Supporting Information

Highly Efficient Fluorescence/Phosphorescence Hybrid White Organic Light-Emitting Devices Based on a Bipolar Blue Emitter to Precisely Control Charges and Excitons

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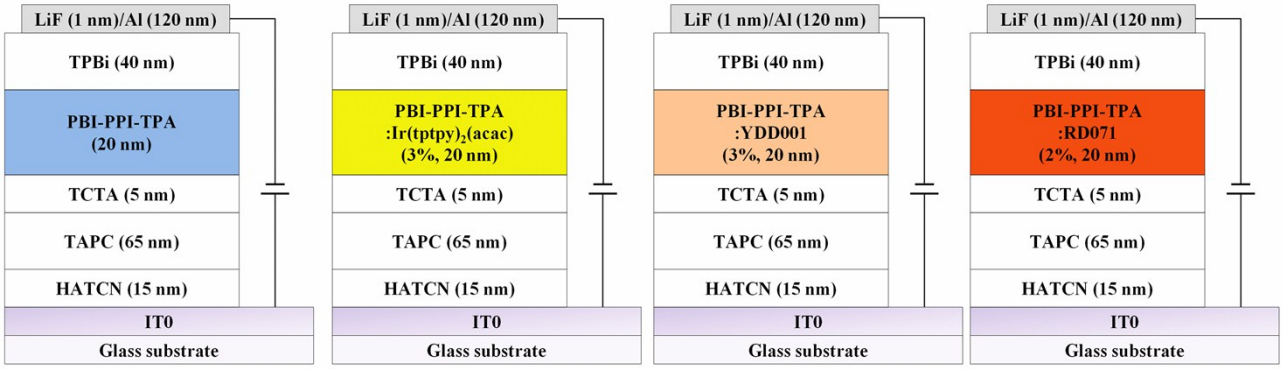

Fig. S1 Schematic structure diagrams of the optimized monochromatic OLEDs, corresponding to device B, device Y, device O, and device R, respectively.

