Supplementary Information

Precursor Engineering towards Orange and Red-Emissive Carbon Dots for LEDs with Tunable Emission Colors

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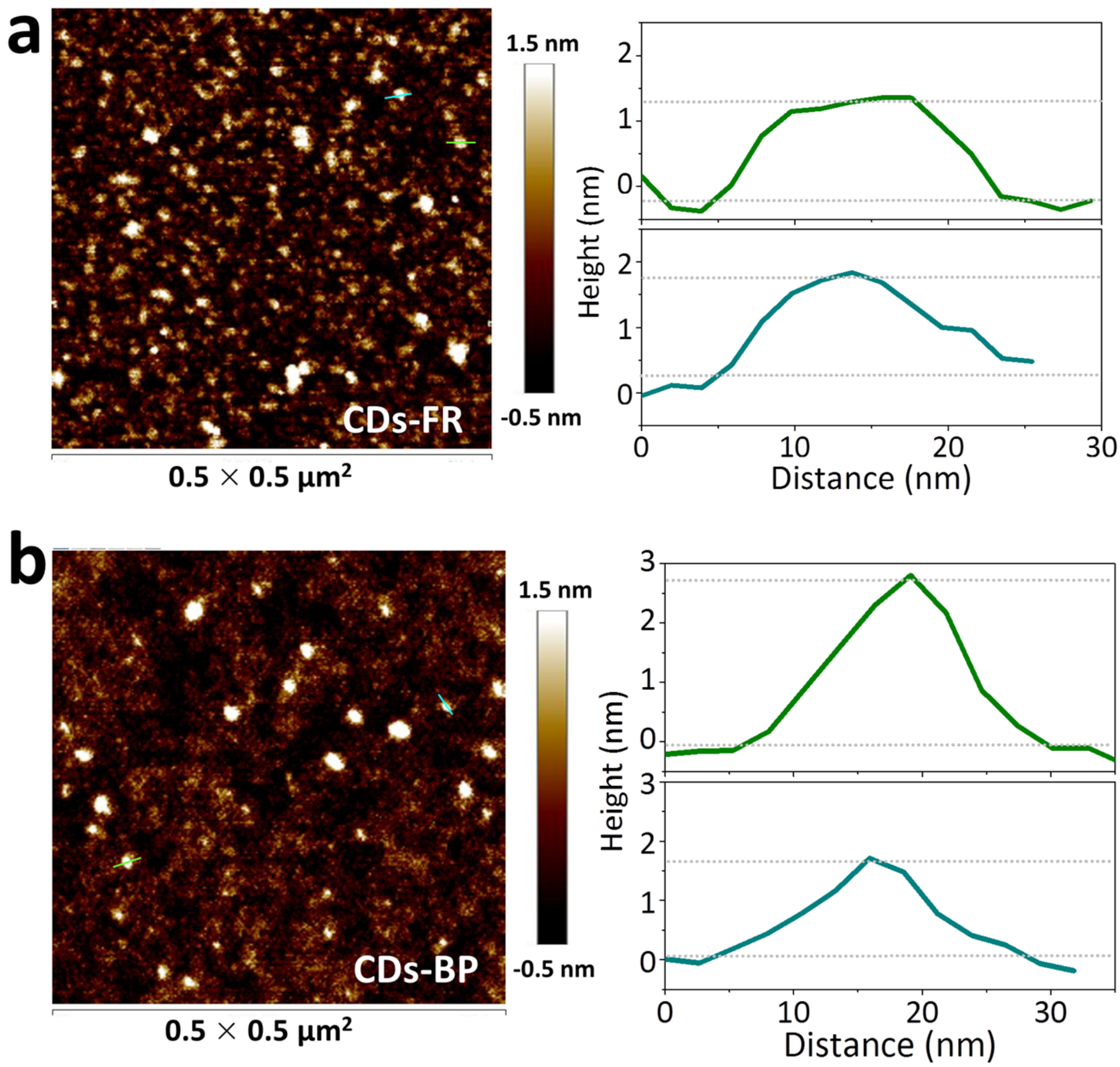
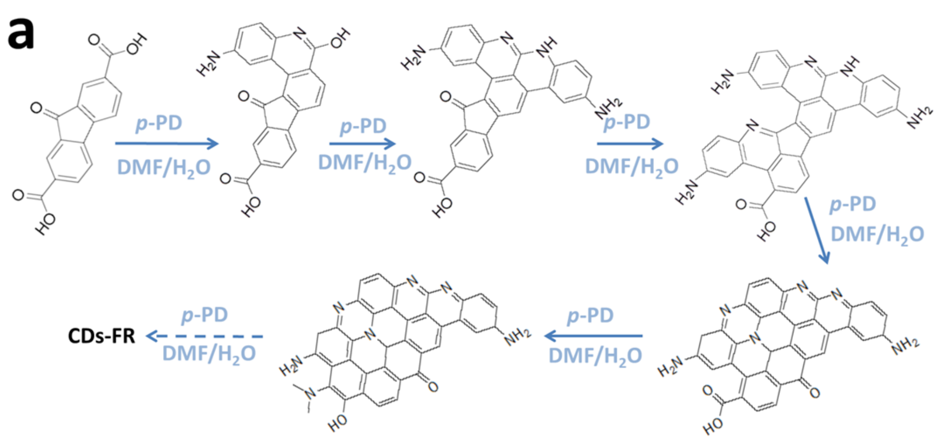


