Effect of PEDOT:PSS on the performance of solution-processed blue phosphorescent organic light-emitting diodes with an exciplex host

Jaber Saghaei,[1] Manikandan Koodalingam,[1] Paul L. Burn,[1*] Ian R. Gentle,[1] Almantas Pivrikas,[2] Paul E. Shaw[1]

[1]Centre for Organic Photonics & Electronics (COPE), School of Chemistry and Molecular Biosciences, The University of Queensland, Brisbane, Queensland 4072, Australia

[2]School of Engineering and Information Technology, Murdoch University, Perth, Western Australia, 6150, Australia

*Email: p.burn2@uq.edu.au

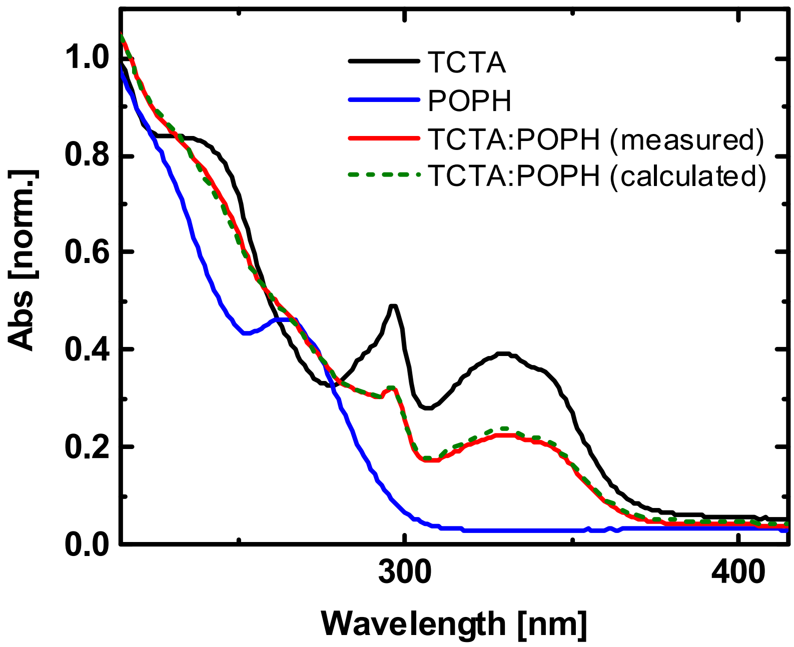


Fig. S1 *Absorption spectra of TCTA and POPH neat films, and their 1:1 mole ratio blend.*

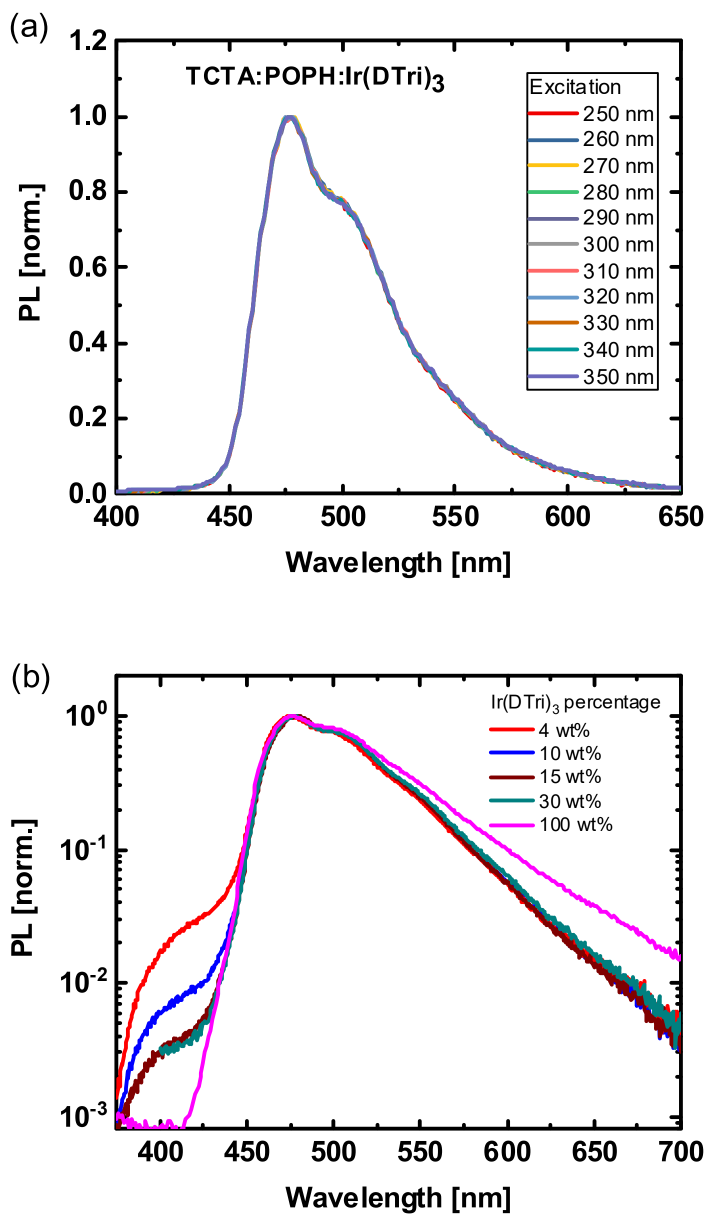
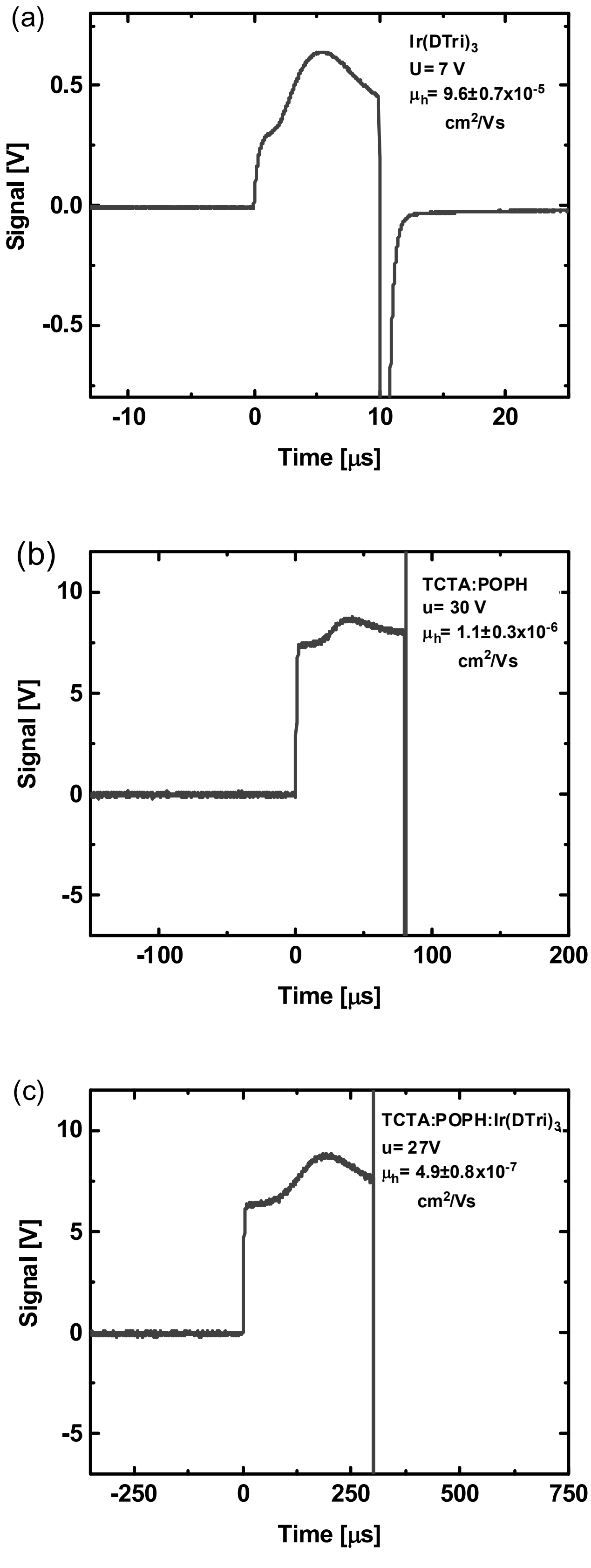


