

# ADVANCED FUNCTIONAL MATERIALS

## Supporting Information

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Enhanced Direct White Light Emission Efficiency in  
Quantum Dot Light-Emitting Diodes via Embedded  
Ferroelectric Islands Structure

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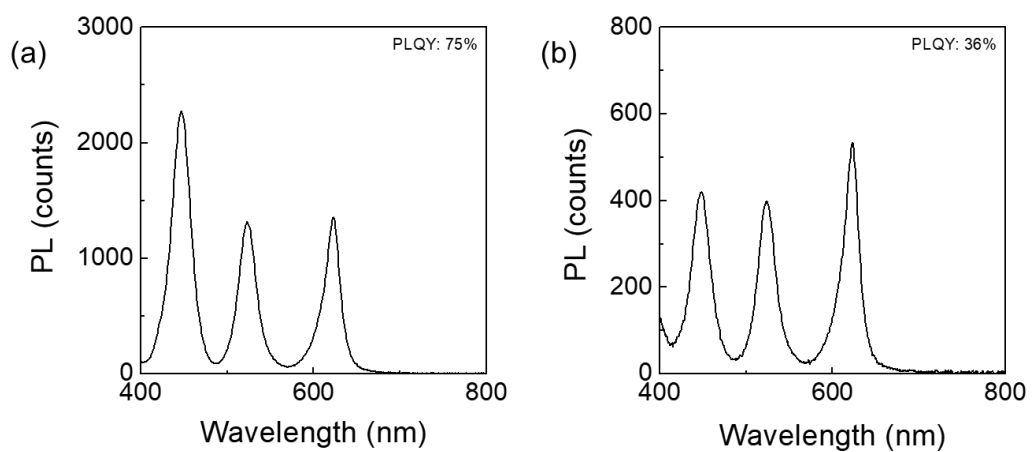
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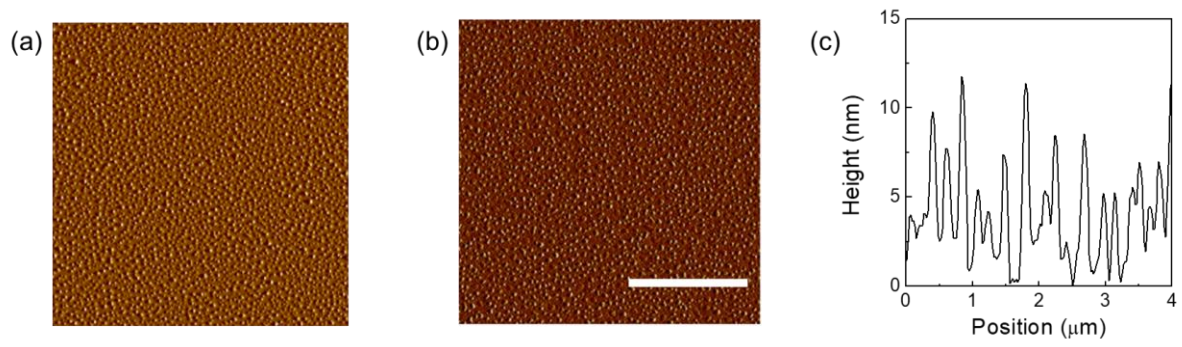
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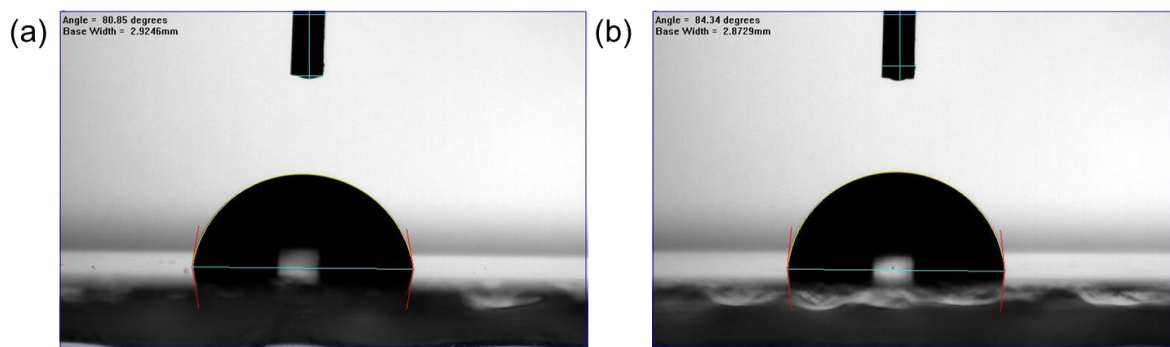
**Keywords:** Quantum dots, White light, Light-emitting diodes, Ferroelectricity, P(VDF-TrFE)