Figure S1. AFM images of (a) CDs-FR and (b) CDs-BP, and corresponding height profiles.



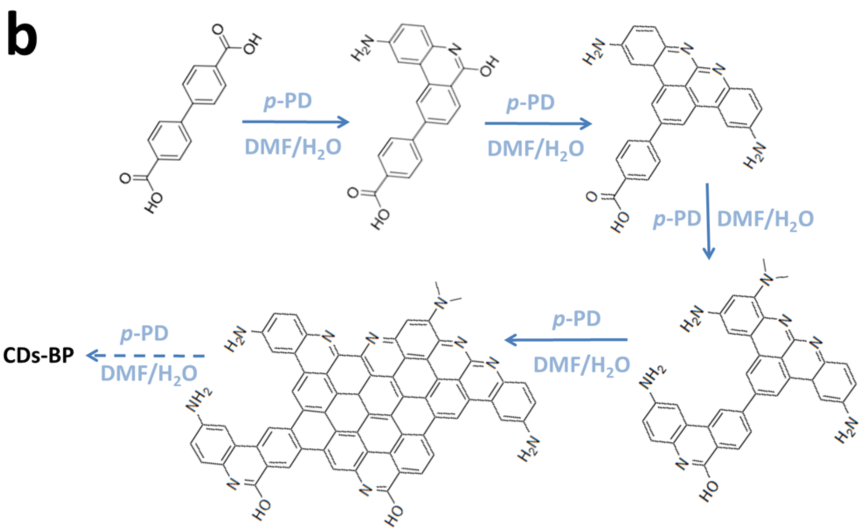


Figure S2. Formation mechanisms of (a) CDs-FR and (b) CDs-BP.

