Electronic Supplementary Information for:

Highly Efficient Wide-color-gamut QD-emissive LCD using Green and Red Perovskite Core/Shell QDs

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Table S1. Summary of the optical properties of colloidal GR core and core/shell PeQDs.

Sample		CIE x	CIE y	Peak Wavelength	FWHM	QY
Green	Core	0.081	0.767	515	19	0.726
	Core/shell	0.061	0.719	509	20	0.789
Red	Core	0.687	0.303	639	40	0.752
	Core/shell	0.672	0.321	628	44	0.774

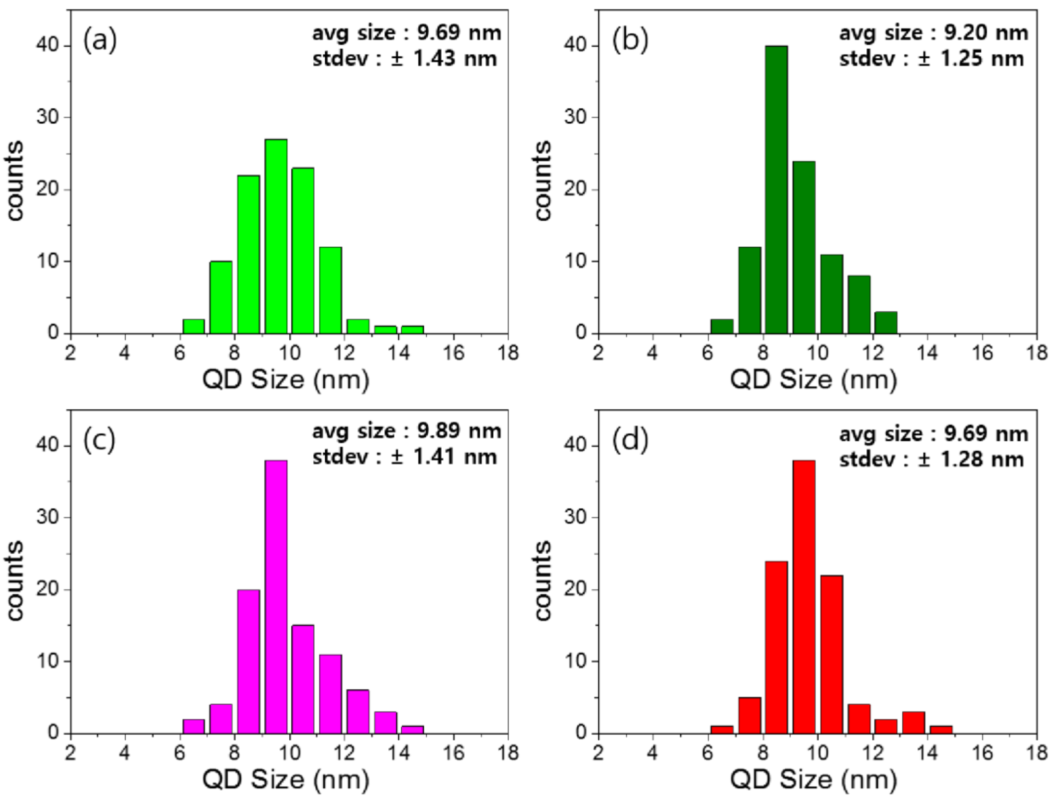


Figure S1. Size distribution diagrams of (a) core, (b) core/shell G PeQDs, and (c) core, (d) core/shell R PeQDs.

