

Supplementary Information

Surface functionalization of ZnO nanoparticles with sulfonate molecules as the electron transport layer in quantum dot light-emitting diodes

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Table S1. Carrier lifetime parameters of TR-PL decay curves of CdSe QDs with different ZnO NPs.

Sample	A ₁ (%)	τ ₁ (ns)	A ₂ (%)	τ ₂ (ns)	τ _{avg} (ns)
QDs/ZnO	58.56	5.946	41.44	2.150	5.17
QDs/STS-ZnO	55.37	6.201	44.62	2.336	5.30
QDs/SBS-ZnO	45.89	6.793	54.11	2.864	5.48
QDs/SβSS-ZnO	29.73	7.692	70.26	3.413	5.50

$$\tau_{\text{avg}} = (A_1\tau_1^2 + A_2\tau_2^2) / (A_1\tau_1 + A_2\tau_2)$$

*τ₁ and τ₂ are the lifetimes of different recombination decays.

Table S2. Device performance of QLEDs based on different ZnO NPs.

ZnO type	V _{on}	L _{max} (cd/m ² @V)	CE _{max} (cd/A@V)	EQE (%)
pristine	4.03	285,609@8.25	24.4@6.84	5.76
STS-modified ZnO	3.56	446,192@8.06	36.1@6.94	8.49
SBS-modified ZnO	3.47	434,722@7.78	33.6@6.09	7.93
SβSS-modified ZnO	3.47	458,810@9.66	40.1@7.13	9.44

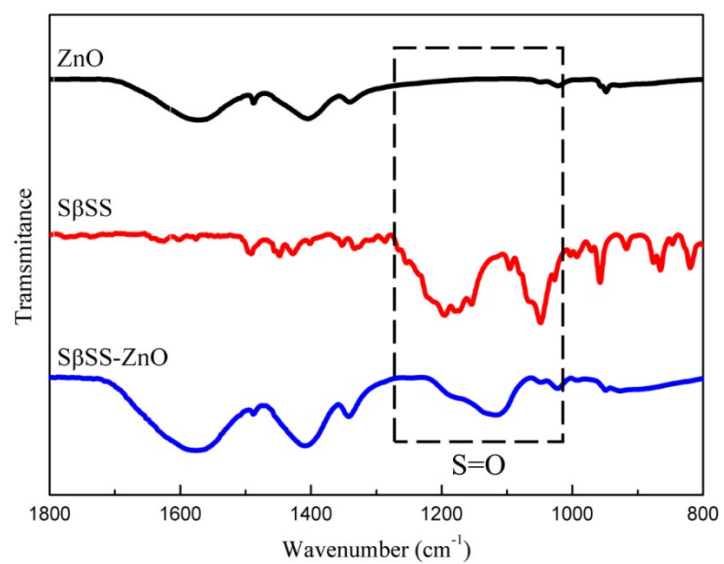


Fig. S1 FT-IR spectra corresponding to ZnO, S β SS, and S β SS-modified ZnO NPs.

