Supporting Information

Ligand Exchange-Ready CuInS₂/ZnS Quantum Dots via Surface Ligand Composition Control for Film Type Display Devices

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Figure S1. Photograph of the samples QDs dispersed in ethanol. (a) DDT:DDA = 1:2 sample QDs dispersed in ethanol without ligand exchange, (b) DDT:DDA = 1:2 with ligand exchange. (c) Ligand exchanged DDT:DDA = 1:2 QDs attached to TiO_2 film under UV light. (d) DDT only QD after ligand exchange attempt dispersed in ethanol.



Figure S2 TEM image of the QDs. (a) $CulnS_2$ core, and (b) $CulnS_2/ZnS$ core – shell QD.



Figure S3. FT-IR spectroscopy of the QDs without the ligand exchange. (a) Overall spectrum, (b) N-H bending signal region for DDT only QD, and (c) DDT:DDA=1:2 QD.



Figure S4 XRD measurement result of the sample QDs. Top graph shows the result for DDT only QD, center graph shows the result for DDT/DDA combined ligand QD without ligand exchange, and the bottom graph shows the result after ligand exchange. Standard XRD peaks of Zinc Blende ZnS and tetragonal CuInS₂ crystals from ICSD are shown in top and bottom of the graph.



Figure S5. XPS survey scan of the DDT:DDA = 1:2 sample QD. Element peaks from the QD are marked written by blue text, and the peaks from the SiO2 substrate are written in black text.



Figure S6. XPS signal peak of the N 1s. (a) Normalized N 1s peaks for the DDT/DDA ligand QDs with synthesis ligand ratio of 1:1, 1:2, and 1:4. (b) Area of the corresponding peaks in (a)

$$\tau_{\text{avg}} = \frac{(\tau_1 \times B_1) + (\tau_2 \times B_2) + (\tau_3 \times B_3) + \cdots}{100}$$

Equation S1. Equation to calculate the average life time (τ_{avg}) from the TCSPC. τ_x indicate the lifetime of each component, and B_x indicate the portion of the each component in percent.



Figure S7. TCSPC result of the DDT/DDA QDs with and without ligand exchange, alongside with the DDT only QD.

	DDT/DDA W/O ligand exchange	DDT/DDA W/ ligand exchange	DDT only
τ ₁ (ns)	50.49	136.8	109.76
B ₁ (%)	8.5	16.2	8.58
τ ₂ (ns)	213.03	322.3	291.47
B ₂ (%)	64.14	70.19	70.85
τ_3 (ns)	524.78	828.68	711.15
B ₃ (%)	27.36	13.6	20.57
τ _{avg} (ns)	284.51	361.09	362.21

Table S1. Numerical value of the components in sample QDs derived by the TCSPC measurement. τ_1 , τ_2 , and τ_3 are lifetime for each component, and B1, B2, B3 are component ratio of each.