

Supporting Information

Efficient and Long-Lifetime Full-Color Light-Emitting Diodes Using High Luminescence Yield Thick-Shell Quantum Dots

Huaibin Shen,^{†,‡} Qingli Lin,[†] Weiran Cao,[‡] Chencheng Yang,[‡] Nathan T. Shewmon,[‡]

Hongzhe Wang,[†] Long Yu,[‡] Lin Song Li,^{†} and Jiangeng Xue^{‡*}*

[†]Key Laboratory for Special Functional Materials of Ministry of Education, Henan University, Kaifeng 475004, China

[‡] Department of Materials Science and Engineering, University of Florida, Gainesville, FL 32611, USA

* Corresponding authors: jxue@mse.ufl.edu, lsli@henu.edu.cn

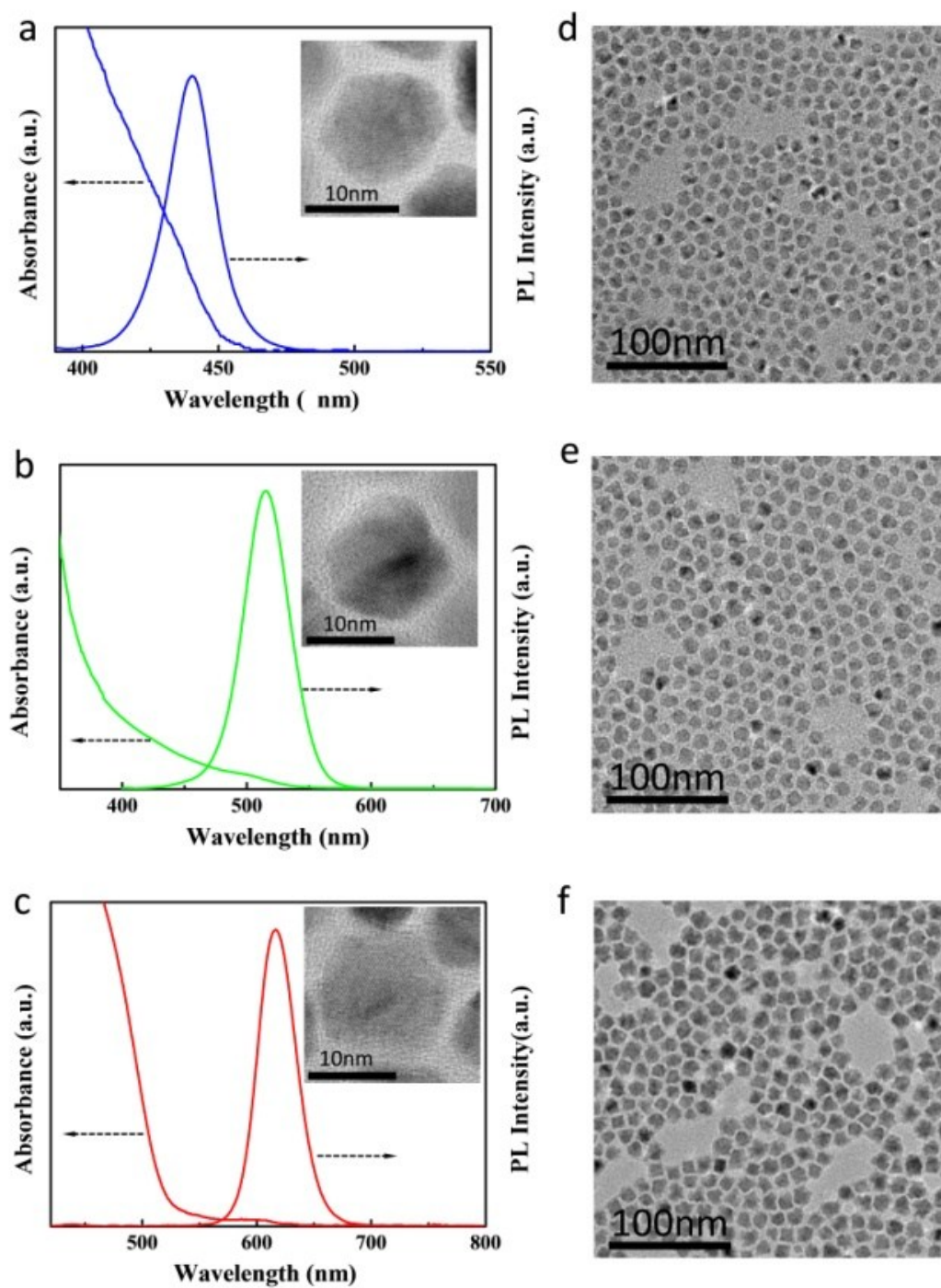


Figure S1. (a-c) Absorption and PL spectra, (d-f) TEM images, and high-resolution TEM (HRTEM) images (inset) of blue, green, and red thick-shell core/shell QDs.