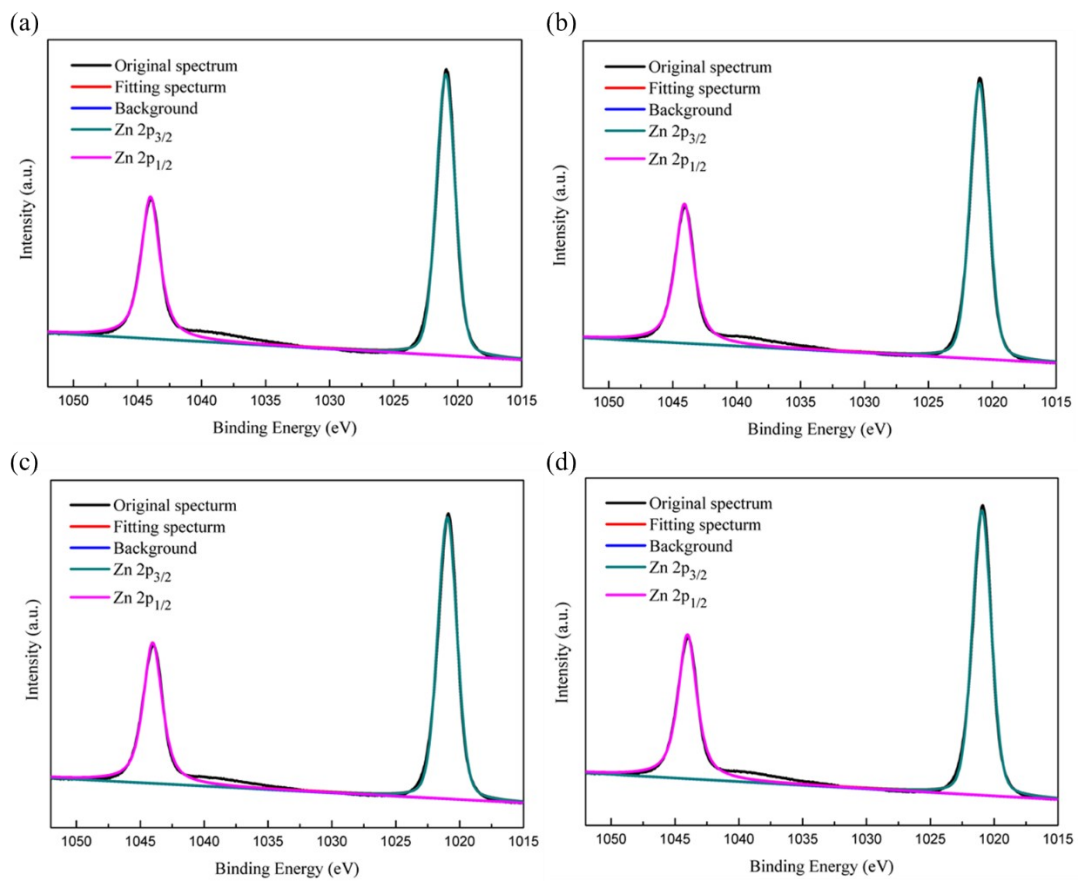


Fig. S2 Zn 2p XPS spectra of the (a) pristine, (b) STS-, (c) SBS-, and (d) S β SS-modified ZnO films.

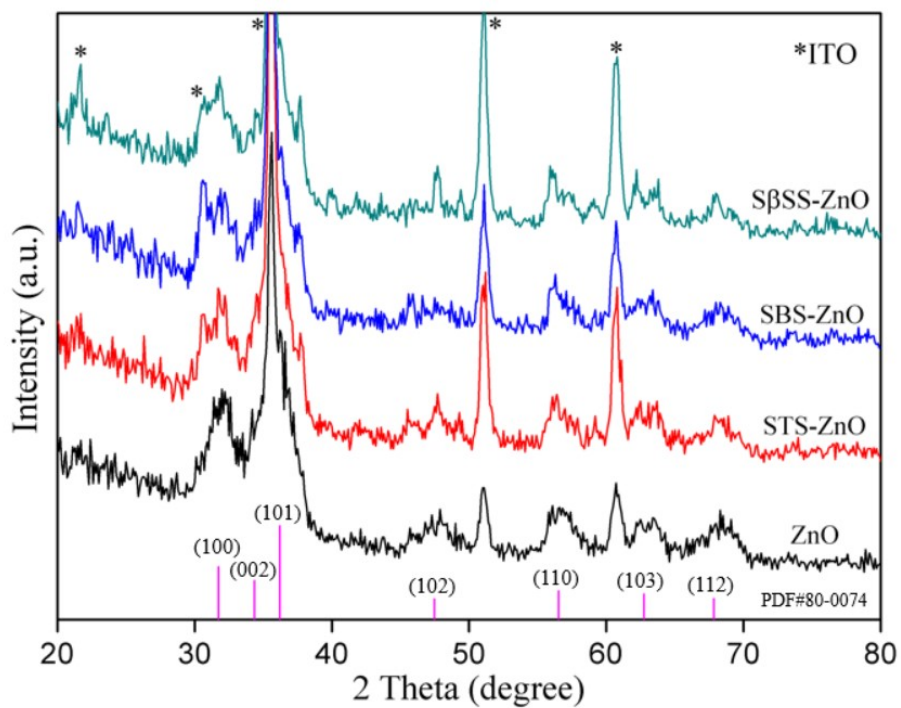


Fig. S3 XRD patterns of the pristine and modified ZnO films.