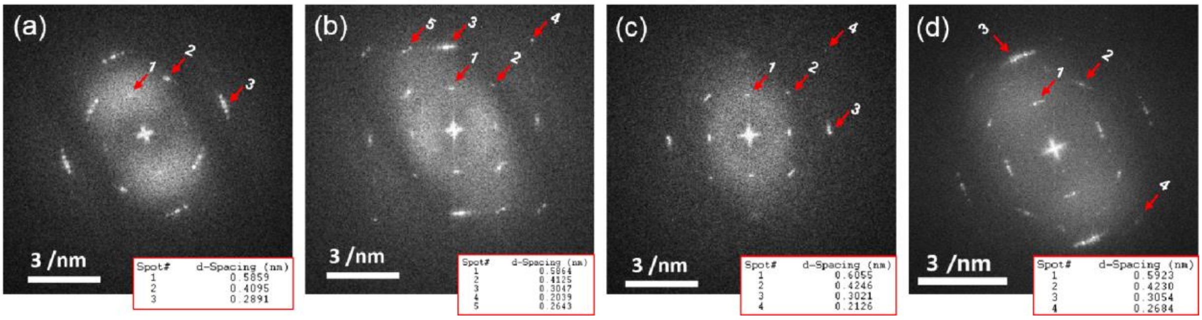
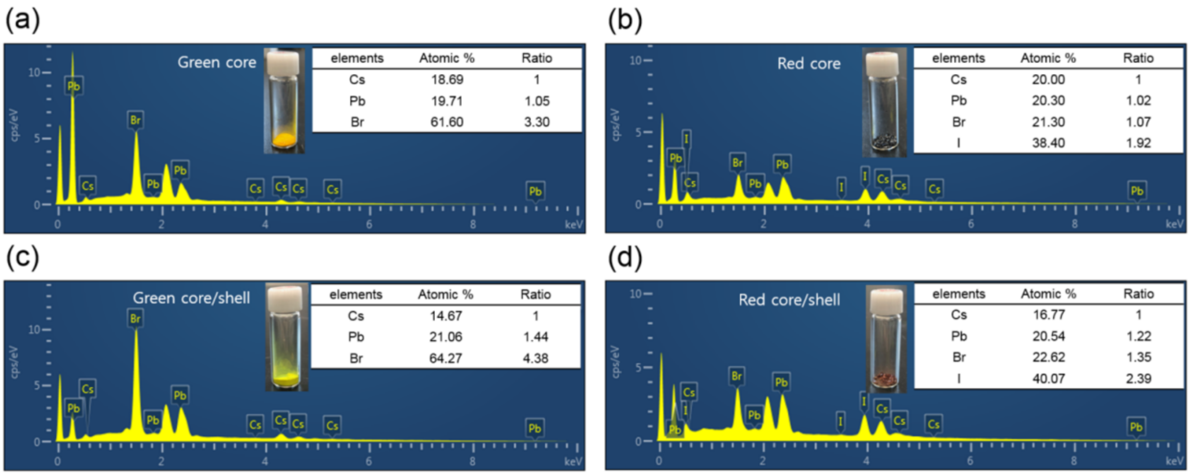


Figure S2. FFT images of (a) core, (b) core/shell G PeQDs, and (c) core, (d) core/shell R PeQDs. The white bars indicate the 3 /nm scale used. Insets show the d-spacing values corresponding to each spot number.



(e)

wt%	Cs	Pb	Cs:Pb molar ratio
Green core	22.83%	35.10%	1 : 0.99
Green core/shell	16.58%	31.84%	1 : 1.23
Red core	19.90%	30.64%	1 : 1.02
Red core/shell	20.52%	38.62%	1 : 1.21

Figure S3. EDX surveys of (a) green core, (b) red core, (c) green core/shell, and (d) red core/shell PeQDs. Insets indicate actual pictures of the PeQD powders, atomic percentages and ratios of Cs, Pb, Br, and I in each sample. (e) ICP-MS results of the PeQD powders with Cs and Pb constituents as wt% and molar ratio.