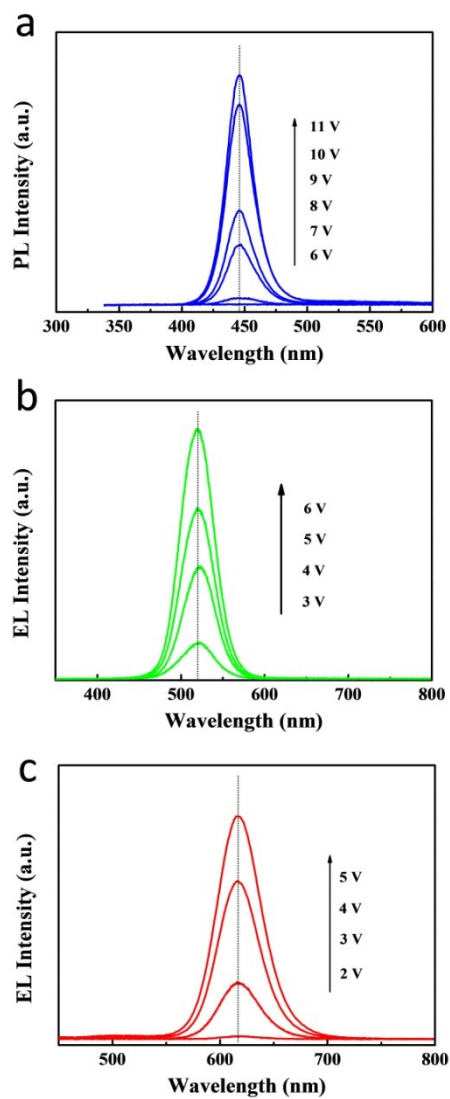
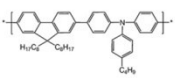
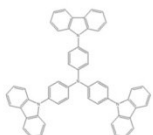
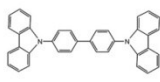


Figure S2. EL spectra of blue (a), green (b), and red (c) QLEDs under different applied voltages.

Table S1. Summary of the electrical properties of different hole transport materials.

Material	Molecular structure	HOMO/LUMO (eV)	Hole mobility ($\text{cm}^2 \text{V}^{-1} \text{s}^{-1}$)
TFB		5.3 / 2.3	1.0×10^{-2}
PVK		5.8 / 2.2	2.5×10^{-6}
TCTA		5.7 / 2.4	1.0×10^{-5}
Poly:TPD		5.2 / 2.3	1.0×10^{-4}
CBP		6.0 / 2.9	1.0×10^{-3}

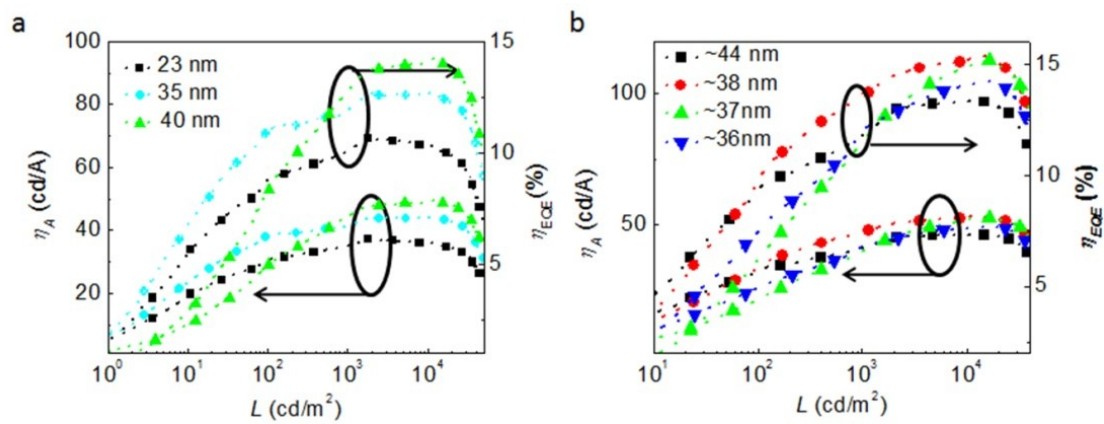


Figure S3. Comparison of device performance of QLEDs using green-emitting, thick-shell core/shell QDs with different thicknesses of QD layers.