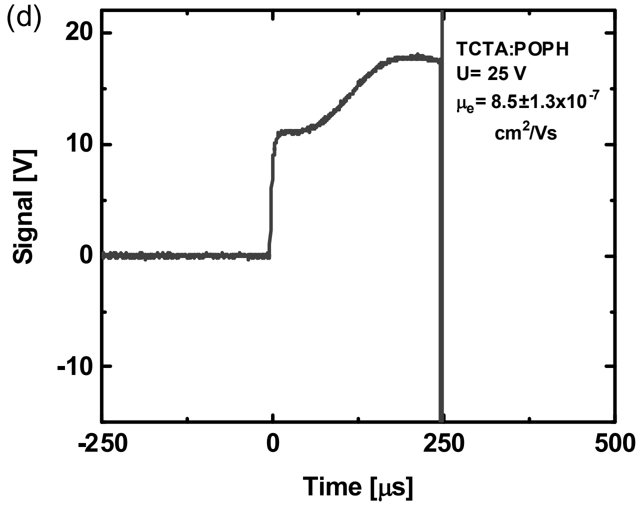
Fig. S2 *(a) PL spectra from a film containing 20 wt% of Ir(DTri)$_3$ in a 1:1 mole ratio TCTA:POPH versus excitation wavelength. (b) PL spectra of TCTA:POPH:Ir(DTri)$_3$ blend films with different Ir(DTri)$_3$ concentrations.*

Table S1 *Summary of lifetimes from the TRPL measurements at the specified wavelength.*

Film	**ϕ_{PL} [nm]**	**τ_1 [µs]**	**τ_1%**	**τ_2 [µs]**	**τ_2%**	**τ_3 [µs]**	**τ_3%**
TCTA:POPH	450	0.014	78.4	0.078	17.6	0.978	3.9
Ir(DTri)$_3$	475	0.049	6.5	0.525	20.3	2.15	73.2
TCTA:POPH:Ir(DTri)$_3$	475	0.241	2.8	1.954	30.6	6.308	66.6



(a)
Ir(DTri)$_3$
U= 7 V
μ_h= 9.6±0.7x10^{-5} cm^2/Vs
Signal [V]
Time [µs]
(b)
TCTA:POPH
u= 30 V
μ_h= 1.1±0.3x10^{-6} cm^2/Vs
Signal [V]
Time [µs]
(c)
TCTA:POPH:Ir(DTri)$_3$
u= 27V
μ_h= 4.9±0.8x10^{-7} cm^2/Vs
Signal [V]
Time [µs]



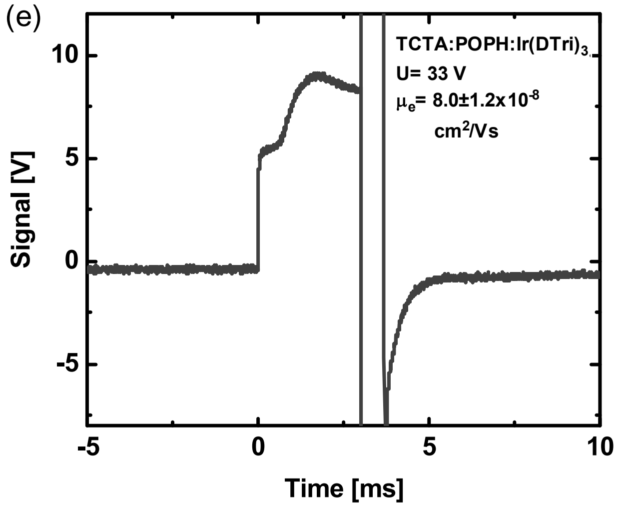


Fig. S3 *MIS-CELIV transients for the hole mobility of (a) Ir(DTri)$_3$, (b) TCTA:POPH and (c) TCTA:POPH:(20 wt%)Ir(DTri)$_3$ and photo-MIS-CELIV transients measurement for electron mobility of (d) TCTA:POPH and (e) TCTA:POPH:(20 wt%)Ir(DTri)$_3$.*