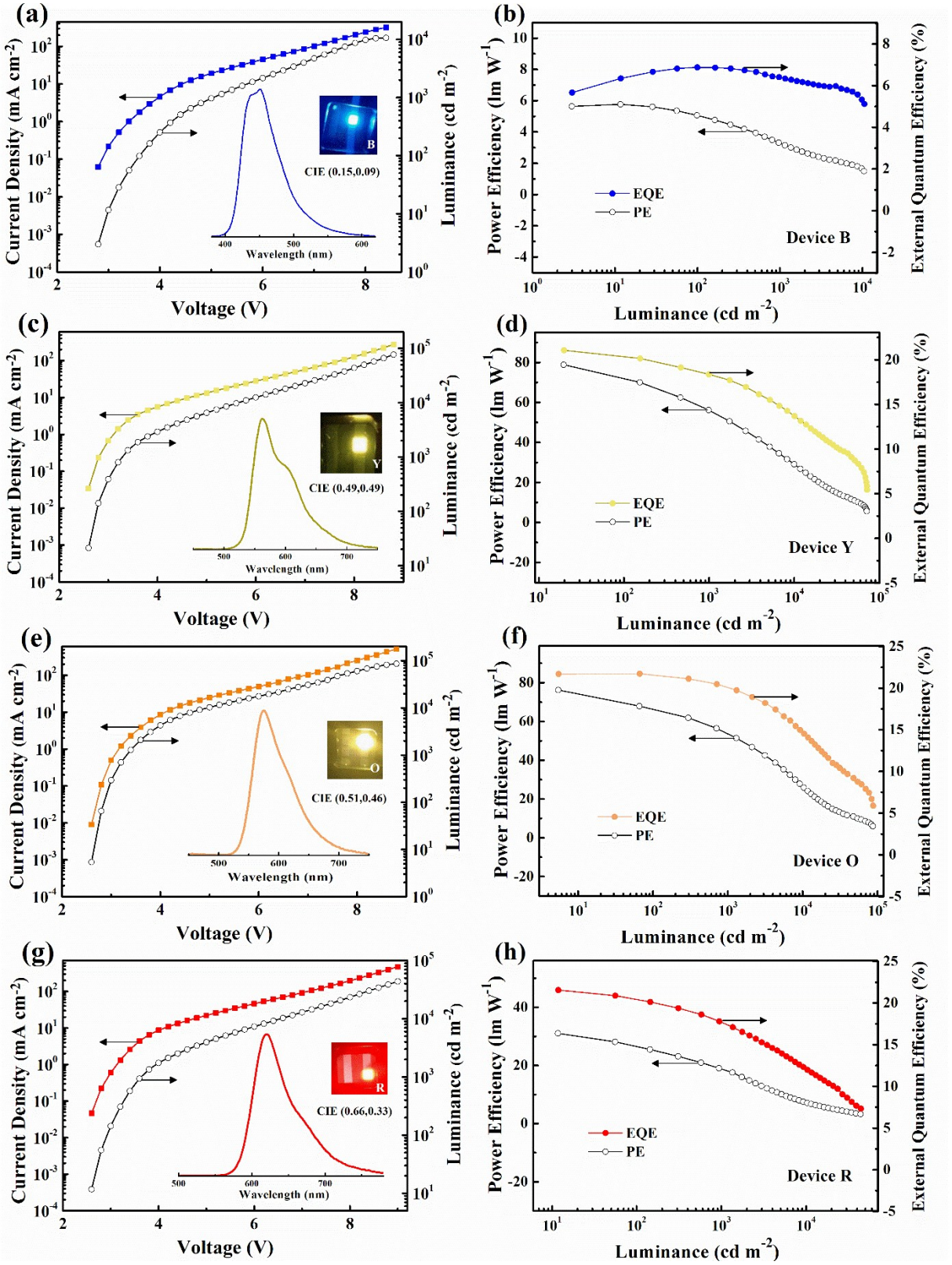

Fig. S2 Current density-luminance-voltage and external quantum efficiency and power efficiency versus luminance characteristics of the optimized monochromatic devices B, Y, O, and R. The insets give the EL spectra and image photographs of the devices at 1000 cd m^{-2}, respectively.

