Electronic Supporting Information (ESI)

Heterogeneous Post-Passivation of Inorganic Cesium Lead Halide Perovskite Quantum Dots for Efficient Electroluminescent Devices

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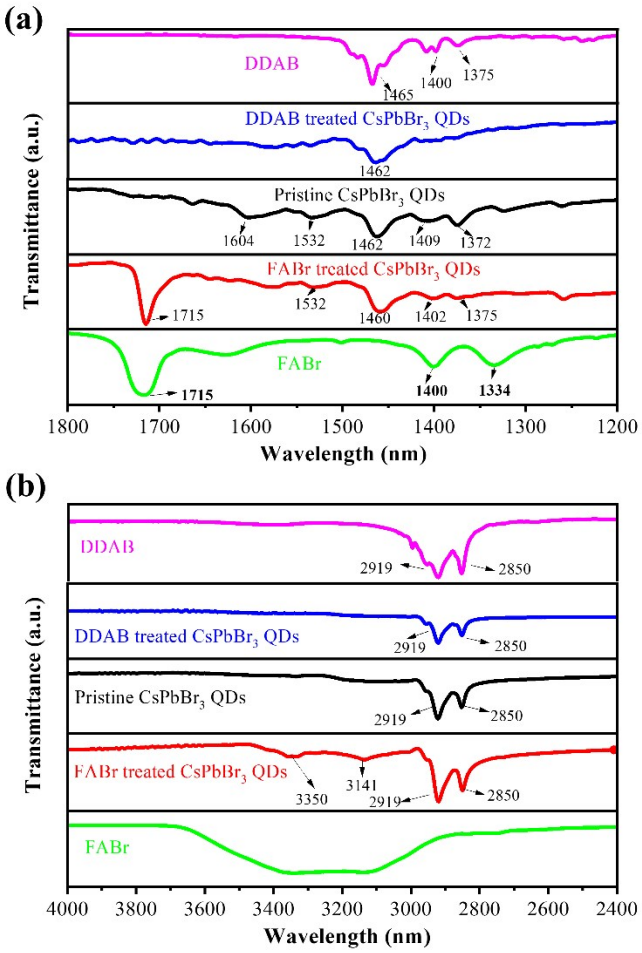

Fig. S1 Magnified FTIR spectra of pristine QDs, FABr treated QDs, FABr ligand, DDAB treated QDs and DDAB ligand ranged from 1800 to 1200 cm^{-1} (a) and from 4000 to 2400 cm^{-1} (b).

