Multilayer Transfer Printing for Pixelated, Multi-Color Quantum Dot Light-Emitting Diodes

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Figure S1. Adhesion force of (a) fluoropolymer/ODTS-treated Si wafer interface at room temperature and (b) fluoropolymer/PDMS interface at high temperature (70°C).



Figure S2. Multilayer pickup & printing yield as function of QD film thickness (20 nm, 40 nm, 60 nm, 100 nm, 160 nm, and 200 nm). Five samples for each case were experimented in order to compute transfer printing yield.



Figure S3. AFM images of (a) multilayer before spin-casting a layer of fluoropolymer, (b) multilayer after spin-casting a layer of fluoropolymer, and (c) multilayer printed on a receiver substrate after removal of the fluoropolymer.



Figure S4. The current density-voltage, the luminance-voltage, and the external quantum efficiency ((a) & (b)) of blue QD LED with different ETL (ZnO or TiO₂).



Figure S5. Maximum EQE of QD LEDs with different ETLs.



Figure S6. Lifetime measurement on red C/S QD LED. Black solid circles indicate transfer printed device with ZnO ETL ($L_0 = 2037 \text{ cd/m}^2$), black open circles indicate spin coated device with ZnO ETL ($L_0 = 2056 \text{ cd/m}^2$), red solid circles indicate transfer printed device with TiO₂ ETL ($L_0 = 2044 \text{ cd/m}^2$), and red open circles indicate spin coated device with TiO₂ ETL ($L_0 = 2071 \text{ cd/m}^2$).



Figure S7. Ultraviolet photoelectron spectroscopy (UPS) spectrums and UV-Vis absorption spectrums for ZnO film ((a) ~ (c)) and TiO₂ layer ((d) ~ (f)).



Figure S8. The schematic illustration of multilayer transfer printing for 'ZnO/red QDs' and 'TiO₂/green QDs' pixel arrays integrated on the same substrate. (a) 'ZnO/red QDs' and 'TiO₂/green

QDs' were spin-coated on the ODTS-treated Si substrate and thermally annealed, respectively. (b) ETL/QDs pixel array was formed by removing the other part with the micro-patterned PDMS stamp. (c) Fluoropolymer thin film was spin-coated on the micro-patterned ETL/QDs pixel and thermally annealed. Then, these pixels embedded in fluoropolymer layer were picked-up with flat PDMS stamp. (d) 'TiO₂/green QDs' pixel arrays were printed the receiver substrate on (TFB/PEDOT:PSS/ITO/Glass) and the fluoropolymer thin film was eliminated by stripper solution. In addition, 'ZnO/red QDs' pixel arrays were printed on them same substrate. (e) Lastly, the fluoropolymer thin film was removed again.



Figure S9. IV characteristics of red/green QD LEDs in small pixel geometries formed using a micropatterned PDMS stamp.