



Supporting Information

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Highly Efficient and Stable White Light-Emitting Diodes Using Perovskite Quantum Dot Paper

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Dot Paper

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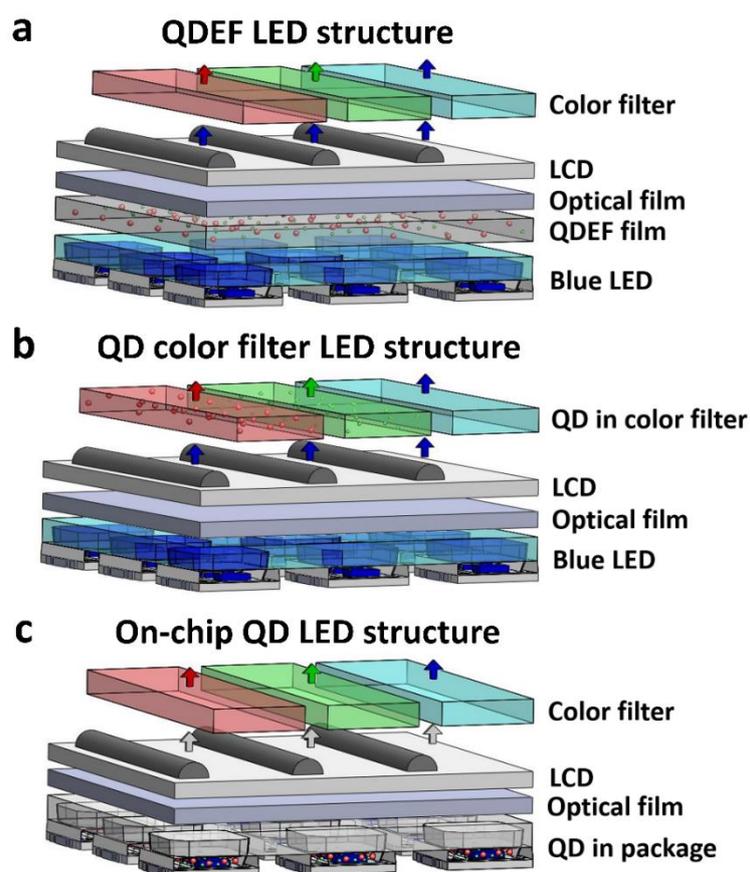


Figure S1. Structural schematic of different converter-type QD LEDs, including a) QDEF, b)

QD color filter, and c) on-chip QD LED structures.

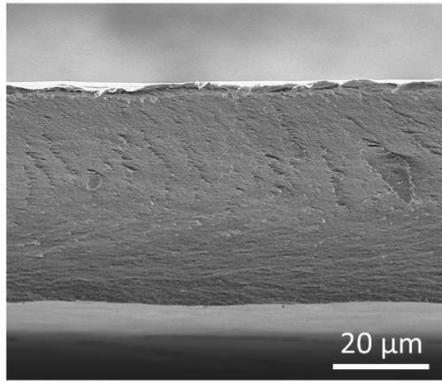


Figure S2. Cross-sectional SEM image, showing the thickness of the PQD paper is 45 μm .

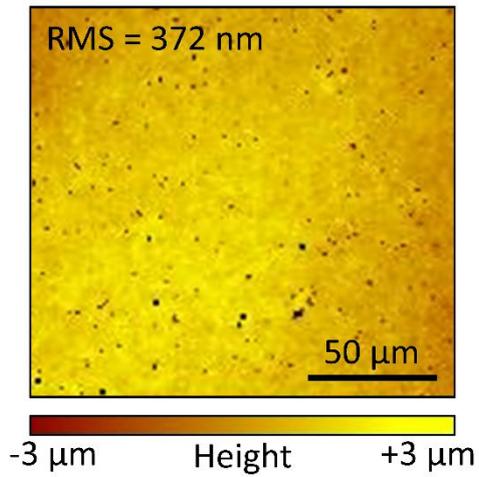


Figure S3. Surface morphology of PQD paper. The root-mean-square surface roughness (RMS) of PQD paper is 372 nm.

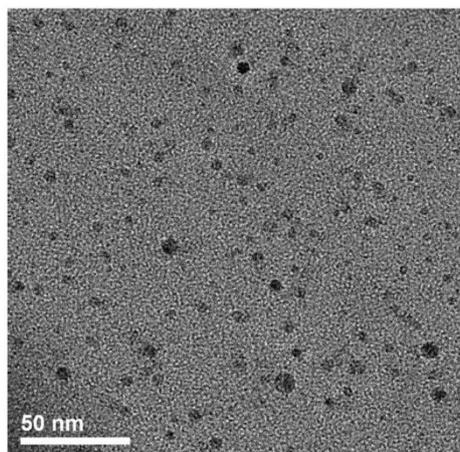


Figure S4. TEM image of the $\text{CH}_3\text{NH}_3\text{PbBr}_3$ QDs obtained from the PQD paper.



