

Enhanced Luminance of CdSe/ZnS Quantum Dots Light-Emitting Diodes Using ZnO-Oleic Acid/ZnO Quantum Dots Double Electron Transport Layer

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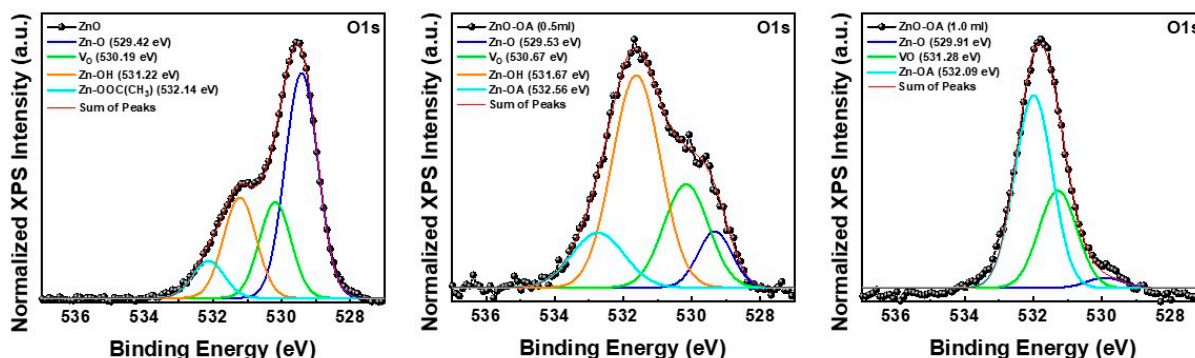
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Figure S1. Deconvoluted Gaussian sub-peaks of O1s XPS spectra of (a) ZnO, (b) ZnO-OA (0.5 ml) and (c) ZnO-OA (1.0 ml), respectively.



Calculated values: deconvoluted Gaussian sub-peaks of O1s XPS spectra of (a) ZnO, (b) ZnO-OA (0.5 ml) and (c) ZnO-OA (1.0 ml), respectively.

| Model | Gauss | | | |
|-----------------|--|---------------------|---------------------|---------------------|
| Equation | $y=y_0 + (A/(w*\sqrt{\pi/2}))*\exp(-2*((x-xc)/w)^2)$ | | | |
| Plot | Peak1(B) | Peak2(B) | Peak3(B) | Peak4(B) |
| y0 | 0.01725 ± 0.00115 | 0.01725 ± 0.00115 | 0.01725 ± 0.00115 | 0.01725 ± 0.00115 |
| xc | 529.42337 ± 0.16294 | 530.19252 ± 0.21216 | 531.22432 ± 0.13661 | 532.14024 ± 0.48295 |
| w | 0.9553 ± 0.08965 | 0.92296 ± 0.63664 | 0.95249 ± 0.54001 | 0.92095 ± 0.31084 |
| A | 1.02263 ± 0.47114 | 0.42045 ± 0.726 | 0.45425 ± 0.48341 | 0.16199 ± 0.21894 |
| Reduced Chi-Sqr | 1.26673E-4 | | | |
| R-Square (COD) | 0.99821 | | | |
| Adj. R-Square | 0.99806 | | | |

| Model | Gauss | | | |
|-----------------|--|---------------------|---------------------|---------------------|
| Equation | $y=y_0 + (A/(w*\sqrt{\pi/2}))*\exp(-2*((x-xc)/w)^2)$ | | | |
| Plot | Peak1(B) | Peak2(B) | Peak3(B) | Peak4(B) |
| y0 | 0.05353 ± 0.0026 | 0.05353 ± 0.0026 | 0.05353 ± 0.0026 | 0.05353 ± 0.0026 |
| xc | 529.32705 ± 1.21473 | 530.16701 ± 1.50183 | 531.62031 ± 0.38263 | 532.73915 ± 3.21811 |
| w | 0.99468 ± 1.27872 | 1.30824 ± 4.65014 | 1.4041 ± 1.45411 | 1.53027 ± 1.62373 |
| A | 0.26665 ± 2.92124 | 0.5455 ± 4.68947 | 1.42428 ± 4.00524 | 0.40037 ± 2.30771 |
| Reduced Chi-Sqr | 5.14493E-4 | | | |
| R-Square (COD) | 0.99411 | | | |
| Adj. R-Square | 0.9936 | | | |