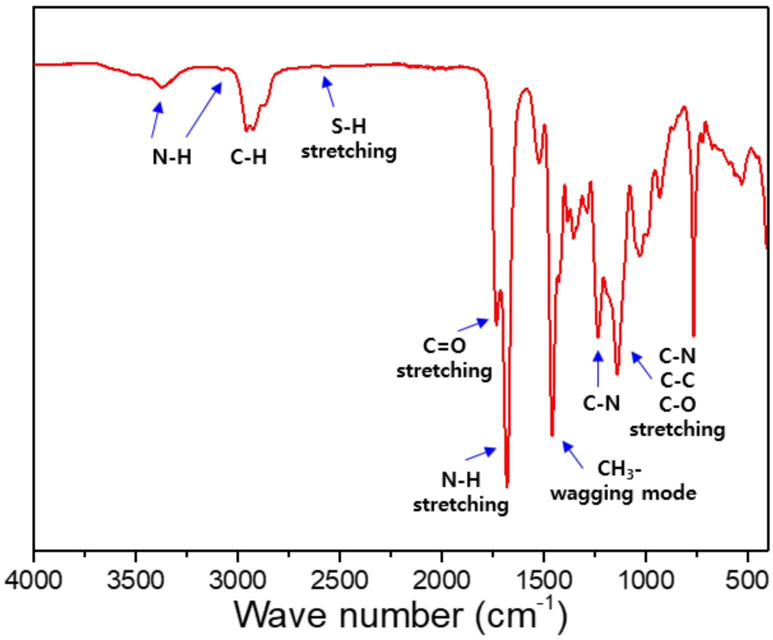


Figure S4. The FT-IR survey of a bare NOA 63 film.

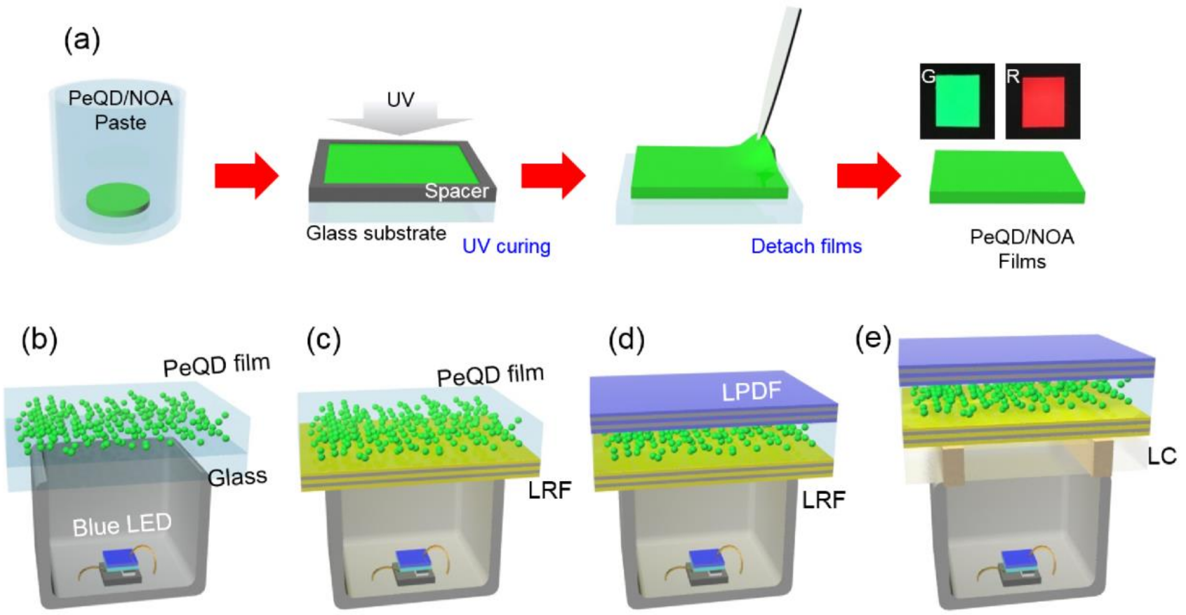


Figure S5. (a) The overall fabrication process of the RG PeQD-NOA films. Schematic images of the (b) PeQD film, (c) LRF-recycled QD film, (d) LRF/LPDF sandwiched QD film, and (e) LRF/LPDF and liquid crystal (LC) sandwiched QD film with a B LED.