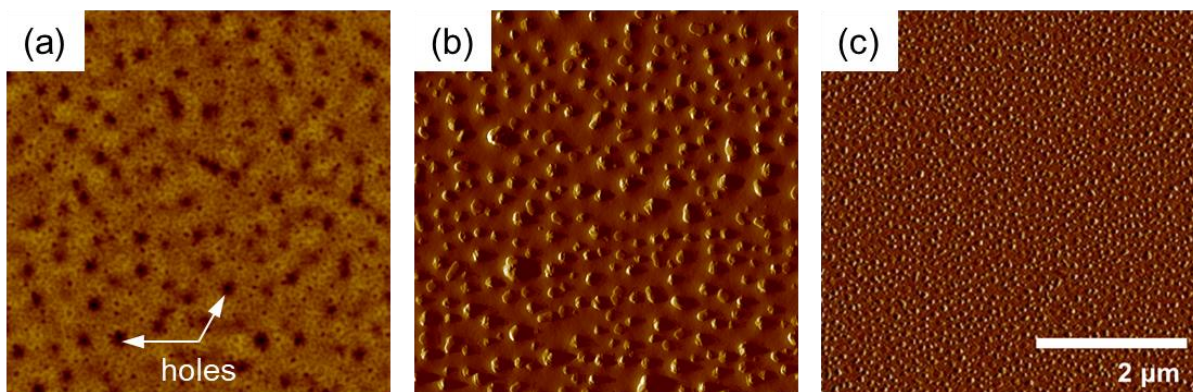
**Figure S1.** PLQY of (a) a QD solution and (b) a QD film.



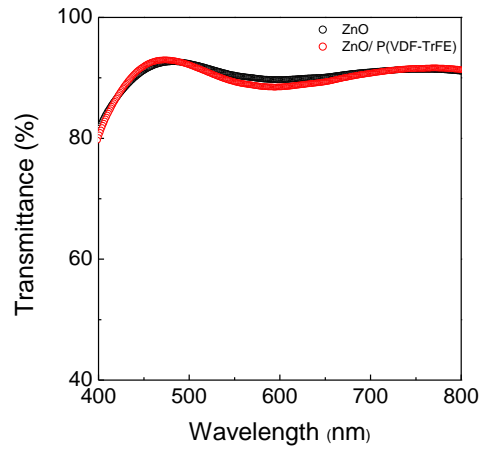
**Figure S2.** P(VDF-TrFE) on (a) a TFB layer and (b) a QD layer. (c) Morphology of a P(VDF-TrFE) islands structure.



