Supporting Information for:

Aqueous dye-sensitized solar cell electrolytes based on the cobalt(II)/(III) tris(bipyridine) redox couple

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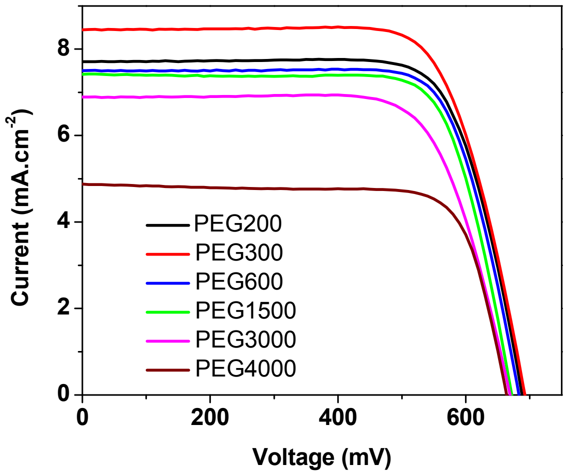

Figure S1. I-V curves of DSCs constructed with MK2 dye and tested with aqueous electrolyte systems containing 20 mM of different molecular weight PEG derivatives. Each electrolyte also contained 0.20 M $[Co(bpy)_3](NO_3)_2$, 0.060 M $[Co(bpy)_3](NO_3)_3$ and 0.70 M NMBI.

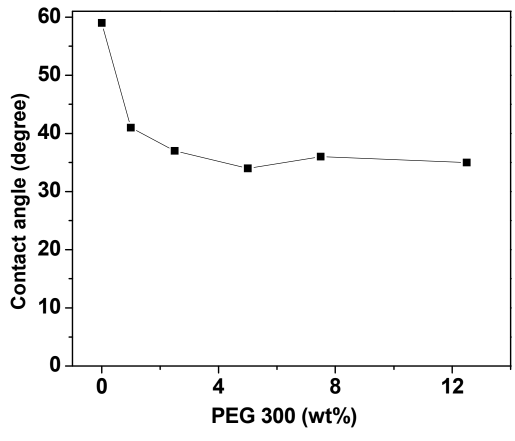

Figure S2. Contact angle of aqueous electrolytes on dyed TiO_2 surface as a function of PEG 300 concentration. TiO_2 films were immersed into MK2 dye solution for 6 hours before being taken out for measurement.

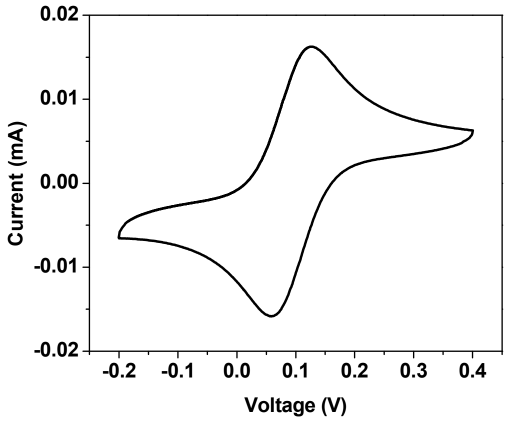

Figure S3. Cyclic voltammograms of the $[Co(bpy)_3]^{2+/3+}$ redox couple in water (vs Ag/AgCl) .

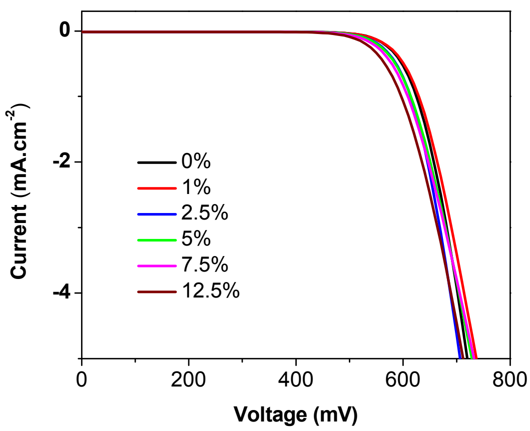

Figure S4. Dark current measurement of DSCs. (same devices as shown in Figure 2)

