Electronic Supplementary Information (ESI)

Aminophosphine-Derived, High-Quality Red-Emissive InP Quantum Dots by Use of an Unconventional In Halide

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Synthesis of ZnMgO NPs

In a typical preparation of ZnMgO NPs, 9.5 mmol of Zn acetate, 0.5 mmol of Mg acetate tetrahydrate, and 40 mL of dimethyl sulfoxide (DMSO) were mixed in a beaker. Then, 10 mmol of tetramethylammonium hydroxide (TMAH) dissolved in 10 mL of ethanol was slowly injected in the mixture, followed by the reaction at 4^{o}C for 1 h. As-grown ZnMgO NPs were precipitated by centrifugation with the acetone and redispersed in ethanol for the following use.

QLED device fabrication.

Bottom-emitting, multilayered red QLED integrated with $InBr_3$-derived InP QDs was fabricated via solution processing of all functional layers except aluminum (Al) cathode. Glass substrate with patterned ITO anode was cleaned in sequence with acetone and methanol by sonication, followed by the treatment with UV-ozone. PEDOT:PSS as an HIL was spin-coated on ITO glass at 3000 rpm for 30 s and baked at 150^{o}C for 30 min. On top of HIL, HTL of TFB solution (8 mg/mL solution in chlorobenzene), was spin-deposited at 4000 rpm for 30 s and baked under the same conditions as in HIL. EML was generated by spin-casting InP QD dispersion (11 mg/mL in hexane) at 3000 rpm for 20 s, followed by baking at 70^{o}C for 10 min. Subsequently, ETL was deposited by spin-casting ZnMgO NP solution (32 mg/mL solution in ethanol) at 3000 rpm for 30 s. The QLED fabrication was completed by thermally evaporating a 100 nm-thick Al cathode.

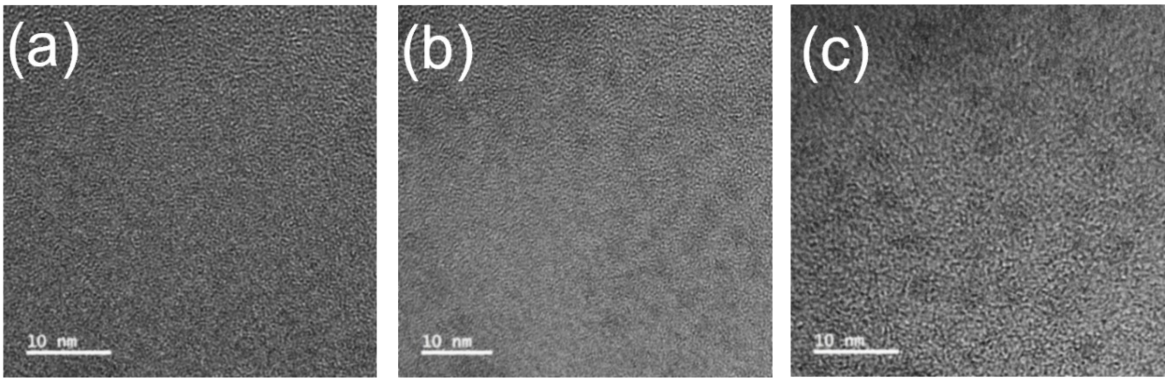

Fig. S1 High-magnification TEM images of $InBr_3$-based InP cores grown for (b) 30 s-, (c) 4 min-, and (d) 60 min at a growth temperature of 185°C. The scale bars are 10 nm for all.

