Electronic Supporting Information (ESI)

Efficient Organic and Inorganic Hybrid Interlayer for High Performance Inverted Red Cadmium-free Quantum Dot Light-Emitting Diodes

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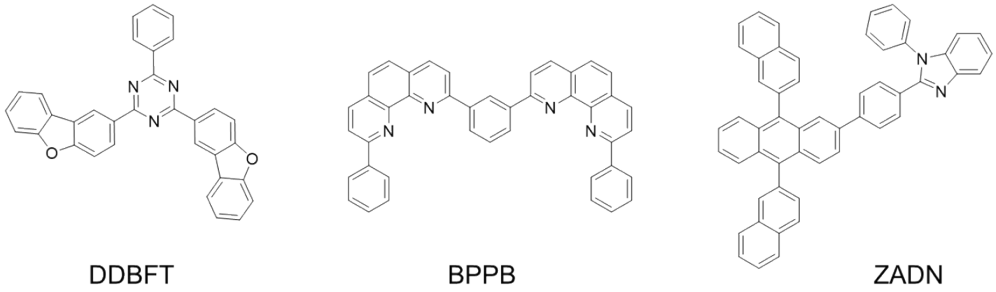

Fig. S1 Chemical strutures of the DDBFT, BPPB and ZADN ETL materials

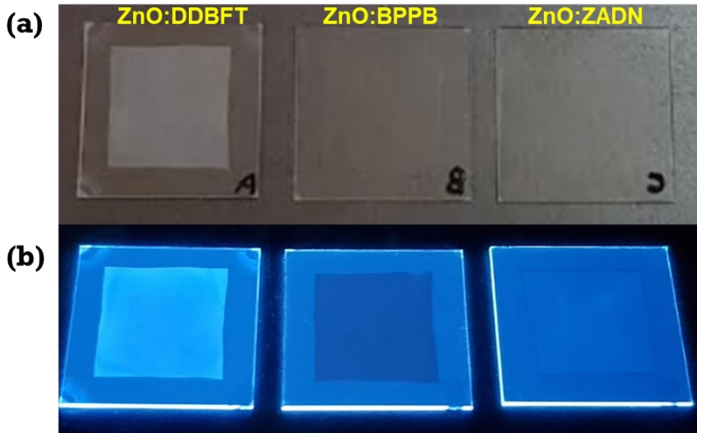

Fig. S2 Photographs of the different small molecule ETLs blended in ZnO (ZnO:DDBFT, ZnO:BPPB, ZnO:ZADN) (a) under normal light (b) under UV light.

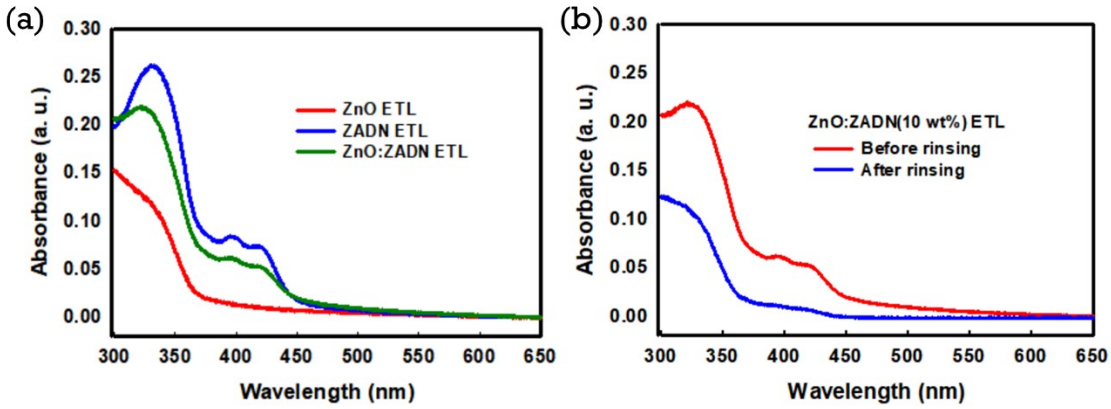

Fig. S3 (a) UV-Vis absorption spectra of ZnO, ZADN and ZnO:ZADN(10wt%) films. (b) UV-Vis absorption spectra of ZnO:ZADN(10wt%) ETL film before and after octane rinsing.