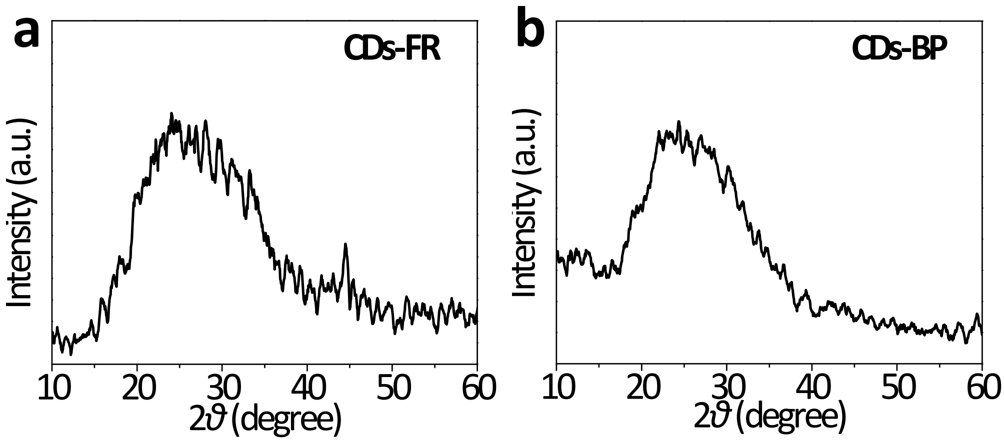


Figure S3. XRD patterns of (a) CDs-FR and (b) CDs-BP.

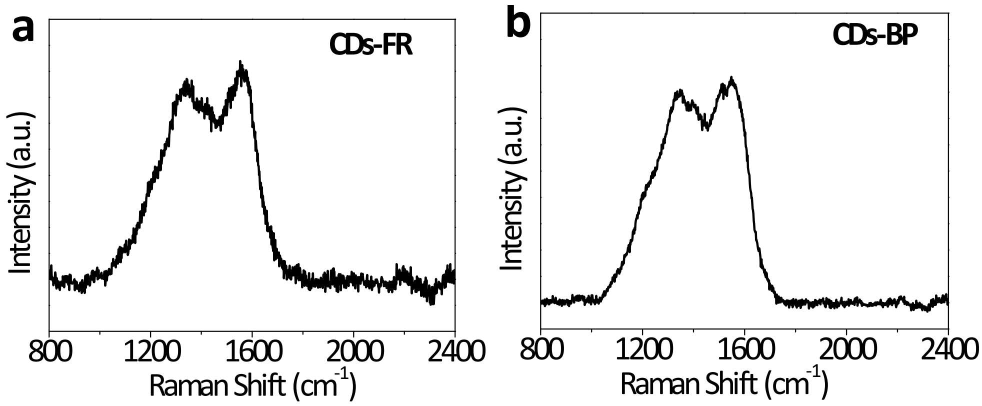


Figure S4. Raman spectra of (a) CDs-FR and (b) CDs-BP.

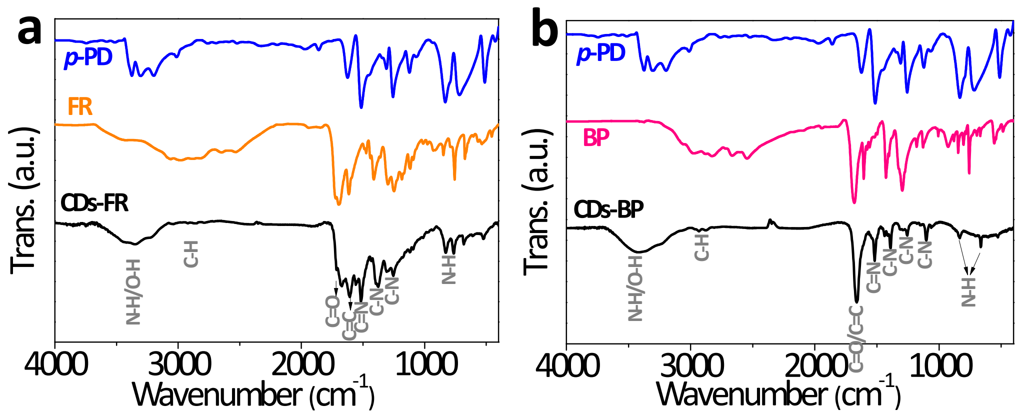


Figure S5. FT-IR spectra of CDs-FR, CDs-BP and precursors (FR, BP and *p*-PD).