Table S2 *Summary of the OLEDs performance characteristics.*

Device	V_{on}[a] [V]	CE_{max}[b] [cd/A]	PE_{max}[c] [lm/W]	EQE_{max}[d] [%]	EQE_{100}[e] [%]	EQE_{1000}[f] [%]
PEDOT:PSS/TCTA:POPH:(15 wt%Ir(DTri)$_3$	4.1±0.1	24.3±0.6	18.9±1.3	11.8±0.6	11.5±0.7	11.1±0.3
PEDOT:PSS/TCTA:POPH:(30 wt%)Ir(DTri)$_3$	4.1±0.1	23.3±0.5	18.7±0.8	11.3±0.4	11.1±0.5	10.5±0.2
PEDOT:PSS/TCTA:POPH:(20 wt%)Ir(DTri)$_3$	4.0±0.1	25.6±0.6	24.5±1.9	12.1±0.5	11.8±0.6	11.1±0.4
m-PEDOT:PSS/TCTA:POPH:(20 wt%)Ir(DTri)$_3$	3.9±0.1	41.4±5.4	33.2±5.1	23.4±4.2	12.7±1.1	11.3±0.4

[a] Voltage at 1cd/cm^2. [b] Maximum current efficiency (*CE*). [c] Maximum power efficiency (*PE*). [d] Maximum EQE. [e] EQE at 100 cd/m^2. [f] EQE at 1000 cd/m^2. Data from the first *J-V* scan, with the average and errors based on ≈12 pixels.

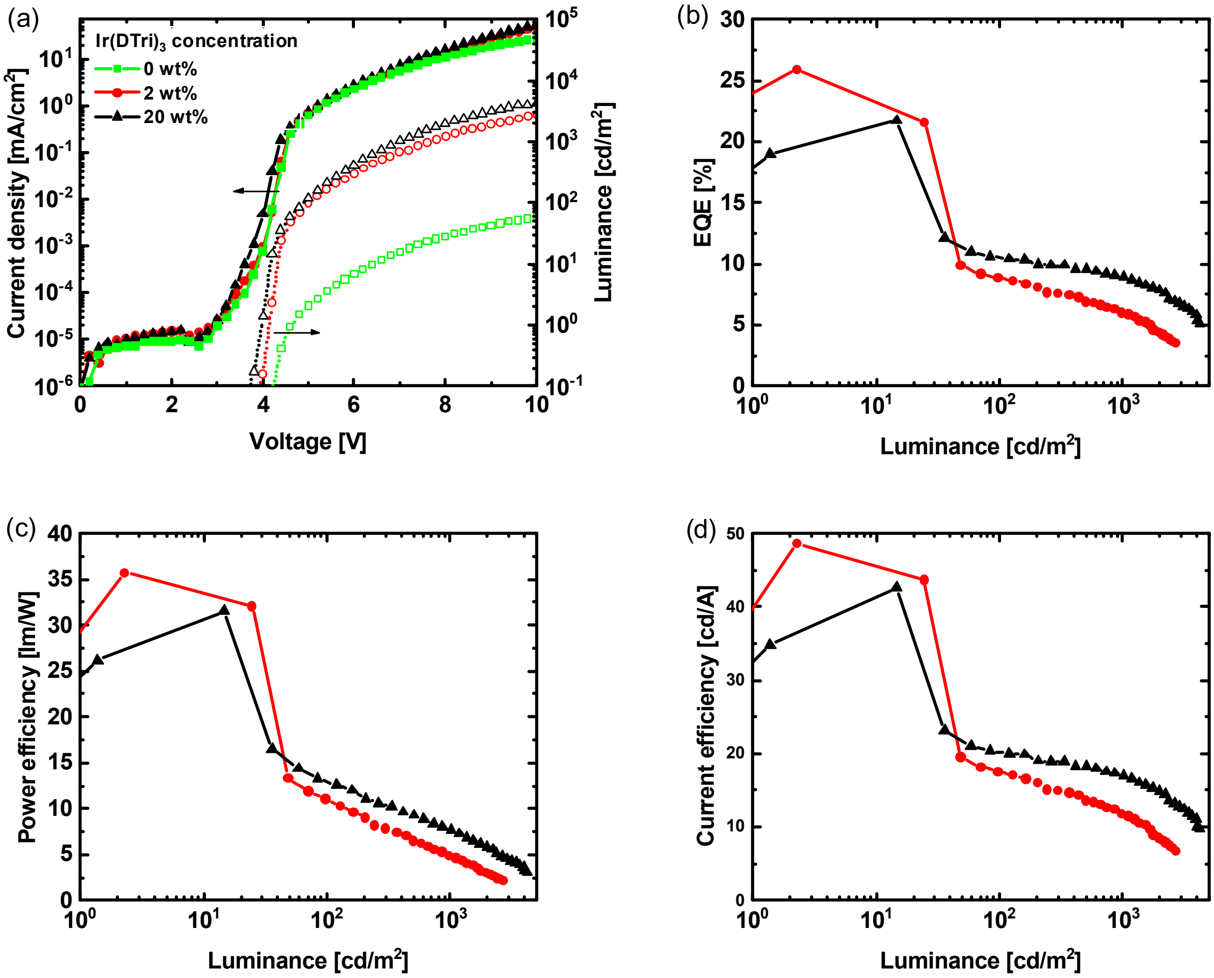


Fig. S4 *(a) J-V-L, (b) EQE-L, (c) PE-L and (d) CE-L of the OLED (ITO/m-PEDOT:PSS/TCTA:POPH:Ir(DTri)$_3$/BP4mPy/LiF/Al) with different weight ratios of dendrimer in the emissive layer.*

