Electronic Supporting Information (ESI)

An arylphosphine oxide and phosphonate combination as solution processable electron injection layer for power-efficient PLEDs

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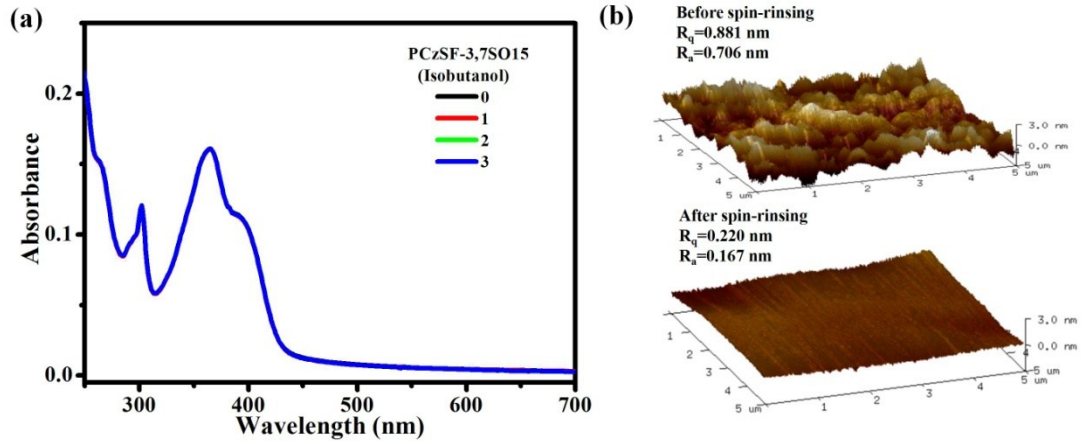

Fig. S1. UV-Vis absorption spectra for PCzSF-3,7SO15 film after different spin-rinsing time with isobutanol (a), and AFM images of PCzSF-3,7SO15 films before and after spin-rinsing with isobutanol (b).