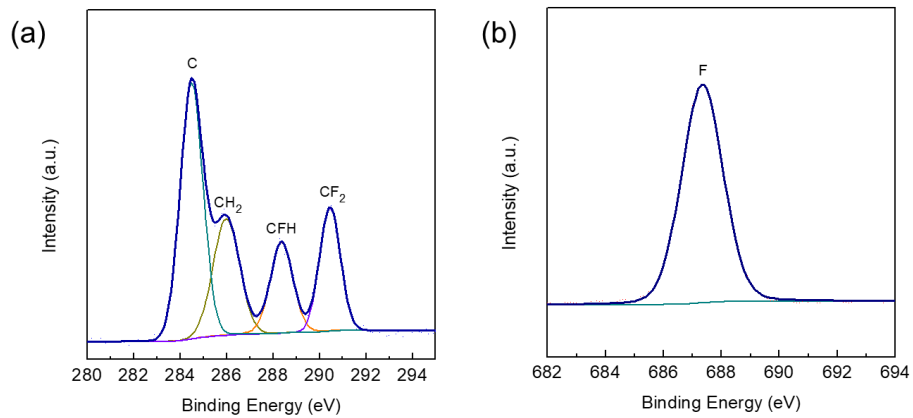
**Figure S3.** Contact angle on (a) TFB (80.85°) and (b) QD (84.34°).



**Figure S4.** AFM images of a P(VDF-TrFE) layer prepared by (a) spin-coating 1 wt%, (b) spin-casting 1 wt%, and (c) spin-casting 0.2 wt% P(VDF-TrFE) solution. (a)-(c) are in the same scale with the scale bar of 2  $\mu\text{m}$ .

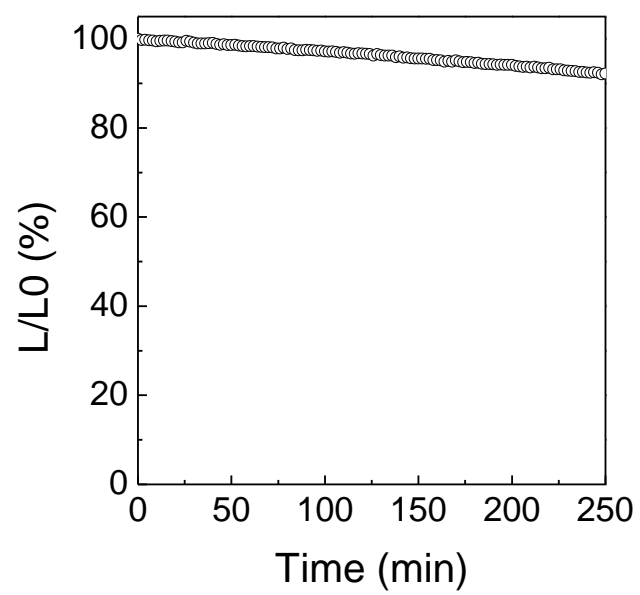


**Figure S5.** Transmittance (%) of the ZnO nanoparticle film and the P(VDF-TrFE) island layer on the ZnO nanoparticle film.

