Electronic Supplementary Information

Electron Injection and Charge Recombination Kinetics on Performance of Porphyrin-sensitized Solar Cells: Effects of 4-*tert*-Butylpyridine Additive

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Fig. S1 Cyclic voltammograms of porphyrins YD12 and YD12CN

Dye ^a	Absorption	Emission ^b	Oxidation	Reduction
	$\lambda_{max}/nm \ (\epsilon/10^5 \ M^{-1} \ cm^{-1})$	$\lambda_{max}/nm~(\phi)$	$E_{1/2}/\mathrm{V}$	$E_{1/2}/\mathrm{V}$
YD12	450 (1.27), 580 (0.06), 650 (0.23)	680	+0.92, +1.30	-1.15
YD12CN	459 (0.68), 584 (0.04), 658 (0.19)	687	+0.93, +1.26	-1.07,-1.30

Table S1. Spectral and electrochemical data for dyes YD12 and YD12CN.^a

^a Absorption and emission data were measured in THF at 25 °C. Electrochemical measurements were performed at 25 °C in THF containing TBAPF₆ (0.1 M) as supporting electrolyte. Potentials measured *vs*. ferrocene/ferrocenium (Fc/Fc⁺) couple were converted to normal hydrogen electrode (NHE) by addition of +0.63 V.

^b The excitation wavelengths were 652 and 655 nm for YD12 and YD12CN, respectively in THF.

^c Irreversible process Epa.



Fig. S2 Potential level diagram of Porphyrins YD12 and YD12CN. The potential level of the HOMO with respect to a normal hydrogen electrode (NHE) was determined from $E_{\text{HOMO}} = E_{\text{ox}} - E_{\text{Fc}/\text{Fc}}^{+} + 0.63$ V for both species (the same as oxidation potential $E_{1/2}$ listed in Table S1), and the potential level of LUMO was determined from $E_{\text{LUMO}} = E_{\text{HOMO}} - E_{0.0}$, where the band gap energy (e $E_{0.0}$) was determined by the intersection point between the absorption and the emission spectra for each species.



Fig. S3 Current-voltage characteristics of the devices made of (a) YD12 and (b) YD12CN under various concentrations of TBP additive as indicated.



Fig. S4 Plots of photovoltaic parameters (a) short-circuit photocurrent density, (b) open-circuit photovoltage, (c) fill factor, and (d) power conversion efficiency as a function of TBP concentrations under the AM 1.5G one-sun irradiation.



Fig. S5 Light-induced photovoltage transients of device YD12 (no TBP) obtained at an open-circuit condition with a pulsed probe at 630 nm under steady-state white-light bias illumination of nine intensities as indicated. The transient data (red circles) were fitted according to a single exponential decay with the fitted curves (black traces) as indicated.



Fig. S6 Light-induced photovoltage transients of device YD12-TBP ([TBP] = 0.5 M) obtained at an open-circuit condition with a pulsed probe at 630 nm under steady-state white-light bias illumination of nine intensities as indicated. The transient data (red circles) were fitted according to a single exponential decay with the fitted curves (black traces) as indicated.



Fig. S7 Light-induced photovoltage transients of device YD12CN (no TBP) obtained at an opencircuit condition with a pulsed probe at 630 nm under steady-state white-light bias illumination of nine intensities as indicated. The transient data (red circles) were fitted according to a single exponential decay with the fitted curves (black traces) as indicated.



Fig. S8 Light-induced photovoltage transients of device YD12CN-TBP ([TBP] = 0.5 M) obtained at an open-circuit condition with a pulsed probe at 630 nm under steady-state white-light bias illumination of nine intensities as indicated. The transient data (red circles) were fitted according to a single exponential decay with the fitted curves (black traces) as indicated.

P_0	$J_{ m SC}$	V _{OC}	ΔV	ΔQ	C_{μ}	$ au_{ m R}$
/mWcm ⁻²	/mAcm ⁻²	/mV	/mV	/μC	/mF	/ms
27	3.21	473	4.25	3.19	0.75	9.31
42	5.17	491	4.6	5.47	1.18	8.14
57	6.94	501	4.77	7.72	1.62	7.63
70	8.56	508	5.13	9.83	1.92	6.68
82	9.91	514	5.01	11.36	2.27	6.14
94	11.81	518	4.97	12.88	2.59	5.85
105	13.07	521	4.87	14.69	3.02	5.57
115	14.26	524	4.89	15.78	3.23	5.52

Table S2. Summary of transient photocurrent and photovoltage data for deviceYD12 (no TBP).