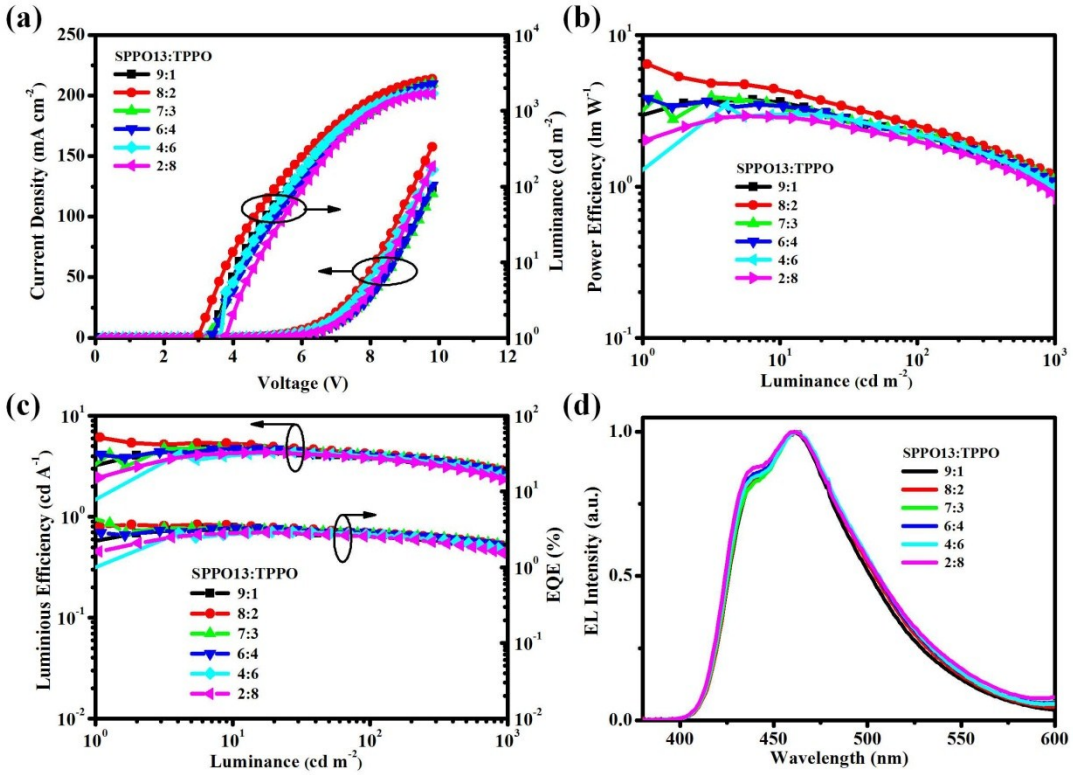

Fig. S2. Performance of blue devices with varying ratio between SPPO13 and TPPO (a) current density-voltage-luminance (*J*-*V*-*L*) characteristics; (b) power efficiency as a function of luminance; (c) luminous efficiency and EQE as a function of luminance; (d) EL spectra.

Table S1. Summary of device performance for blue devices with varying ratio between SPPO13 and TPPO.

Mixed EIL SPPO13:TPPO	V_{on} (V)	LE (cd/A)	PE (lm/W)	EQE (%)	CIE (x, y)
9:1	3.4	4.8	3.7	3.3	(0.16, 0.16)
8:2	3.0	5.4	5.3	3.6	(0.17, 0.17)
7:3	3.3	4.8	3.9	3.3	(0.17, 0.17)
6:4	3.4	4.7	3.8	3.3	(0.17, 0.18)
4:6	3.6	4.3	3.4	2.9	(0.17, 0.17)
2:8	3.8	4.4	2.9	2.9	(0.17, 0.18)

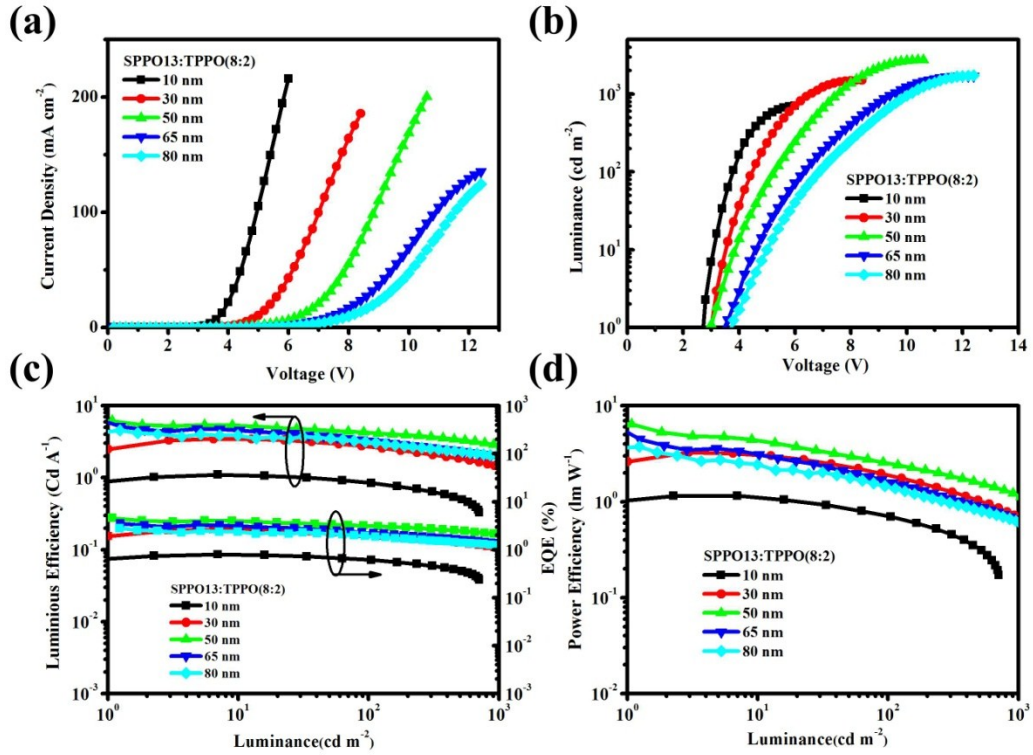

Fig. S3. Performance of blue devices with varying thickness of mixed EIL SPPO13:TPPO (8:2): (a) current density-voltage (*J-V*) characteristics; (b) luminance-voltage (*L-V*) characteristics; (c) luminous efficiency and EQE as a function of luminance; (d) power efficiency as a function of luminance.