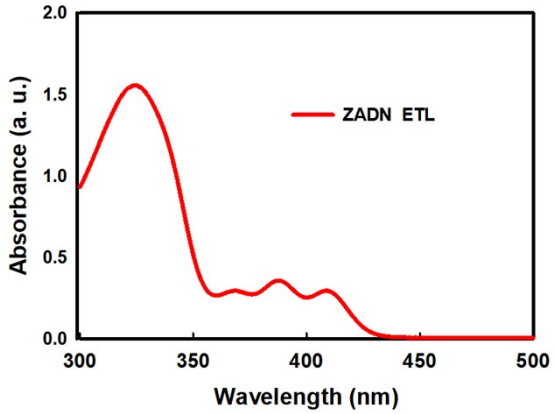

Fig. S4 Solubility test of ZADN ETL in octane solvent.

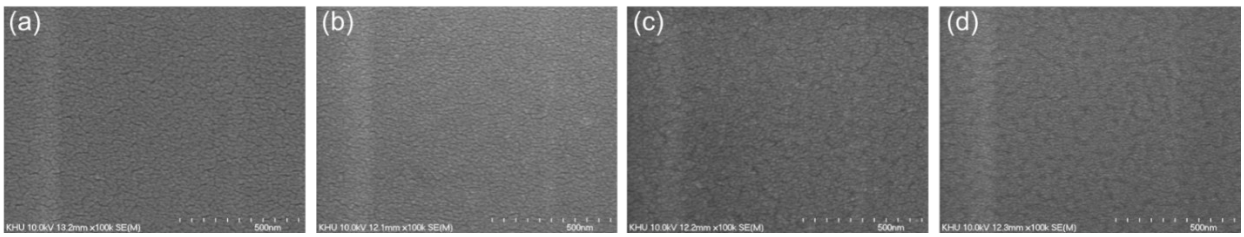

Fig. S5 SEM images of the samples (a) ZnO (b)ZnO/ZnO:BPPB(10wt%) (c) ZnO/ZnO:BPPB(15wt%), and (d)ZnO/ZnO:BPPB(20wt%).

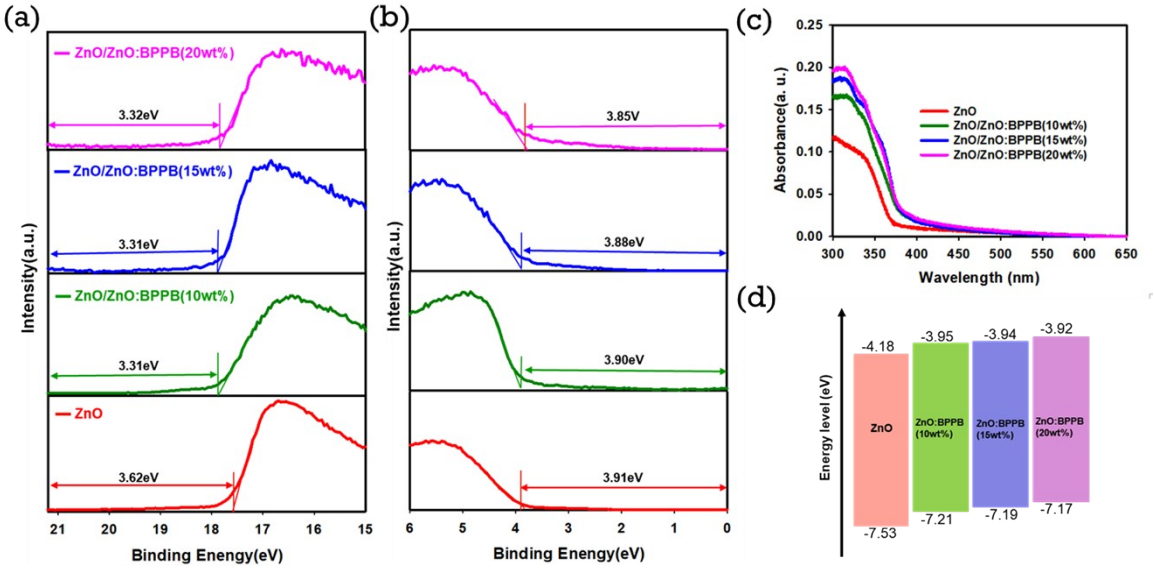

Fig. S6 UPS spectra of the samples ZnO, ZnO/ZnO:BPPB(10wt%) ZnO/ZnO:BPPB(15wt%) and ZnO/ZnO:BPPB(20wt%) (a) Secondary electron cutoff regions (b) valance band edge regions (c) UV-Vis absorption spectra (d) Energy band diagram.

