Supporting Information

Multilayer Heterostructure Engineering for Ultrapure and Area Emission in Perovskite Quantum-Dot Light-Emitting Transistors

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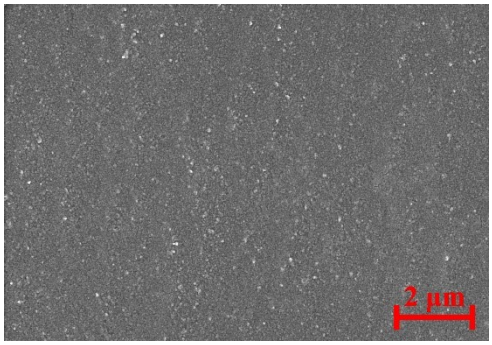

Figure S1. The SEM image of the $CsPbBr_3$ QD film spin-coated on the ZTO.

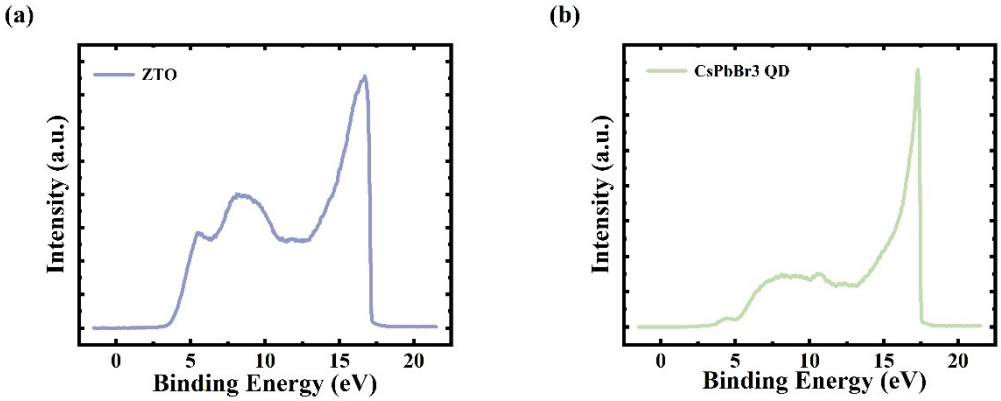

Figure S2. UPS spectra of the ZTO film and $CsPbBr_3$ QD film.

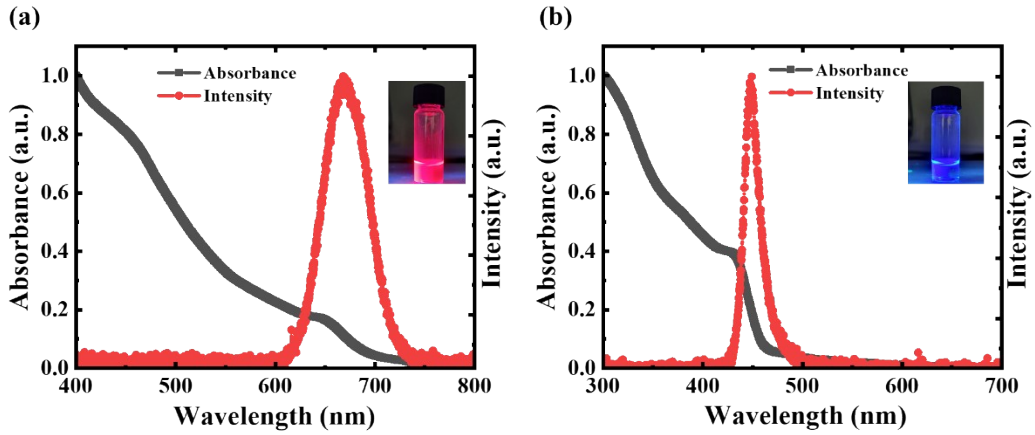

Figure S3. (a) Absorption spectra and PL spectra of the synthesized $CsPbI_3$ perovskite QD dispersion. (b) Absorption spectra and PL spectra of the synthesized $CsPbBr_xCl_{3-x}$ perovskite QD dispersion.