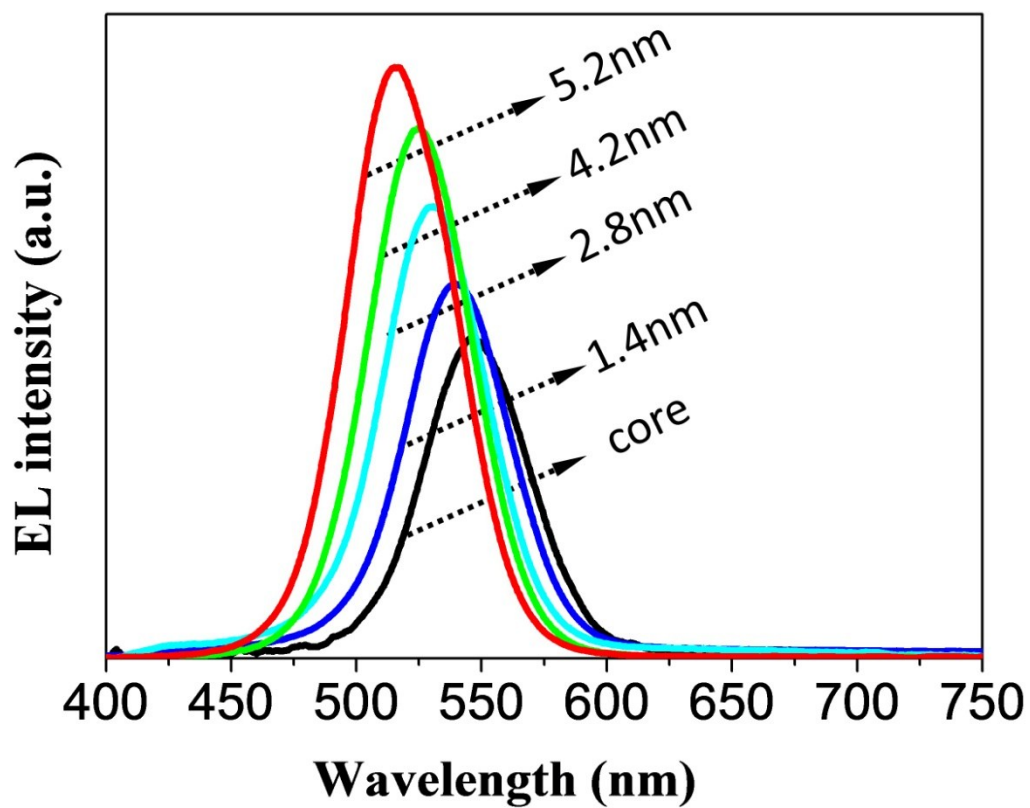


Figure S4. The PL spectra of Zn_{1-x}Cd_xSe/ZnS core/shell QDs with different shell thickness.

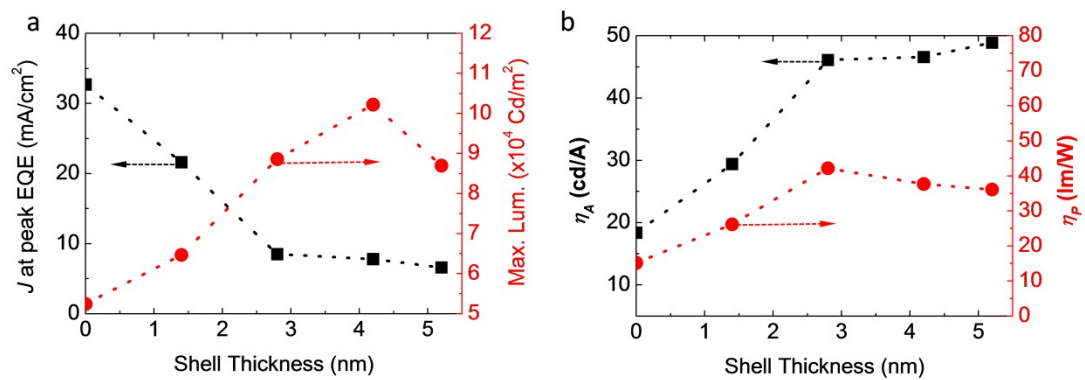


Figure S5. (a) Current density (J) at maximum EQE and maximum luminous; and (b) peak luminous efficiency (η_A) and maximum power efficiency (η_P) as a function a shell thickness.

