

Supporting Information

Long-term Spontaneous Negative Aging Behavior of Encapsulated Blue Quantum Dot Light Emitting Devices: The Influence of the Hole Transport Material

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EXPERIMENTAL SECTION

Materials: PEDOT: PSS aqueous solution (Clevios P VP Al 4083, Heraeus), poly-TPD, PVK and TFB were purchased from Xi'an Polymer Light Technology Corporation. PEDOT:PSS solution was filtered twice with 0.22 μm water filter before spin coating. The three hole transport materials were each dissolved in chlorobenzene at different concentration and stirred at room temperature for a night. 9,9-bis[4-[(4-ethenylphenyl)methoxy]phenyl]-N2,N7-di-1-naphthalenyl-N2,N7-diphenyl-9H-fluorene-2,7- diamine (VB-FNPD) was purchased from Luminescence Technology Corporation and dissolved in chlorobenzene at 10 mg/ml and stirred overnight at 50 °C until clear and transparent. The molecular structure of TFB and VB-FNPD are shown in Fig. S1. CdZnSeS/ZnS blue QDs, ZnMgO nanoparticle dispersion and UV-curable resin were purchased from Mesolight. CdZnSeS/ZnS QDs with surface ligands of oleic acid was dispersed in n-octane at a concentration of 25 mg/ml. The PL peak of QDs centered at 465 nm and the PLQY can reach 65%. ZnMgO

nanoparticles were dispersed in ethanol at a concentration of 25 mg/ml. The solvents used in the preparation of these solutions, such as chlorobenzene and n-octane, were purchased from Sigma-Aldrich. All materials and solvents are used as is without further purification.

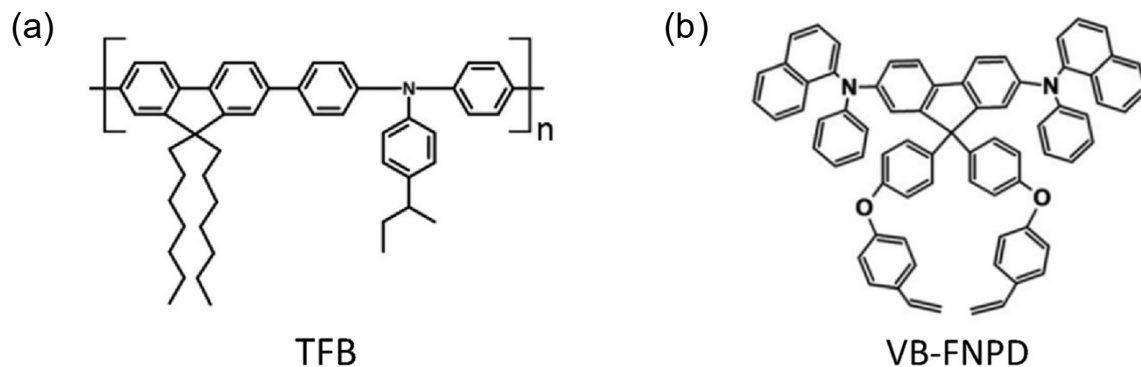


Figure S1. Molecular structure of (a) TFB and (b) VB-FNPD.

Device Fabrication: Devices were fabricated on commercially available patterned ITO glass substrates (Kintec) with a sheet resistance of $15 \Omega/\text{sq}$. Before depositing the functional layers, the ITO substrates were cleaned with Micro 90, and then successively ultrasonic treated with deionized water, acetone, and isopropanol for 10 min, then dried by nitrogen. After oxygen plasma treatment for 5 min, PEDOT: PSS solutions were spin-coated onto the ITO-coated glass substrates at 5000 rpm for 60 s and baked at 150°C for 15 minutes in the air. Then, the PEDOT: PSS-coated substrates were transferred into a nitrogen-filled glove box to sequentially deposit the other functional layers. The hole transport layer TFB dissolved in chlorobenzene (8 mg/ml) was spin-coated at 4000 rpm and baked at 120°C for 15 min. 10 mg/ml solution of VB-FNPD in chlorobenzene was spin-coated at 3000 rpm for 40 seconds and annealed first at 100°C for 15 minutes followed by 1h annealing at 220°C . And after that, the 10 mg/ml B-QDs solution were spin-coated at 3000 rpm, followed by baking at 100°C . The ZnMgO dispersion with a concentration of 25 mg/ml was spin-coated on top of QDs at the speed of 3000 rpm to form an electron transport layer. Then, the samples were transferred to an Angstrom Engineering EvoVac thermal evaporation chamber to deposit an Al cathode at a base pressure of 5×10^{-6} Torr. The active area of the devices is controlled to be 4 mm^2 by using a shadow mask. Finally, the devices were encapsulated with UV-curable resin and cover glass, then cured under 365 nm UV radiation for 20 min. The samples were kept in an N_2 -filled glove box after encapsulation.