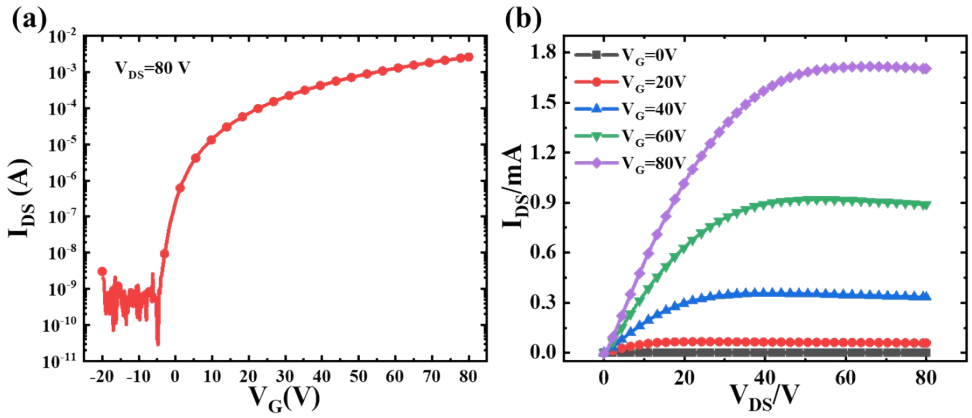

Figure S4. ZTO field-effect transistor transfer curve and output curve.

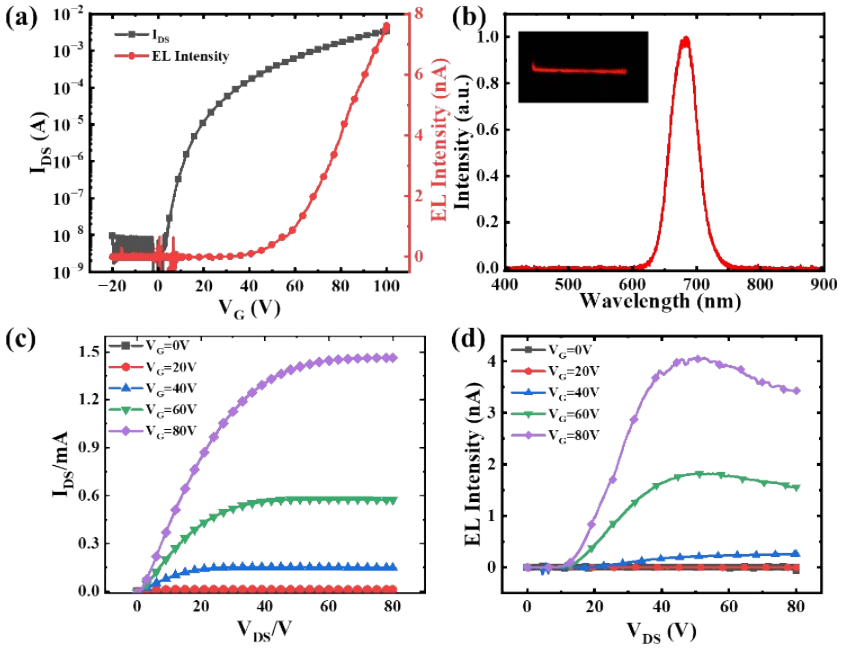

Figure S5. (a) the drain current transfer curve and the electroluminescence intensity transfer characteristics of the fabricated multi-layer LET device based $CsPbI_3$ QD emissive layer. (b) electroluminescence spectrum of ZTO/$CsPbI_3$ LET (inset is the picture of line EL along the drain electrode edge next to the channel). (c) electrical output curve of ZTO/$CsPbI_3$ LET. (d) electroluminescence output curve of ZTO/$CsPbI_3$ LET.