Table S3. Summary of transient photocurrent and photovoltage data for device YD12-TBP.

P_0	$J_{ m SC}$	V _{OC}	ΔV	ΔQ	C_{μ}	$ au_{ m R}$
/mWcm ⁻²	/mAcm ⁻²	/mV	/mV	/μC	/mF	/ms
27	3.14	697	4.40	4.84	1.10	34.46
42	5.05	712	4.21	7.97	1.89	24.81
57	6.79	720	4.05	10.69	2.64	21.45
70	8.40	725	4.07	13.48	3.31	18.83
82	9.78	728	4.08	16.14	3.96	17.94
94	11.71	730	4.15	19.00	4.58	16.14
105	13.05	732	4.18	21.73	5.20	15.16
115	13.92	735	4.24	24.07	5.68	14.32

P_0	$J_{ m SC}$	$V_{\rm OC}$	ΔV	ΔQ	C_{μ}	$ au_{ m R}$
/mWcm ⁻²	/mAcm ⁻²	/mV	/mV	/μC	/mF	/ms
27	2.94	506	4.15	3.02	0.73	12.71
42	4.72	527	4.33	5.04	1.16	10.61
57	6.33	539	4.50	6.68	1.48	9.55
70	7.82	549	4.61	8.59	1.86	8.73
82	9.07	557	4.73	10.23	2.16	8.30
94	10.29	563	4.88	12.17	2.49	7.88
105	12.01	568	4.99	14.32	2.87	7.54
115	13.09	572	4.94	16.10	3.26	7.38

Table S4. Summary of transient photocurrent and photovoltage data for device YD12CN (no TBP).

Table S5. Summary of transient photocurrent and photovoltage data for device YD12CN-TBP.

P_0	$J_{ m SC}$	$V_{\rm OC}$	ΔV	ΔQ	C_{μ}	$ au_{ m R}$
/mWcm ⁻²	/mAcm ⁻²	/mV	/mV	/μC	/mF	/ms
27	1.76	579	4.20	2.22	0.53	13.08
42	2.83	598	4.33	3.34	0.77	11.08
57	3.82	610	4.37	4.72	1.08	10.04
70	4.76	619	4.52	6.37	1.41	9.31
82	5.58	626	4.62	7.19	1.56	8.89
94	6.40	631	4.73	8.62	1.82	8.16
105	7.15	635	4.76	9.65	2.03	7.81
115	7.87	639	4.96	10.88	2.19	7.32



Fig. S9 Femtosecond fluorescence decays of YD12 adsorbed on Al_2O_3 (left panels) and TiO₂ (right panels) films without (top panels) and with (bottom panels) TBP additive. The blue and green traces show the fast and slow decay components with the fitted decay coefficients and relative amplitudes (in parentheses) as indicated.

Dye	Film	$\tau_1(\%)/ps$	$\tau_2(\%)/ps$	$ au_{avg}$	k _{avg}	k_{inj}	$\Phi_{ m inj}$
				/ps	$/10^{10} s^{-1}$	$/10^{10} s^{-1}$	
YD12	Al_2O_3	6.7(73%)	291.3(27%)	82.0	1.2	6.0	0.85
(no TBP)	TiO ₂	5.9(81%)	42.7(19%)	12.3	8.1	0.9	0.85
YD12-	Al_2O_3	48.5(76%)	378.1(24%)	125.6	0.8	27	0.77
TBP	TiO ₂	11.7(64%)	58.9(36%)	28.8	3.5	2.1	0.77

Table S6. Fitted decay coefficients and evaluated rate coefficients to obtain the quantum yields of electron injection for the YD12 devices without and with TBP.



Fig. S10 Femtosecond fluorescence decays of YD12CN adsorbed on Al_2O_3 (left panels) and TiO₂ (right panels) films without (top panels) and with (bottom panels) TBP additive. The blue and green traces show the fast and slow decay components with the fitted decay coefficients and relative amplitudes (in parentheses) as indicated.

Table S7. Fitted decay coefficients and evaluated rate coefficients to obtain the quantum yiel	ds of
electron injection for the YD12CN devices without and with TBP.	