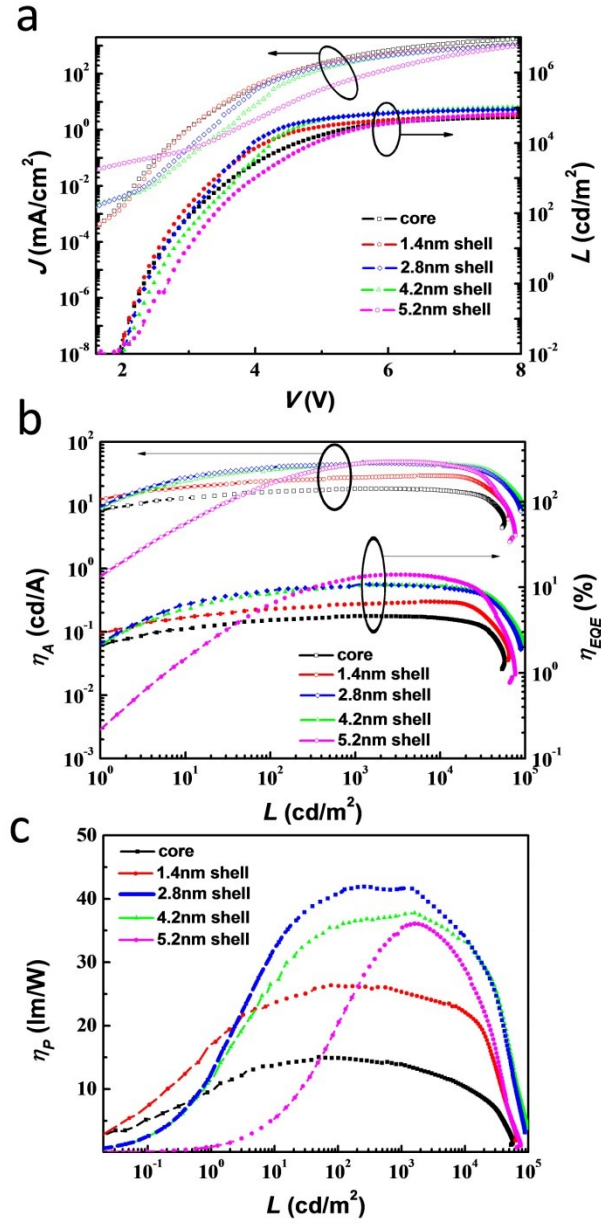


Figure S6. (a) Current density (J) and luminance (L) of the devices based on QDs with different shell thickness as a function of driving voltage (V). (b) Current efficiency (η_A) and external quantum efficiency (η_{EQE}) of these devices as a function of L . (c) Power efficiency (η_p) of these devices as a function of L .