The secondary electron cutoff regions (E_{cutoff}) and onset valance band edge regions (E_{onset}) are shown in above Fig. S6 (a) and (b). The valance band maximum (VBM) level is calculated by equation VBM= 21.22-(E_{cutoff}-E_{onset}). The VBM levels are 7.53 eV, 7.21 eV, 7.19 eV, and 7.17 eV for the samples ZnO, ZnO:BPPB(10wt%), ZnO:BPPB(15wt%), and ZnO:BPPB(20wt%). From the UV-absorption spectra the bandgaps (Eg) were 3.35 eV, 3.26 eV, 3.25 eV, and 3.25 eV, respectively. The conduction band minimum (CBM) levels are calculated to be 4.18 eV, 3.95 eV, 3.94eV, and 3.92 eV. The CBM levels are raised from 4.18 eV to 3.92 eV. The raised CBM level cause a large energy barrier, which inhibits the electron transportation and enhance the charge balance.

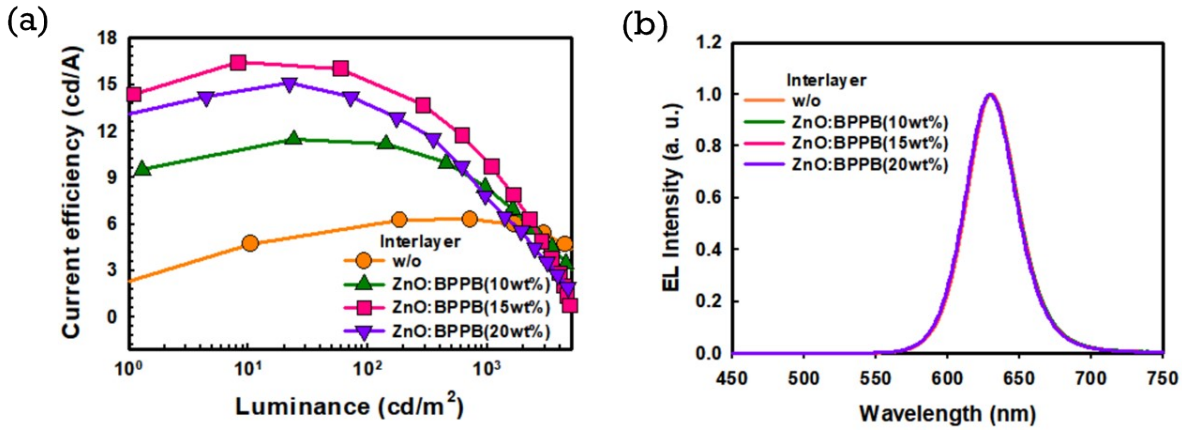

Fig. S7 (a) Current efficiency versus luminance characteristics (b) Electroluminescent (EL) spectrum of InP-QLED devices without (w/o) and with interlayers.

Table S1: Summary of the average exciton decay lifetime of different samples.

Sample	Exciton lifetime
Glass/QD	28.3 ns

Glass/ZnO/QD	23.2 ns
Glass/ZnO/ZnO:BPPB(10wt%) interlayer/QD	25.7 ns
Glass/ZnO/ZnO:BPPB(15wt%) interlayer/QD	27.2 ns
Glass/ZnO/ZnO:BPPB(20wt%) interlayer/QD	26.1 ns

Table S2: Film PLQY of QDs samples on ZnO, ZnO:BPPB(10wt%), ZnO:BPPB(15wt%) and ZnO:BPPB(20wt%)

Sample	**Film PLQY (%)**
QD	56.0
ZnO/QD	41.2
ZnO/ZnO:BPPB(10wt%) interlayer/QD	44.6
ZnO/ZnO:BPPB(15wt%) interlayer/QD	51.3
ZnO/ZnO:BPPB(20wt%) interlayer/QD	47.1