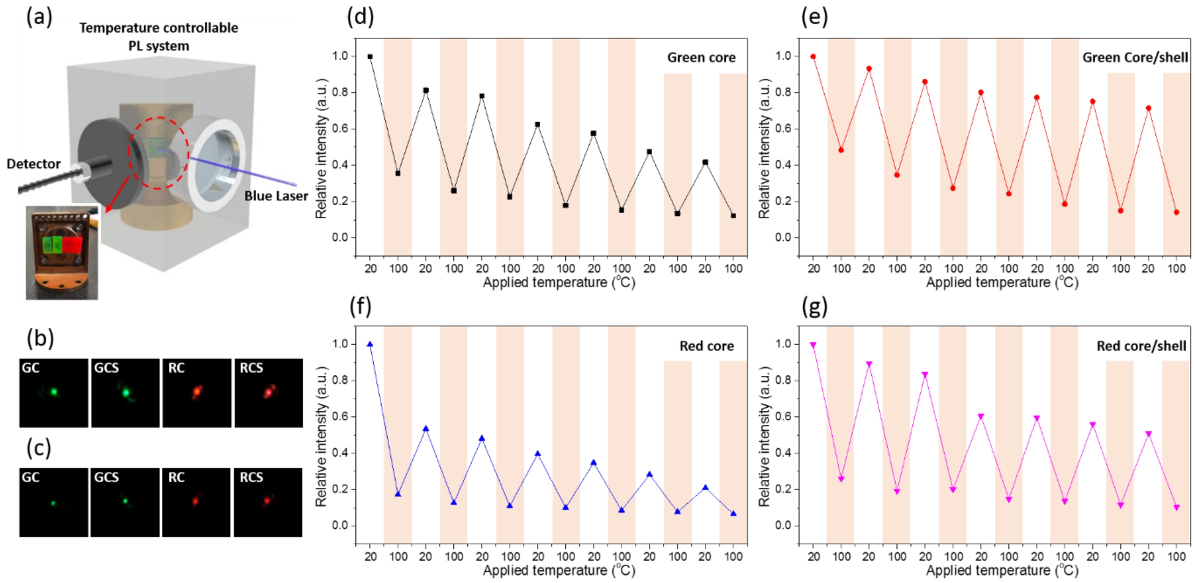


Figure S6. (a) Schematic illustration of the temperature-controllable PL system which uses a blue laser (50 mW cm^{-2}), and an optical detector. The blue laser is incident on the samples only during the measurement. Actual pictures of emissive green and red cores and core/shell PeQD films at (c) 20 °C and (d) 100 °C during the first step. The thermal recovery results of the green (d) core and (e) core/shell PeQD films, and the red (f) core and (g) core/shell PeQD films.

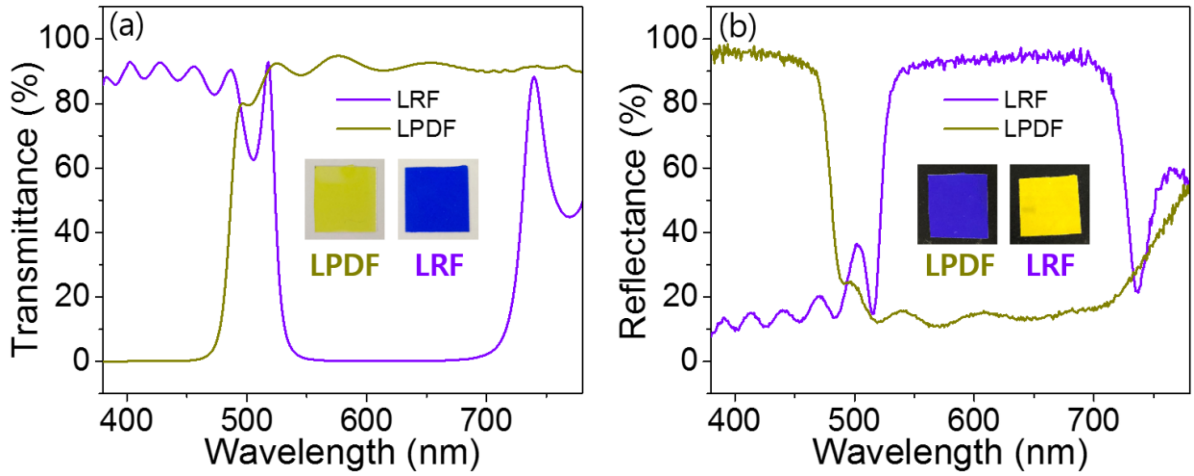


Figure S7. (a) Transmittance and (b) reflectance spectra of LRF and LPDF as used in the sandwiched PeQD films. Insets are actual color images of the transmittance in (a) and reflectance in (b) of LPDF and LRF.