Table S2. Summary of device performance for blue devices with varying thickness of mixed EIL SPPO13:TPPO (8:2).

Mixed EIL thickness	V_{on} (V)	LE (cd/A)	PE (lm/W)	EQE (%)
10 nm	2.5	1.1	1.1	0.8
30 nm	3.0	3.5	3.2	2.6
50 nm	3.0	5.4	5.3	3.6
65 nm	3.5	4.8	3.8	3.3
80 nm	3.7	4.2	3.3	2.8

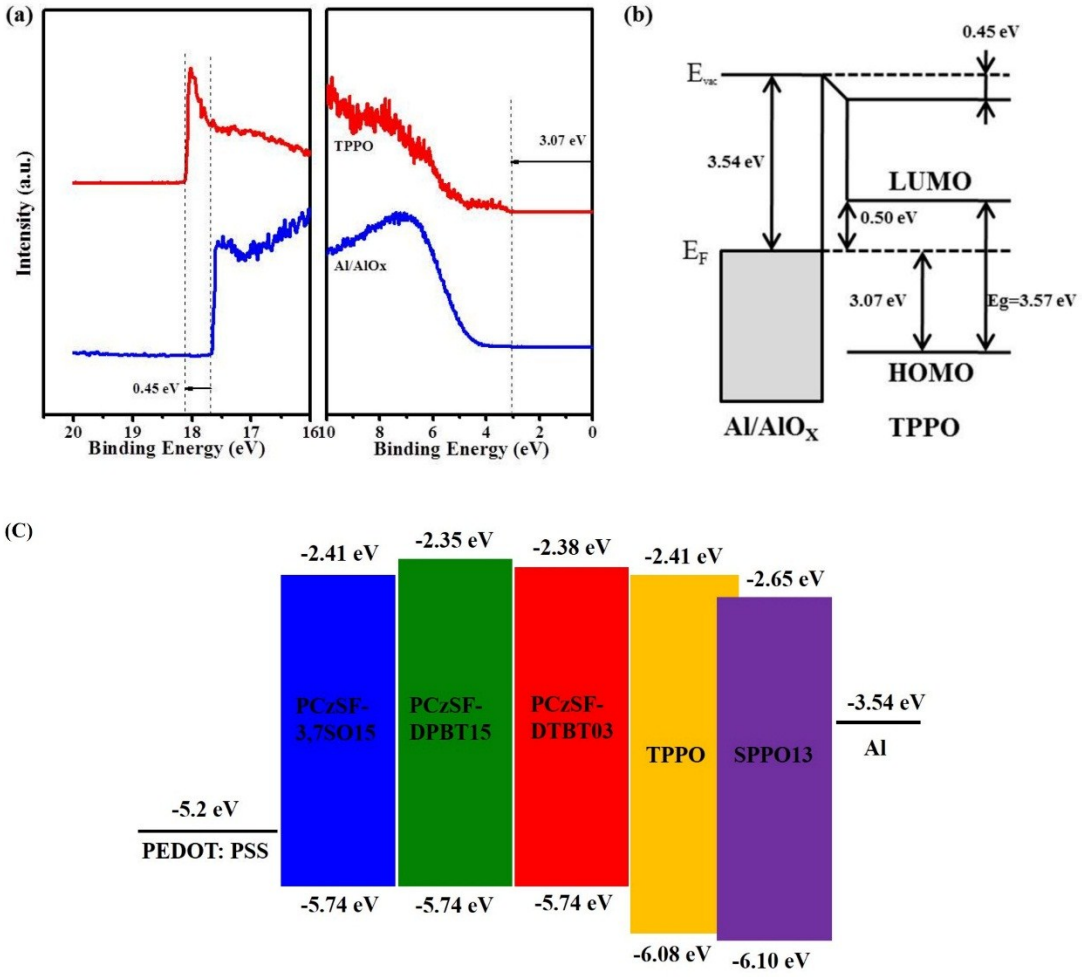

Fig. S4. UPS spectra of Al/TPPO (a); The corresponding energy diagram at the interfaces (b); Energy level alignment of the multi-layer PLEDs (c).