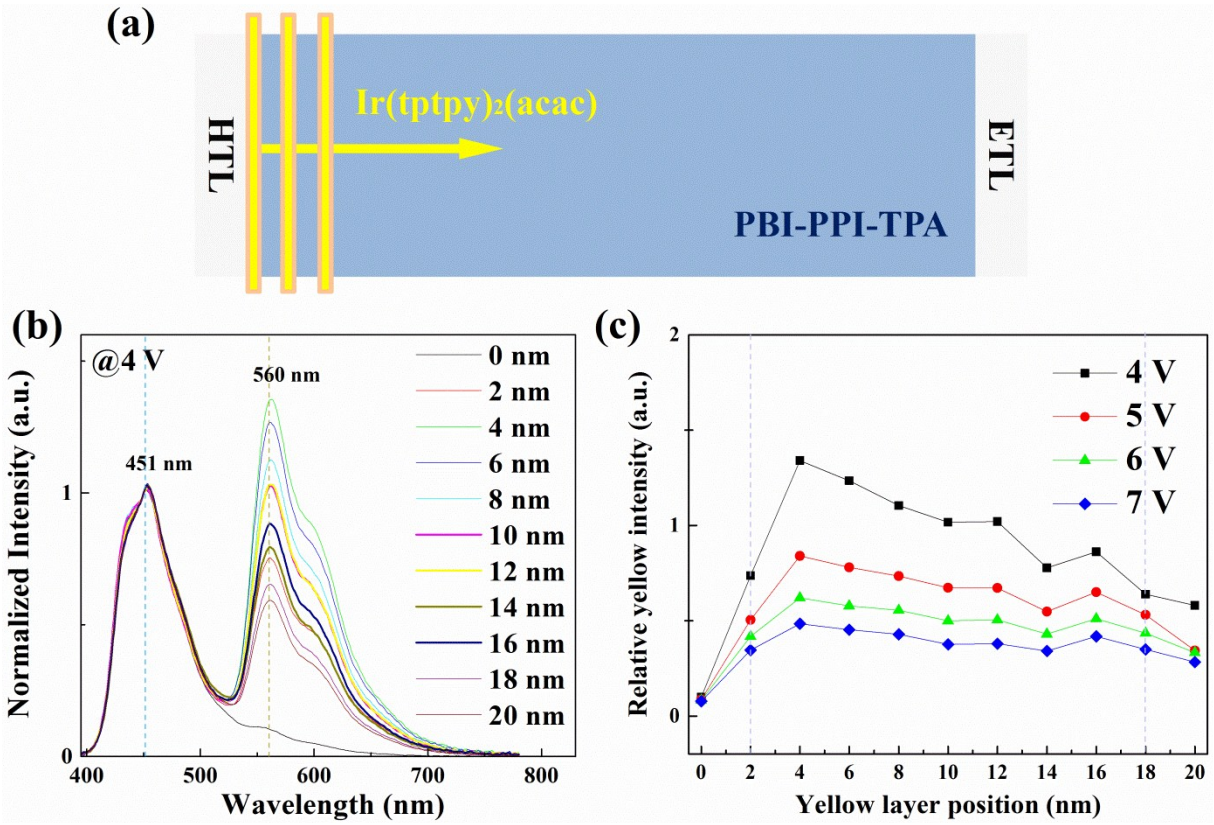

Fig. S3 (a) Schematic diagram for the exploration on exciton density distribution in EML. (b) Normalized emission spectra after inserting ultra-thin phosphor sensing layer at different positions. (c) Ratios of yellow emission peak intensity to blue intensity as a function of the position of yellow ultra-thin sensing layer in EML at different voltages.

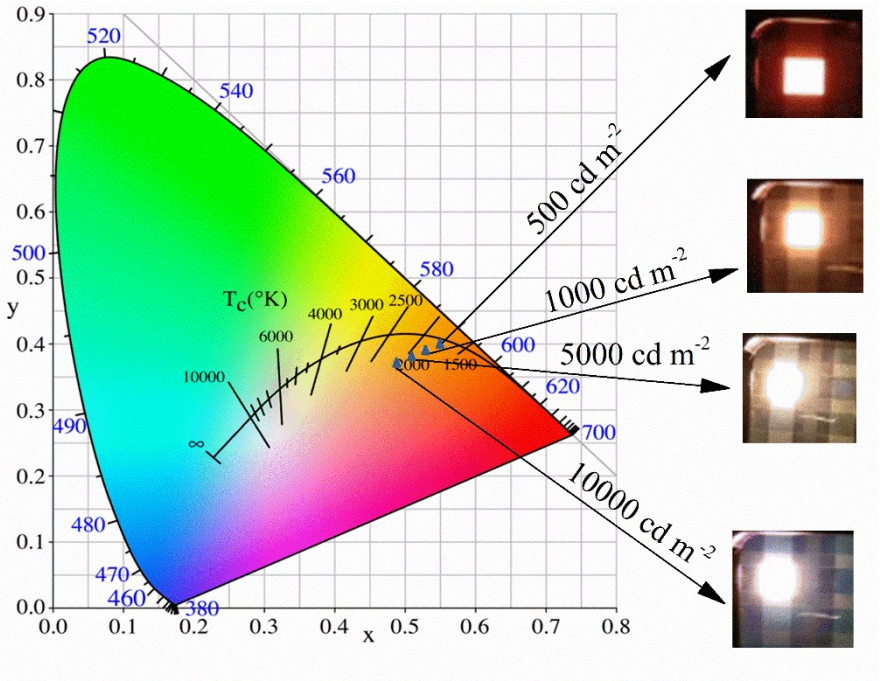

Fig. S4 Diagram of Commission International de L'Eclairage (CIE) chromaticity and photographs of device W2 at different luminance.