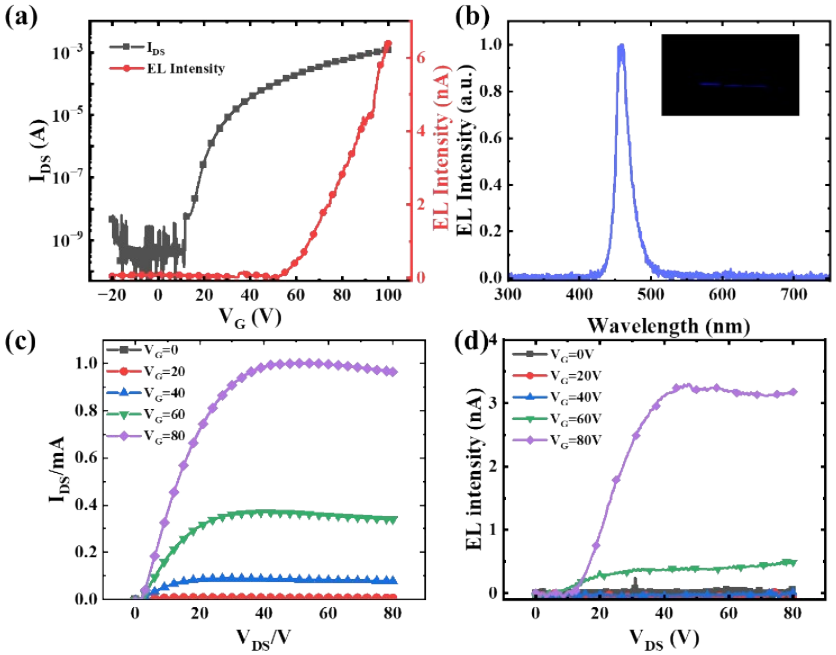

Figure S6. (a) the drain current transfer curve and the electroluminescence intensity transfer characteristics of the fabricated multi-layer LET device based $CsPbBr_xCl_{3-x}$ QD emissive layer. (b) electroluminescence spectrum of ZTO/$CsPbBr_xCl_{3-x}$ LET (inset is the picture of line EL along the drain electrode edge next to the channel). (c) electrical

output curve of ZTO/$CsPbBr_xCl_{3-x}$ LET. (d) electroluminescence output curve of ZTO/ $CsPbBr_xCl_{3-x}$ LET.

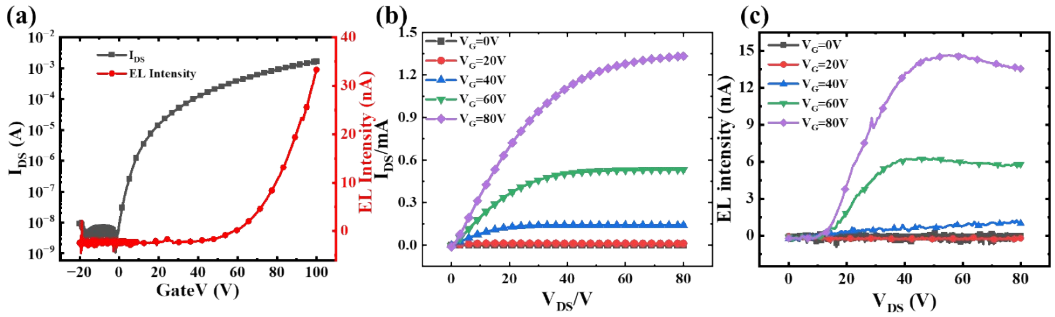

Figure S7. (a) the drain current transfer curve and the electroluminescence intensity transfer characteristics of the fabricated multi-layer area emission LET device based $CsPbI_3$ emissive layer. (b) electrical output curve. (c) electroluminescence output curve of area emission ZTO/$CsPbI_3$ LET.

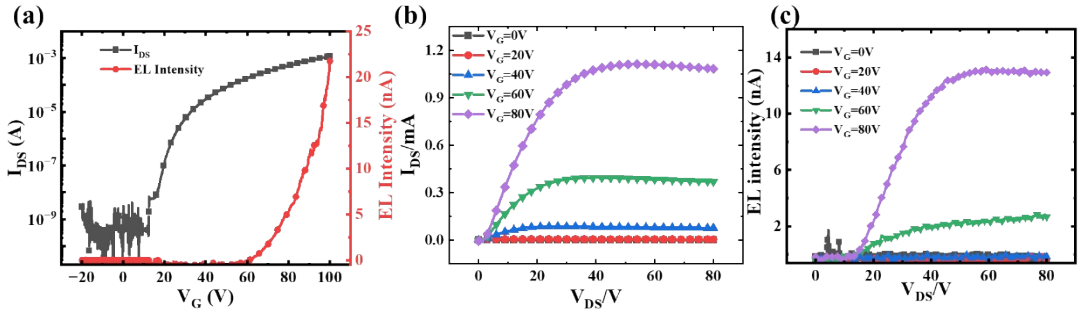

Figure S8. (a) the drain current transfer curve and the electroluminescence intensity transfer characteristics of the fabricated multi-layer area emission LET device based $CsPbBr_xCl_{3-x}$ emissive layer. (b) electrical output curve. (c) electroluminescence output curve of area emission ZTO/$CsPbBr_xCl_{3-x}$ LET.