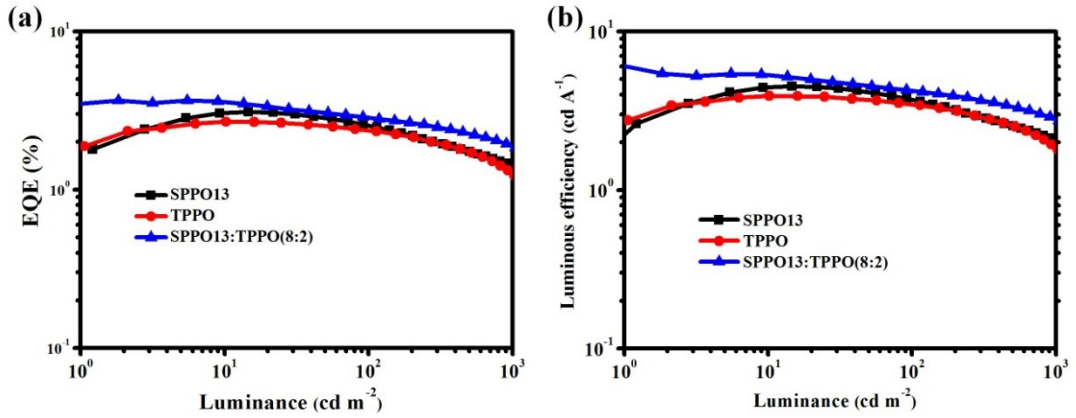

Fig. S5. Performance of blue devices with different electron injection layers (SPPO13, TPPO, and SPPO13: TPPO (8: 2, w/w)) (a) EQE as a function of luminance; (b) luminous efficiency as a function of luminance.