In Figure S7, LRF and LPDF have strong reflectance for the incident visible ambient light. As previously reported,[1] it is very important for a high static contrast ratio (CR) in PeQD-LCDs to be realized in bright ambient light conditions. Thus, it is also a requirement to study and adopt an improvement in the ambient CR (ACR) through the use of many previously developed technologies to improve the ACR, such as a black matrix, black tinted glass, RGB pigments, anti-reflection coatings, and black polarizers.[2-7]

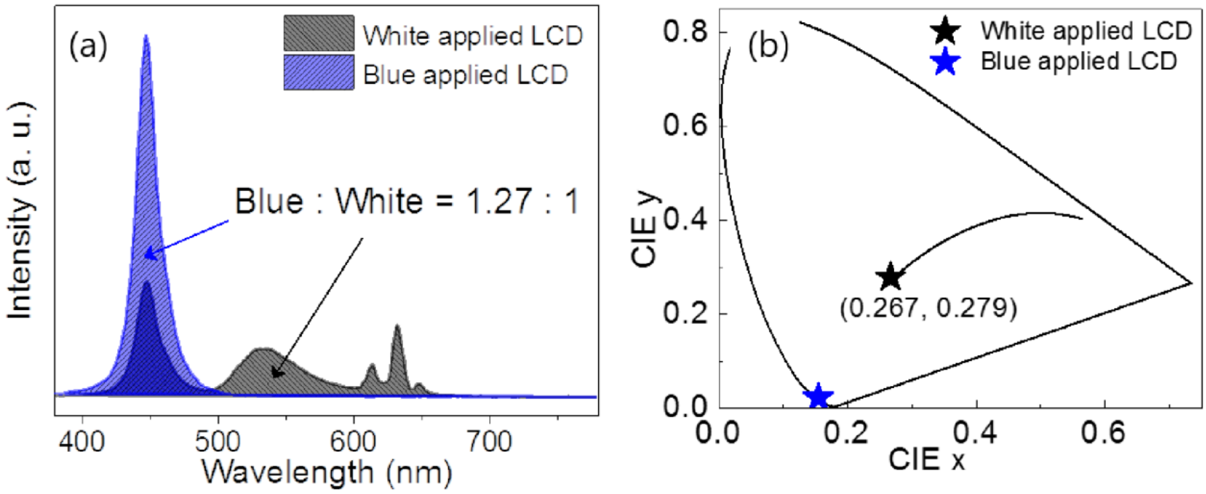


Figure S8. (a) EL spectra and (b) CIE color coordinates of two backlight systems: (a color-by-blue LCD and a conventional CF-LCD)