Dye	Film	$\tau_1(\%)/ps$	$\tau_2(\%)/ps$	τ_{avg}	k _{avg}	k _{inj}	Φ_{inj}
				/ps	$/10^{10} \mathrm{s}^{-1}$	$/10^{10} s^{-1}$	
YD12CN	Al_2O_3	18.2(71%)	289.3(29%)	95.3	1.0	3.6	0.77
(no TBP)	TiO ₂	5.7(86%)	119.5(14%)	21.6	4.6	5.0	0.77
YD12CN	Al_2O_3	58.8(79%)	417.0(22%)	130.7	0.8	12	0.62
-TBP	TiO ₂	16.6(78%)	157.9(14%)	47.3	2.1	1.5	0.05



Fig. S11 Absorption spectra of YD12 (top panels) and YD12CN (bottom panels) adsorbed on Al_2O_3 and TiO₂ films without (left panels) and with (right panels) TBP additive. Those samples were used for the femtosecond fluorescence decay measurements to obtain the results shown in Figure 6 in the main text.

Experimental

All reagents and solvents were obtained from commercial sources and used without further purification, unless otherwise noted. CH_2Cl_2 was dried over CaH_2 and freshly distilled before use. THF was dried over sodium/benzophenone and freshly distilled before use. Tetrabutylammonium hexafluorophosphate (TBAPF₆) was recrystallized twice from absolute ethanol and further dried for two days under vacuum. Column chromatography was performed on silica gel (Merck, 70-230 Mesh ASTM).

Spectral and Electrochemical Measurements

¹H NMR spectra (Varian spectrometer, 400 MHz), UV-visible spectra (Varian Cary 50), emission spectra (JASCO FP-6000 spectrofluorimeter), high resolution mass spectra (LTQ Orbitrap XL, Thermo Fisher Scientific) and FAB mass spectra (JMS-SX/SX102A Tandem Mass spectrometer) were recorded on the indicated instruments. Electrochemical tests were performed with a three-electrode potentiostat (CH Instruments, Model 750A) in THF deoxygenated on purging with prepurified dinitrogen gas. Cyclic voltammetry was conducted with a three-electrode cell equipped with a BAS glassy carbon disk (0.07 cm²) as the working electrode, a platinum wire as auxiliary electrode, and an Ag/AgCl (saturated) reference electrode; the reference electrode is separated from the bulk solution with a double junction filled with an electrolyte solution. The working electrode was polished with aluminum (0.03 µm) on felt pads (Buehler) and treated ultrasonically for 1 min before each experiment. The reproducibility of individual potential values was within ±5 mV.







Molecular structures of Porphyrins YD12 and YD12CN under investigation.

Reagents & conditions: (i) $Br_2/CHCl_3$, 0 °C to rt, 24h (ii) *n*-BuLi(1.0 eq),THF, DMF(1.0 eq) (iii) ethylene glycol(1.5 eq), *p*-TsOH.H₂O(0.02 eq),toluene,12h (iv) *n*-BuLi(1.5 eq),I₂(1.5 eq),ether,12h (v) *p*-TsOH.H₂O (0.02 eq), acetone/H₂O, rt,4h (vi) Piperdine (2.0 eq),cyanoacetic acid (2.0 eq) CH₃CN/THF, reflux, 12h.