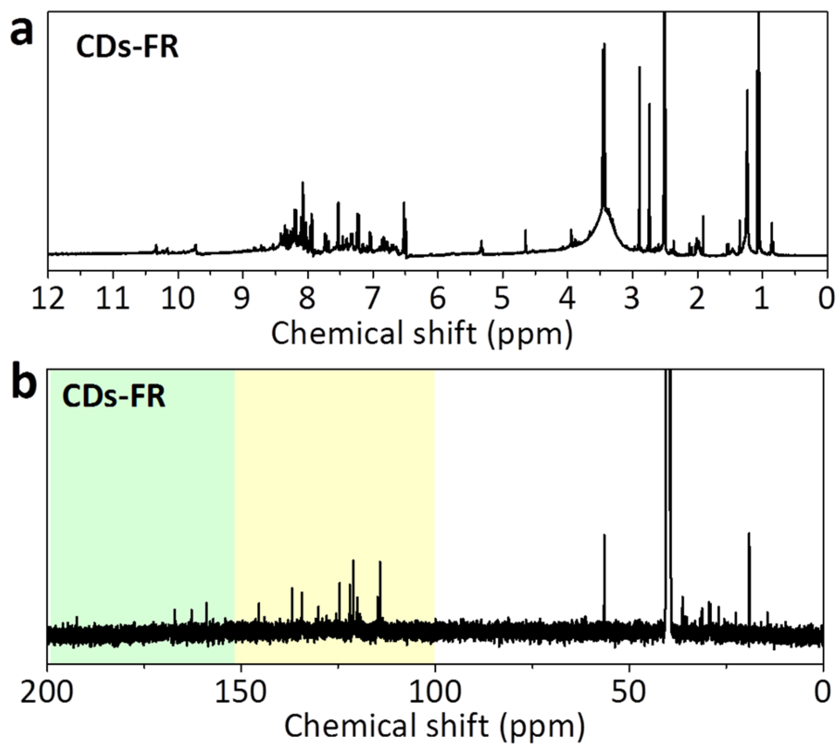


Figure S6. (a)^{1}H and (b)^{13}C NMR spectra (400/100 MHz with DMSO-d_6) of CDs-FR.

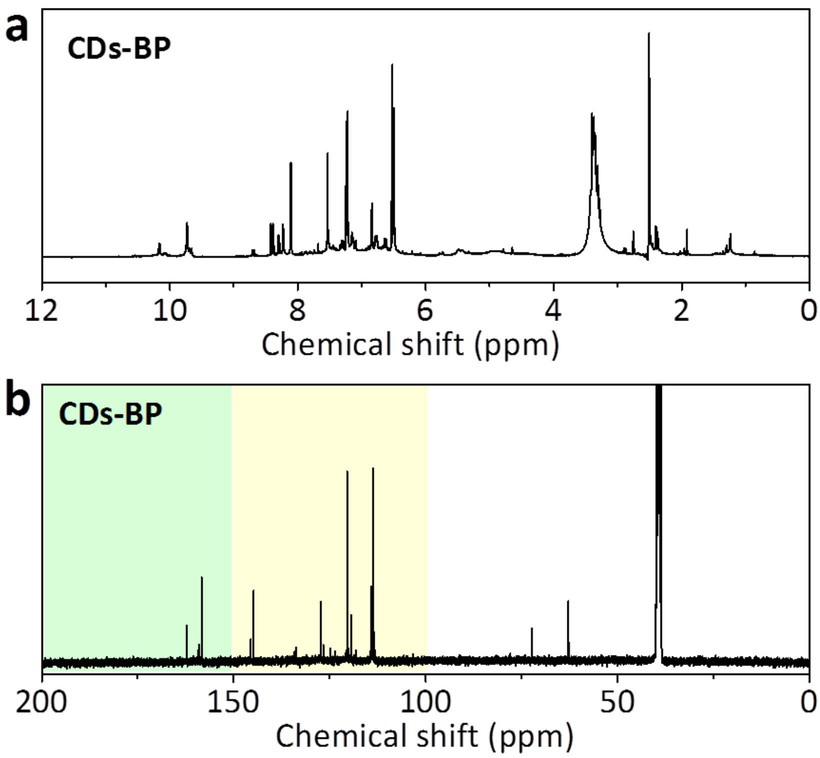


Figure S7. (a)^{1}H and (b)^{13}C NMR spectra (400/100 MHz with DMSO-d_6) of CDs-BP.

