

Supporting Information

Stepwise co-sensitization of two metal-based sensitizers: probing into their competitive adsorption for improving the photovoltaic performance of dye-sensitized solar cells

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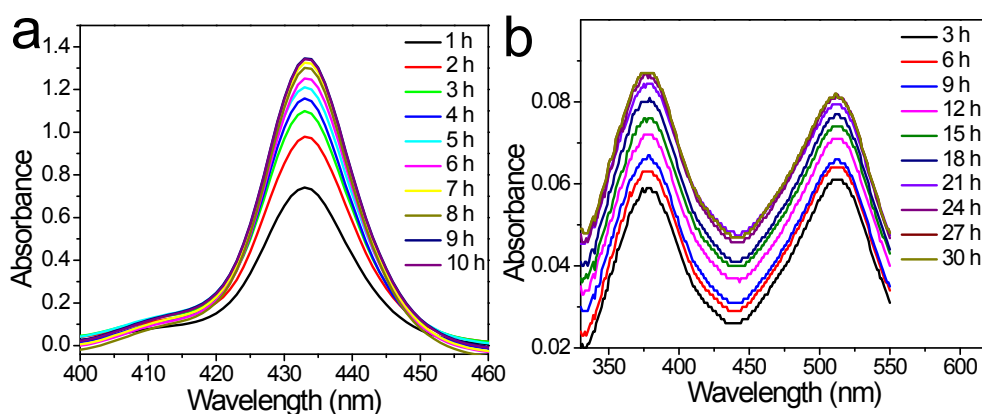


Fig. S1 UV-Vis absorption spectra of the desorbed solutions of LP-2 (a) and N719 (b) with various adsorbed time.

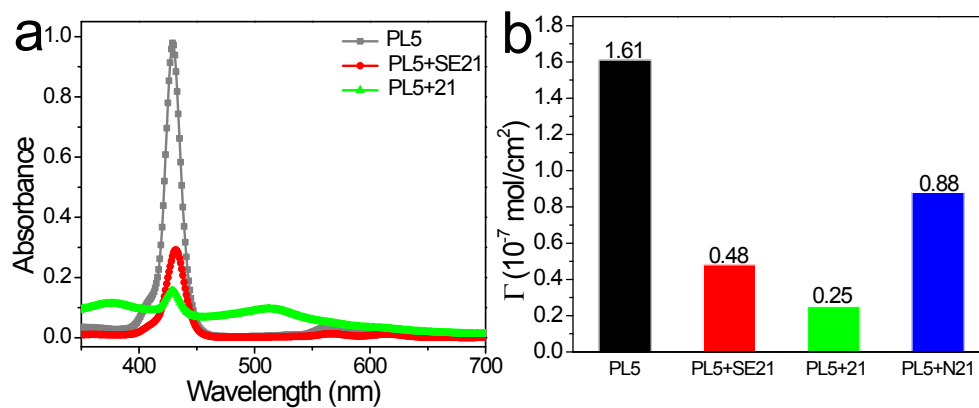


Fig. S2 Absorption spectra of the desorbed LP-2 solution for PL5, PL5 + SE21 and PL5 + 21 (a), and the desorption amounts of LP-2 for PL5, PL5 + SE21, PL5 + 21 and PL5 + N21 (b).

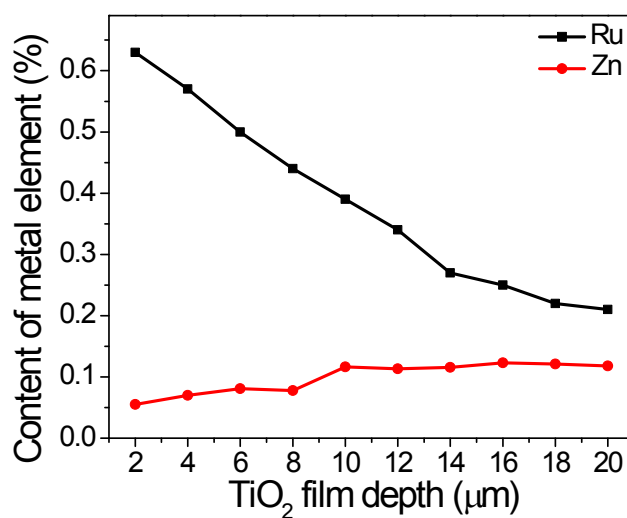


Fig. S3 Distributions of Zn and Ru with actual contents along the TiO₂ film depth in device 5. (The total content of Zn, Ru and Ti serving as 1).