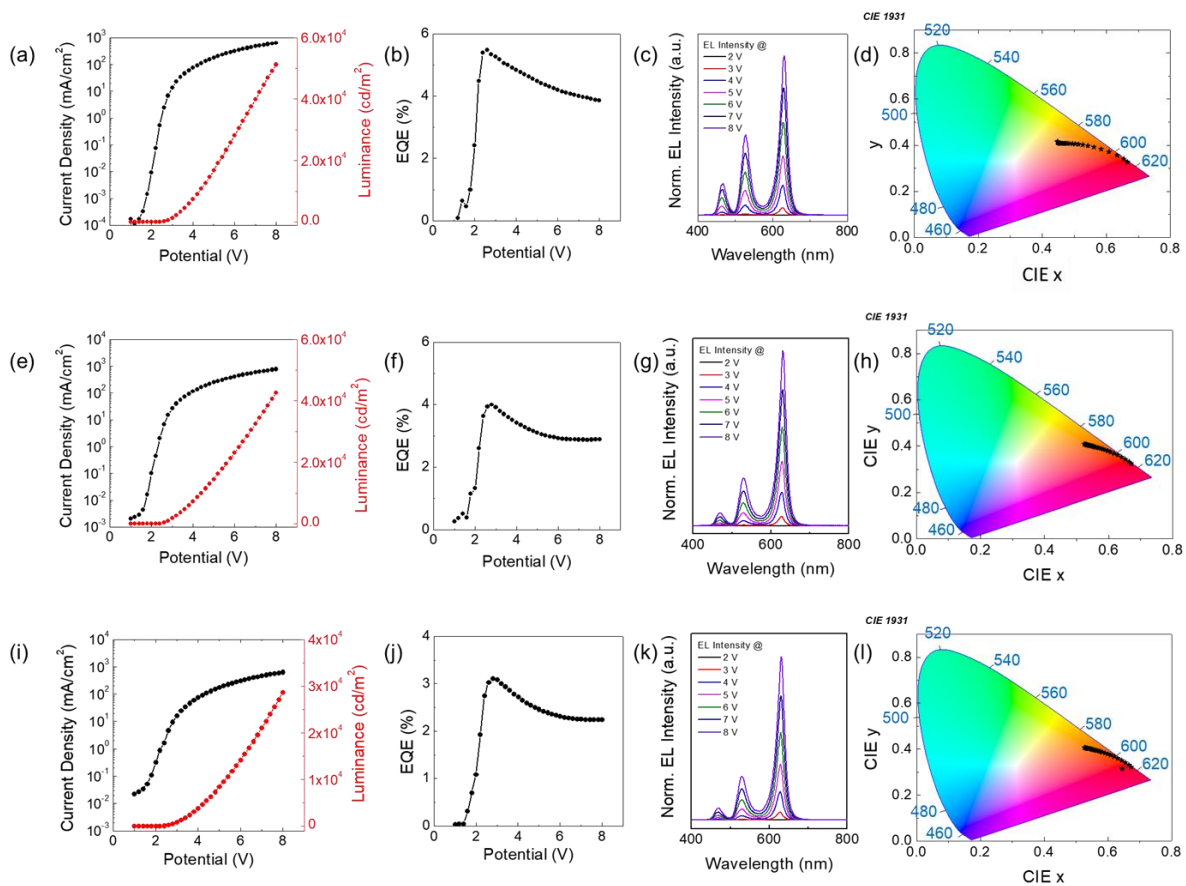


**Figure S6.** Core-level X-ray photoelectron spectra (XPS) of each composition in P(VDF-TrFE) island layer (a) C 1s and (b) F 1s.