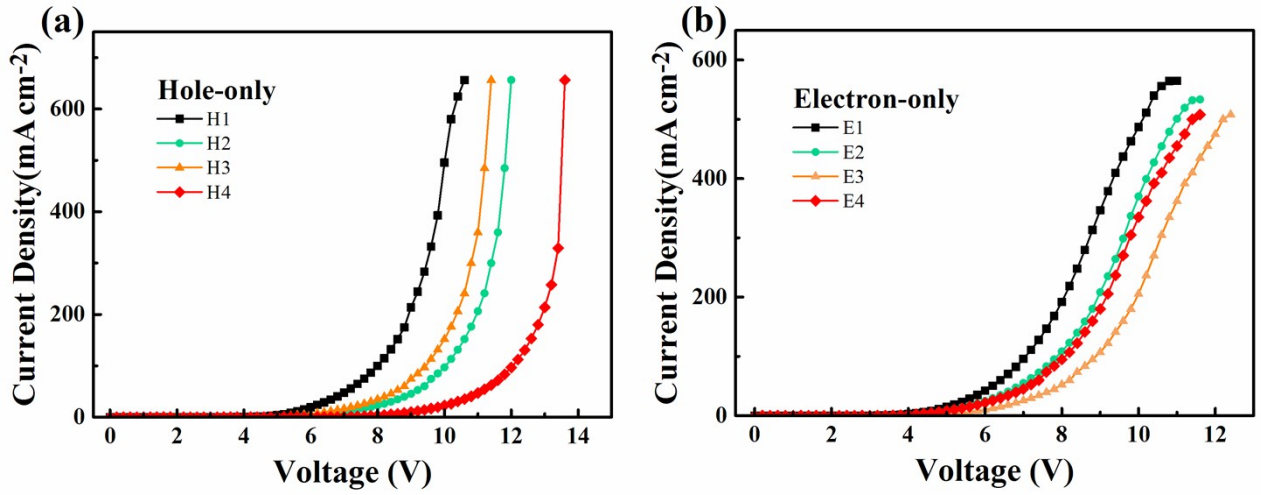

Fig. S5 Current density-voltage characteristics of a) the hole-only devices of ITO/HATCN (15 nm)/TAPC (50 nm)/EML (15 nm)/TAPC (50 nm)/HATCN (15 nm)/Al, where EML is H1: PBI-PPI-TPA, H2: PBI-PPI-TPA:3%Ir(tptpy)$_2$(acac), H3: PBI-PPI-TPA:3%YDD001, H4: PBI-PPI-TPA:2%RD071, and b) the electron-only devices of ITO/LiF (1 nm)/TPBi (40 nm)/EML (15 nm)/TPBi (40 nm)/LiF (1 nm)/Al, where EML is E1: PBI-PPI-TPA, E2: PBI-PPI-TPA:3%Ir(tptpy)$_2$(acac), E3: PBI-PPI-TPA:3%YDD001, E4: PBI-PPI-TPA:2%RD071.

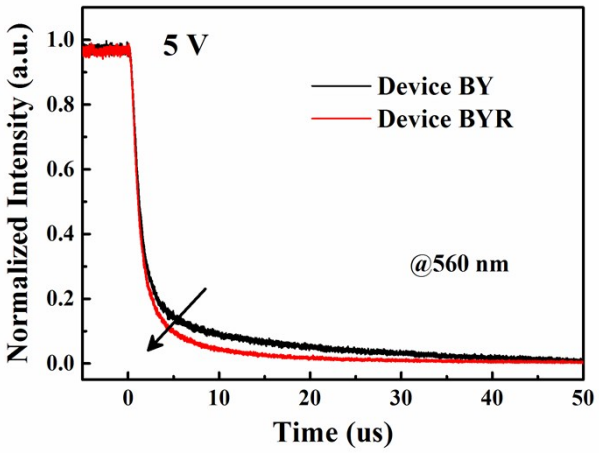

Fig. S6 Time-resolved transient EL decay characteristics of devices BY and W2 recorded at 560 nm at 5 V. The structure of device BY is ITO/HATCN (15 nm)/TAPC (65 nm)/TCTA (5 nm)/PBI-PPI-TPA:Ir(tptpy)$_2$(acac) (3%, 7 nm)/PBI-PPI-TPA (10 nm)/TPBi (40 nm)/LiF (1 nm)/Al.