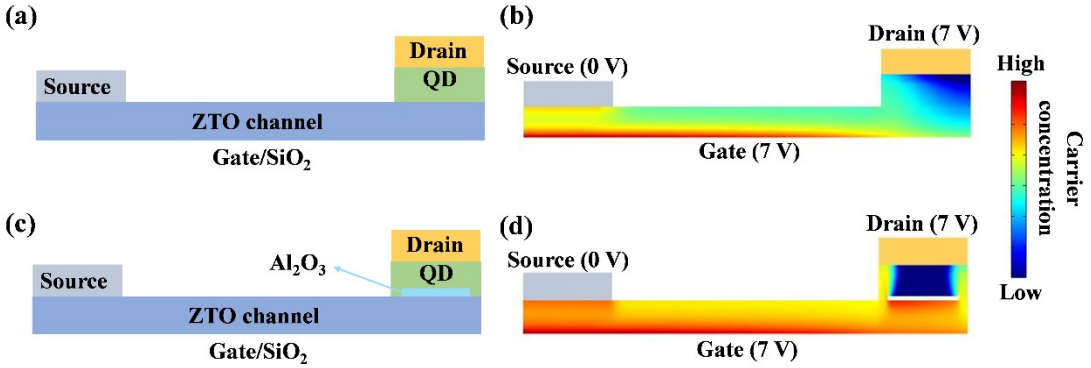

Figure S9. Schematic illustration of (a) the conventional LET device structure and (b)the simulation of its charge carrier distribution; (c) the area emission LET with Al_2O_3(5 nm) device structure and (d) the simulation of its charge carrier distribution.

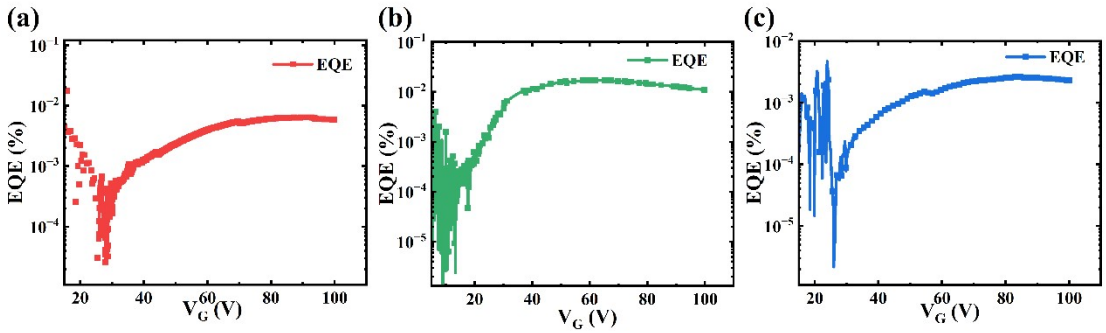

Figure S10. The EQE of the fabricated area emission RGB perovskite LET.

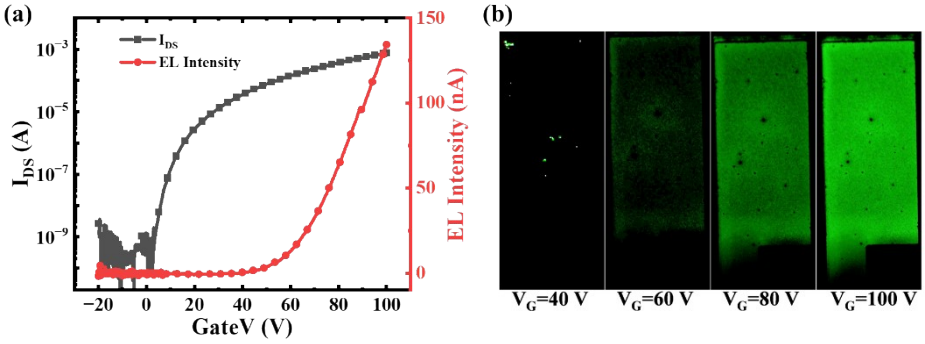

Figure S11. The fabricated multi-layer area emission LET device with 15nm Al_2O_3 layer. (a)the drain current transfer curve and the electroluminescence intensity transfer characteristics. (b)electroluminescence picture at different V_G.