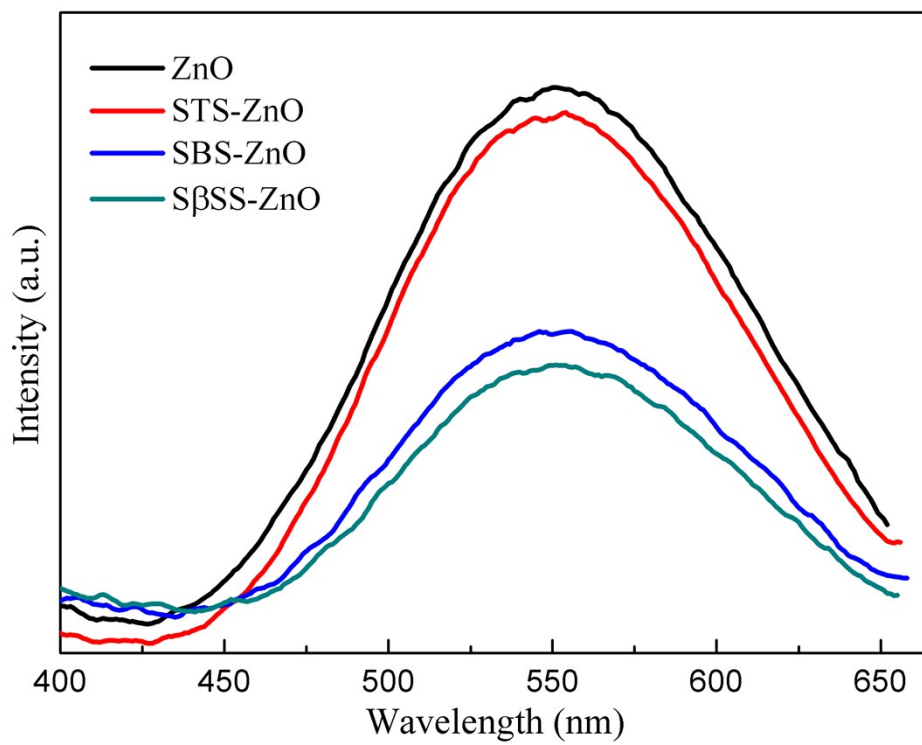


Fig. S4 PL spectra of the pristine and modified ZnO films.