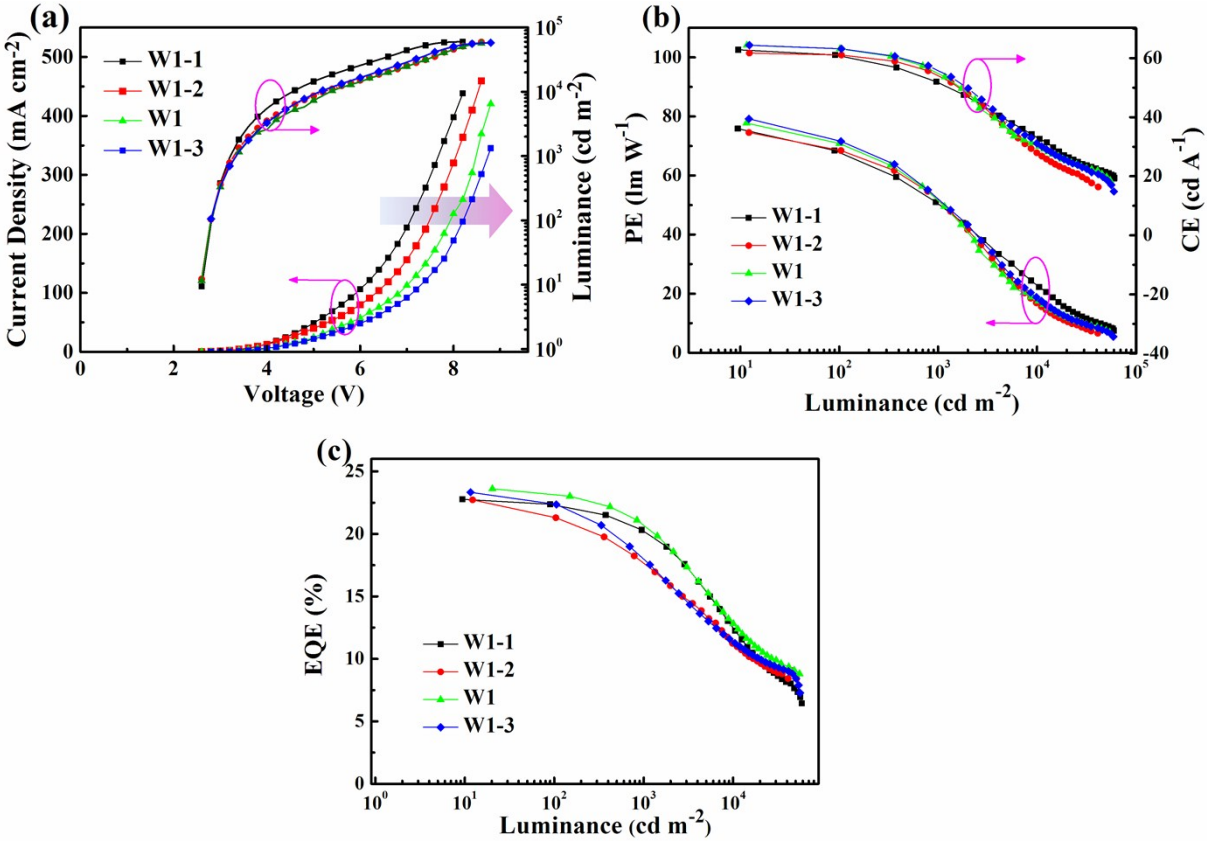

Fig. S7 EL performances of the resulting two-color white device W1 and the reference devices W1-1, W1-2 and W1-3): (a) J−V−L, (b) CE−L−PE, and (c) EQE−L characteristics.

