Supporting Information

Organic Thin-Film Red-Light Photodiodes with Tunable Spectral Response via Selective Exciton Activation

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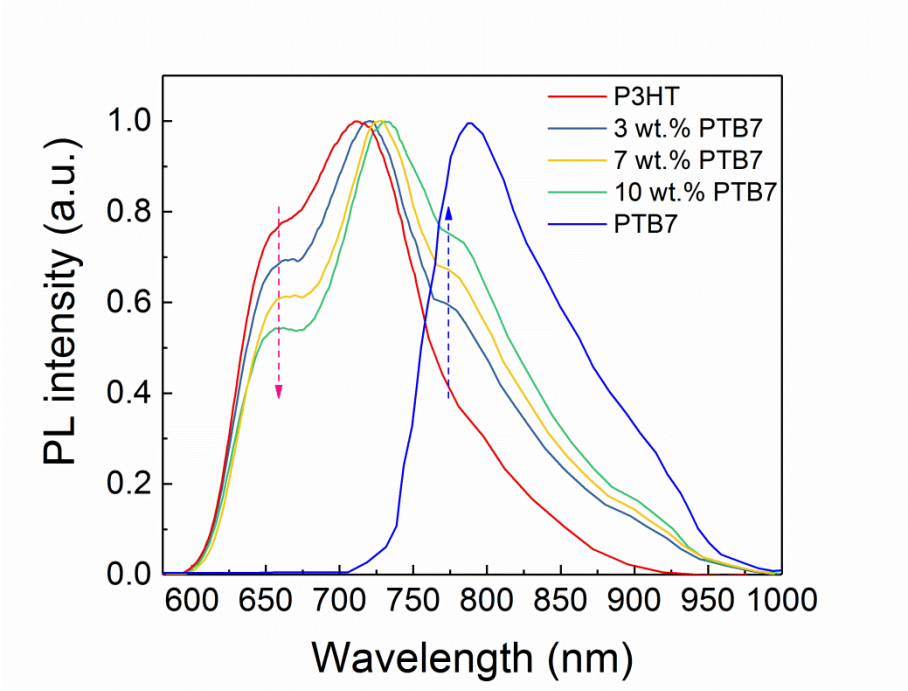

Figure S1. PL spectra of pristine P3HT, PTB7, and their blend films.

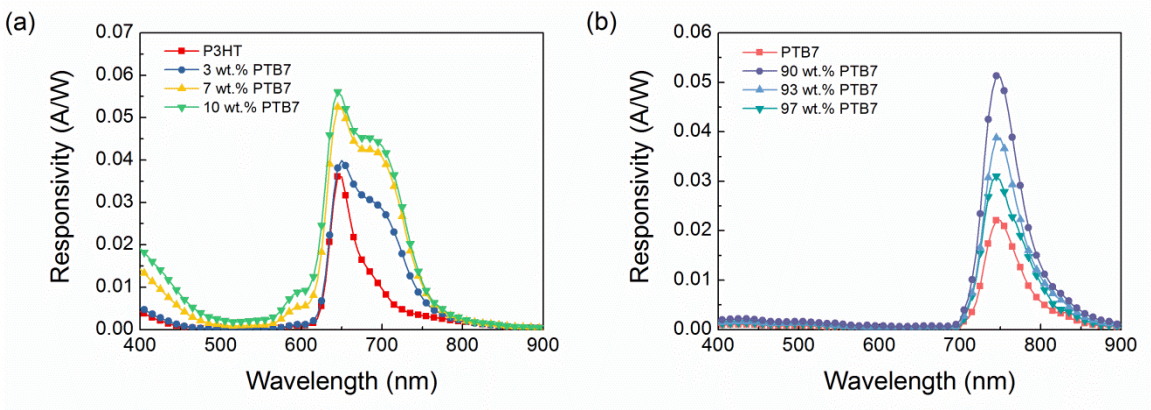

Figure S2. Responsivity spectra of red-light OPDs based on (a) pristine P3HT film and blend donor films with low PTB7 doping ratio and (b) pristine PTB7 film and blend donor films with high PTB7 doping ratio under -1 V.