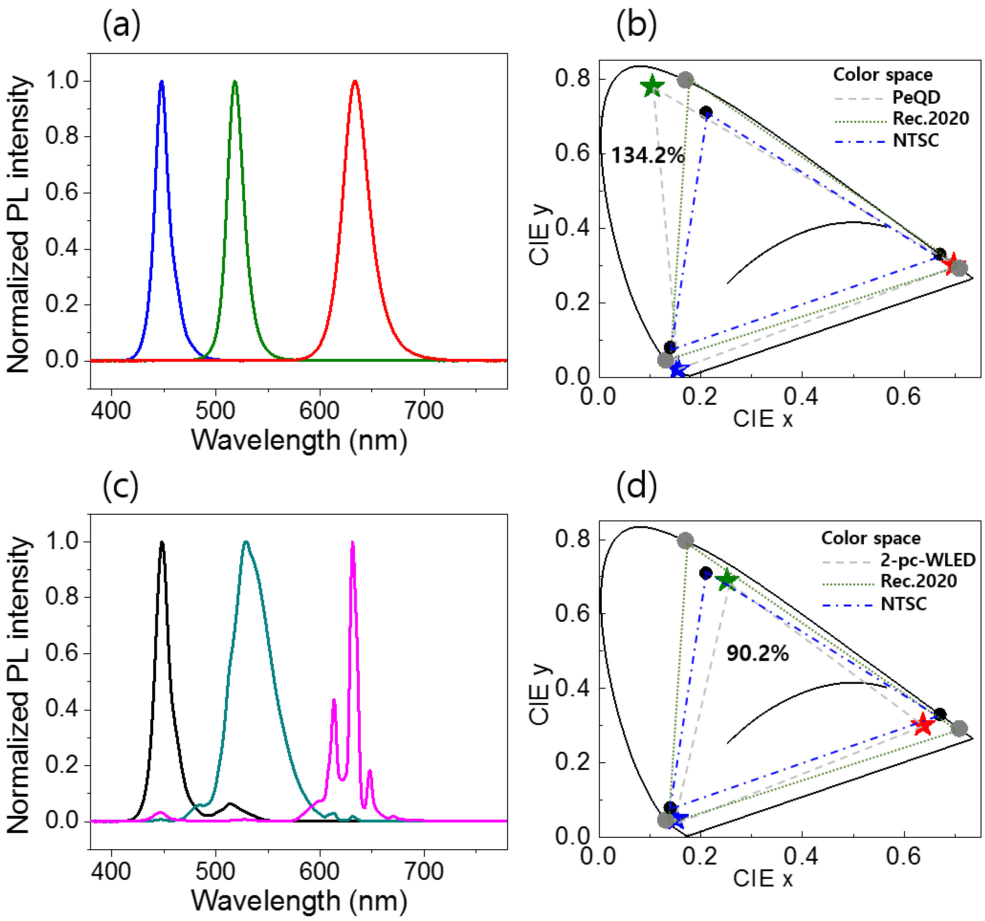


Figure S9. (a) Normalized emission intensity and (b) CIE color coordinates of LRF/LPDF-sandwiched PeQD film and a blue LED transmitted through a liquid crystal shutter: (c) Normalized emission intensity, and (d) CIE color coordinate of the CF-assisted 2-pc-WLED through a liquid crystal shutter.

We synthesized and utilized red-emissive K_2SiF_6:Mn (KSF) phosphors for 2-pc-WLED. As many research groups have previously demonstrated, the spectrum of KSF phosphor consists of five narrow peaks located at 609 nm, 613 nm, 630 nm, 635, and 648 nm. There are attributed to the $^2E_2$-$^4A_1$ transition in Mn^{4+} ion-activated phosphors.[8,9] So, with these characteristics, red-emissive KSF phosphor has currently been the subject of research for application for excellent color-quality lighting and display lighting sources.

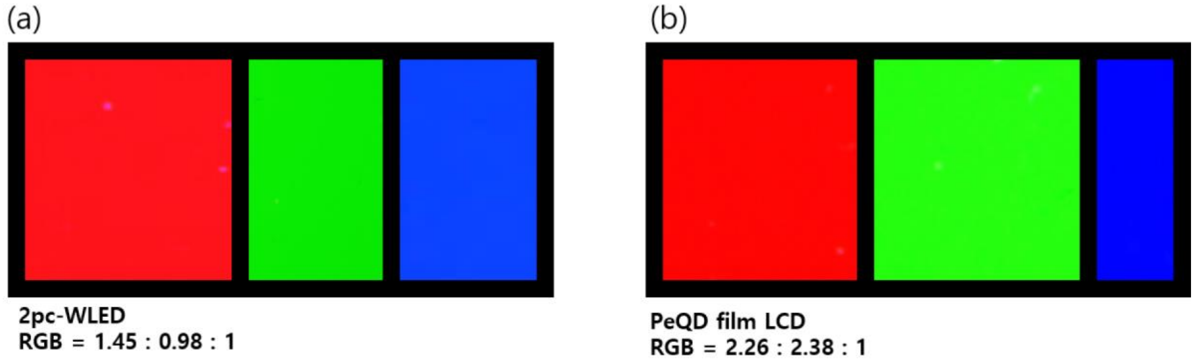


Figure S10. Relative transmitted light efficiency: (a) CF-assisted LCD and (b) color-by-blue PeQD LCD.

References

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