Supporting Information

Organic and quantum-dot hybrid white LEDs employing a narrow bandwidth blue TADF emitter

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Experimental Section

General information: PEDOT:PSS, the hole transporting material TFB, the host material mCP, and the electron injecting material Liq were purchased from Xi'an Polymer Light Technology Corp. The hole blocking material DPEPO and the electron transport material TmPyPB were purchased from Luminescence Technology

Corporation. QD-G and QD-R were purchased from Jiaxing Nading Optoelectronics Technology Co., Ltd.. All the materials were used as received.

OLED fabrication:

On glass-ITO substrate: The ITO glass substrates were cleaned with acetone and ethanol ultrasonic bath constantly. Then, the substrates were dried with N_2 and treated by UV-ozone for 20 min. A layer of 45 nm-thick modified PEDOT:PSS was spin-coated onto the ITO substrate and then baked at 120 ºC for 10 min.[S1] Later, for the device with the double EMLs (device A and B), a layer of 30 nm-thick TFB was spin-coated on m-PEDOT:PSS, followed with a baking at 120 ºC for 10 min. Then a 35 nm-thick QD layer (EML1) was spin-coated on TFB and then annealed at 100 ºC for 10 min. After that, a 50 nm-thick EML2 was spin-coated directly on the EML1 accompanied with a baking at 50 ºC for 10 min. For the mixed-EML device (device C), a 50 nm-thick EML was directly spin-coated on m-PEDOT:PSS followed with a baking at 50 ºC for 10 min. The hole blocking layer (DPEPO), electron transporting layer (TmPyPB), electron injection layer (Liq) and cathode (Al) were constantly thermally evaporated onto the EML in a vacuum chamber. Then all the devices were encapsulated with the UV-curable resin.

On PET-ITO substrate: The substrates were rinsed consecutively with acetone and ethanol and then further dried with N_2 flow. Similar to the procedure mentioned above, after treated in a UV-ozone chamber for 20 min, a layer of 45 nm-thick m-PEDOT:PSS was spin-coated on the flexible substrate and then baked at 60 ºC for 10 min. The following steps were identical to those for the glass-ITO substrate mentioned above.

Table S1. Summary of the EL performances of the three monochromatic devices.

Emitter of the monochromatic device	Weight ratio of the emitter in mCP host	EQE_{max} [%]	λ_{max}[a] [nm]	FWHM[b] [nm]	CIE[c] (x, y)
TADF-B	30 %	8.0	464	30	(0.16, 0.14)
QD-G	10 %	0.7	538	34	(0.25, 0.70)
QD-R	1 %	0.2	624	31	(0.64, 0.33)

[a]Peak wavelength of the EL spectrum. [b]Full-width-half-maximum of the EL spectrum. [c]The Commission Internationale de I'Eclairage (CIE) coordinates.

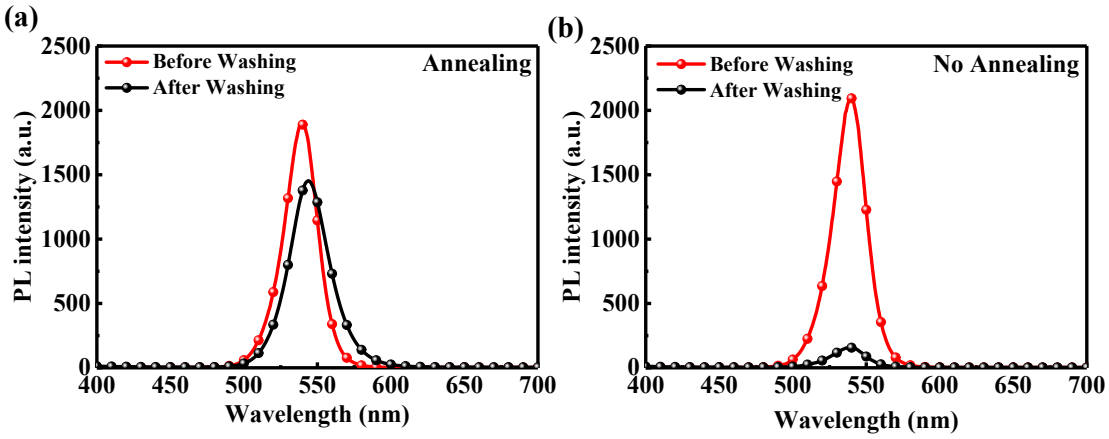

Figure S1. The PL intensity of the neat film of QD-G before and after washing with chlorobenzene: (a) annealed at 100 ºC for 10 min and (b) without annealing. The washing process was conducted by spin-coating the pure chlorobenzene solution without any solute directly on QD-G at 1000 rpm for 30 s.

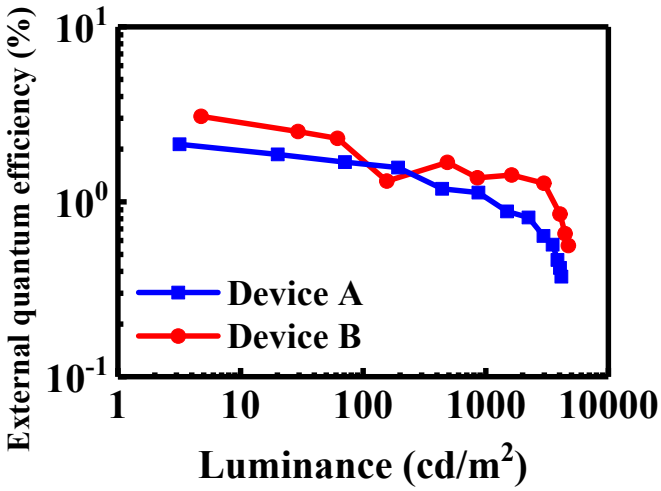

Figure S2. Luminance-external quantum efficiency curves of the devices A and B.

