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Blue quantum dot light-emitting diodes with high luminance by improving the charge transfer balance

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Experimental section

Chemicals

Cadmium oxide (CdO, 99.998%), Tributylphosphine (TBP, 98%), tellurium powder (Te, 99.8%), 1-octadecence (1-ODE, 90%), oleic acid (OA, 90%),1-octadecene (ODE, 90%), sulfur (S, 99.99%, powder), dimethyl sulfoxide (DMSO, 99.7%), TFB(poly[9,9-dioctylfluorene-co-N-[4-(3-methylpropyl)]-diphenylamine]), chlorobenzene(99%), zinc acetate ($Zn(Ac)_2$, 99.99%), tetramethylammoniumhydroxide (TMAH, 97%) and were purchased from Aldrich. poly(3,4-ethylenedioxylenethiophene)-polystylene sulfonic acid (PEDOT:PSS) and methanol (analytical reagent) were obtained from Sigma-Aldrich. ITO glasses were obtained from Xiamen Weihua. Poly-TPD was purchased from American Dye Source., hexanes (analytical grade), acetone (analyticalgrade), sopropanol (analytical grade) and methanol (analytical grade) were obtained from Beijing Chemical Reagent Co. Ltd, China.

Preparation of $Cd_{1-x}Zn_xS/ZnS$ core/shell QDs

The synthesis of $Cd_{0.1}Zn_{0.9}S$ core has been described in our previous work.[1] In a typical synthetic procedure, 0.5 mmol of CdO and 5 mmol $Zn(Ac)_2$ were placed in mixture solvent containing 4 mL of OA and 10 mL ODE in 50 mL of 3-neck rector in 150 ^oC, degassed under 100 mtorr pressure for 30 min, and then the temperature of the reaction was further heated to 300 ^oC under N_2 flow. At this temperature, 0.8 mmol of S powder dissolved in 2 mL of ODE was quickly injected into reaction flask, subsequently, the temperature was elevated to 310 ^oC for growth of $Cd_xZn_{1-x}S$ cores. After the elapse of 8 min of reaction, 7 mmol S powder dissolved in OA (S-OA) were introduced into the reactor to overcoat ZnS shells onto existing $Cd_xZn_{1-x}S$ cores. Timing sampling was

taken during the reaction to monitor the development of QDs. The temperature was kept for 1 hour to annealing the QDs and then cooled down to room temperature. Finally, QDs were purified by adding hexane and an excess amount of ethanol (done thrice); then they were redispersed in n-octane or chloroform for further characterization.

Device fabrication

ZnO and ZnO:Mg nanoparticles were synthesized using the method reported previously.[2] For a typical preparation, a solution of zinc acetate with or without magnesium acetate tetrahydrate in DMSO (0.5 M) and 30 mL of a solution of TMAH in ethanol (0.55 M) were mixed and stirred for 1 h in ambient air, then washed and dispersed in ethanol at a concentration of 30 mg mL^{-1}. The spin-coating or evaporation of each layer is the same as our previous work except the TBF layer. The TFB layer was spin-coated at a concentration of 8 mg mL^{-1} in chlorobenzene at 3000 rpm for 50 s, and then baked at 150℃ for 30 min. The active area of the QLED is 4 mm^2.

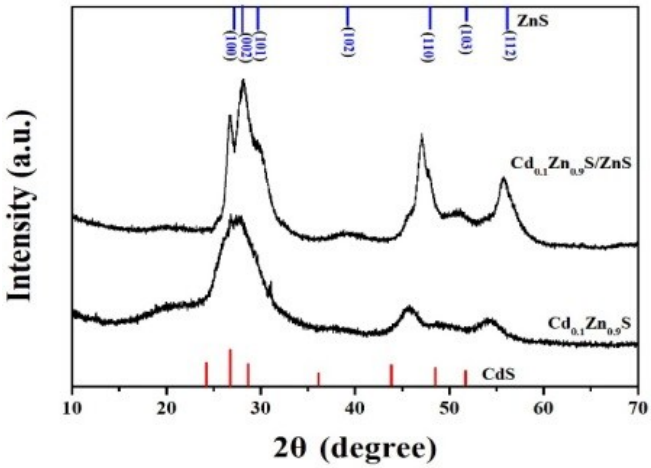

Fig. S1 XRD patterns of the pure $Cd_{0.1}Zn_{0.9}S$ and $Cd_{0.1}Zn_{0.9}S$/ZnS core/shell QDs.

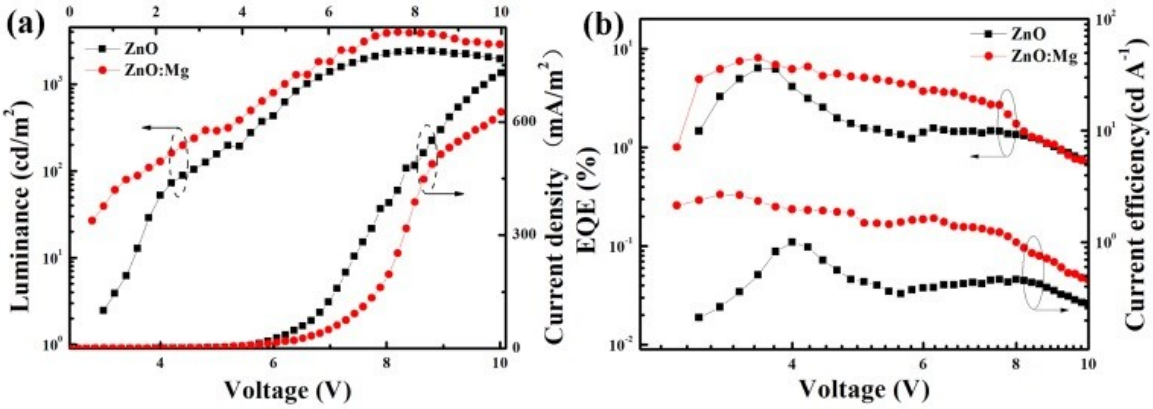

Fig. S2 (a) The current density and Luminance, (b) EQE and current efficiency of ZnO and ZnO:Mg devices.

References

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2. S. Wang, Y. Guo, D. Feng, L. Chen, Y. Fang, H. Shen and Z. Du, *J. Mater. Chem. C*, 2017, 5, 4724-4730.