Synthesis of YD12CN: In a 50 ml round bottom flask solution of porphyrin 8¹ (150 mg, 0.113 mmol) in THF (15 mL) was added TBAF (0.5 mL, 1 M in THF, 0.57 mmol). The solution was stirred at 23 °C for 5 min. The solvent was removed under decreased pressure then H₂O was added and extracted with CH₂Cl₂. The organic layer was dried over anhydrous MgSO₄ and the solvent was removed under vacuum. The above obtained residue porphyrin, 2-cyano-3-(4iodonaphthalen-1-yl)acrylic acid 7 (118 mgs, 0.339 mmol), Pd₂(dba)₃ (10.0 mgs, 0.0113 mmol) and AsPh₃ (28.0 mgs, 0.09 mmol) were placed in an oven dry schlenk tube and degassed 10 min then degassed mixture of THF (30 mL) and Et₃N (10 mL) were added and the solution was refluxed under N₂ for 12 h and the solvent was removed under vacuum. The residue was purified by column chromatography (silica gel) using CH_2Cl_2 /methanol = 92/8 as eluent. Recrystallization from CH₂Cl₂/CH₃OH gave **YD12-CN** as dark green solid 108.0 mg, 72 %.¹H NMR (400 MHz, CDCl₃/CD₃OD) δ 9.75 (d, J = 4.4 Hz, 2H), 9.13 (d, J = 4.4 Hz, 2H), 9.1 (s, 1H), 9.03 (s, 1H), 8.88 (d, J = 4.4 Hz, 2H), 8.65 (d, J = 4.8 Hz, 2H), 8.37 (d, J = 8.0 Hz, 1H), 8.27 (d, *J* = 6.8 Hz, 1H), 8.22 (d, *J* = 8.4 Hz, 1H), 7.94 (d, *J* = 1.6 Hz, 4H), 7.79 (t, *J* = 8.0 Hz, 1H), 7.7 (s, 1H), 7.69 (s, 2H), 7.16(d, J = 8.4 Hz, 4H), 6.88(d, J = 8.8 Hz, 4H), 2.38 (t, J = 7.6 Hz, 4H), 1.44 (s, 36H), 1.22 (br, 16H), 0.74 (t, 6H); ¹³C NMR (100 MHz,CDCl₃/CD₃OD) δ167.6, 152.1, 150.6, 150.5, 149.7, 148.9, 148.2, 146.0, 141.4, 136.3, 134.5, 132.9, 131.7, 130.4, 129.8, 129.2, 128.5, 127.7, 127.3, 126.9, 126.2, 124.1, 123.6, 121.7, 120.5, 98.2, 93.7, 34.9, 34.7, 31.4, 31.3, 31.1, 28.7, 22.2, 13.6; HRMS: m/z calcd. for C₈₈H₉₂N₆O₂Zn: 1328.6568, found: 1328.6579 ([M]⁺).



1, 4-Dibromonaphthalene: A solution of bromine (1.2 mL) in chloroform (6 mL) added over 30 min to a solution of naphthalene (1.0 g) in chloroform (10 mL) and DMF (0.5 mL) at 0 °C. The reaction is stirred at 0 °C for another 2 h and then brings to room temperature stirred up to 24 h and then chloroform (20 mL) is added. The reaction mixture is washed with aqueous sodium bisulphite (15 mL), then washed with 5% aqueous sodium bicarbonate (10 mL), then water (10 mL), then evaporated. The residue is crystallized from methanol (26 mL), by heating to 65-70 °C, and cooling to 20 °C for 3-4 h. The product white needles is filtered, and dried under vacuum at 55 °C dry weight 1.62g, yield 74% over night. ¹H NMR (CDCl₃, 400 MHz) δ 8.25-8.22 (m, 2H), 7.65-7.62 (m, 2H), 7.62 (s, 2H). Other spectral data are similar to literature reports².



4-Bromo-1-naphthaldehyde: Following a standard procedure³, 1, 4-dibromonaphthalene (6.0 g, 21.0 mmol) in dry THF (127 mL) was added dropwise n-butyl lithium (16.0 mL, 25.2 mmol, 1.6 M in hexanes) at -78 °C. After the reaction mixture was stirred additionally 45 min at -78 °C then treated with anhydrous DMF (3.3 mL, 42.0 mmol), slowly warmed to room temperature and stirred for 12 h. The reaction mixture was quenched with H₂O and extracted with CH₂Cl₂.The combined organic phases were washed with aqueous NH₄Cl solution and H₂O, and dried over MgSO₄. After filtration and evaporation to dryness, the crude product was purified by column chromatography on silicagel. ¹H NMR (CDCl₃, 400 MHz) δ 10.4 (s, 1H), 9.28 (d, *J* = 10.4 Hz, 1H), 8.35 (d, *J* = 2.0 Hz, 1H), 7.98 (d, *J* = 10.4 Hz, 1H), 7.81 (d, *J* = 10.4 Hz, 1H), 7.77-7.67 (m, 2H).