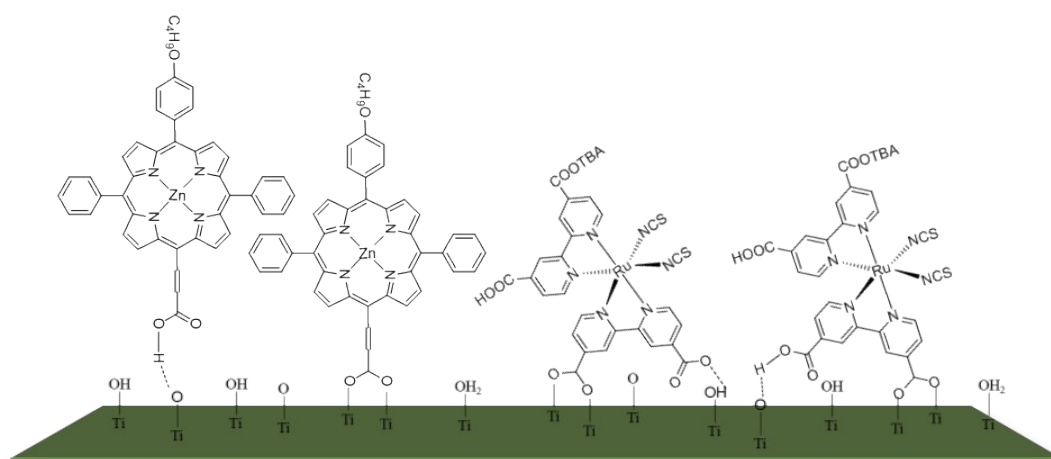


Fig. S4 The possible binding modes of LP-2 and N719 on TiO₂.

Table S1 Photovoltaic parameters of the cocktail-type DSSCs sensitized with N719 and LP-2 with different molar ratios.

Molar ratio of N719/LP-2	$J_{sc}/\text{mA cm}^{-2}$	V_{oc}/mV	$FF/\%$	PCE/%
50/1	13.34 ± 0.23	748 ± 4	67.13 ± 1.00	6.61 ± 0.09
20/1	13.39 ± 0.18	756 ± 7	67.54 ± 2.00	6.73 ± 0.13
10/1	13.71 ± 0.21	735 ± 5	68.27 ± 1.00	6.93 ± 0.12
5/1	13.46 ± 0.14	721 ± 2	66.49 ± 1.00	6.31 ± 0.07
2/1	13.22 ± 0.32	697 ± 2	63.57 ± 1.00	5.86 ± 0.16
1/1	12.87 ± 0.16	674 ± 4	63.44 ± 1.00	5.31 ± 0.11

Table S2 Photovoltaic parameters of DSSCs with various adsorbed time of LP-2.

Dye	$J_{sc}/\text{mA cm}^{-2}$	V_{oc}/mV	$FF/\%$	PCE/%
15 h in N719 /2 h in LP-2	13.23 ± 0.20	725 ± 4	67.97 ± 1.00	6.41 ± 0.12
15 h in N719 /1 h in LP-2	12.81 ± 0.16	736 ± 6	67.78 ± 2.00	6.30 ± 0.15
15 h in N719 /0.5 h in LP-2	12.57 ± 0.19	738 ± 3	67.52 ± 1.00	6.22 ± 0.10

Table S3 Loading amounts of LP-2 and N719 in the single dye-sensitized and co-sensitized DSSCs with different adsorption sequence.

Dye	Γ^a of LP-2 (mol cm ⁻²)	Γ^a of N719 (mol cm ⁻²)
5 h in LP-2/21 h in N719	2.53×10^{-8}	1.16×10^{-7}
5 h in LP-2	1.61×10^{-7}	—
5 h in N719/21 h in LP-2	8.41×10^{-8}	7.20×10^{-8}
5 h in N719	—	7.84×10^{-8}

^a The dye loading amounts (Γ) were obtained from the absorption spectra of the desorbing NaOH solution of the single- and co-sensitized TiO₂ photoanode.

Table S4 Absorption wavelength and coefficients of LP-2 and N719 in ethanol solution (3.0×10^{-6} M).

Dye	Absorption/ $\lambda_{\max}^a$ /nm (ϵ /M ⁻¹ cm ⁻¹)
LP-2	431(162,667), 567(7,333), 613(5,667)
N719	383(45,333), 527(44,000)

^a Absorption data were obtained in ethanol solution (3×10^{-6} M) at 298 K.

Table S5 Simulated device parameters from the EIS spectra in Fig. 7(b) and (c) in main text.

device	R_{CT} (Ω)	f (Hz)	τ (ms)
1	64	6.33	25.16
2	48	16.07	9.91
5	58	7.71	20.65