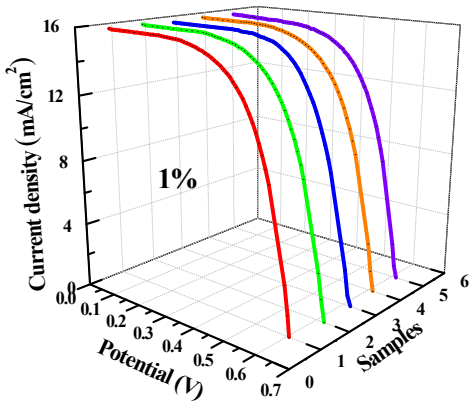

Fig. S4. *J-V* curves of cell devices based on polysulfide electrolyte containing 1% (wt%) concentrations of PEG additive under the irradiation of AM 1.5G full one sun with 5 devices in parallel.

Table S2. Photovoltaic parameters for QDSCs based on polysulfide electrolyte containing 1% (wt%) concentrations of PEG additive under the irradiation of AM 1.5G full one sun with 5 devices in parallel.

PEG Concentration (wt%)	J_{sc} (mA·cm^{-2})	V_{oc} (V)	FF (%)	PCE (%)
1%	15.67	0.606	62.31	5.92
	15.79	0.623	61.22	6.02
	15.72	0.621	62.49	6.10
	15.38	0.613	63.12	5.95
	15.85	0.608	62.15	5.99
average	15.68±0.182	0.614±0.007	62.26±0.687	6.00±0.069

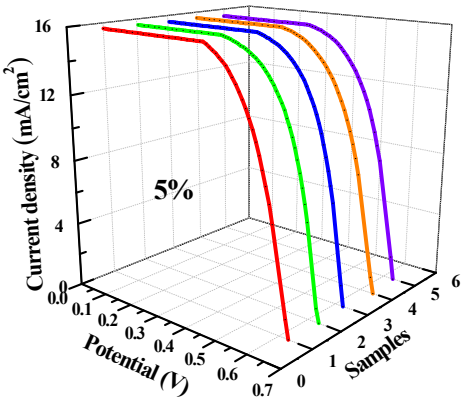

Fig. S5. *J-V* curves of cell devices based on polysulfide electrolyte containing 5% (wt%) concentrations of PEG additive under the irradiation of AM 1.5G full one sun with 5 devices in parallel.

Table S3. Photovoltaic parameters for QDSCs based on polysulfide electrolyte containing 5% (wt%) concentrations of PEG additive under the irradiation of AM 1.5G full one sun with 5 devices in parallel.

PEG Concentration (wt%)	J_{sc} (mA·cm^{-2})	V_{oc} (V)	FF (%)	PCE (%)
5%	15.72	0.629	62.09	6.14
	15.98	0.632	62.18	6.28
	15.84	0.639	62.83	6.36
	15.58	0.624	63.89	6.21
	15.53	0.630	64.68	6.33
average	15.73±0.186	0.631±0.005	63.13±1.124	6.26±0.089

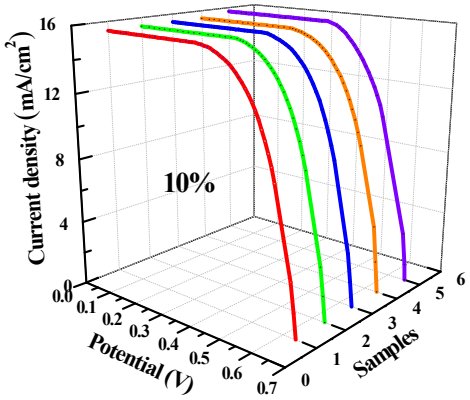

Fig. S6. *J-V* curves of cell devices based on polysulfide electrolyte containing 10% (wt%) concentrations of PEG additive under the irradiation of AM 1.5G full one sun with 5 devices in parallel.

Table S4. Photovoltaic parameters for QDSCs based on polysulfide electrolyte containing 10% (wt%) concentrations of PEG additive under the irradiation of AM 1.5G full one sun with 5 devices in parallel.

PEG Concentration (wt%)	J_{sc} (mA·cm^{-2})	V_{oc} (V)	FF (%)	PCE (%)
10%	15.21	0.637	66.26	6.42
	15.65	0.636	65.39	6.51
	15.51	0.637	66.08	6.53
	15.63	0.642	66.28	6.65
	15.46	0.637	65.79	6.48
average	15.49±0.177	0.638±0.002	65.96±0.374	6.52±0.084

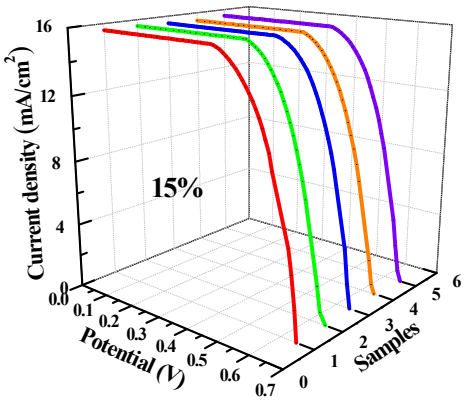

Fig. S7. *J-V* curves of cell devices based on polysulfide electrolyte containing 15% (wt%) concentrations of PEG additive under the irradiation of AM 1.5G full one sun with 5 devices in parallel.