2-(4-Bromonaphthalen-1-yl)-1,3-dioxolane: A mixture of 4-Bromo-1-naphthaldehyde (4.4 g, 18.7 mmol) of ethylene glycol (4.2g, 75.0 mmol), and *p*-toluenesulfonic acid monohydrate (0.3g, 1.6 mmol) was refluxed with Dean-Stark adaptor for 21 h. After allowing cooling down to room temperature, the reaction mixture was washed with aqueous NaHCO₃ (three times), water, and saturated NaCl solution, and dried over anhydrous Na₂SO₄. Concentration vacuo afforded crude product which was recrystallized from hexane-dichloromethane mixture to yield 4.5 g, 86%. ¹H NMR (CDCl₃, 400 MHz) δ 8.32-8.29 (m, 1H), 8.23-8.20 (m, 1H), 7.79 (d, *J* = 10.0 Hz, 1H), 7.64-7.58 (m, 3H), 6.45 (s, 1H), 4.22-4.11 (m, 4H); FAB-MS: *m/z* calcd. for C₁₃H₁₁Br₁O₂: 278; found: 279 ([M+H]⁺).



4-Iodo-1-naphthaldehyde: n-Butyllithium (9.7 mL, 15.5 mmol, 1.6 M in hexanes) was added dropwise over the period of 30 min to a vigorously stirred suspension of 2-(4-bromonaphthalen-1-yl)-1,3-dioxolane (3.6 g, 13.0 mmol) in anhydrous diethyl ether (200 mL). The mixture was stirred for an additional 2 h after which period iodine (4.0 g, 15.5 mmol) added in several portions over 20 min. The reaction mixture was stirred for an additional 2 h until the color was dark brown. The ethereal solution was washed with several times with aqueous sodium

thiosulfate (25% w/w), dried over anhydrous magnesium sulfate and the solvent removed under vacuum to obtain the crude product. The crude product and *p*-toluenesulfonic acid monohydrate (110mgs, 0.58 mmol) in 50 mL of acetone was stirred for 4 h at room temperature. The reaction mixture was poured into water, extracted with CH₂Cl₂ (3x 30 mL), and dried over Na₂SO₄. After concentration in vacuo, the crude product was purified by column chromatography on silica gel (eluent dichloromethane-hexane 1:1) to afford 1.0g, 83%. ¹H NMR (CDCl₃, 400 MHz) δ 10.4 (s, 1H), 9.21 (d, *J* = 8.8 Hz, 1H), 8.32 (d, *J* = 7.6 Hz, 1H), 8.22 (d, *J* = 9.2 Hz, 1H), 7.75-7.62 (m, 3H); FAB-MS: *m/z* calcd. for C₁₁H₇IO: 282; found: 283 ([M+H]⁺).



2-Cyano-3-(4-iodonaphthalen-1-yl)acrylic acid: Piperidine(0.2 mL, 1.6 mmol) was added to a solution of 4-iodo-1-naphthaldehyde (0.2g, 0.82 mmol) and cyanoacetic acid (0.2g, 1.63 mmol) in acetonitrile (82 mL) and THF (20 mL) at room temperature under nitrogen. After the mixture was heated to reflux for 12 h then the mixture was poured into an aqueous NH₄Cl solution. The aqueous layer was extracted with CH₂Cl₂. The combined organic extracts were washed with brine and dried over Na₂SO₄. After removal of the solvent under reduced pressure the residue was purified by flash chromatography to afford 0.28 g, 98% yield. ¹H NMR (DMSO-*d*₆, 400 MHz) δ 8.54 (s, 1H), 8.25 (d, *J* = 7.6 Hz, 1H), 8.10 (d, *J* = 8.8 Hz, 1H), 7.94 (d, *J* = 9.2 Hz, 1H), 7.75-7.67 (m, 2H), 7.60 (d, *J* = 8.4 Hz, 1H); FAB-MS: *m*/*z* calcd. for C₁₄H₈INO₂: 349; found: 350 ([M+H]⁺).

Device fabrication and characterization

The porphyrin-sensitized solar-cell (PSSC) devices were fabricated with a working electrode based on TiO₂ nanoparticles (NP) and a Pt-coated counter electrode. For the working electrode, a paste composed of TiO₂ NP (particle size ~25 nm) prepared with a sol-gel method for the transparent nanocrystalline layer was coated on a TiCl₄-treated FTO glass substrate (TEC 7, Hartford). Crystallization of TiO₂ films was performed with a programmed procedure: (1) heating at 80 °C for 15 min; (2) heating at 135 °C for 10 min; (3) heating at 325 °C for 30 min; (4) heating at 375 °C for 5 min; (5) heating at 450 °C for 15 min, and (6) heating at 500 °C for 15 min. The resulting layer had a transparent layer (thickness ~12 µm) and a scattering layer (thickness ~5 µm), which were treated again with TiCl₄ at 70 °C for 30 min and sintered at 500 °C for 30 min. The electrode was then immersed in a dye solution (0.2 mM) with EtOH at 25 °C for 3 h for dye loading onto the TiO₂ film. The dye-sensitized electrode was rinsed with ethanol