Figure S5. Optical photos of PQD papers under different bending curvatures.

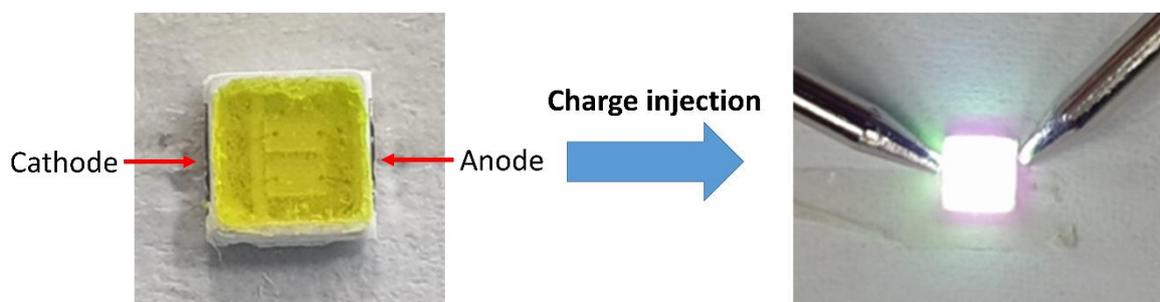


Figure S6. The PQD paper-based white LED can be immediately lit up by charge injection.

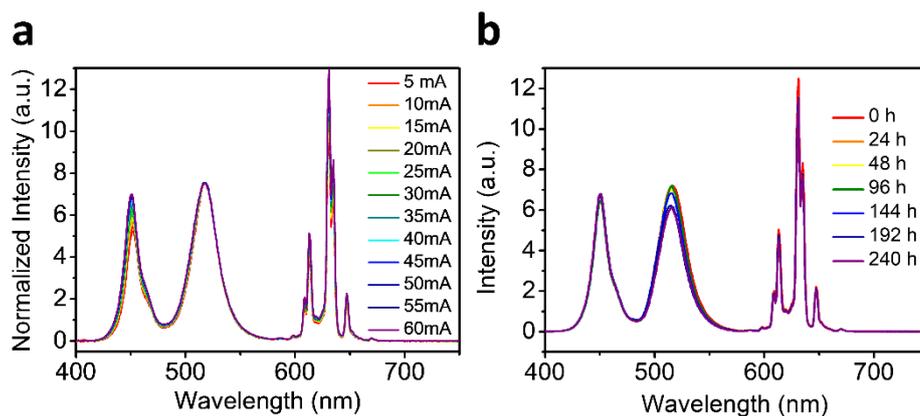


Figure S7. a) Normalized EL spectra of the PQD paper-based LED at different drive currents. b) EL spectra of the PQD paper-based LED under different operation durations.