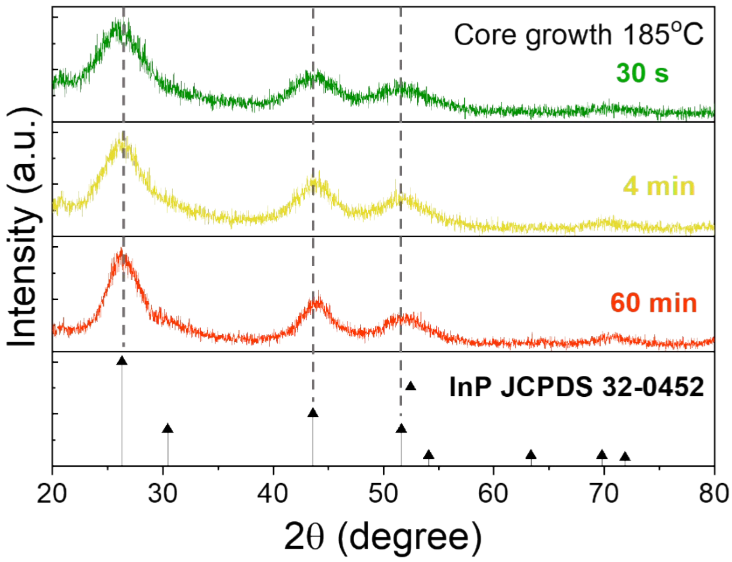

Fig. S2 XRD patterns of $InBr_3$-based InP cores grown for (b) 30 s-, (c) 4 min-, and (d) 60 min at a growth temperature of 185°C.

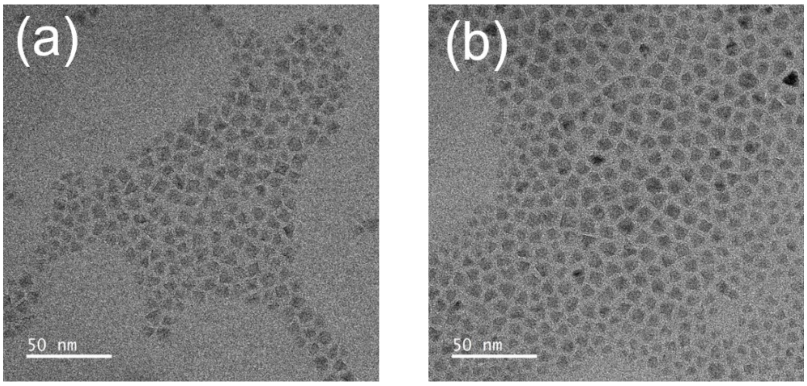

Fig. S3 (a) Low-magnification TEM images of InP/ZnSe/ZnS QDs synthesized with $InBr_3$-based red-emissive InP cores under (a) standard (185°C, 60 min) versus (b) two-step growth conditions (185°C, 60 min→280°C, 60 min). The scale bars are 50 nm for both.

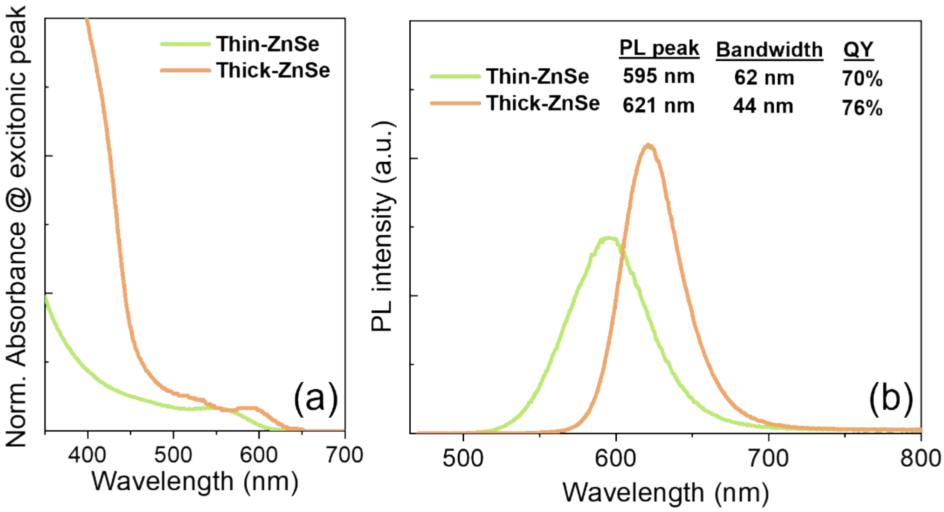

Fig. S4 (a) Excitonic peak-normalized absorption and (b) PL spectra of InP/thin-ZnSe and InP/thick-ZnSe QDs. Their PL peak, bandwidth, and QY are also included in (b).