| Model | Gauss | | |
|-----------------|--|---------------------|---------------------|
| Equation | $y=y_0 + (A/(w*\sqrt{\pi/2}))*\exp(-2*((x-xc)/w)^2)$ | | |
| Plot | Peak1(B) | Peak2(B) | Peak3(B) |
| y0 | 0.05176 ± 0.00256 | 0.05176 ± 0.00256 | 0.05176 ± 0.00256 |
| xc | 529.91163 ± 1.4121 | 531.28659 ± 2.02117 | 532.09478 ± 0.88995 |
| w | 1.05431 ± 1.33975 | 1.10886 ± 1.52123 | 1.09282 ± 0.37244 |
| A | 0.04164 ± 0.14927 | 0.28578 ± 3.02394 | 1.04653 ± 2.90128+E |
| Reduced Chi-Sqr | 6.48152E-4 | | |
| R-Square (COD) | 0.98989 | | |
| Adj. R-Square | 0.98925 | | |

Table S1. ZnO nanoparticles hybridized with various inorganic and organic materials for electron transport layer or emissive materials.

| | Materials | Approaches | Results | References |
|---|---|--|---|--|
| 1 | ZnO/OA | Passivation of surface defects | Strong blue emission | J. Am. Chem. Soc. 2007 , 129, 16029–16033 |
| 2 | ZnO@TiO ₂ | Blue emitter | White emission | Sci. Rep. 2015 , 4, 4085–4090 |
| 3 | Zn _{1-x} Mg _x O (x=0~0.1) | ETL for QLEDs | Increased luminescence of CIS/ZnS QLEDs | Chem. Mater. 2015 , 27, 197–204 |
| 4 | ZnO/PEIE | ETL for inverted QLEDs | Enhanced electron injection by lowering work function | Sci. Rep. 2015 , 5, 1–5 |
| 5 | ZnO/OA | ETL for MAObBr ₃ -PVP PeLEDs* | Enhanced luminescence and current efficiency | J. Alloys Comp. 2019, 786, 11–17 |
| 6 | ZnO@SnO ₂ | ETL for | Improved Efficiency of Perovskite Solar Cell | J. Am. Chem. Soc. 2019 , 141, 17610–17616 |
| 7 | ZnO(Ga, Mg) | ETL for QLEDs | Optimization of e/h injection | RSC Adv. 2019 , 9, 32066–32071 |
| 8 | ZnO/C ₆₀ | ETL for CsPbI ₃ PeLEDs* | Enhanced luminescence by suppression of exciton quenching | J. Phys. Chem. C 2020 , 124, 28277–28284 |
| 9 | ZnO-OA/ZnO | Double ETL for QLEDs | Enhanced luminescence by hole blocking | This study |

*PeLEDs : perovskite LEDs

Table S2. XPS O1s spectra evaluated from ZnO, ZnO-OA (0.5ml) and ZnO-OA (1.0ml), respectively.

| | Peak 1 (Zn-O) | Peak 2 (VO) | Peak 3 (Zn-OH) | Peak 4 (Zn-OOC) or (Zn-OA) | |
|---------------------------------|--------------------------------|------------------------------|---------------------------------|---|------------|
| ZnO | 49.7 | 20.5 | 22.0 | 7.8 | 100 |
| ZnO-OA (0.5ml) | 9.9 | 20.6 | 54.2 | 15.3 | 100 |
| ZnO-OA (1.0ml) | 2.9 | 20.6 | | 76.5 | 100 |