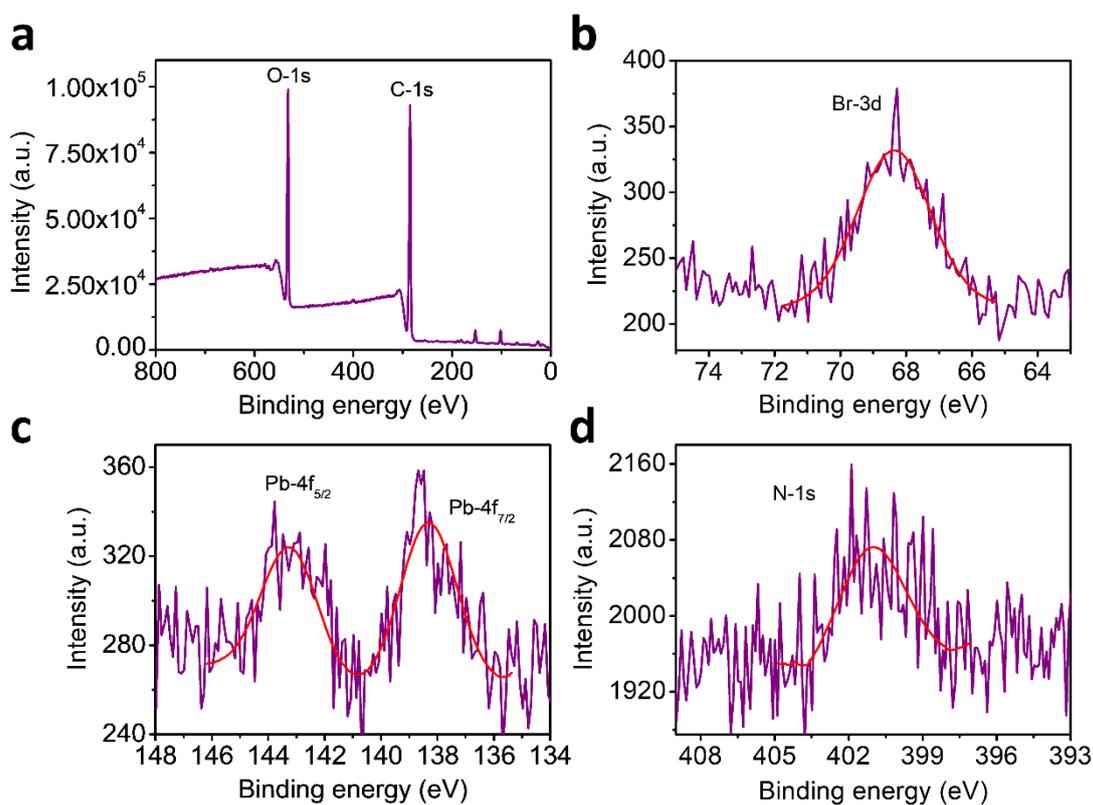


Figure S8. XPS spectra of PQD paper. a) Full XPS spectrum. b-c) High resolution Br-3d, Pb-4f, and N-1s XPS spectra.

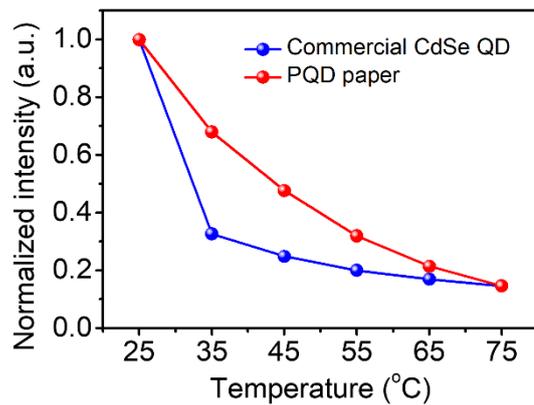


Figure S9. The normalized radiant intensity of the PQD paper-based and CdSe QD-based LEDs as a function of temperature, demonstrating the better thermal resistance of the PQD paper.

Table S1. Quantum yield of the PQD paper obtained by the PL spectrometer.

Absorption	91.1%
Transmission	8.9%
Absorbance	1.05
Quantum Yield	63.9%
Color	x = 0.1379, y = 0.7429

Table S2. The luminous efficiency and color gamut of QD-based white LEDs.

Ref	Year	Material	Quantum dot type in package	Efficiency (lm/W)	NTSC (%)
[18]	2016	519 nm green mesoporous PQD, 625 nm red PQD	Mixed in silicone resin	30	113
[23]	2016	523 nm mesoporous CsPbBr ₃ /SDDA in PMMA, 630 nm KSF	Powders type	37	102
[9]	2016	522 nm & 624 nm perovskite, QD/silica composites	Powders type	61	120
[24]	2015	515 nm colloidal CH ₃ NH ₃ PbBr ₃ QDs, 630 nm KSF	PQD in PMMA, KSF in silicone,	48	130
[25]	2016	525 nm MAPbX ₃ /PVDF composite films, 630 nm KSF	PQD in PVDF, KSF in silicone,	109	121
[26]	2016	495 nm CsPb(Br _{0.75} Cl _{0.25}) ₃ , 515 nm CsPbBr ₃ , 540 nm CsPb(Br _{0.65} I _{0.35}) ₃ , 578 nm CsPb(Br _{0.5} I _{0.5}) ₃ , 635 nm CsPb(Br _{0.35} I _{0.65}) ₃	Film type	62	145
[39]	2018	625 nm red CdSe/CdS/ZnS QD, 555 nm green CdSe/ZnS/CdSZnS QD	Liquid type	64	104
[19]	2019	519 nm Green PQD, 625 nm Red PQD	Liquid + solid type (hybrid)	51	122

Table S3. The operation lifetime and radiation performance of QD-based white LEDs.

Ref	Year	Material	Quantum dot type in package	Operation time (h)	Radiation remained
[18]	2016	519 nm green mesoporous PQD, 625 nm red PQD	Mixed in silicone resin	96	80%
[10]	2018	407 nm Cs ₃ Bi ₂ Br ₉ QDs/silica composites, 551 nm Y ₃ Al ₅ O ₁₂ phosphor	Powders type	16	78%
[9]	2016	522 nm & 624 nm perovskite QD/silica composites	Powders type	10	90%
[42]	2017	525 nm TDPA coated CsPbBr ₃ QD, 630 nm KSF	Mixed in silicone resin	16	93%
[43]	2018	630 nm CsPbBr _{1.2} I _{1.8} QD, 540 nm Y ₃ Al ₅ O ₁₂ :Ce ³⁺ phosphor	Liquid type	100	95%
[19]	2019	519 nm Green PQD, 625 nm Red PQD	Liquid + solid type (hybrid)	200	88%