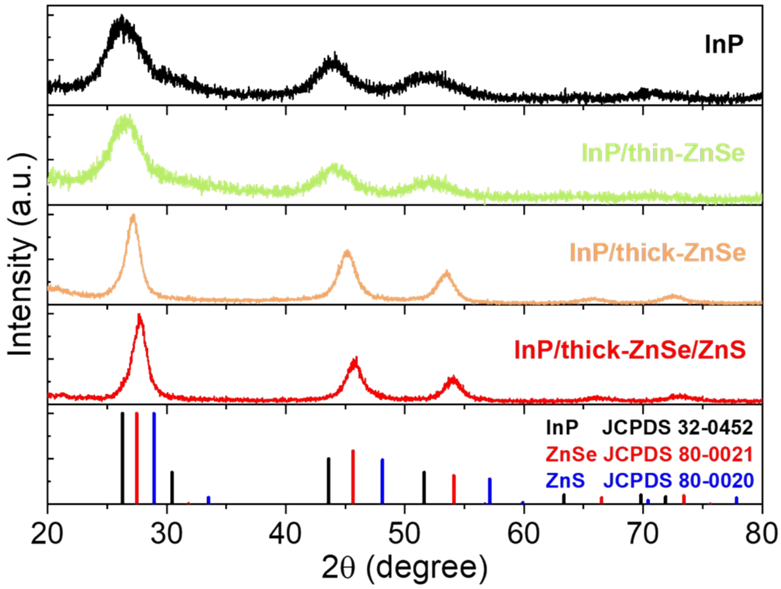

Fig. S5 XRD patterns of InP core, InP/thin-ZnSe, InP/thick-ZnSe core/shell, and InP/thick-ZnSe/ZnS core/shell/shell QDs. InP cores were commonly synthesized with $InBr_3$ at 185°C.

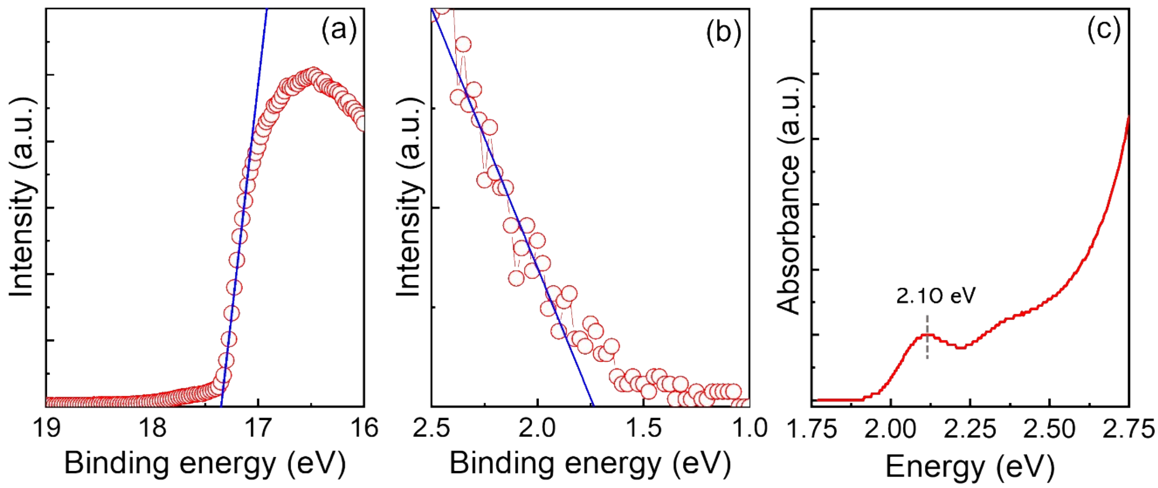

Fig. S6 UPS spectra of InP/thick-ZnSe/ZnS QDs showing (a) secondary-electron cutoff and (b) valence-band edge regions and (c) their second derivative absorption spectrum.