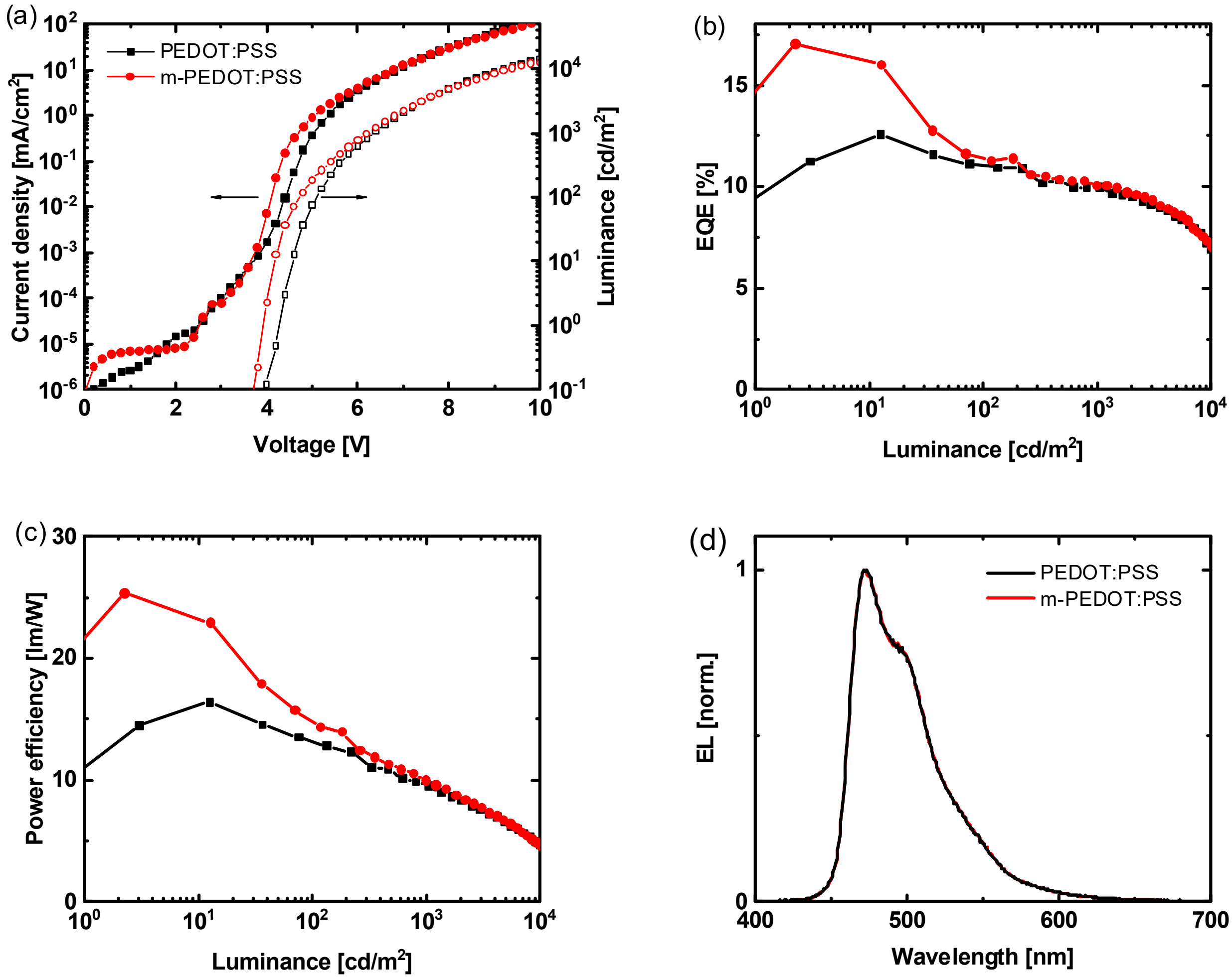


Fig. S5 *(a) J-V-L, (b) EQE-L (c) PE-L and (d) CE-L of the OLED with PEDOT:PSS or m-PEDOT:PSS as hole injection layers and TCTA:POPH:(10 wt%)FIrpic as the emissive layer.*