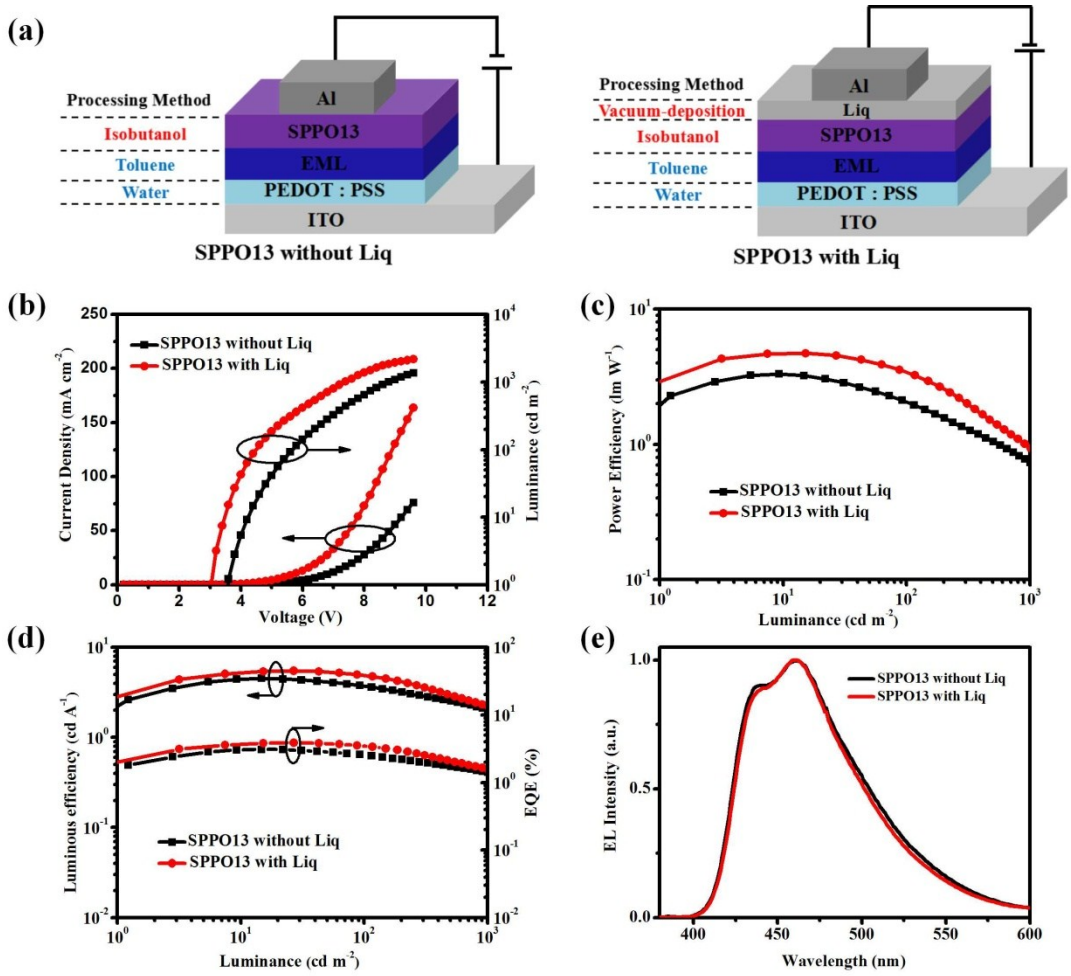

Fig. S6. Comparison between devices without Liq and with Liq: (a) device configuration of devices without Liq and with Liq; (b) current density–voltage–luminance (*J-V-L*) characteristics; (c) power efficiency as a function of luminance; (d) luminous efficiency and EQE as a function of luminance; (e) EL spectra.

Table S3. Summary of device performance for devices without Liq and with Liq.

EIL	V_{on} (V)	LE (cd/A)	PE (lm/W)	EQE (%)	CIE (x, y)
SPPO13 without Liq	3.6	4.5	3.3	3.1	(0.16, 0.16)
SPPO13 with Liq	3.0	5.5	4.7	3.9	(0.17, 0.19)

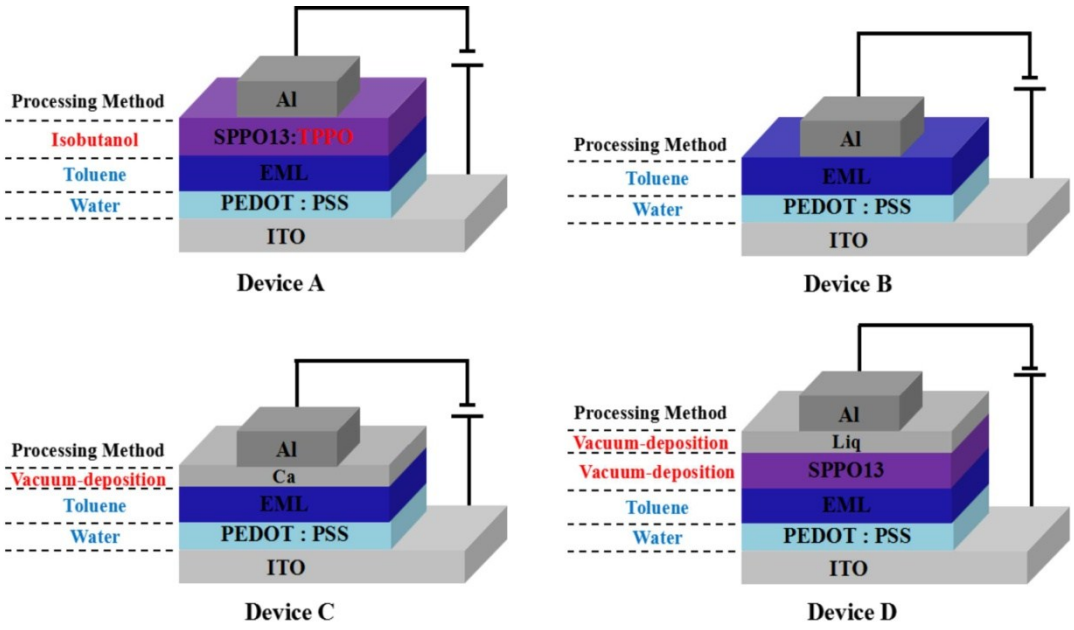

Fig. S7. Configuration and processing method of different blue devices: device A: solution-processed SPPO13:TPPO (8: 2, w/w) is used as EIL; device B: without EIL; device C: vacuum-deposited Ca is used as EIL; device D: vacuum-deposited SPPO13/Liq are used as ETL/EIL.