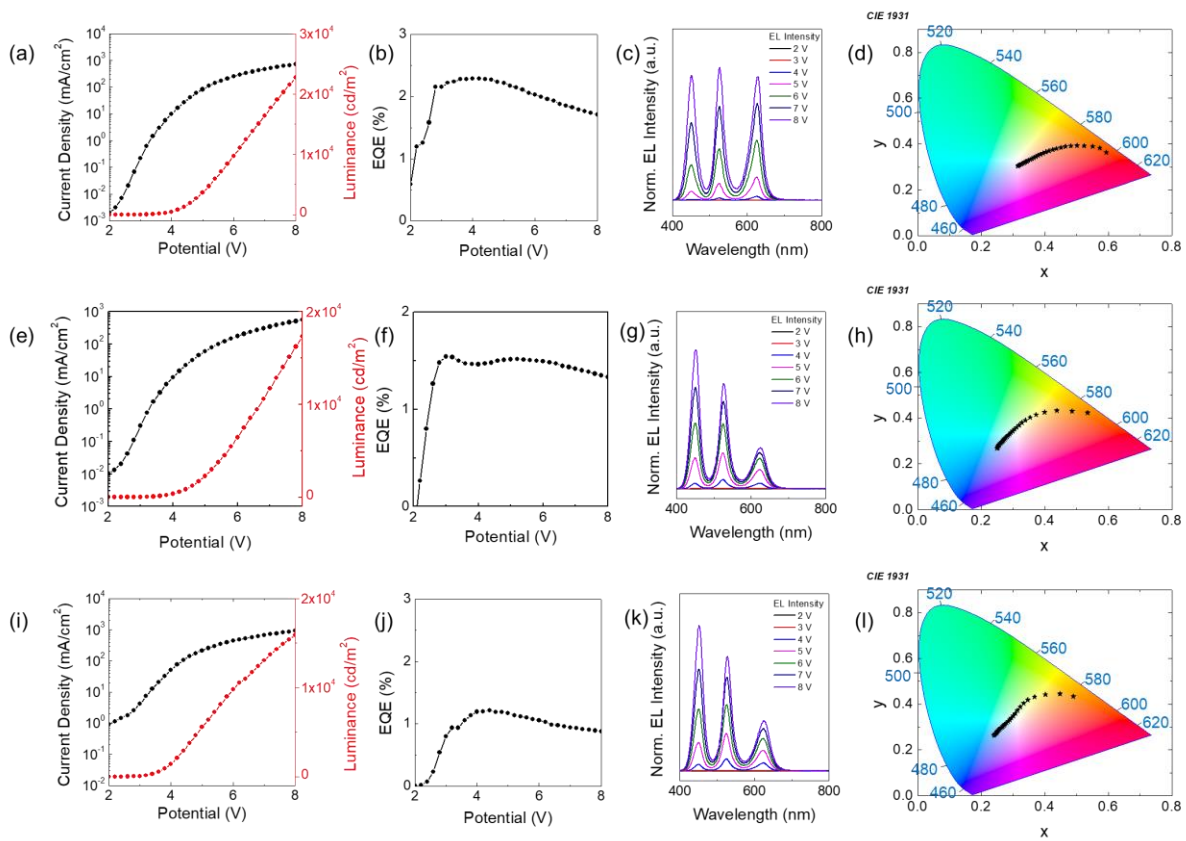




**Figure S7.** Long-term stability measurement of FE-QLED under continuous DC bias.



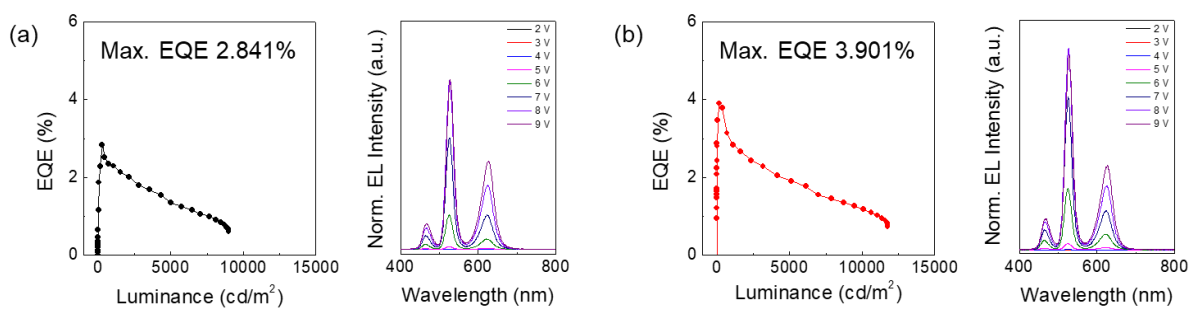
**Figure S8.** Characteristic behaviors of warm white QLEDs. (a)-(d) Q/Z FE-QLEDs, (e)-(h) references, and (i)-(l) T/Q FE-QLEDs.