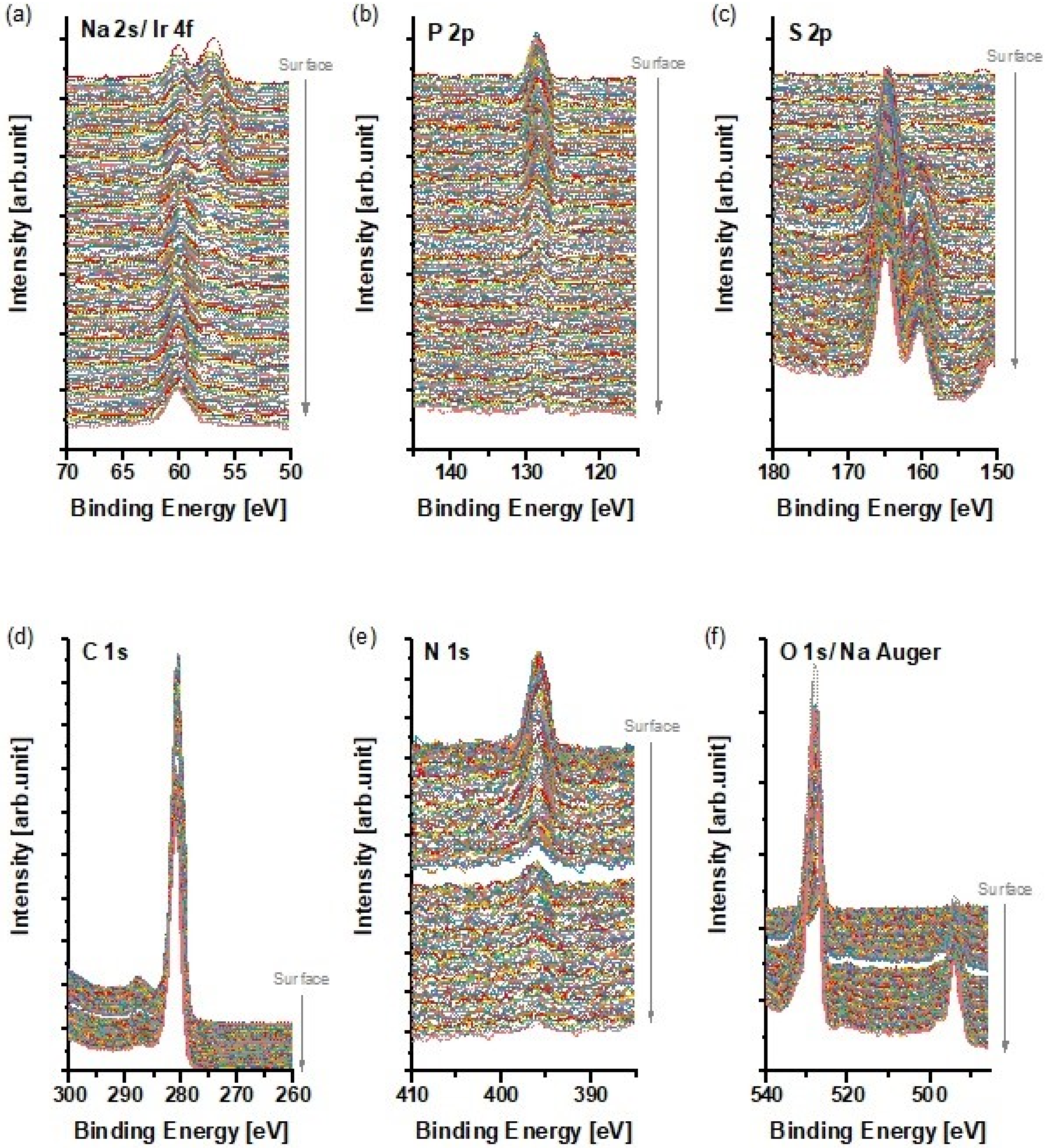
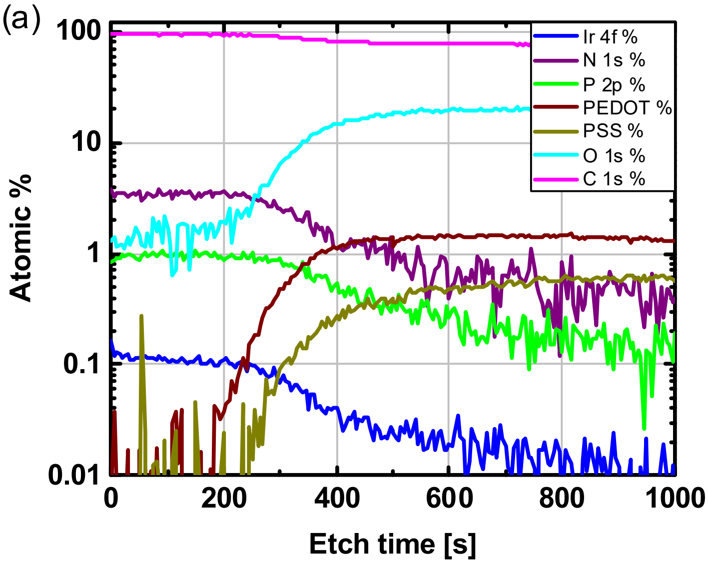


Fig. S6 *XPS depth profiles of glass/m-PEDOT:PSS/TCTA:POPH:(20 wt%)Ir(DTri)$_3$ using an argon cluster ion beam for (a) Na 2s/ Ir 4f, (b) P 2p, (c) S 2p, (d) C 1s, (e) N 1s and (f) O 1s/ Na Auger spectra.*

(a)



(b)

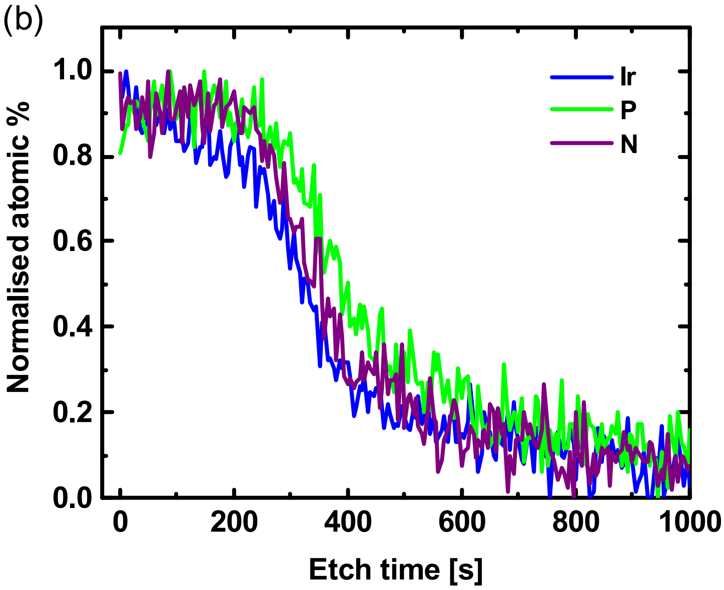


Fig. S7 *(a) Atomic concentrations of emissive layer on glass/m-PEDOT:PSS as a function of etch time and (b) normalized concentration for Ir 4f, P 2p and N 1s.* To determine the uniformity of the ratio of components in the emissive layer perpendicular to the substrate, the normalised atomic percentages for Ir, P and N are shown in Fig. S7b. For normalisation we avoid the data before etching begins due to the surface contamination (with adventitious carbon), which may result in higher variation the concentrations. The N 1s could belong to either TCTA or Ir(DTri)$_3$. The three graphs are nearly coincident, implying that TCTA, POPH and Ir(DTri)$_3$ are distributed homogeneously within the EML in the z-direction (Fig. S7b).