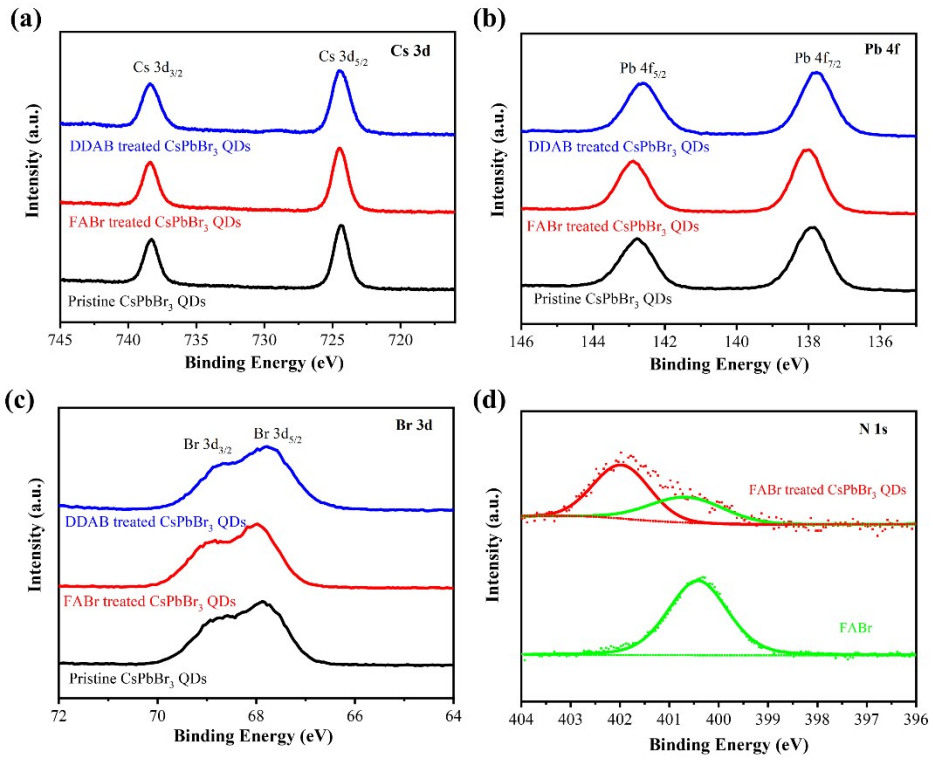

Fig. S2 XPS spectra. (a) Cs 3d spectra, (b) Pb 4f spectra and (c) Br 3d spectra of pristine, FABr and DDAB treated $CsPbBr_3$ QDs. (d) N 1s spectra of FABr treated $CsPbBr_3$ QDs and FABr.

Table S1. Summary of the atom ratio of $CsPbBr_3$ QDs.

$CsPbBr_3$ QDs	Cs:Pb:Br ratio	N:Pb ratio	O:Pb ratio
Pristine	1.11:1:4.01	0.56	1.90
FABr treated	1.09:1:4.35	0.88	1.15
DDAB treated	1.27:1:4.24	0.81	0.67

Table S2 The summary of photophysical parameters of pristine, FABr treated and DDAB treated $CsPbBr_3$ QDs including solution and film state.

$CsPbBr_3$ QDs[a]	λ_{em} (nm)	PLQY[b] (%)	τ_{ave}[c,d] (ns)	k_r[d] (10^{-2} ns^{-1})	k_{nr}[d] (10^{-2} ns^{-1})
Pristine	513 / 513	46 / 30	10.3 / 16.8	4.5 / 1.8	5.2 / 4.1
FABr treated	513 / 514	87 / 72	13.7 / 17.7	6.3 / 4.1	1.0 / 1.5
DDAB treated	514 / 515	92 / 73	19.8 / 21.2	4.7 / 3.4	0.4 / 1.3

[a]The data in front of "/" were measured in toluene at a concentration of 0.1 mg mL^{-1} and the data followed "/" were measured in the films spin-coated on the quartz substates. [b]Measured by using an integrating sphere and excited at 400 nm. [c]The lifetimes were determined by triple exponential fit of PL decay curves. [d]The τ_{ave}, k_r and k_{nr} are calculated based on the following formulas: $\tau_{ave} = \frac{\sum_{i=1}^{3} a_i \tau_i^2}{\sum_{i=1}^{3} a_i \tau_i} = \frac{1}{k_r + k_{nr}}$, $k_r = \frac{PLQY}{\tau_{ave}}$, $k_{nr} = \frac{1}{\tau_{ave}} - k_r$ (a_i and τ_i are normalized coefficients and time constants, respectively.