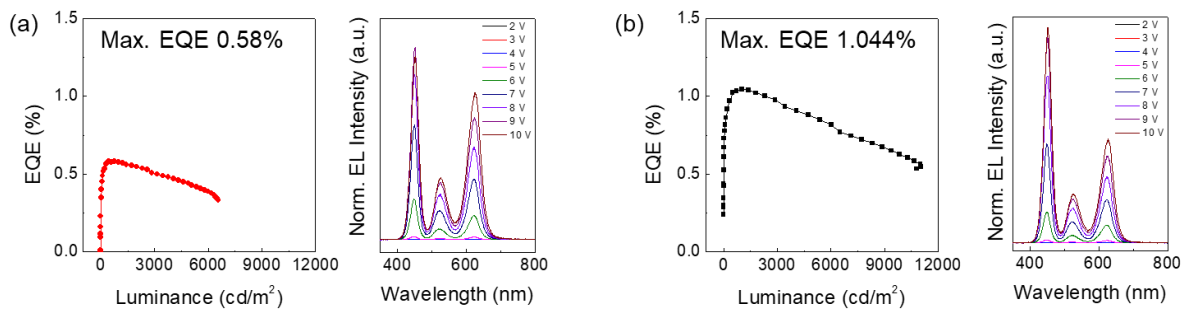
**Figure S9.** Characteristic behaviors of daylight white QLEDs. (a)-(d) Q/Z FE-QLEDs, (e)-(h) references, (i)-(l) T/Q FE-QLEDs.

**Table S1.** CCT values and CIE coordinates with respect to the RGB QDs mixing ratio.

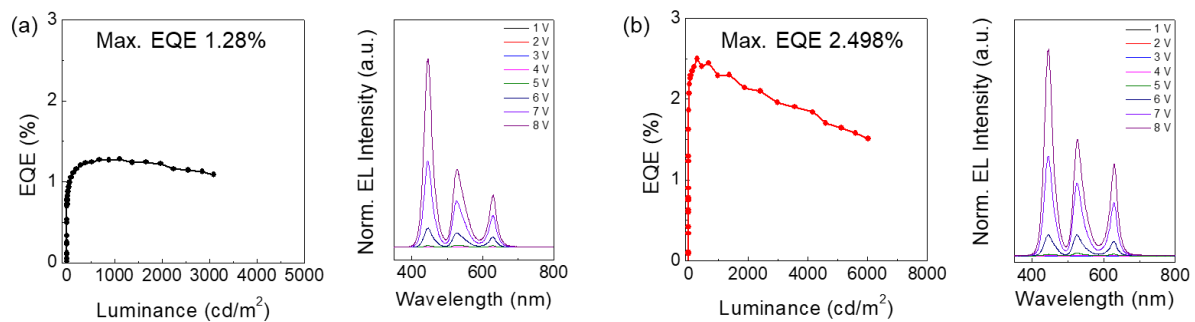
<b>RGB Volume Ratio</b>	<b>CCT [K]</b>	<b>CIE (X, Y)</b>
1:3.5:3.5	3000	0.4473 0.4165
1:2:4	4700	0.3743, 0.5042
1:2:9	6500	0.3183 0.3065
1:1:10	100,000	0.2938 0.1951
1:1.5:15	114,600	0.2440 0.2367



**Figure S10.** QLEDs with 4700 K of the CCT value (a) without P(VDF-TrFE) island layer and (b) with P(VDF-TrFE) island layer between the QDs and ZnO layer.



**Figure S11.** QLEDs with 100,000 K of the CCT value (a) without P(VDF-TrFE) island layer and (b) with P(VDF-TrFE) island layer between the QDs and ZnO layer.