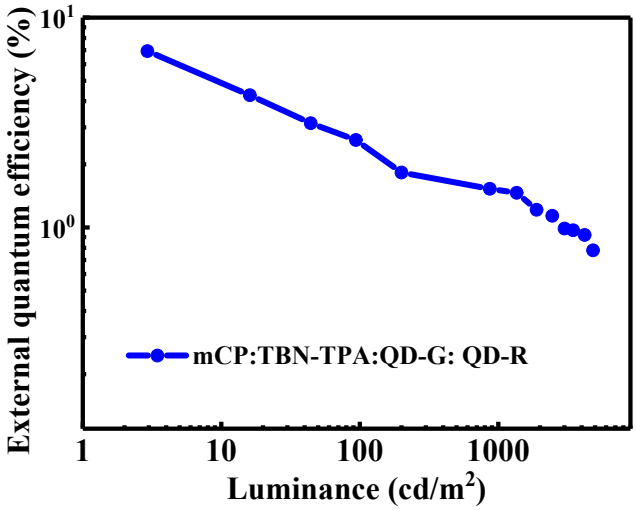

Figure S3. Luminance-external quantum efficiency curve of the device C.

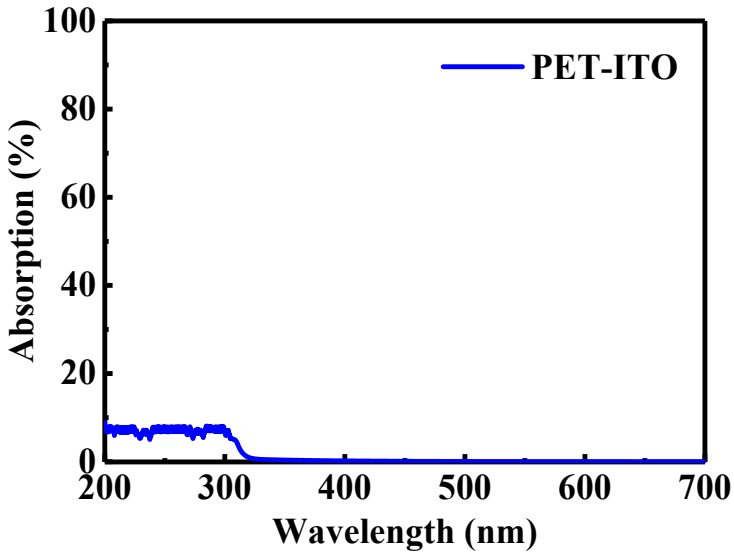

Figure S4. The absorption of the PET-ITO substrate.

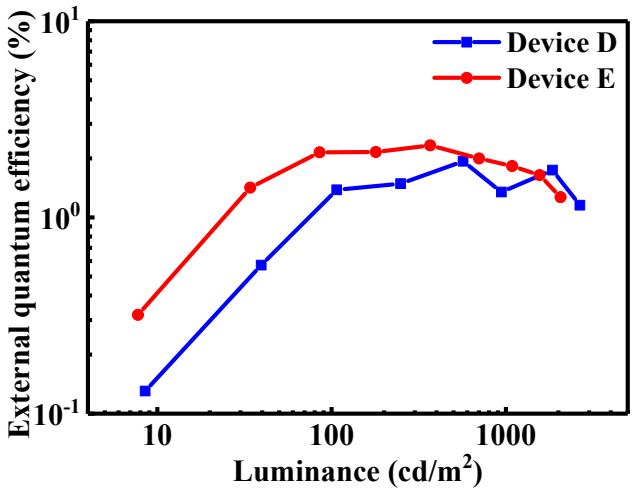

Figure S5. Luminance-external quantum efficiency curves of the devices D and E.

Table S2. The spectral parameters for the devices A-E.

Device	CIE (x, y)	CRI	CCT (K)
A	(0.32, 0.45)	73	5766
B	(0.31, 0.49)	60	5921
C	(0.32, 0.44)	76	5939
D	(0.26, 0.55)	38	7025
E	(0.31, 0.46)	73	6140

Table S3. Comparison of the performances of the solution-processed hybrid white LEDs.

Device	EML configuration (emission color)	EQE_{max} [%]	CIE (x, y)	CRI [a]	CCT(K) [b]
This work	Monolayer (RGB)	6.9	(0.32, 0.44)	76	5939
S1	Bilayer (RGB)	9.2	(0.27, 0.35)	65	--
S2	Multi-layer (RGB)	9.6	(0.33, 0.33)	74	--
S3	Bilayer (RB)	1.0	(0.35, 0.33)	60	--
S4	Monolayer (RGB)	5.0	(0.28, 0.31)	67	8924
S5	Multi-layer (RGB)	6.8	(0.32,0.33)	--	--
S6	Bilayer (YB)	0.6	(0.48, 0.44)	67	2637
S7	Monolayer (RGB)	10.9	(0.45, 0.33)	71	6126
S8	Monolayer (RGB)	0.9	(0.33, 0.35)	70	5521

[a]Color rendering index. [b]Correlated color temperature.

Reference

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