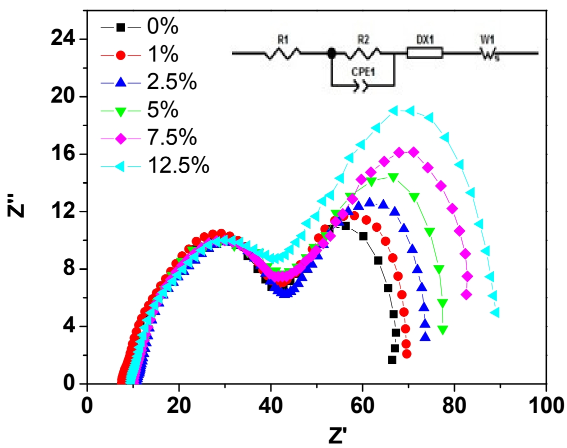

Figure S5. Nyquist plot of DSCs for aqueous electrolytes differing in the PEG 300 content measured under 100 mW cm^{-2} sun irradiation. Inset: Equivalent circuit used to represent interfaces in aqueous electrolyte based DSCs.

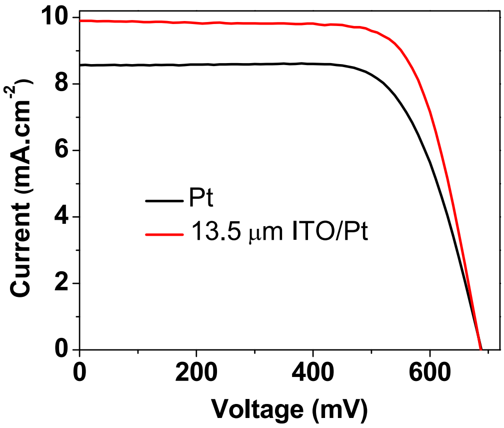

Figure S6. I-V curves of DSCs constructed with MK2 dye and tested under simulated AM1.5 solar irradiation (100 mW cm^{-2}) for aqueous electrolyte system with different counter electrodes.

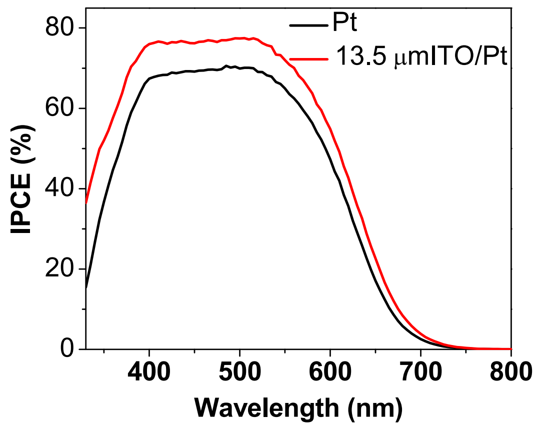

Figure S7. IPCEs of DSCs corresponding to I-V curve shown in Figure S6.

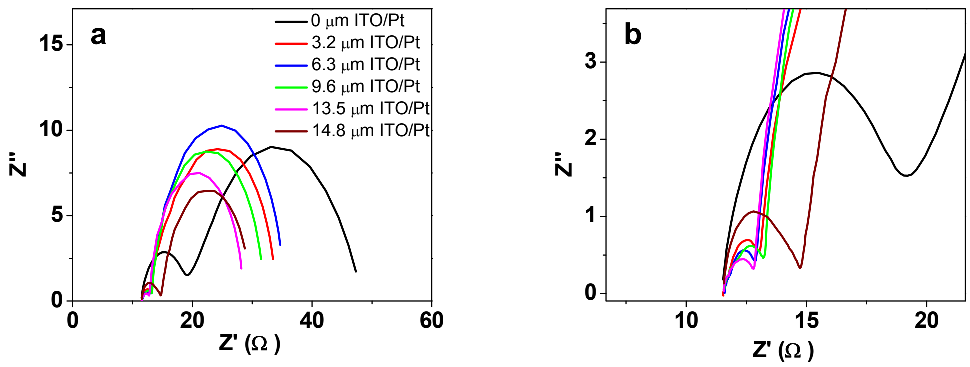

Figure S8. a) Nyquist plot of DSCs of symmetric cells based on CE // aqueous electrolyte // CE structure with 0V bias voltage; b) Zoom in high frequency area.