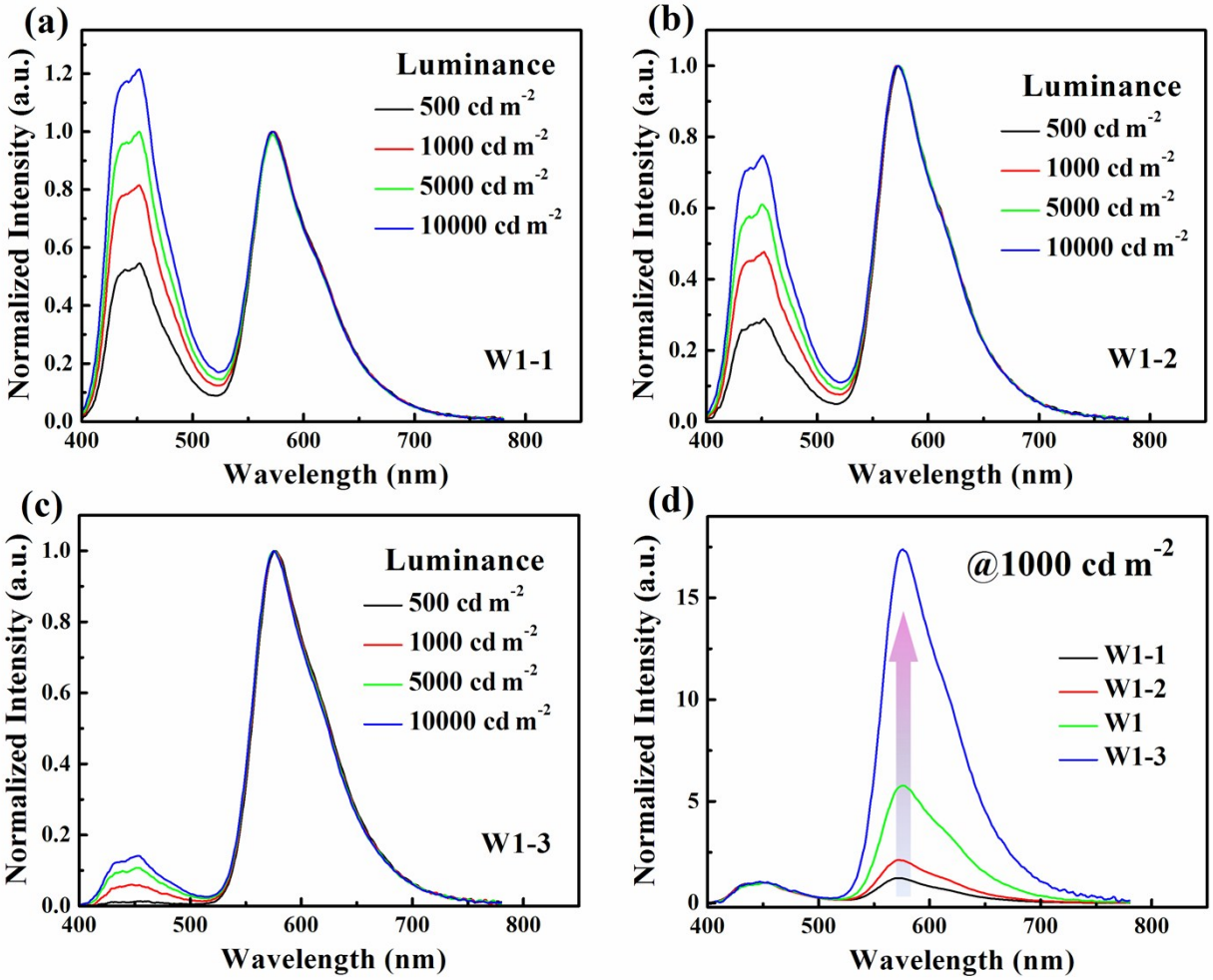

Fig. S8 EL spectral characteristics of devices (a) W1-1, (b) W1-2, and (c) W1-3. (d) Normalized EL spectra of device W1 and the reference devices measured at 1000 cd m^{-2}.

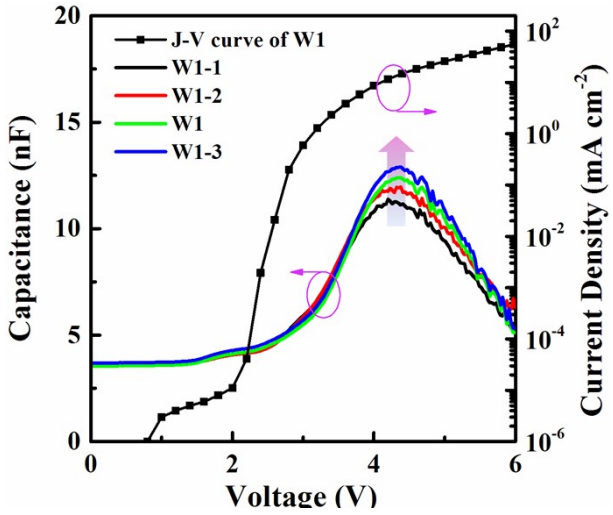

Fig. S9 Capacitance–V characteristics of devices W1-1, W1-2, W1 and W1-3, and J–V characteristic of device W1.

Table S1. Summary of EL performances of the optimized monochromatic OLEDs.

Device	V_{on}[a] [V]	Max EQE[b] [%]	Max PE[b] [lm W^{-1}]	CIE[c] (x, y)	EQE[c] [%]	PE[c] [lm W^{-1}]
B	2.8	6.9	5.8	(0.15,0.09)	6.3	3.2
Y	2.6	21.1	78.9	(0.49,0.49)	17.7	50.6
O	2.6	21.7	76.2	(0.51,0.46)	19.7	51.5
R	2.6	21.6	31.1	(0.66,0.33)	17.1	17.6

[a] At a luminance of 1 cd m^{-2}, [b] The maximum efficiencies, [c] Measured at 1000 cd m^{-2}.