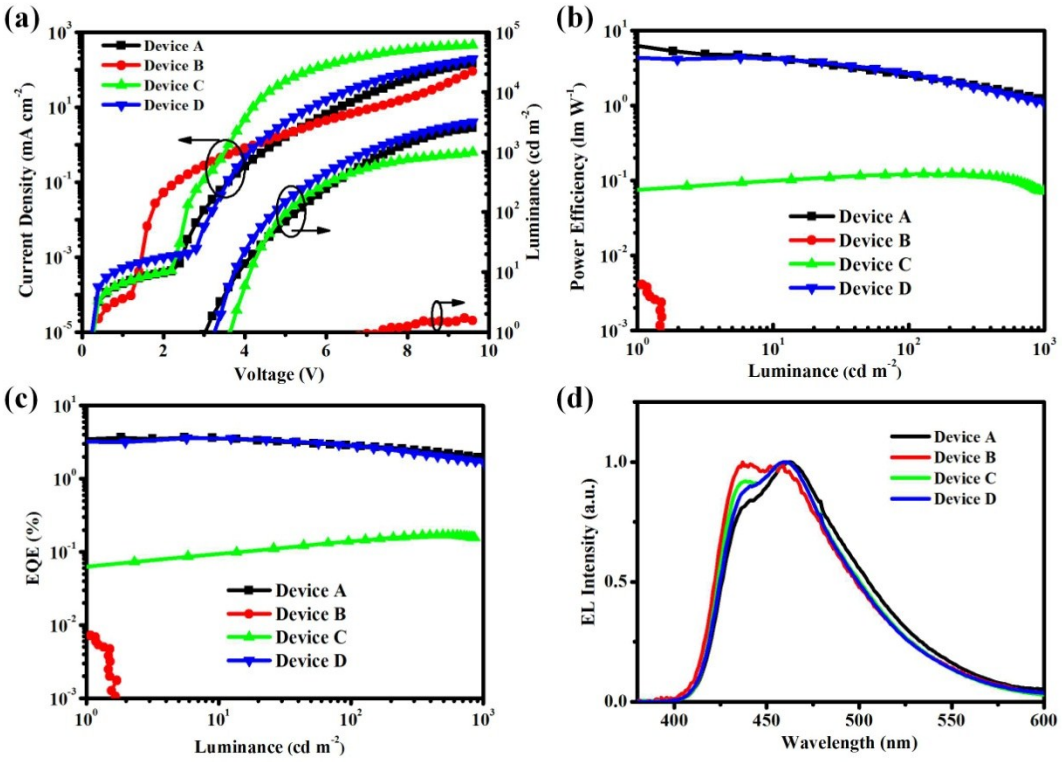

Fig. S8. Performance comparison of device A (SPPO13:TPPO (8: 2, w/w)), device B, device C and device D: (a) current density-voltage-luminance (*J*-*V*-*L*) characteristics; (b) power efficiency as a function of luminance; (c) EQE as a function of luminance; (d) EL spectra.

Table S4. Summary of device performance for device A (SPPO13:TPPO (8: 2, w/w)), device C, device D and device E.

Device	V_{on} (V)	LE (cd/A)	PE (lm/W)	EQE (%)	CIE (x, y)
Device A	3.0	5.4	5.3	3.6	(0.17, 0.17)
Device B	7.0	0.01	0.005	0.007	(0.25, 0.33)
Device C	3.6	0.23	0.12	0.17	(0.16, 0.15)
Device D	3.3	5.0	4.4	3.6	(0.16, 0.15)