Table S1. Photovoltaic performance of DSCs constructed using MK2 and aqueous $[Co(bpy)_3]^{2+/3+}$ electrolytes containing increasing amounts of PEG 300.[a]

PEG 300	V_{oc} (mV)	J_{sc} ($mAcm^{-2}$)	ff	η (%)
1 Sun				
0%	673±2	7.4±0.1	0.72±0.02	3.6±0.1
1%	685±4	8.3±0.2	0.72±0.01	4.2±0.1
2.5%	670±2	7.8±0.2	0.73±0.02	3.9±0.1
5%	665±3	7.5±0.2	0.73±0.01	3.6±0.1
7.5%	659±2	7.3±0.1	0.72±0.01	3.5±0.1
12.5%	647±2	7.1±0.2	0.70±0.01	3.3±0.1
0.1 Sun				
0%	605±2	0.83±0.02	0.77±0.01	3.9±0.1
1%	615±3	0.96±0.01	0.76±0.01	4.4±0.1
2.5%	603±2	0.96±0.02	0.77±0.01	4.3±0.1
5%	596±3	0.97±0.02	0.76±0.01	4.3±0.2
7.5%	591±1	0.99±0.01	0.76±0.01	4.4±0.1
12.5%	577±3	0.97±0.01	0.76±0.01	4.2±0.1

[a] Electrolyte composition was: 0.20 M $[Co(bpy)_3](NO_3)_2$, 0.060 M $[Co(bpy)_3](NO_3)_3$, 0.70 M NMBI and various wt% of PEG 300 in water. V_{oc} is the open circuit voltage, J_{sc} is the short circuit current, ff is the fill factor and η is the energy conversion efficiency. The performance parameters are averaged from the test results obtained for at least three devices.

Table S2. Photovoltaic performance of DSCs with different molecular weight of PEG under simulated AM 1 sun solar irradiation (100 $mWcm^{-2}$).[a]

PEG M_W	V_{oc} (mV)	J_{sc} ($mAcm^{-2}$)	ff	η (%)
200	687±2	7.6±0.1	0.73±0.01	3.9±0.1
300	690±4	8.4±0.2	0.72±0.01	4.3±0.1
600	682±1	7.5±0.1	0.73±0.02	3.9±0.1
1500	672±2	7.2±0.2	0.73±0.02	3.6±0.2
3000	666±3	6.8±0.1	0.72±0.01	3.3±0.1
4000	661±3	4.8±0.1	0.75±0.01	2.5±0.1

[a] DSCs were constructed with MK2 dye and tested with two electrolyte systems whose compositions was as follows: 0.20 M $[Co(bpy)_3](NO_3)_2$, 0.060 M $[Co(bpy)_3](NO_3)_3$, 0.70 M NMBI, 20 mM PEG with different molecular weight in deionized water.

Table S3. Parameters fitted from EIS measurements under simulated AM1.5 solar irradiation (100 mW cm^{-2}).[a]

PEG 300 (wt%)	R_{ct} (Ω)	R_{diff} (Ω)	τ ($\times 10^{-4}$s)
0	42.5±0.2	35.5±1.5	2.22±0.12
1	43.8±0.5	30.5±1.7	2.54±0.10
2.5	41.9±0.4	34.8±2.4	2.24±0.14
5	40.7±0.3	38.2±1.8	1.25±0.35
7.5	40.1±0.5	48.1±1.5	0.87±0.11
12.5	38.7±0.6	55.0±1.7	0.54±0.15

[a] Same devices as described in Table S1. R_{ct} is the charge transfer resistance at TiO_2 and electrolyte interface, R_{diff} is the Warburg diffusion resistance in electrolyte, τ is electron lifetime in conduction band of TiO_2.

Table S4 Photovoltaic performance of aqueous DSCs constructed using MK2 and two Ru-dyes (C106 and Z907) and 13.5 µm ITO/Pt counter electrode.[a]

[b]Dye	V_{oc} (mV)	J_{sc} (mAcm^{-2})	ff	η (%)
MK2	687 ± 2	9.7 ± 0. 1	0.73 ± 0.01	4.9 ± 0.1
C106	660 ± 3	7.5 ± 0.1	0.73 ± 0.01	3.7 ± 0.1
Z907	621 ± 4	7.1 ± 0.1	0.73 ± 0.01	3.3 ± 0.1

[a] The performance parameters are averaged from the test results obtained for at least three devices.
[b] For DSCs with MK2 dye, 1 µm transparent TiO_2 + 3 µm scattering TiO_2 working electrodes were used. Due to their low molar extinction coefficients, for DSCs with C106 and Z907 dyes, 2 µm transparent TiO_2 + 3 µm scattering TiO_2 working electrodes were used.