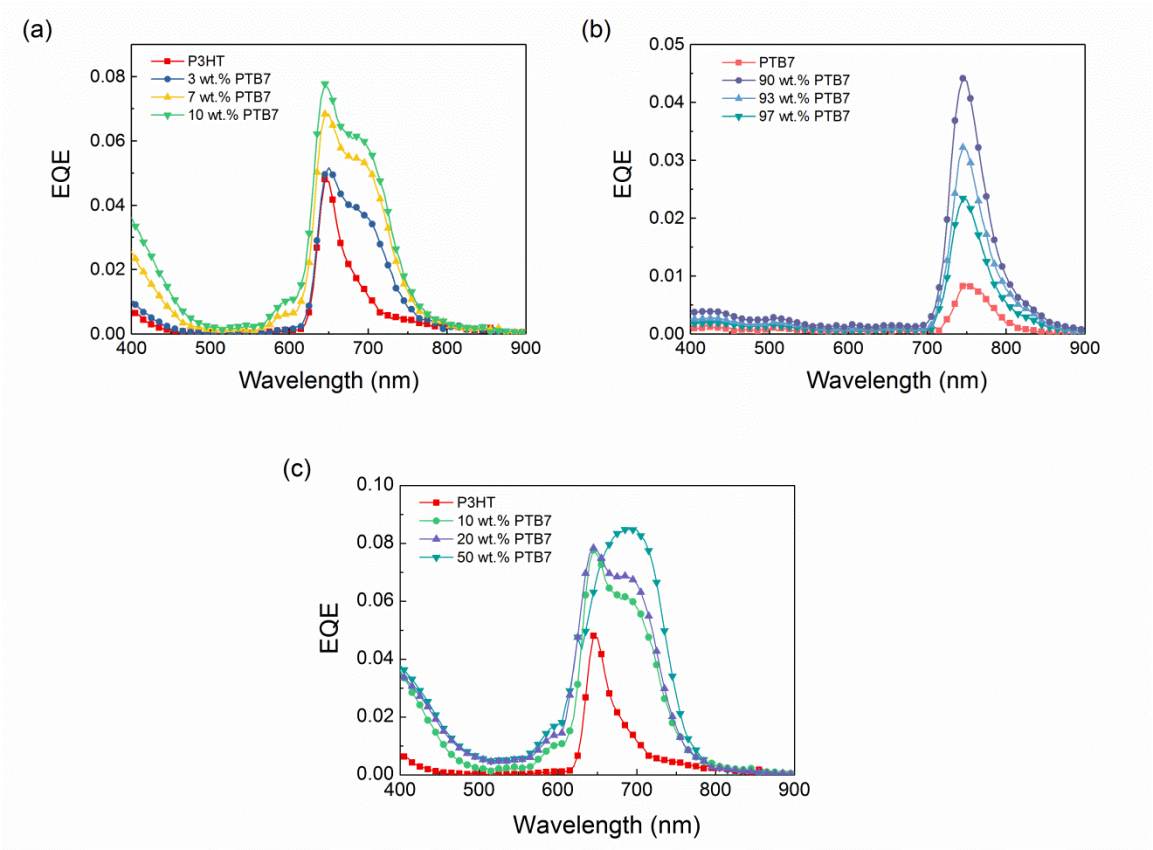

Figure S3. EQE spectra of red-light OPDs based on (a) pristine P3HT film and blend donor films with low PTB7 doping ratio, (b) pristine PTB7 film and blend donor films with high PTB7 doping ratio and (c) pristine P3HT film and blend donor films with other PTB7 doping ratio for comparison under 0 V.