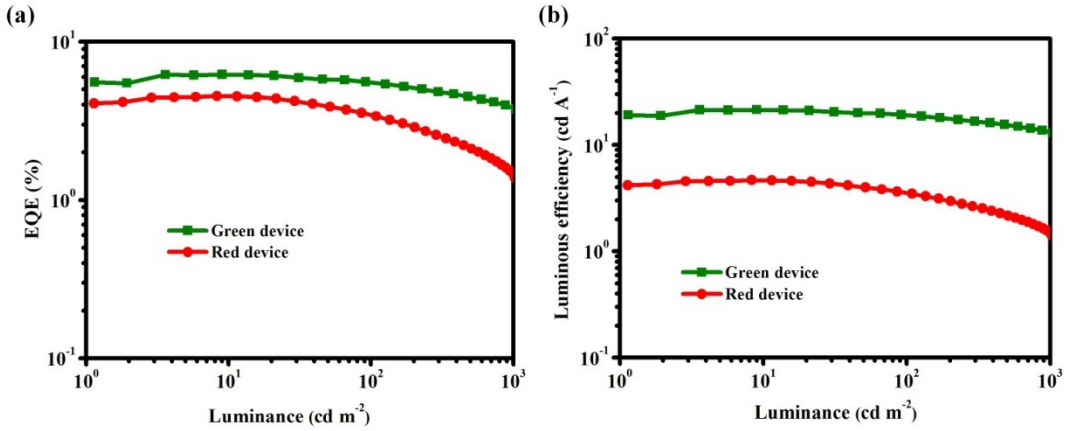

Fig. S9. EQE (a) and luminous efficiency (b) as a function of luminance for green and red devices with SPPO13: TPPO (8: 2, w/w) as electron injection layer.

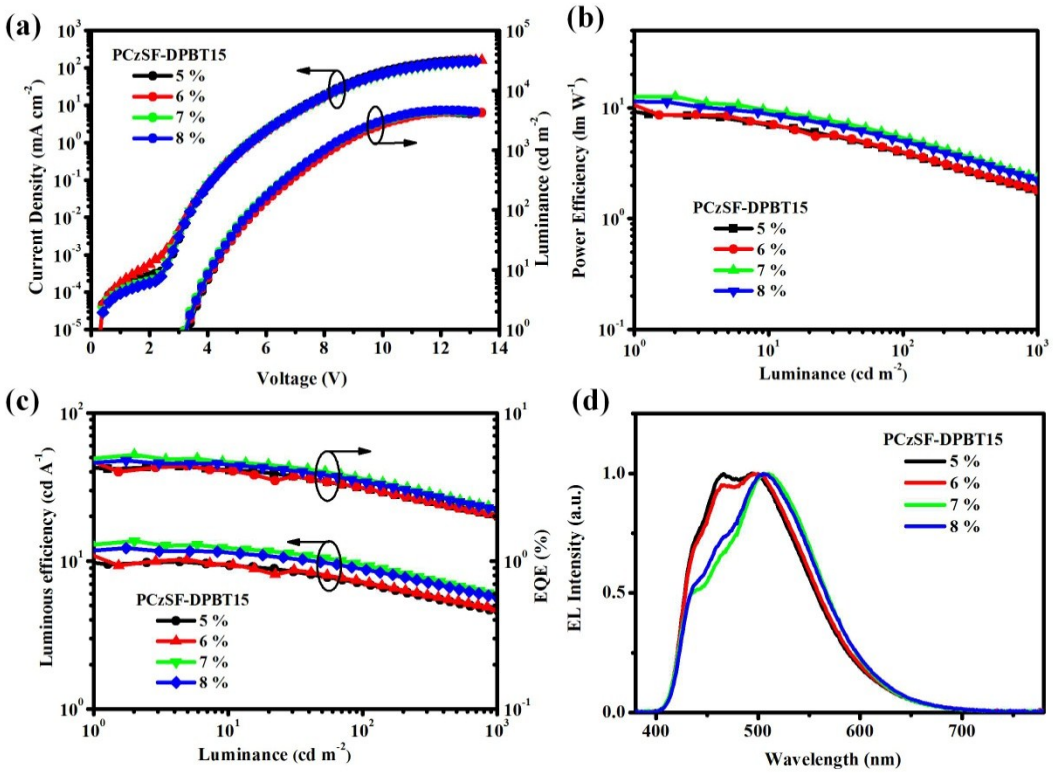

Fig. S10. Concentration tuning of green polymer PCzSF-DPBT15 (green polymer doped into blue polymer as the EML): (a) current density–voltage–luminance (*J-V-L*) characteristics; (b) power efficiency as a function of luminance; (c) luminous efficiency and EQE as a function of luminance; (d) EL spectra.