and dried by an air-gun. The Pt counter electrodes were prepared on spin-coating drops of H_2PtCl_6 solution onto FTO glass and heating at 385 °C for 15 min. The porphyrin working electrode and the thermally platinized counter electrode were separated and sealed with a hot-melt film (SX1170, Solaronix, thickness 30 µm). The electrolyte solution containing LiI (0.1 M), I_2 (0.05 M), PMII (0.6 M), with or without the 4-*tert*-butylpyridine additive (0.5 M), in a mixture of acetonitrile and valeronitrile (volume ratio 85 : 15). The performance of a PSSC device was assessed through measurement of a *J*–*V* curve with an AM-1.5 G solar simulator (XES-502S, SAN-EI), calibrated with a Si-based reference cell (S1133, Hamamatsu). The incident monochromatic efficiencies for conversion from photons to current (IPCE) spectra of the corresponding devices were measured with a system comprising a Xe lamp (PTi A-1010, 150 W), monochromator (PTi, 1200 gr mm⁻¹ blazed at 500 nm), and source meter (Keithley 2400, computer controlled). A standard Si photodiode (S1337-1012BQ, Hamamatsu) served as a reference to calibrate the power density of the light source at each wavelength.

Photocurrent and photovoltage decay measurements

The photocurrent and photovoltage decays were measured with a computer-controlled instrumental setup containing LED light sources. Nine steady-state light intensities were obtained as bias irradiations from a white LED on tuning the driving voltage. A red LED ($\lambda = 630$ nm) controlled with a pulse generator (DG535, SRS) generated a perturbation pulse of duration 50 ms. Both the pulsed red light and the steady-state white light irradiated the photoanode side of the cell. The pulsed-probe irradiation was controlled with a LED power supply to maintain the modulated photovoltage less than 5 mV in each measurement. The probe beams generated carriers causing a slightly increased photocurrent (ΔJ_{SC}) near J_{SC} of the cell at the short-circuit condition, or a slightly increased photovoltage (ΔV_{OC}) near V_{OC} of the cell at the open-circuit condition, subjected to the white bias light; the current and voltage decays were thereby measured, respectively. The resulting photocurrent and photovoltage transients were recorded on a digital oscilloscope (MSO2014, Tektronix); the signals passed a current preamplifier (SR570, SRS) at a short-circuit condition. The chemical capacitance of the TiO₂/electrolyte interface at each V_{OC} was calculated as $C_{\mu} = \Delta Q/\Delta V$: ΔV is the maximum of the photovoltage transient and ΔQ is the total charge integrated from the photocurrent transient.

Femtosecond fluorescence up-conversion measurements

Fluorescence decays were recorded with an optically gated up-conversion system (FOG100, CDP). Briefly, the femtosecond laser system (Mira 900D, Coherent) generated output pulses at 870 nm of duration ~120 fs at a repetition rate 76 MHz. The frequency of the laser pulse was doubled for excitation ($\lambda_{ex} = 435$ nm). The residual fundamental pulse served as an optical gate;

a dichroic beam splitter separated excitation and gate beams. The intensity of the excitation beam was appropriately attenuated and focused onto a rotating cell (optical path of length 1 mm) containing the thin-film samples. The emission was collected with two parabolic mirrors and focused onto a crystal (BBO type-I); the gate pulse was also focused on that BBO crystal for sum-frequency generation. The up-converted signal was collected with a lens, and separated from interference light with an iris, a band-pass filter, and a double monochromator (DH10, Jobin Yvon), then detected with a photomultiplier (R1527P, Hamamatsu) connected to a computer-controlled photon-counting system. On varying the temporal delay between gate and excitation pulses via a stepping-motor translational stage, a temporal profile was obtained. The transient fluorescence decays were measured with the films immersed in either a pure 3-methoxypropionitrile (MPN) solvent or in a solution containing 0.5M TBP in MPN.