Table S5. Photovoltaic parameters for QDSCs based on polysulfide electrolyte containing 15% (wt%) concentrations of PEG additive under the irradiation of AM 1.5G full one sun with 5 devices in parallel.

PEG Concentration (wt%)	J_{sc} (mA·cm^{-2})	V_{oc} (V)	FF (%)	PCE (%)
15%	15.60	0.647	66.08	6.68
	15.61	0.639	67.65	6.75
	15.81	0.643	66.97	6.81
	15.84	0.646	65.77	6.73
	15.47	0.651	66.91	6.74
average	15.66±0.156	0.646±0.004	66.68±0.753	6.74±0.046

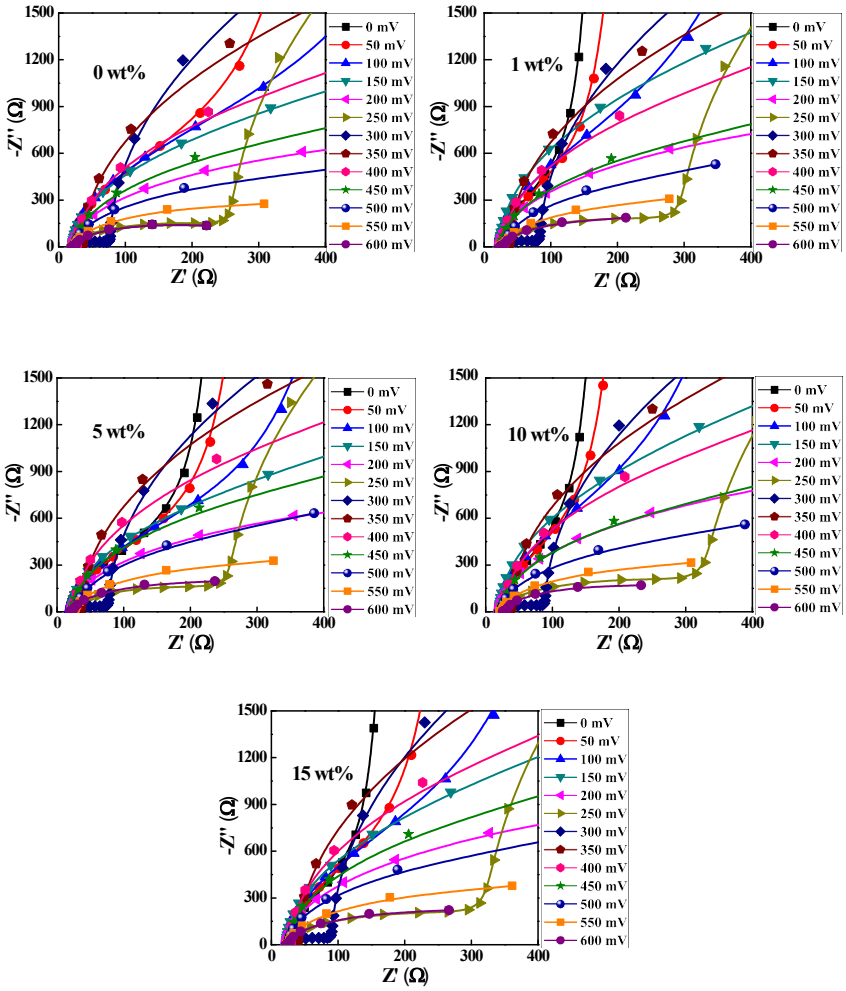

Fig. S8. Nyquist plots for polysulfide electrolyte containning different concentrations of PEG additives based cell devices under different forward bias voltages.

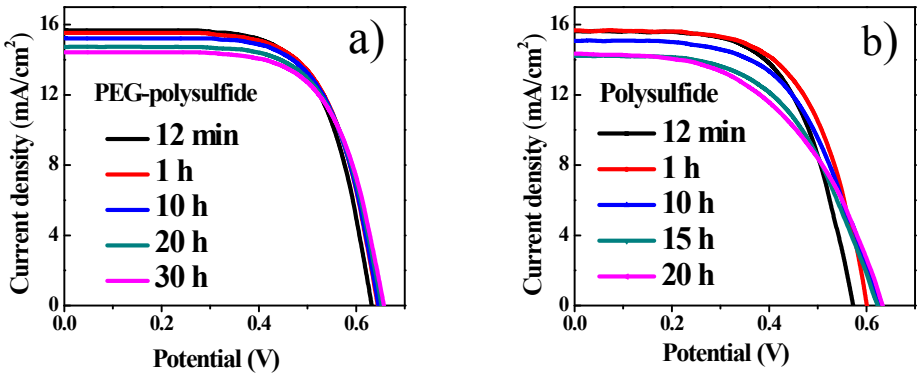

Fig. S9. Temporal evolution of *J-V* curves for cell devices based on PEG-polysulfide electrolyte (a), and polysulfide electrolyte (b) under the continuous irradiation by an AM 1.5 G solar simulator with intensity of 100 mW/cm^2 at room temperature.