Table S5. Summary of device performance for devices with different concentration of green polymer PCzSF-DPBT15 (green polymer doped into blue polymer as the EML).

PCzSF-DPBT15 concentration	V_{on} (V)	LE (cd/A)	PE (lm/W)	EQE (%)	CIE (x, y)
5 wt.%	3.2	9.9	8.8	4.4	(0.21, 0.31)
6 wt.%	3.0	10.2	8.7	4.4	(0.21, 0.32)
7 wt.%	3.1	13.6	12.6	5.2	(0.23, 0.38)
8 wt.%	3.2	12.2	11.3	4.8	(0.23, 0.37)

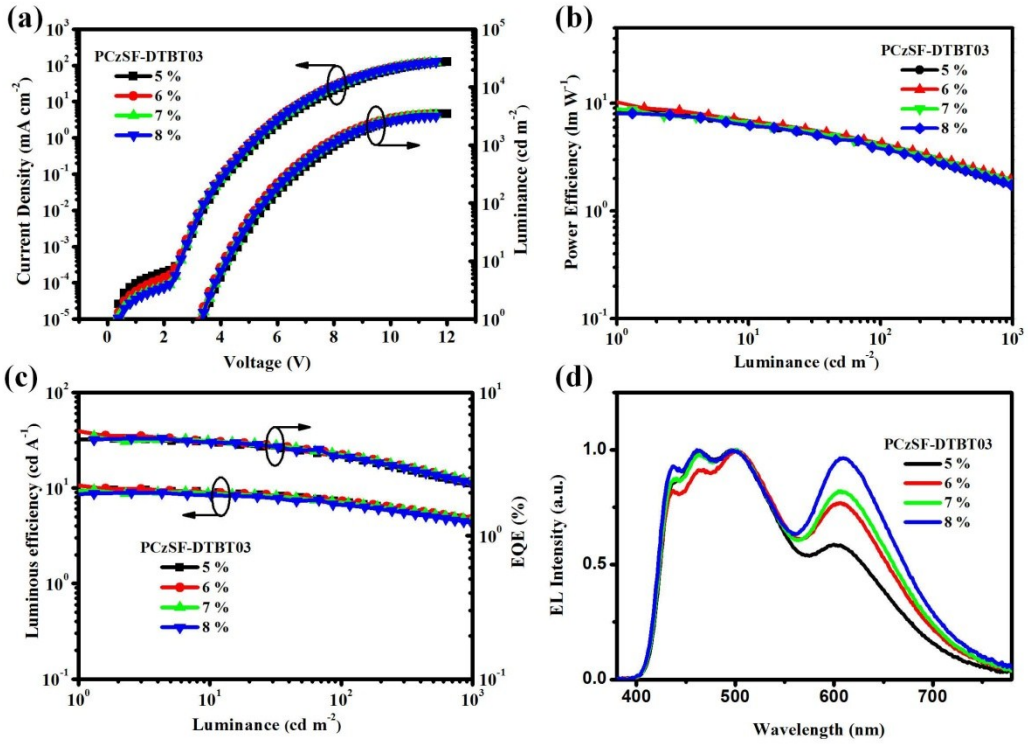

Fig. S11. Concentration tuning of red polymer PCzSF-DTBT03 (green and red polymers are doped into blue polymer as the EML, and the concentration of green polymer is 7 wt. %): (a) current density–voltage–luminance (*J-V-L*) characteristics; (b) power efficiency as a function of luminance; (c) luminous efficiency and EQE as a function of luminance; (d) EL spectra.

Table S6. Summary of device performance for devices with different concentration of red polymer PCzSF-DTBT03 (green and red polymers are doped into blue polymer as the EML, and the concentration of green polymer is 7 wt. %).

PCzSF-DTBT03 concentration	V_{on} (V)	LE (cd/A)	PE (lm/W)	CRI (0-100)	CCT (K)	CIE (x, y)
5 wt.%	3.1	9.5	8.7	94	5676	(0.28, 0.32)
6 wt.%	3.0	9.8	9.0	92	6580	(0.31, 0.33)
7 wt.%	3.1	9.5	8.7	89	6511	(0.31, 0.32)
8 wt.%	3.1	8.9	8.1	85	5769	(0.33, 0.32)