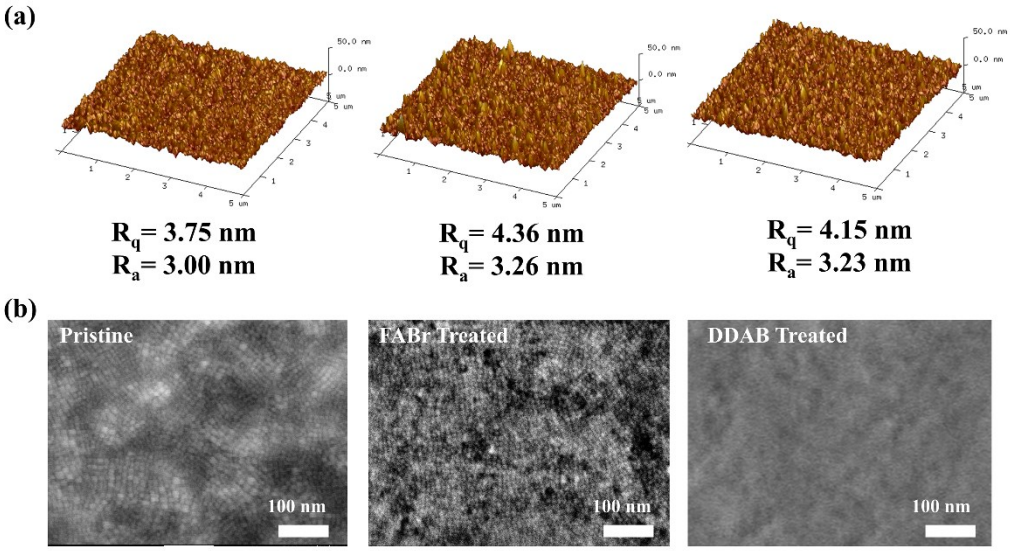

Fig. S3 (a) AFM images of $CsPbBr_3$ QD films (from left to right: pristine, FABr treated and DDAB treated) and corresponding R_q and R_a values listed on the bottom. (b) SEM images of $CsPbBr_3$ QD films (from left to right: pristine, FABr treated, and DDAB treated).

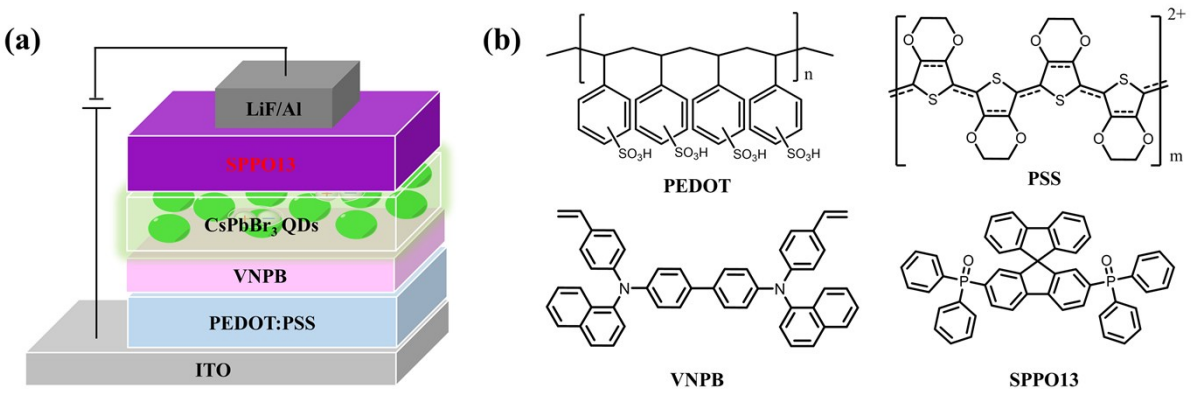

Fig. S4 (a)The diagram of $CsPbBr_3$ PeQLEDs device configuration. (b) The molecular structure of PEDOT:PSS, VNPB and SPPO13.