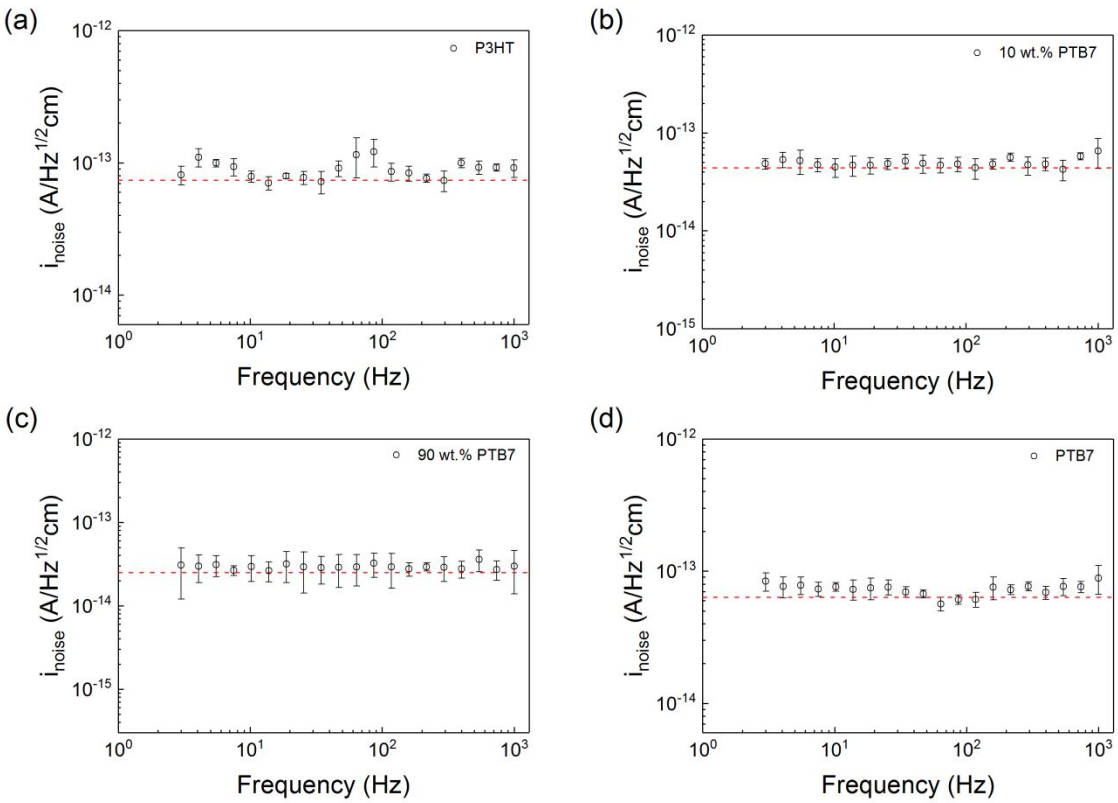

Figure S4. Measured noise spectra of (a) pristine P3HT, (b) 10 wt.% PTB7, (c) 90 wt.% PTB7 and (d) pristine PTB7 red-light OPDs. Red dashed line is calculated thermal noise limit.

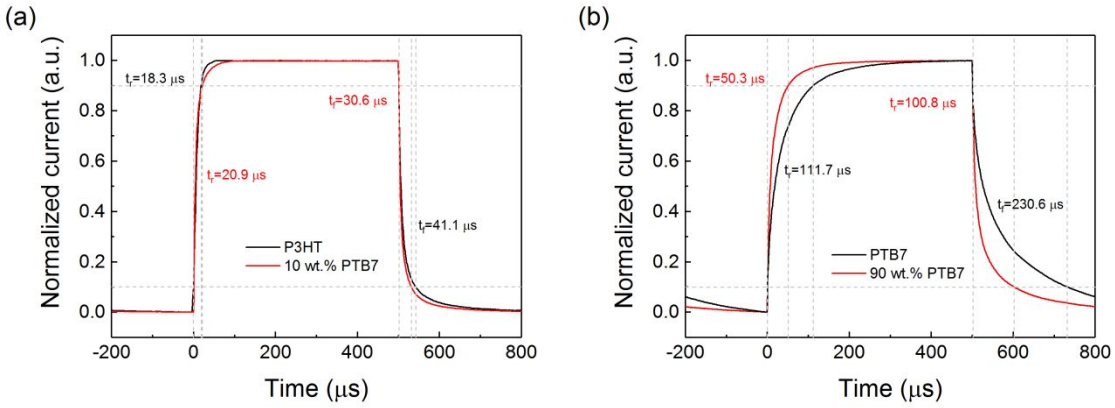

Figure S5. Transient photocurrent response of (a) pristine P3HT and 10 wt.% PTB7 and (b) 90 wt.% PTB7 and pristine PTB7 red-light OPDs at a pulse frequency of 1 kHz with a device area of 6.44 mm^2.

Table S1. Response peak, Responsivity (R), Calculated Detectivity (D^*-C) and Calculated Noise Current (Noise-C) of Red-Light OPDs at -1 V.

Device	Response peak (nm)	R (A/W) $\times 10^{-2}$	D^*-C (Jones) $\times 10^{11}$	Noise-C (A/Hz$^{1/2}$cm) $\times 10^{-13}$
Pristine P3HT	645	3.6	1.3	2.8
	685	1.4	0.5	2.8
10 wt.% PTB7	645	5.6	3.2	1.7
	685	4.5	2.6	1.7
90 wt.% PTB7	745	5.1	5.0	1.0
Pristine PTB7	745	2.2	0.8	2.7

Calculation of theoretical RC-limited frequency

Capacitance (C) can be calculated by

$$C = \frac{\varepsilon_0 \varepsilon_r A}{d} \quad \text{(S1)}$$

where ε_0 and ε_r are the vacuum and relative permittivity, respectively, A is the active area (6.44 mm^2) and d is the corresponding film thickness (700 nm and 50 nm for donor layer and acceptor layer, respectively.). Typically, ε_r is regarded as 3. Therefore, calculated capacitance values are C_{donor} = 3.79 nF/cm^2 and $C_{acceptor}$ = 53.1 nF/cm^2. Since the donor and acceptor layers are arranged in series, the calculated total capacitance (C_t) is $C_t = (C_{donor})^{-1}+(C_{acceptor})^{-1}$ = 3.54 nF/cm^2. Series resistance of 10 wt.% PTB7 doped device, which can be directly calculated from the inverse of slope of illuminated current-voltage curve at open-circuit voltage position, is ~1035 $\Omega \cdot cm^2$. From the parameters and Equation 6, f_{RC} (10 wt.% PTB7) is calculated as 43.4 kHz.