Device Characterizations: QLEDs luminance was measured using a Minolta Chroma Meter CS-100. Current-voltage-luminance (per) measurements were carried out via an Agilent 4155C semiconductor

parameter analyzer connected to a silicon photodiode. EQE was calculated as outlined by Okamoto et al. assuming a Lambertian emission distribution. PL and EL spectral measurements were collected using an Ocean Optics QE65000 spectrometer. Time-resolved photoluminescence (TRPL) was measured using an Edinburgh Instruments FL920 spectrometer.

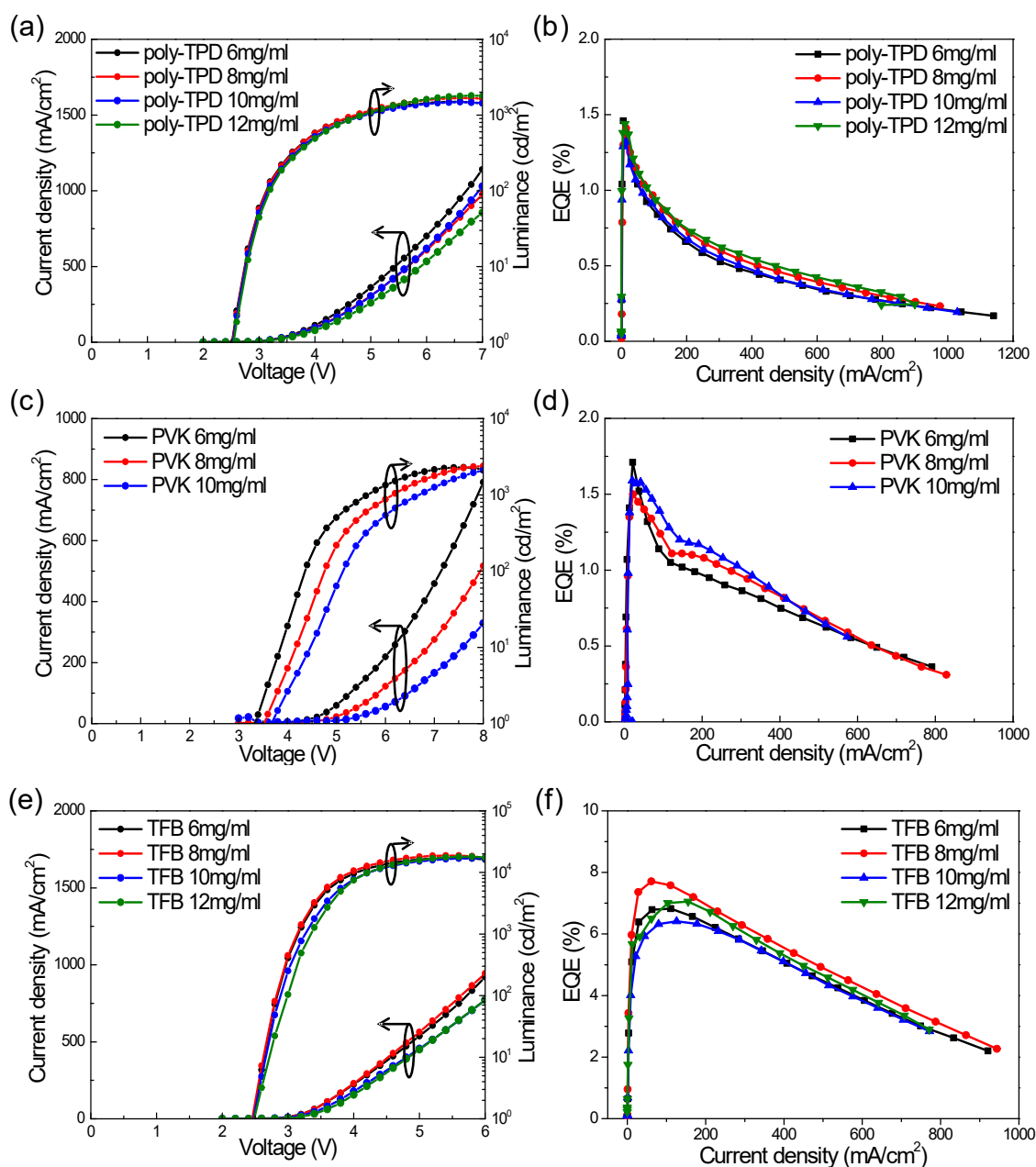


Figure S2. (a) J-V-L and (b) EQE-J of blue QLEDs with different concentrations of poly-TPD as HTL. (c) J-V-L and (d) EQE-J of blue QLEDs with different concentrations of PVK as HTL. (e) J-V-L and (f) EQE-J of blue QLEDs with different concentration of TFB as HTL. All the devices were encapsulated and stored for a night in a nitrogen-filled glovebox.