

Supporting Information

Enhanced performance through trap states passivation in quantum dot light emitting diode

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Experimental Methods

Materials: CdO (99%), ZnO (99.9%), $\text{Mg}(\text{OAc})_2 \cdot 4\text{H}_2\text{O}$ (99%), $\text{Zn}(\text{OAc})_2 \cdot 2\text{H}_2\text{O}$ (99%), S (99.99%), KOH (98%), DDT (98%), were purchased from Aladdin. Se (99.999%), OA (90%), ODE (90%) were purchased from Alfa Aesar. TBP (99%), was purchased from Shanghai Changgen Chemical technology Co.,Ltd. Ethanol (AR), toluene (AR), n-octane (AR), ethyl acetate (AR) were from Guangdong Guanghua Sci-Tech Co., Ltd. Dimethyl sulfoxide was from Tianjin Baishi Chemical Co., Ltd. All materials are used as received.

Synthesis of luminescent QDs and ZnMgO nanoparticles: For a typical synthesis of CdZnSe/ZnSe/ZnS red emission quantum dots: 0.1 mmol of CdO, 2.5 mmol of ZnO, 5 mL of OA and 8 mL of ODE were mixed in a 50 mL three-neck bottle flask. The mixture was heated to 160°C and degassed under vacuum for 1 hour, then filled with N_2 gas and further heated to 300°C to get a clear light-yellowish solution. At this temperature, 0.2mL 2M Se precursor (dissolved in TBP) was injected swiftly into the flask. The reaction remain at 300°C for 40 min. To grow ZnSe and ZnS shell, 0.1mL 2M Se precursor and 0.1mL DDT were added dropwise into the flask successively. Each shelling process last for 30 min at 300°C. After the reaction, the temperature was naturally cooled down to room temperature. The synthesized quantum dots were finally repeated purified using ethanol and toluene and finally dispersed in n-octane. To synthesize 10 wt% magnesium doped ZnO nanoparticles, 0.5 mmol of $\text{Mg}(\text{OAc})_2 \cdot 4\text{H}_2\text{O}$ and 4.5 mmol $\text{Zn}(\text{OAc})_2 \cdot 2\text{H}_2\text{O}$ were added into the mixture of 48mL of dimethyl sulfoxide and 8 mL of absolute ethanol in a three-neck bottle flask, and then vigorously stirred to get a colorless solution. Then 0.4M potassium hydroxide solution (dissolved in ethanol) dropwise added to the mixture, and the reaction lasted for three hours. The as-synthesized nanoparticles were washed by ethanol and ethyl

acetate, followed by introduction of a certain amount of ethanolamine to stabilize the nanoparticles. The sample was finally dispersed in absolute ethanol for further use.

Device fabrication. The QLEDs with a structure of ITO / PEDOT:PSS / TFB / PMMA modified QDs (or pure QDs) / ZnMgO / Al were fabricated. Pre-patterned ITO glass substrates were firstly cleaned using consecutive ultrasonic baths in acetone, detergent, deionized water, and isopropyl alcohol, respectively. The substrates were treated with oxygen plasma for 5 min, and then a 40 nm-thick poly(styrene sulfonate)-doped poly(ethylenedioxythiophene) (PEDOT: PSS, Clevios AI 4083) film was obtained by spin-coating on the ITO-coated glass. The substrates were subsequently dried at 150 °C. After that, the hole transport material TFB (purchased from LUMTEC Inc.), dissolved in chlorobenzene with a concentration of 10 mg/mL, was spin-casted at 3000 rpm for 30 s in a N₂-glovebox and baked at 120 °C for 10 min. The QDs were dispersed in octane with a total concentration of 30 mg/mL, and different amounts of PMMA were added to form mixed solutions. Then the solutions were spin-coated at 2000 rpm and baked at 100 °C for 10 min. It is worth noting that the content of PMMA should not be too high, otherwise it will affect the dispersion of the solution, as shown in Figure S1. After that, ZnMgO nanoparticles, dispersed in ethanol with a concentration of 30 mg/mL, were spin-coated as electron transport layer at 3000 rpm and baked at 100 °C for 10 min. To complete the device, a 70 nm thick layer of Al was thermally evaporated in a vacuum chamber at 1×10^{-5} Pa.

Device Characterization. The current density-voltage-luminance characteristics were measured using a Keithley 2450 source meter and a Konica Minolta luminance meter LS-150. The electroluminescence spectra were collected using a Topcon SR-UL2 Spectroradiometer. The photoluminescence spectra were obtained using a fluorescence spectrometer (Edinburgh, FLS 920). The capacitance spectra were recorded using an impedance analyzer (Keysight, E4990A).

The optical permittivity was measured using a dual rotating-compensator Mueller matrix ellipsometer (Wuhan Eoptics Technology Co., ME-L ellipsometer). The low temperature environment in the experiments was provided by a cryostat system (Janis, ST-100).

