Supporting Information

Influence of Ionic Liquid on Recombination and Regeneration Kinetics in Dye-sensitized Solar Cells

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Part 1. Information on the recently developed organic D-A-π-A dye CBTC.
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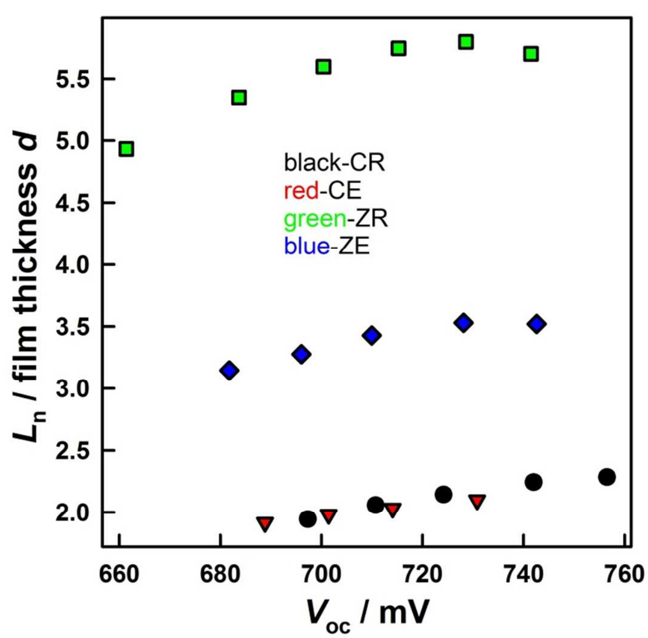
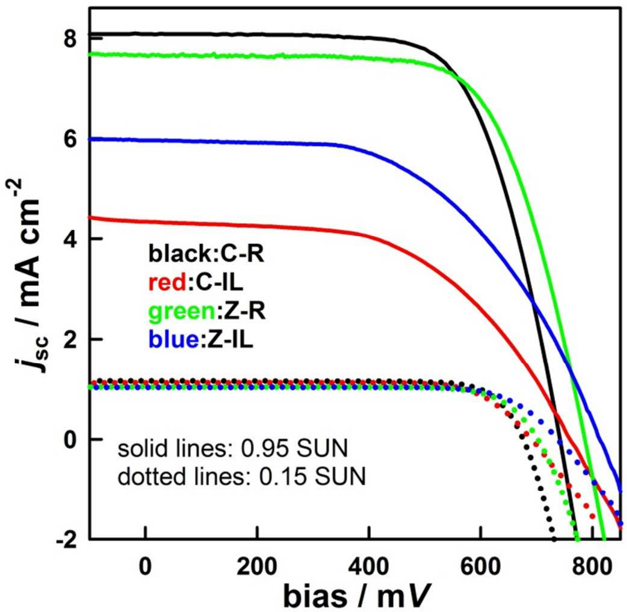
Part 2. Figure. **SI-1**. Electron diffusion length L_n calculated using $L_n = d\sqrt{R_{\mathrm{ct}}/R_{\mathrm{t}}}$ where *d* is the film thickness and R_{ct} and R_{t} are the recombination resistance and electron transport resistance derived from IS data.



Part 3. Figure. **SI-2**. *j-V* characteristics of cells based on $[\mathrm{Co(bpy)_3}]^{2+/3+}$ redox mediator under both 0.95 SUN and 0.15 SUN.



Part 4. Calibration of electron density n during TA measurements.

To obtain $k_{\mathrm{rg}}[Red]$ and $k_{\mathrm{edr}}n^{\chi}$, the electron density n during TA measurements is needed. Here the electron density following the laser pulse is used as the reference, which can be determined by:

$$n_{\mathrm{peak}} = n_{\mathrm{bg}} + \Delta n_{\mathrm{laser}} \tag{SI.1}$$

where n_{bg} is the background electron density with only 627 nm background illumination but no laser pulse and $\Delta n_{\mathrm{laser}}$ is the extra electron density injected into the film due to dye excitation by the laser pulse. n_{bg} can be easily calculated using Eq.**1** from the main article. In order to determine $\Delta n_{\mathrm{laser}}$, the OD change at 970 nm (where only electrons absorb) caused by varying the background light intensity was recorded for Z907 cells ($CBTC^{+}$ absorbs at 970 nm) and correlated to n obtained from integrated $C_{\mu}\sim V_{\mathrm{oc}}$ plots. Fig. **SI-3a** is an example of the $n\sim\Delta\mathrm{OD}$ plots, from which it is estimated that ΔOD = 1 approximately corresponds to Δn of $2.13\times10^{21}\ \mathrm{cm^{-3}}$ (linear fit). With this correlation, and comparing $\Delta\mathrm{OD}_{0,\mathrm{e^-},970}$ fitted from 970 nm TA (Fig.**SI-3b** and Eq.**5**) to $\Delta\mathrm{OD}_{0,\mathrm{e^-},850}$ determined from 850 nm TA (Eq.**4**) measured under identical conditions, $\Delta n_{\mathrm{laser}}$ can be linked to $\Delta\mathrm{OD}_{0,\mathrm{e^-},850}$. Note that $\Delta\mathrm{OD}$ at *t* = 0.2 s (period of laser pulses) is practically zero as shown in Fig.**SI-3b**, thus the application of Eq.**SI.1** is validated. Given that the TiO_2 electrodes used for CBTC cells are identical to those used for Z907 cells, this correlation should also apply for CBTC cells.