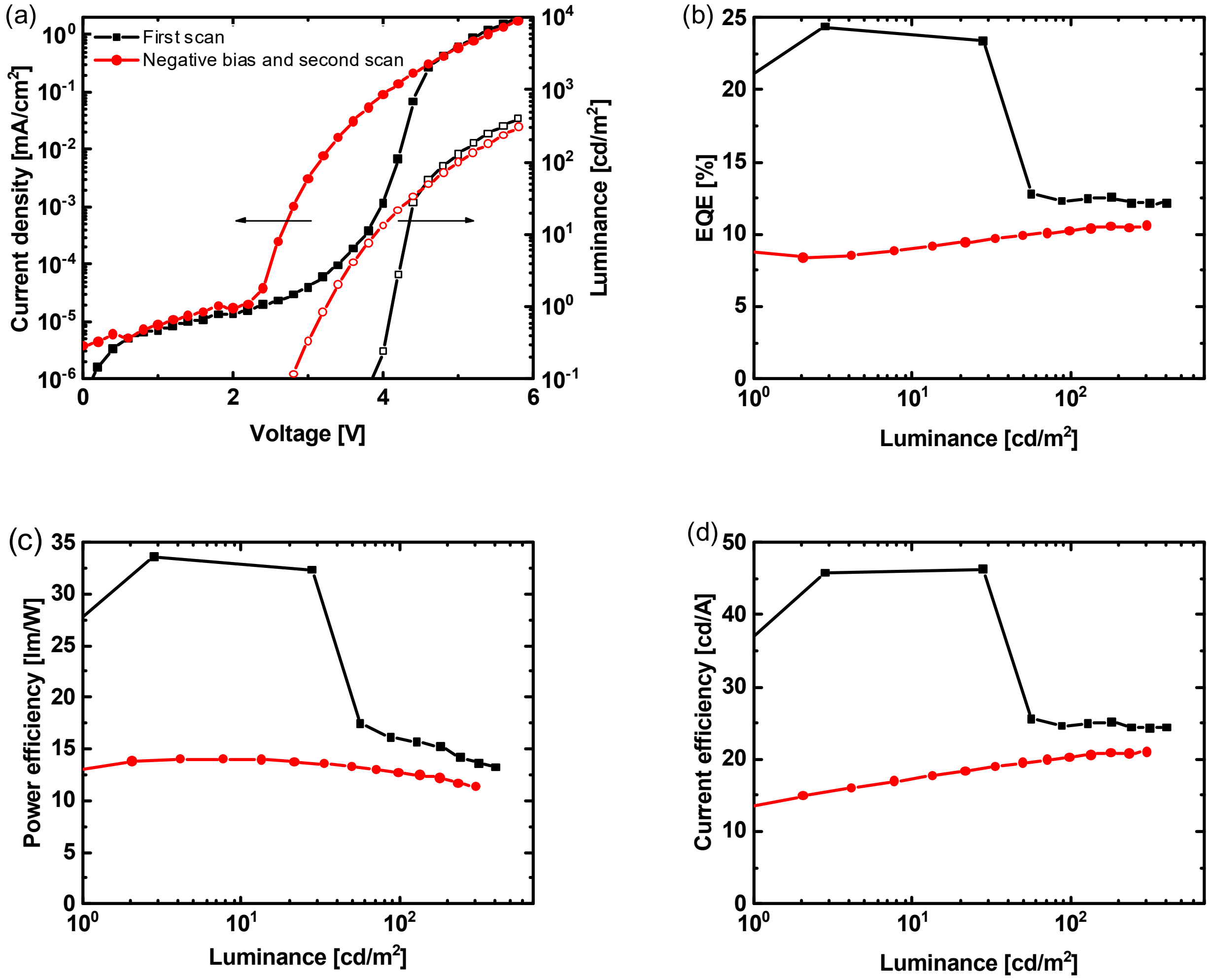


Fig. S8 *(a) J-V-L, (b) EQE-L, (c) PE-L and (d) CE-L of the OLED at first scan and second scan after holding at negative bias of -5 V for 10 min.*