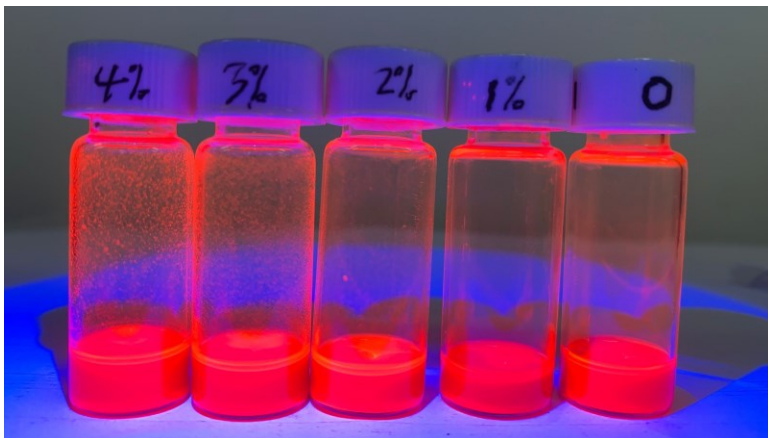


Figure S1. Photoluminescence photos of the PMMA-contained solutions after shaking under UV light.

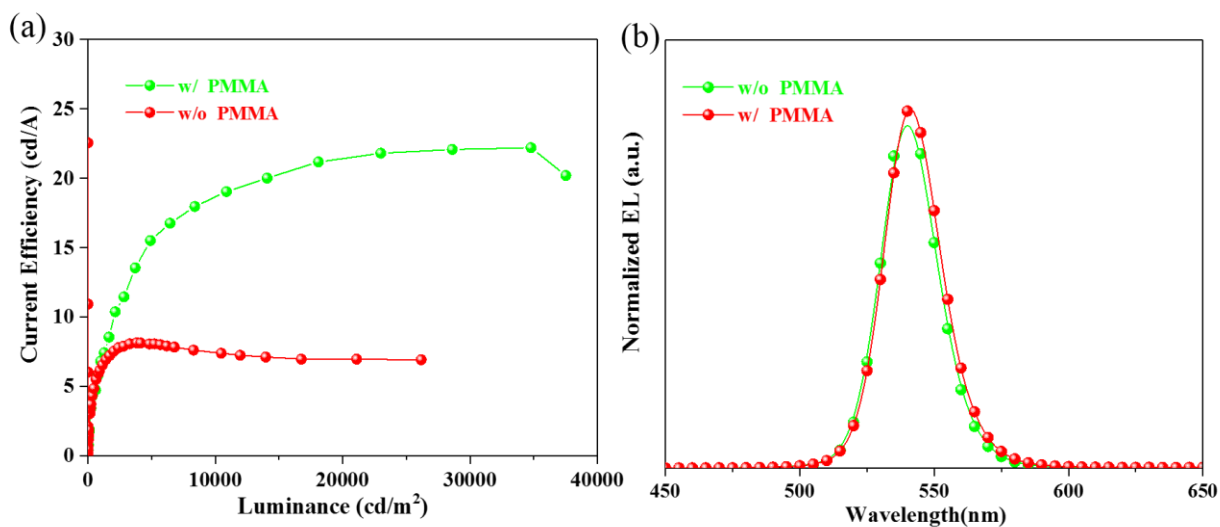


Figure S2. (a) Current efficiency-luminance characteristics and (b) Normalized EL spectra of green QLEDs without PMMA or with 1% PMMA.

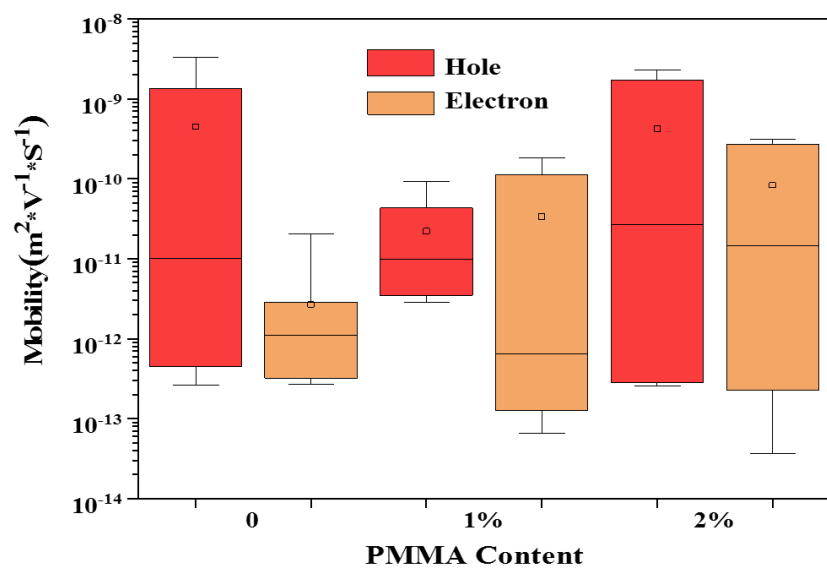


Figure S3. Charge carrier mobilities of the QLEDs with various PMMA content measured by the SCLC method.