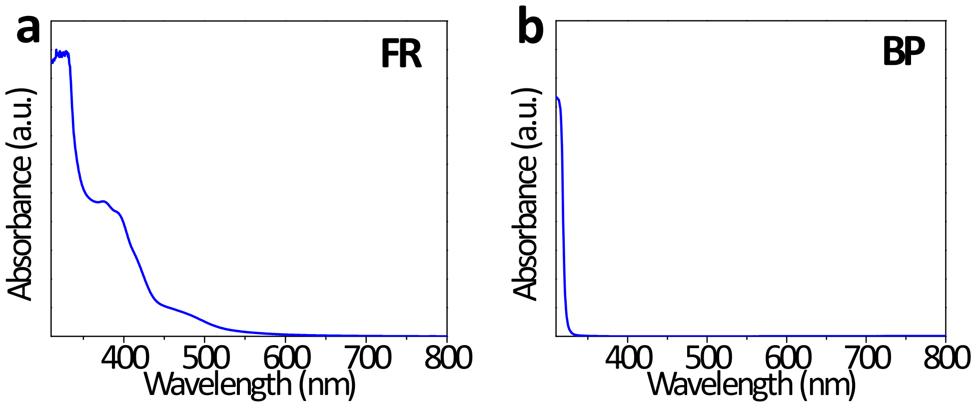


Figure S8. UV-Vis absorption spectra of precursors (a) FR and (b) BP (each 0.2 mg mL^{-1} in acetone).

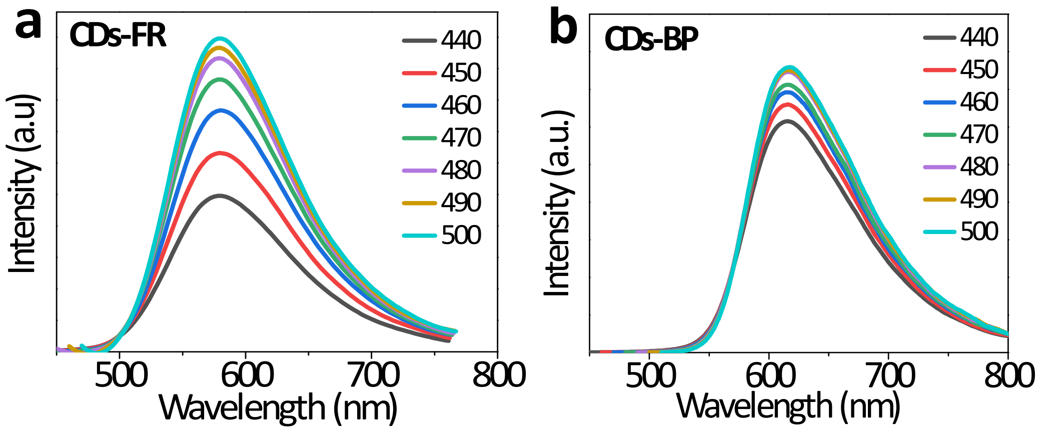


Figure S9. PL emission spectra of (a) CDs-FR and (b) CDs-BP in acetone solution with various excitation wavelengths.