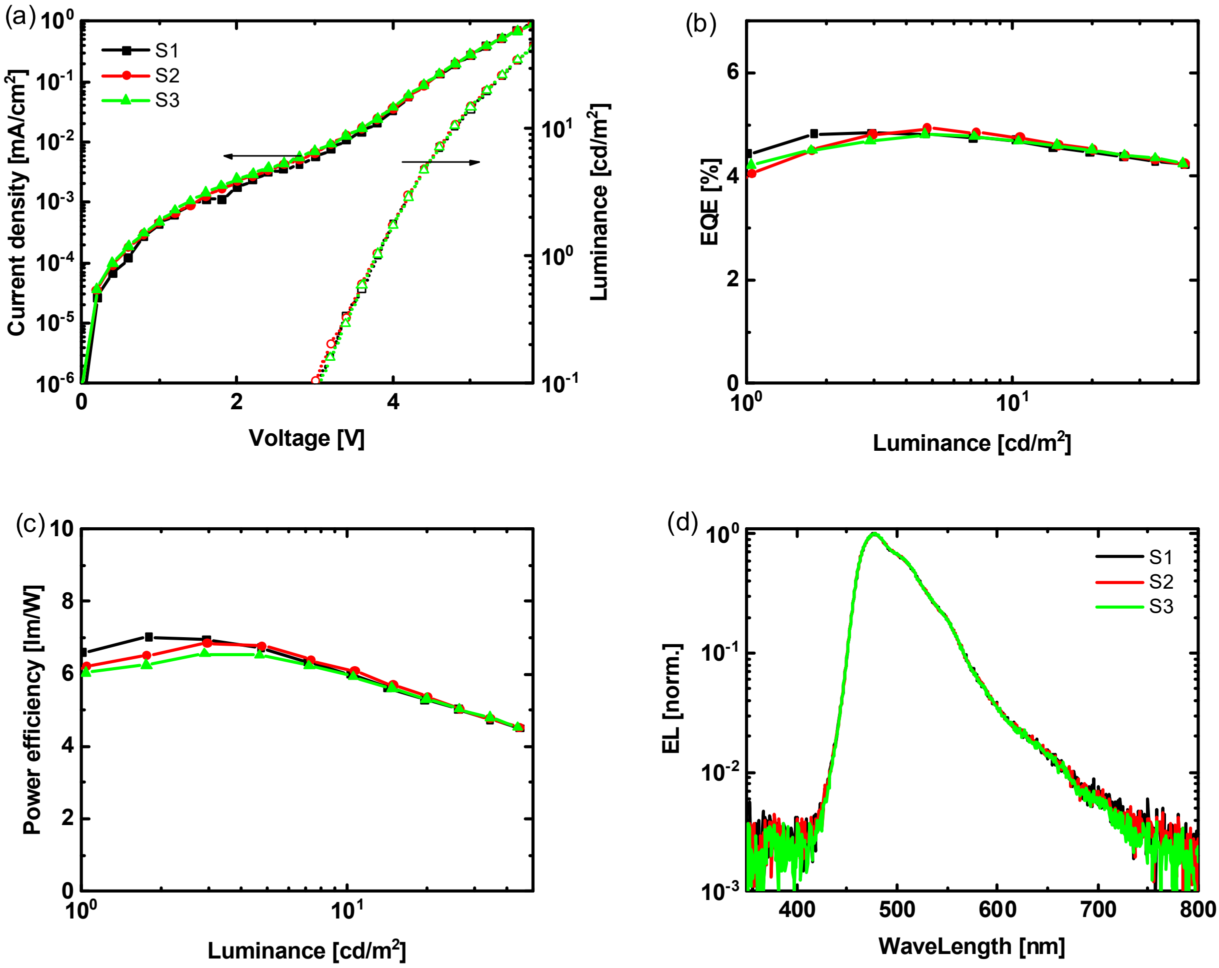


Fig. S9 *(a) J-V-L, (b) EQE-L, (c) PE-L and (d) EL spectra of the OLED with* MoO_x *as the hole injection layer versus scan (S) number.*

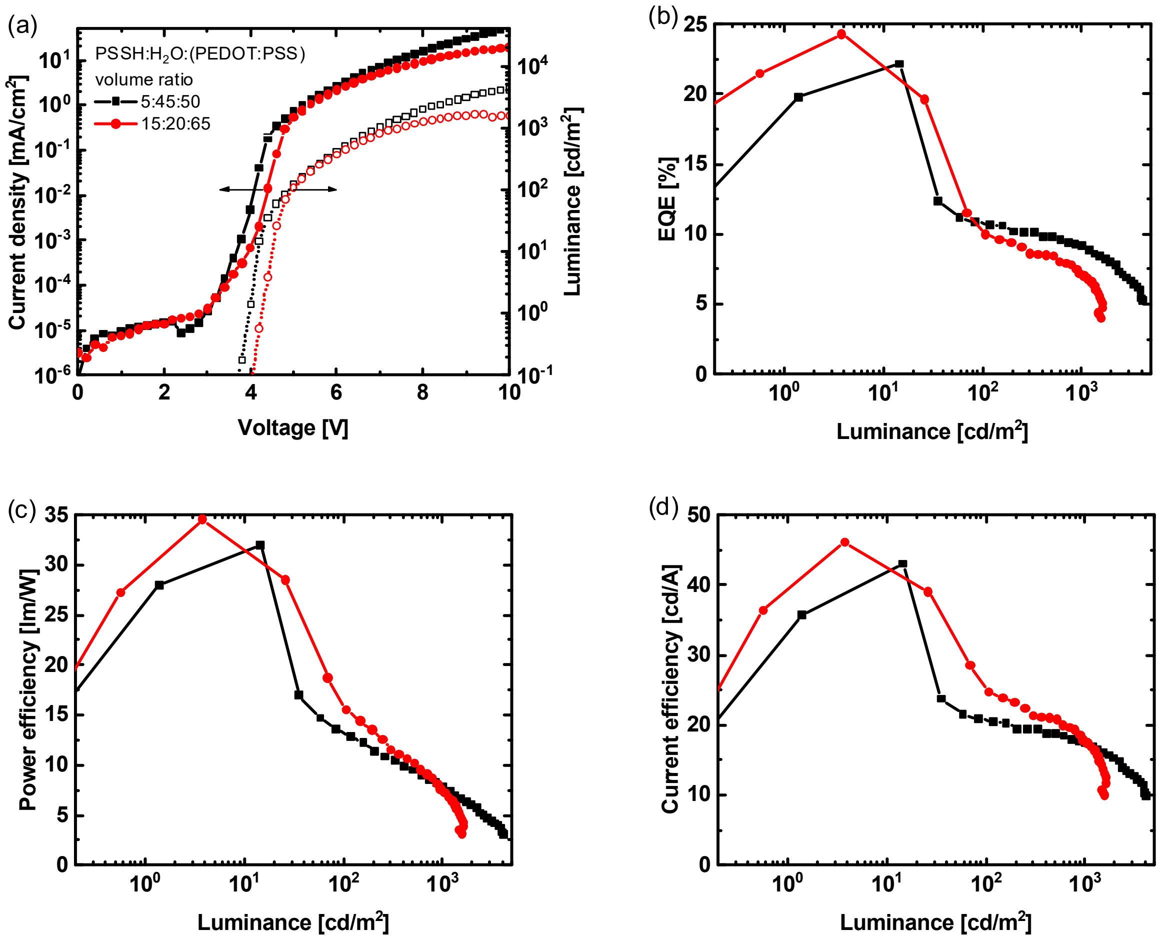


Fig. S10 *(a) J-V-L, (b) EQE-L, (c) PE-L and (d) CE-L of OLEDs with different ratios of PSSH in m-PEDOT:PSS layer.*