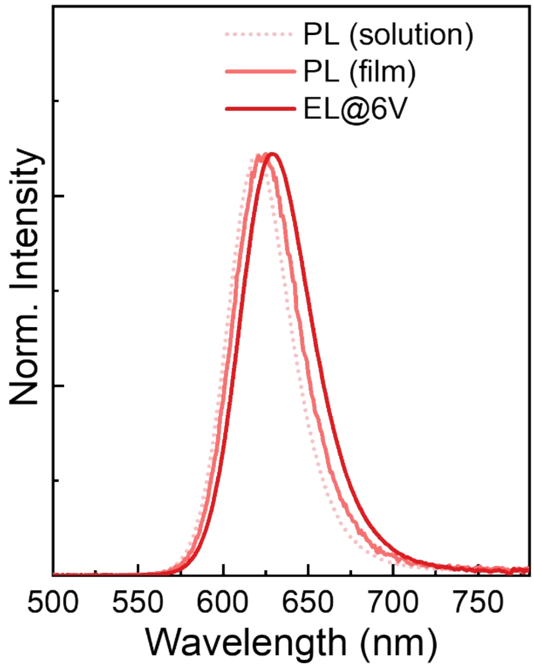

Fig. S7 Normalized spectral comparison of solution, film PL and EL (collected at 6V) of InP/thick-ZnSe/ZnS QDs.

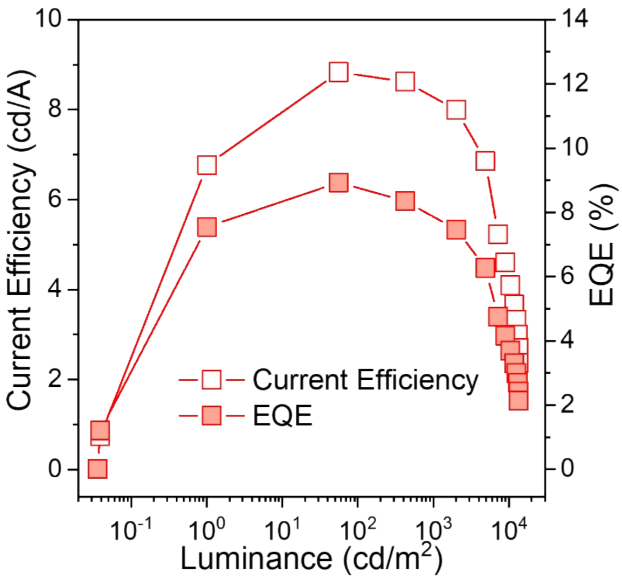

Fig. S8 Variation of current efficiency−EQE as a function of luminance of red QLED integrated with InP/thick-ZnSe/ZnS QDs.

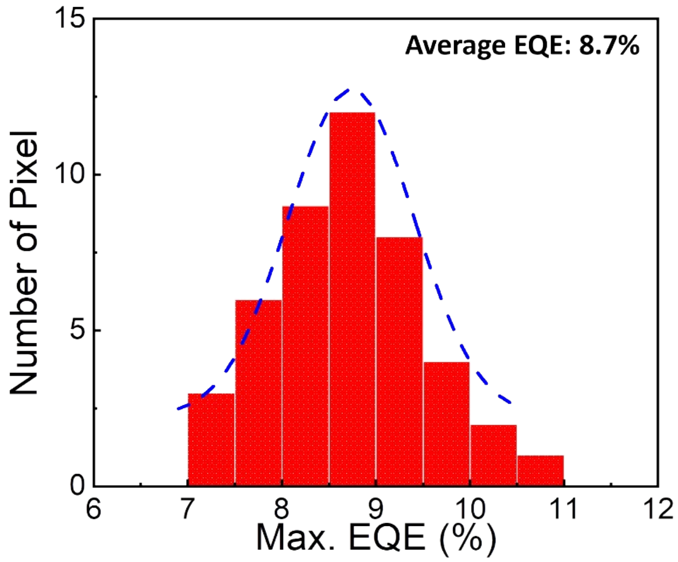

Fig. S9 Histogram of maximum EQEs obtained from 40 pixels, showing an average EQE of 8.7%.