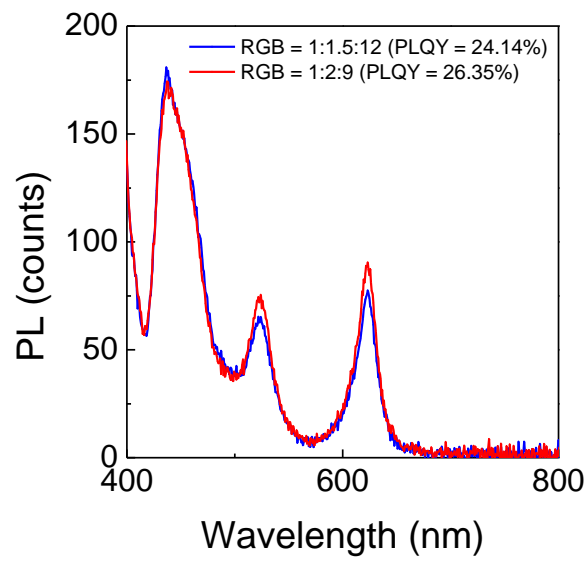


**Figure S12.** QLEDs with 114,600 K of the CCT value (a) without P(VDF-TrFE) island layer and (b) with P(VDF-TrFE) island layer between the QDs and ZnO layer.

**Table S2.** The summary of device parameters of white QLEDs with various CCT values.

CCT [K]		Turn-on [V]	Max. Luminance [cdm <sup>-2</sup> ]	Avg. Luminance [cdm <sup>-2</sup> ]	Max. EQE [%]	Avg. EQE [%]	CIE coordinate [x, y]
3000	Ref	2.0	42670	39278 ± 2193	3.998	3.91 ± 0.26	0.5242, 0.4092
	Q/Z	2.1	51220	49023 ± 3753	5.476	5.10 ± 0.35	0.4473, 0.4165
4700	Ref	3.6	8995	8306 ± 792	2.831	2.96 ± 0.15	0.3743, 0.5042
	Q/Z	3.8	11750	10885 ± 1208	3.901	4.17 ± 0.28	0.3509, 0.5136
6500	Ref	2.6	17338	17477 ± 1426	1.542	1.41 ± 0.15	0.2490, 0.2686
	Q/Z	2.7	22710	22638 ± 1929	2.284	2.16 ± 0.12	0.3151, 0.3039
100,000	Ref	3.4	6656	6117 ± 420	0.580	0.50 ± 0.12	0.2938, 0.1951
	Q/Z	3.4	11040	10045 ± 1313	1.044	0.93 ± 0.18	0.3006, 0.2054
114,600	Ref	3.4	3094	2332 ± 360	1.280	1.13 ± 0.12	0.2387, 0.2387
	Q/Z	3.4	6016	5539 ± 423	2.498	2.26 ± 0.17	0.2440, 0.2367





**Figure S13.** PLQY measurement with the structure of Glass/ PEDOT:PSS/ TFB/ QDs/ ZnO results of the different ratio of RGB in the mixed QD solutions: one with R:G:B = 1:2:9 and the other with higher blue QD ratio, R:G:B = 1:1.5:12.

**Table S3.** Comparison of Cd-based white QLEDs performances.

Ref	Material	Type	V <sub>on</sub> [V]	Max L. [cd/m <sup>2</sup> ]	EQE [%]	CIE	Year
[1]	CdSe/ZnS	BY mixed	5.3	6390	1.0	0.28, 0.33	2014
		RGB mixed	4.3	1440	1.3	0.39, 0.40	
		BCYR mixed	6.1	5340	0.9	0.29, 0.29	
[2]	CdSe/ZnS	RGB mixed	5	23352	10.9	0.20, 0.17	2015
[3]	CdZnSeS/ZnS	RGB mixed	3.1	60810	6.39	0.33, 0.32	2018
		Three-unit tandem	9.0	65690	23.9	0.33, 0.34	
[4]	CdSe/ZnS	RGB mixed	8.5	2953	5.0	0.28, 0.31	2018
[5]	CdSe/ZnS	RGB mixed	4.0	58361	10.6	0.38, 0.35	2020
		Light outcoupling	3.2	74363	28.4	0.33, 0.34	
<b>This work</b>	CdSe/ZnS	RGB mixed, ferroelectric coupling	2.1	51220	5.48	0.44, 0.42	2021
			2.7	22710	2.23	0.31, 0.30	

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