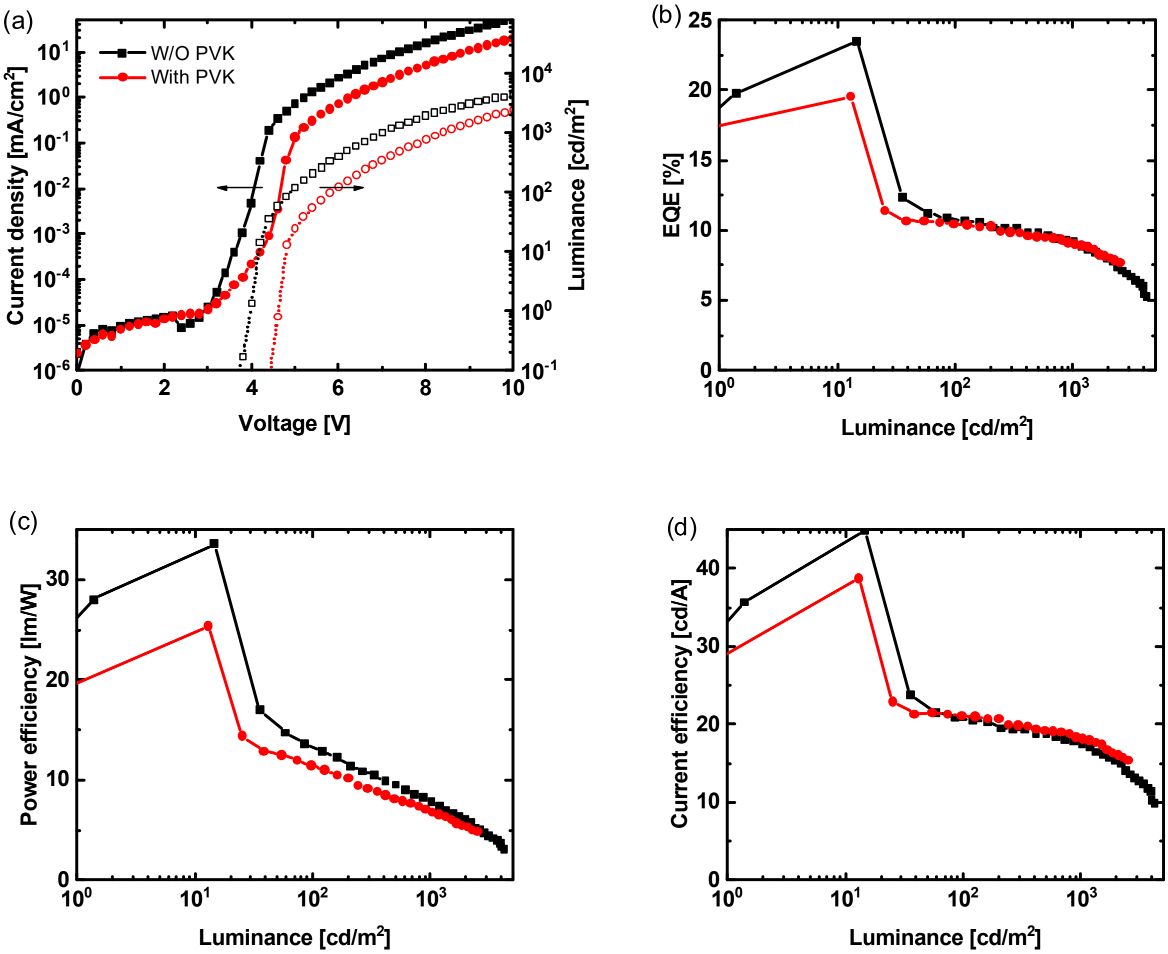


Fig. S11 *(a) J-V-L, (b) EQE-L, (c) PE-L and (d) CE-L of OLEDs with and without (W/O) PVK layer.*

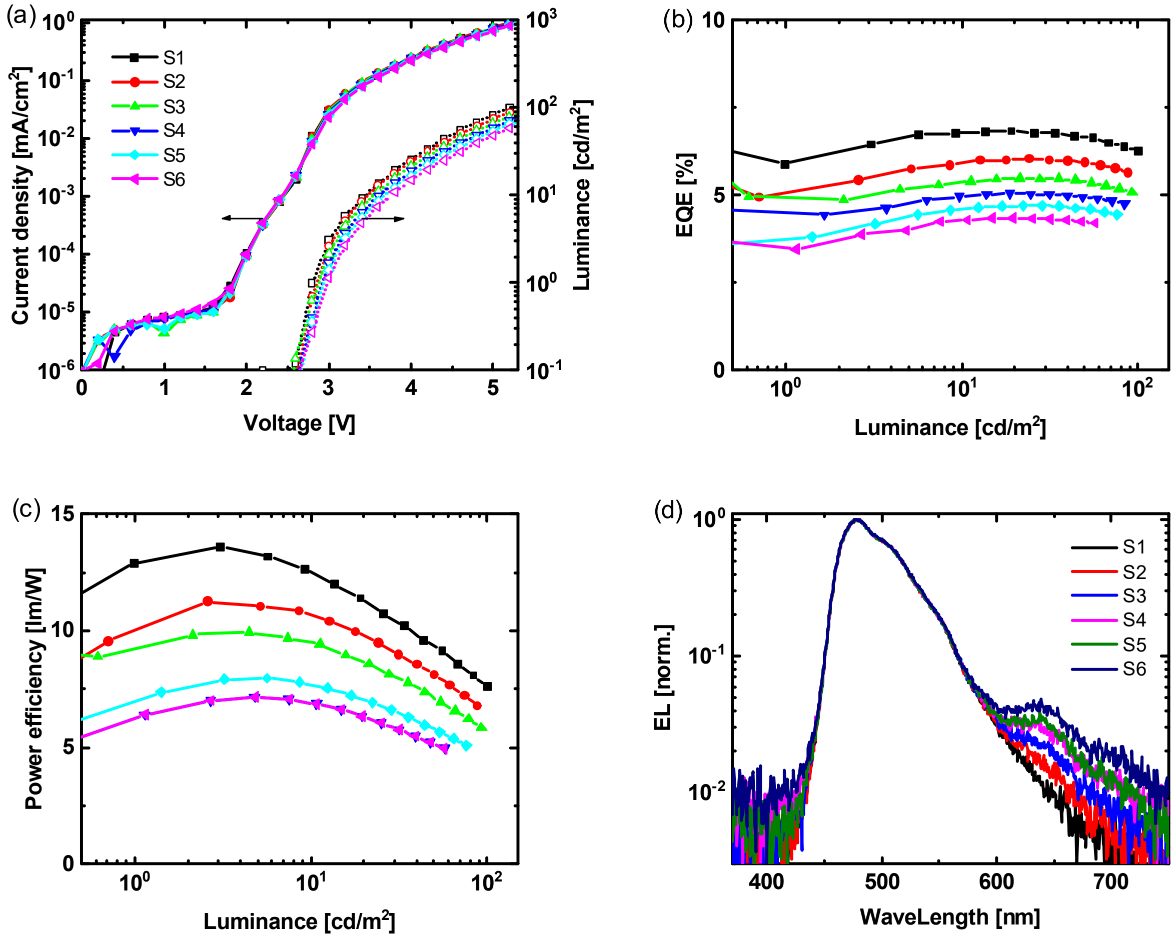


Fig. S12 *(a) J-V-L, (b) EQE-L, (c) PE-L and (d) EL spectra of an OLED with TCTA:Ir(DTri)$_3$ as the emissive layer versus voltage scan number.*