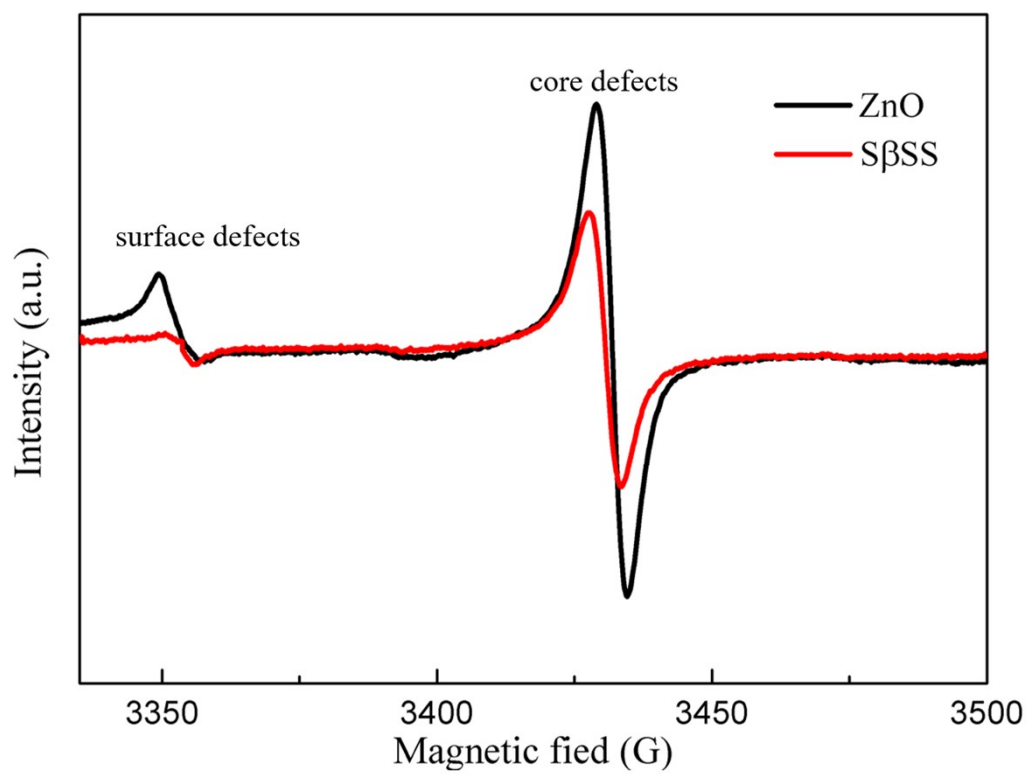


Fig. S5 EPR spectra of the pristine and SβSS-modified ZnO NPs at room temperature.

The g value can be calculated by the following equation: $g = h\nu/\mu_B B$.

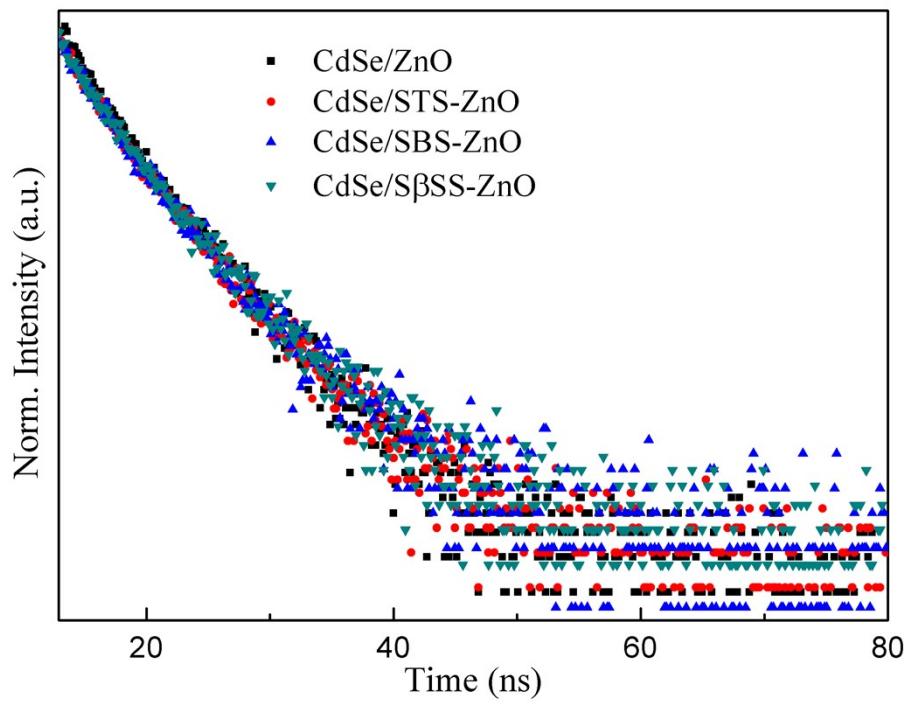


Fig. S6 TR-PL decay curves of CdSe QDs covered with the pristine, STS-, SBS-, and SβSS-modified ZnO NPs.