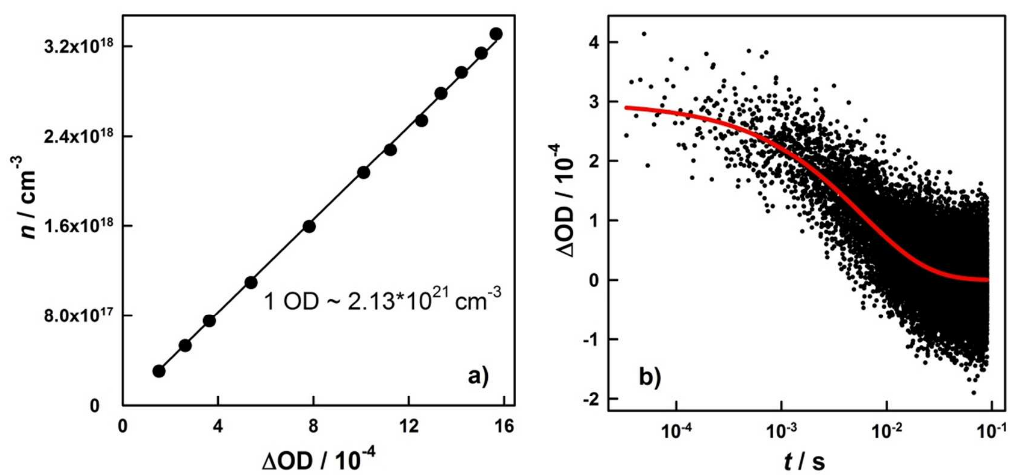
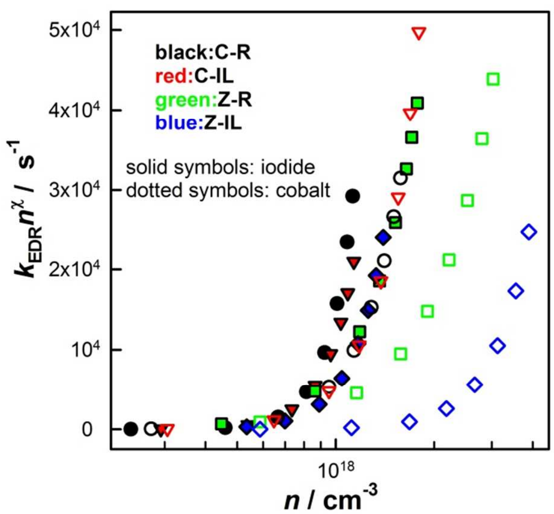


Figure SI-3. (a) Electron density n versus $\Delta\mathrm{OD}$ measured at 970 nm for Z907 cells under various 627 nm background illumination levels. (b) An example for 970 nm TA of Z907 cells, measured under identical conditions to 850 nm TA. Red line is the fit to Eq.**5**.

Part 5. Table **SI-1**. Table of EDR rate constant k_{edr} and reaction order χ obtained from the fits of Fig.**5a** to $k_{\mathrm{obs,D^+}} = k_{\mathrm{rg}}[Red] + k_{\mathrm{edr}}n^{\chi}$. Note that the large error in k_{edr} is misleading as discussed in our previous work.[1]

Label	**C-R-I**	**C-IL-I**	**Z-R-I**	**Z-IL-I**
$\boldsymbol{k_{\mathrm{edr}}} / \boldsymbol{cm^{-3\chi}}$	1.12E-97	2.47E-84	1.85E-50	1.25E-78
$\boldsymbol{\sigma_k}$	1.08E-96	2.26E-83	5.13E-49	3.00E-77
$\boldsymbol{\chi}$	5.6181	4.87	2.9779	4.5347
$\boldsymbol{\sigma_\chi}$	0.2321	0.22	0.6581	0.5719
Label	C-R-Co	C-IL-Co	Z-R-Co	Z-IL-Co
$\boldsymbol{k_{\mathrm{edr}}} / \boldsymbol{cm^{-3\chi}}$	2.38E-60	2.28E-63	1.56E-39	1.28E-68
$\boldsymbol{\sigma_k}$	1.77E-58	1.17E-61	1.72E-38	3.98E-67
$\boldsymbol{\chi}$	3.5236	3.689	2.351	3.8883
$\boldsymbol{\sigma_\chi}$	1.773	1.2281	0.2592	0.7259

Part 6. Figure. **SI-4**. Comparison of pseudo first-order rate constant for EDR ($k_{\mathrm{edr}}n^{\chi}$) of different cells calculated using the fitting results from Fig.**5a** in the main text.



References

1. Li, F., J.R. Jennings, and Q. Wang, *Determination of Sensitizer Regeneration Efficiency in Dye-Sensitized Solar Cells.* ACS Nano, 2013. **7**(9): p. 8233-8242.