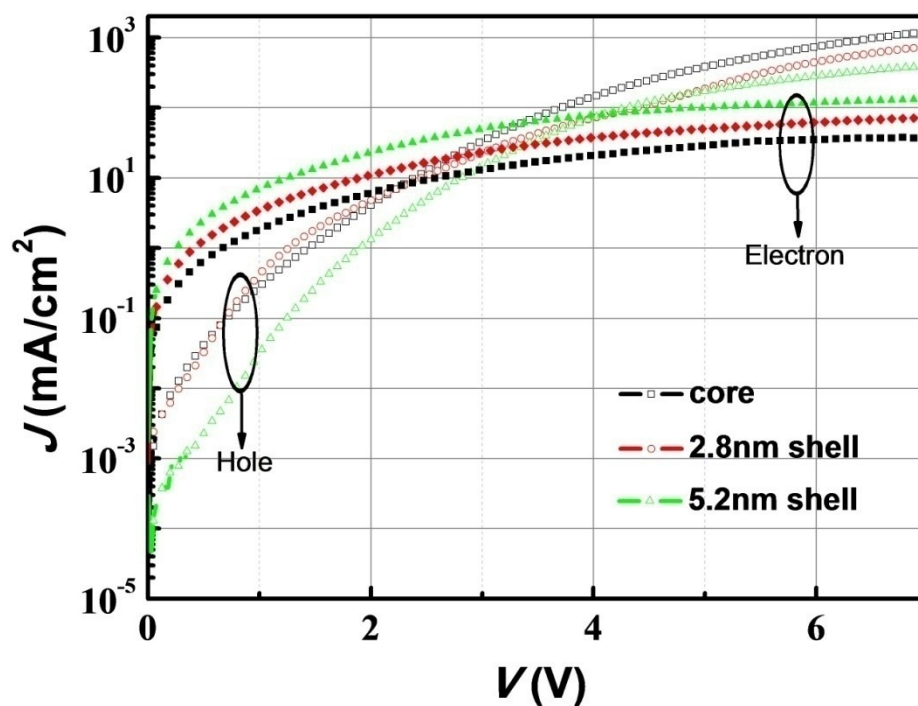


Figure S7. Current-density-voltage (J - V) characteristics of electron- and hole-only devices based on different shell thickness QDs. (Electron only device structure: ITO/ZnO (30 nm)/QDs (40 nm)/ZnO (30 nm)/Al; Hole only device structure: ITO/PEDOT:PSS (30 nm)/TFB (40 nm)/QDs (40 nm)/MoO_x (30 nm)/Al).

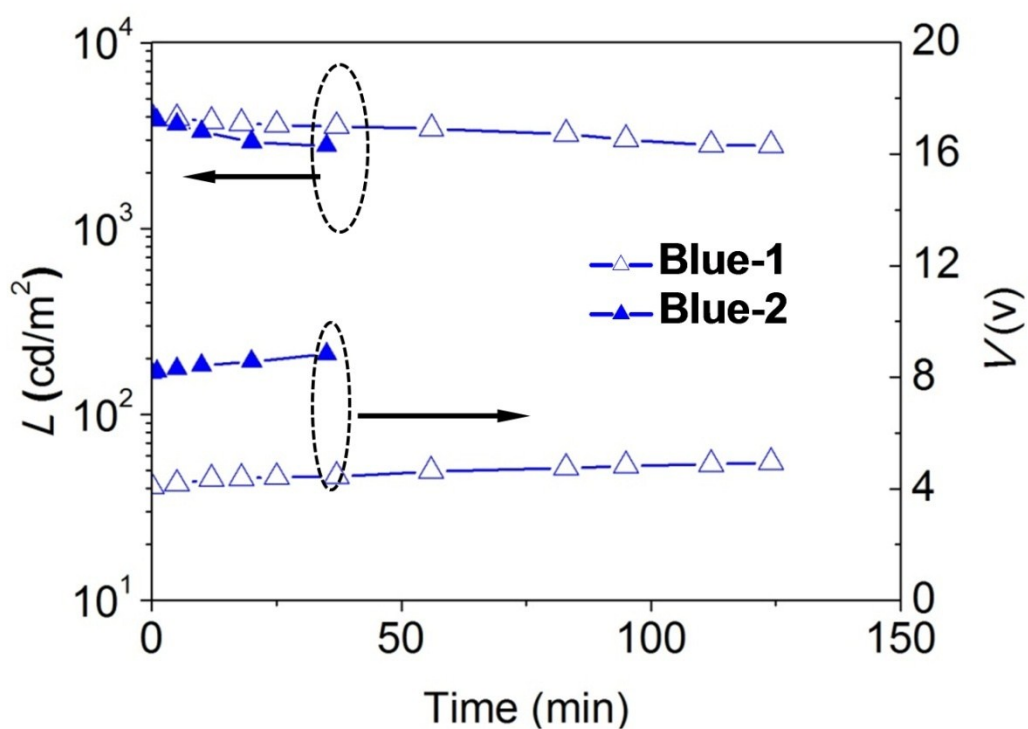


Figure S8. The operational lifetime characteristics of blue QLEDs, the luminance of QLEDs was measured during the continuous operation at a constant current density corresponding to an initial luminance of 4,000 cdm^{-2} T_{70} is only 124 min (Blue-1, with TFB HTL) and 36 min (Blue-2, with PVK HTL). The operating voltage bias was increased from 4.12 V to 5.07 V (TFB), and from 8.2 V to 8.9 V (PVK).