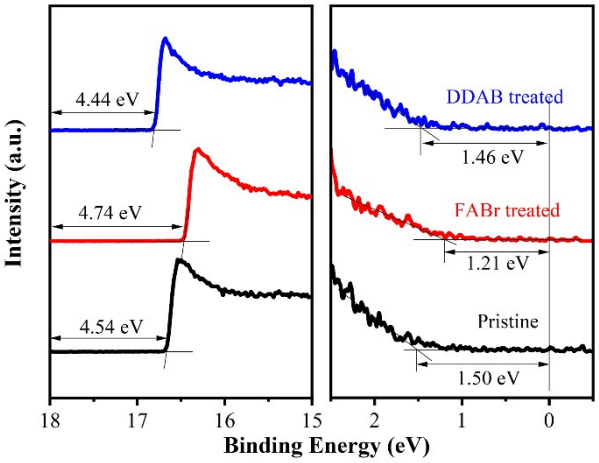

Fig. S5 UPS spectra of pristine, FABr and DDAB treated $CsPbBr_3$ QDs including cut-off region (left) and band-edge region (right).

Table S3 Summary of VB and CB values of $CsPbBr_3$ QDs

$CsPbBr_3$ QDs	VB[a] (eV)	CB[b] (eV)
Pristine	-6.04	-3.65
FABr treated	-5.95	-3.56
DDAB treated	-5.86	-3.47

[a]The VB was determined by UPS spectra, $VB = -(h\upsilon - E_{cut\text{-}off} + E_{band\text{-}edge})$. [b]The CB was determined by VB and E_g (estimated from the absorption onset), $CB = VB + E_g$.

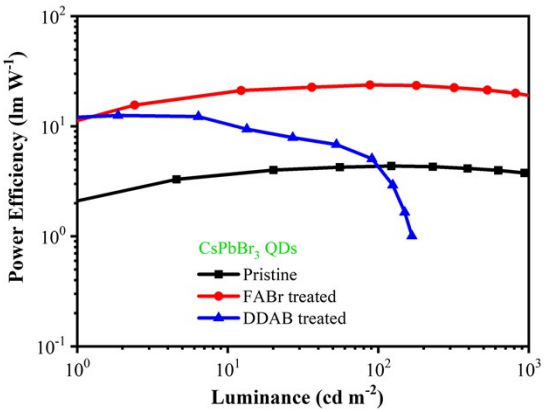

Fig. S6 Power efficiency as a function of luminance for $CsPbBr_3$ PeQLEDs.

Table S4 Summary of R_s and R_{ct} values of $CsPbBr_3$ PeQLEDs. The R_s and R_{ct} were calculated by fitting the impedance curves of all $CsPbBr_3$ PeQLEDs.

$CsPbBr_3$ PeQLEDs	R_s (Ω)	R_{ct} (kΩ)
Pristine	39.89	8.97
FABr treated	58.19	4.58
DDAB treated	64.21	22.76