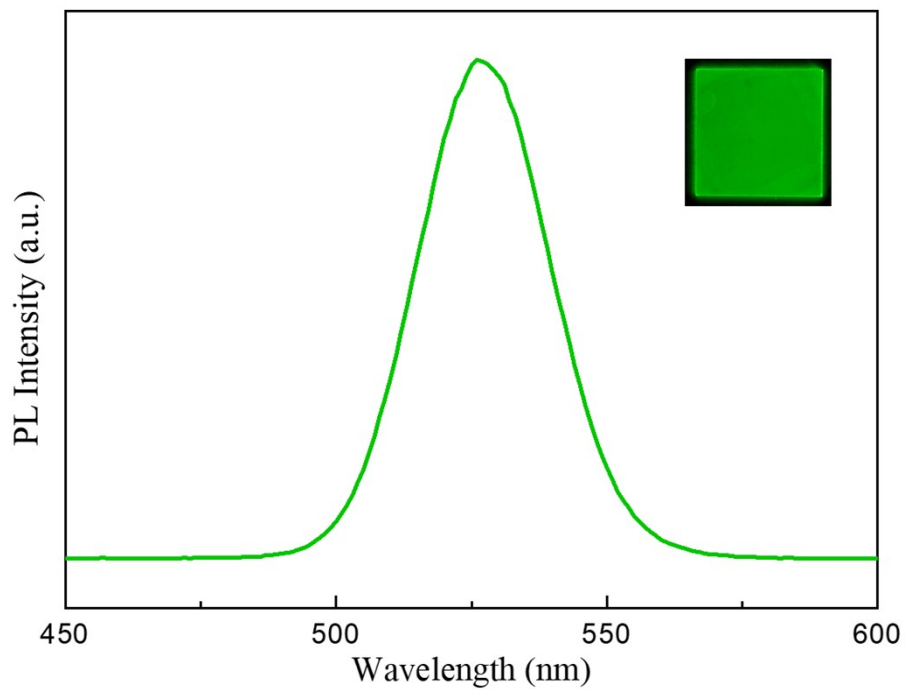


Fig. S7 PL spectrum of the CdSe QDs. The inset shows the snapshot of the CdSe QD film under UV light exposure.

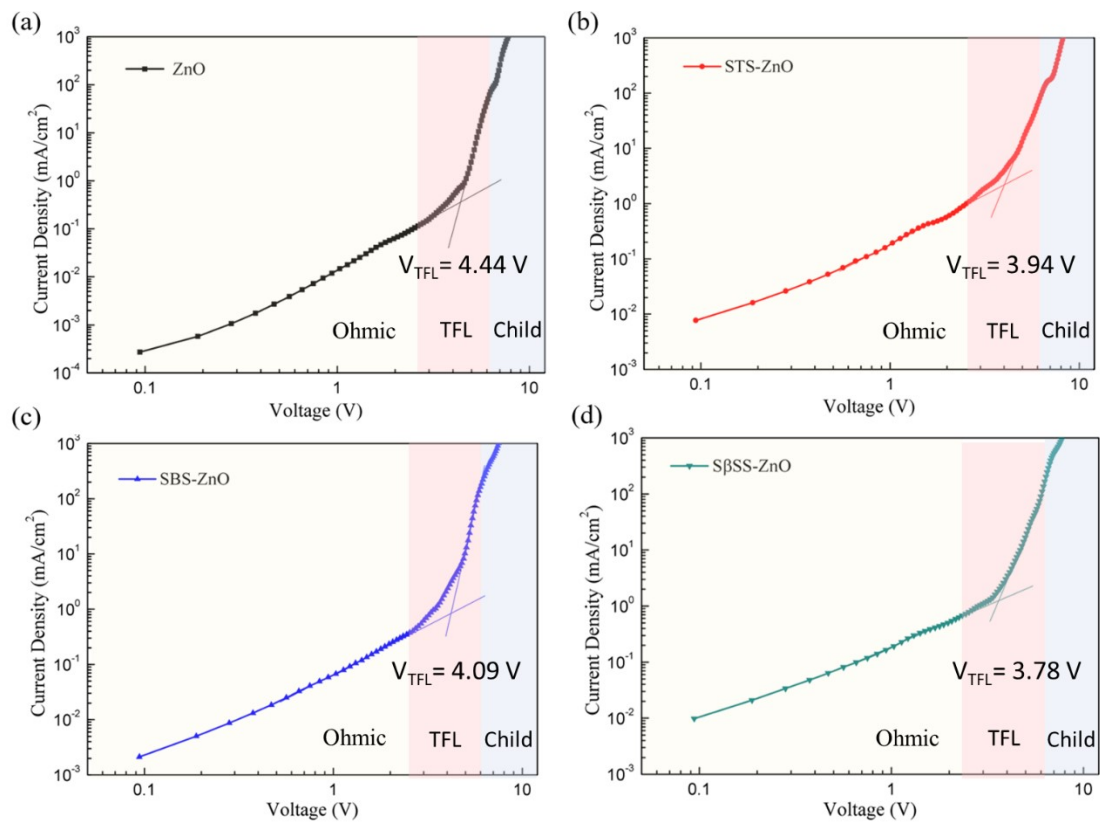


Fig. S8 J–V characteristics of devices with the (a) pristine, (b) STS-, (c) SBS-, and (d) SβSS-modified ZnO ETLs for estimating the defect densities in QLEDs.