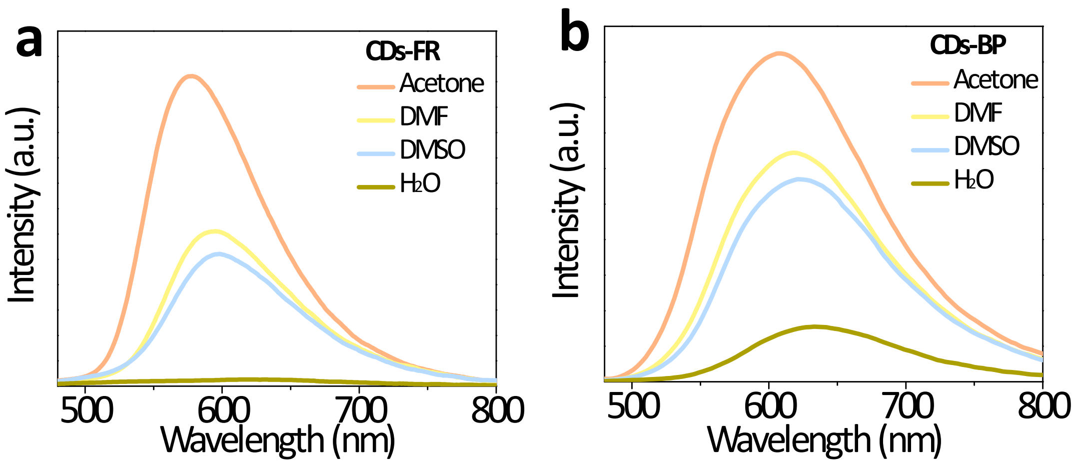


Figure S10. PL emission spectra of (a) CDs-FR and (b) CDs-BP in various solvents (i.e., acetone, DMF, DMSO and H_2O with increasing polarity; λ_{ex}=470 nm).

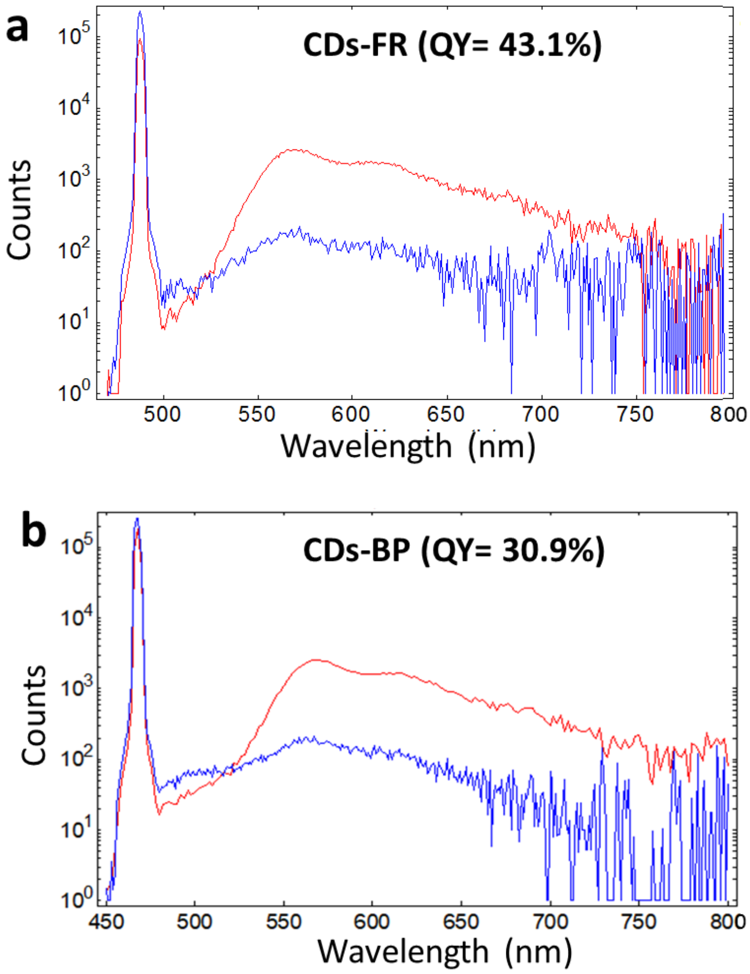


Figure S11. PL quantum yields of (a) CDs-FR and (b) CDs-BP with the same concentrations in acetone solution.