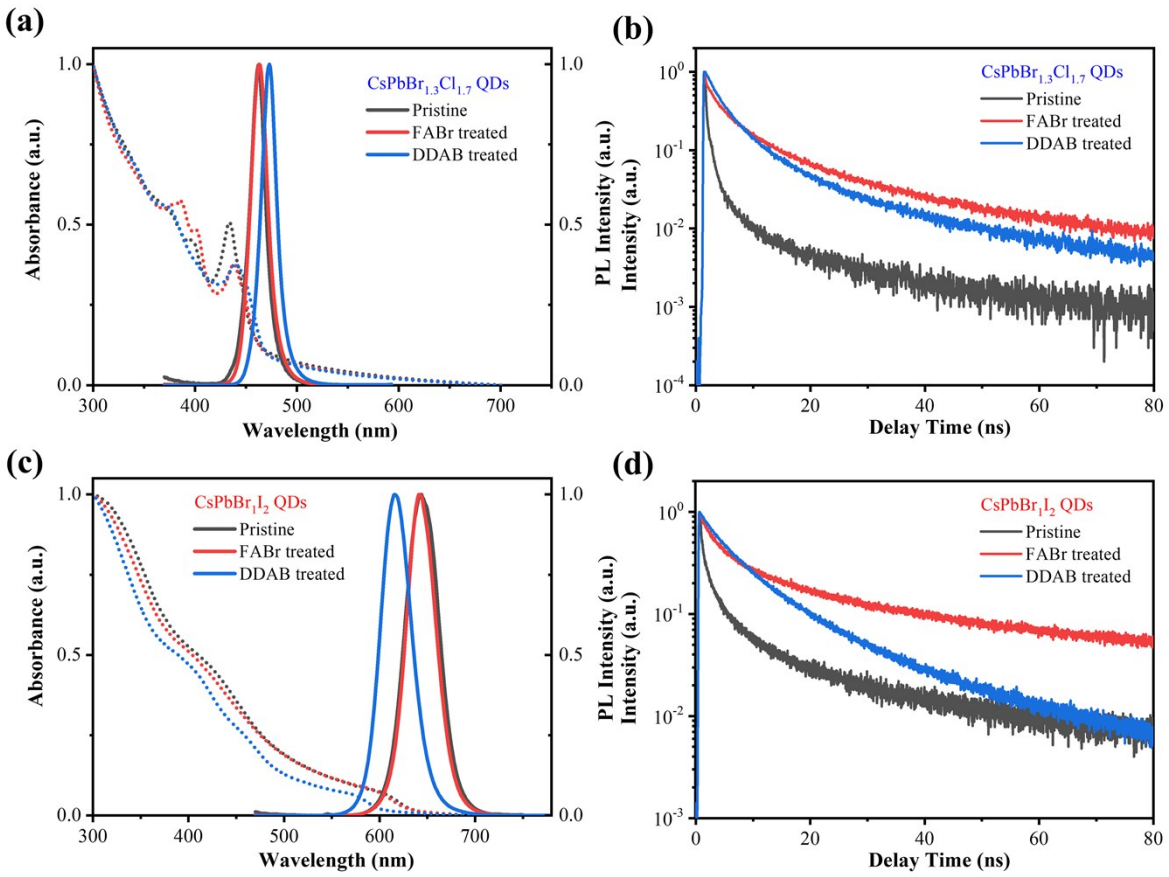

Fig. S7 (a) Absorption and PL spectra of pristine, FABr treated and DDAB treated $CsPbBr_{1.3}Cl_{1.7}$ QD films (dash line: absorption spectra; solid line: PL spectra). (b) The time-resolved PL decay spectra of pristine, FABr treated and DDAB treated $CsPbBr_{1.3}Cl_{1.7}$ QD films. (c) Absorption and PL spectra of pristine, FABr treated and DDAB treated $CsPbBr_1I_2$ QD films (dash line: absorption spectra; solid line: PL spectra). (d) The time-resolved PL decay spectra of pristine, FABr treated and DDAB treated $CsPbBr_1I_2$ QD films.

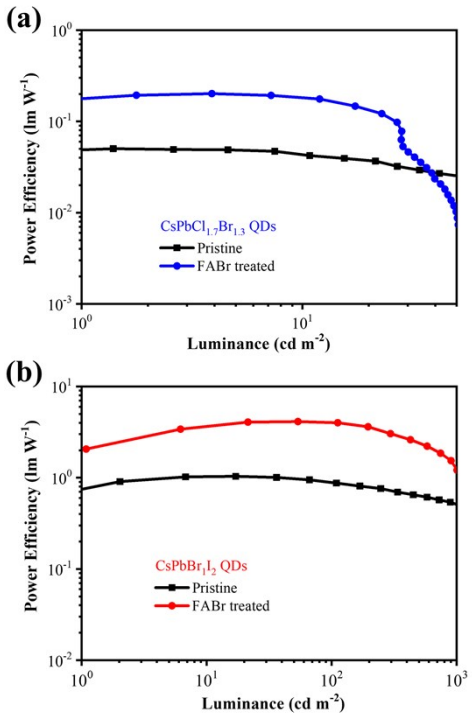

Fig. S8 Power efficiency as a function of luminance for $CsPbBr_{1.3}Cl_{1.7}$ and $CsPbBr_1I_2$ PeQLEDs.