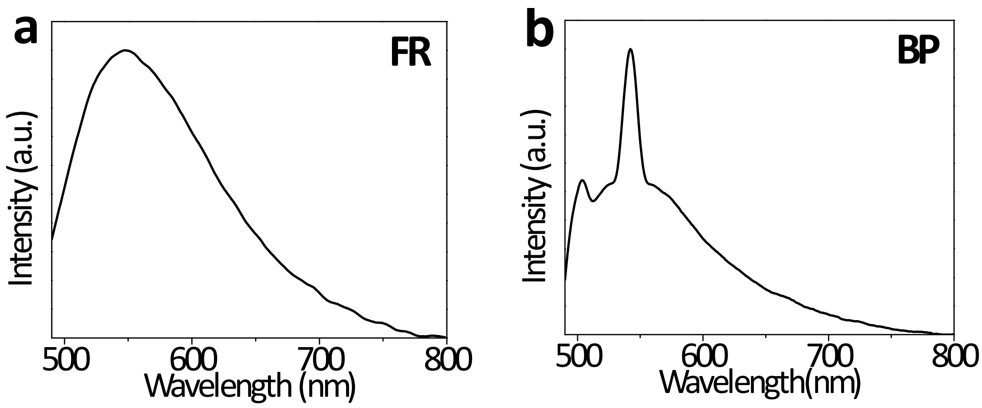


Figure S12. PL spectra of precursors (a) FR and (b) BP (each 0.2 mg mL^{-1} in acetone).

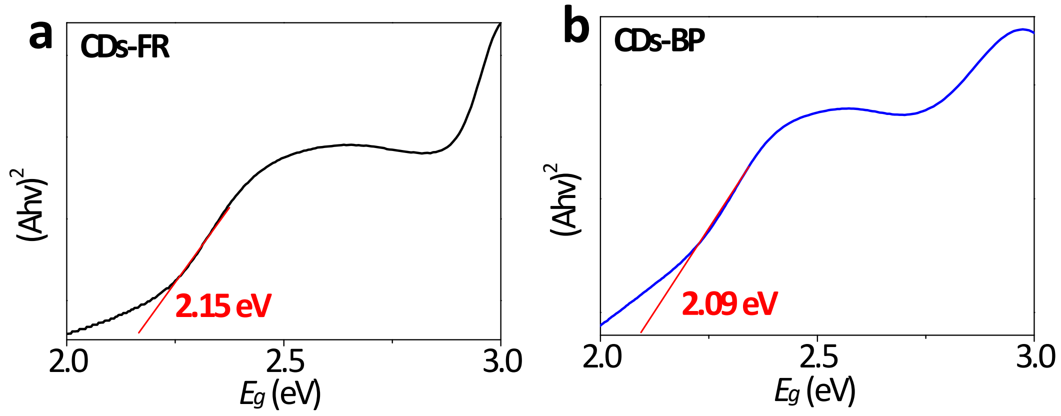


Figure S13. Tauc plots of (a) CDs-FR and (b) CDs-BP.

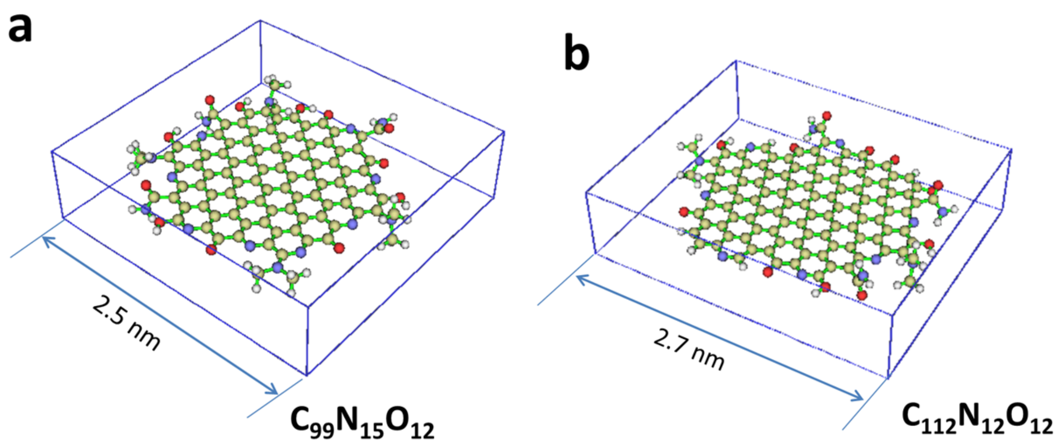


Figure S14. Size measurements of (a) $C_{99}N_{15}O_{12}$ and (b) $C_{112}N_{12}O_{12}$ models.

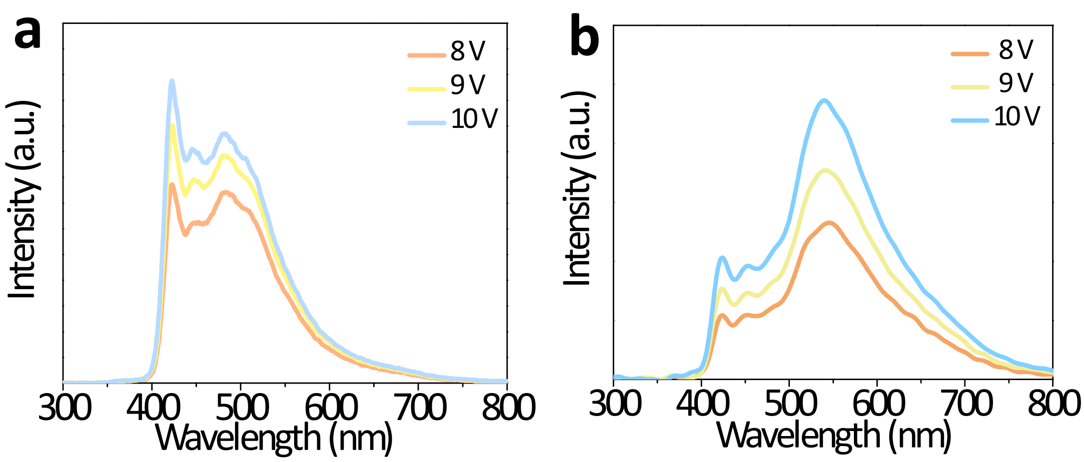


Figure S15. EL emission spectra of the LED devices with (a) CDs-FR and (b) CDs-BP at various voltages.

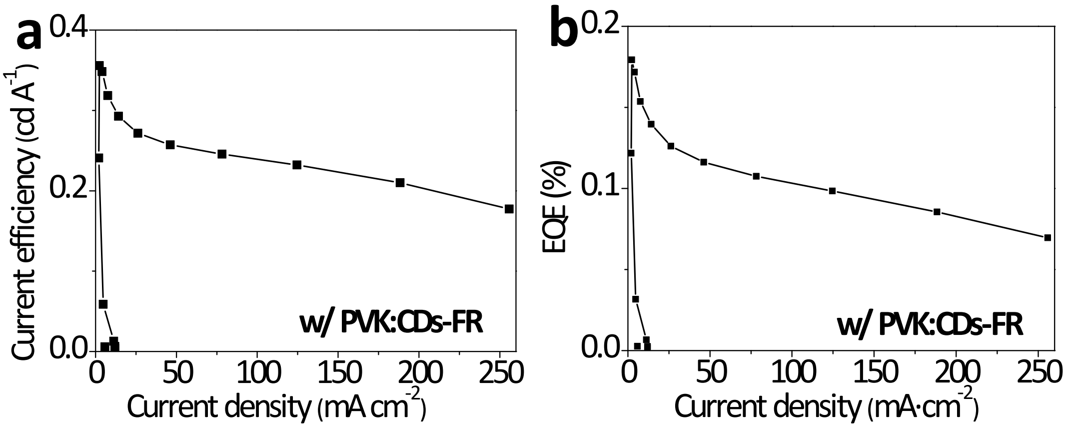


Figure S16. (a) Current efficiency and (b) EQE profiles measured for the LED device based on PVK:CDs-FR film.

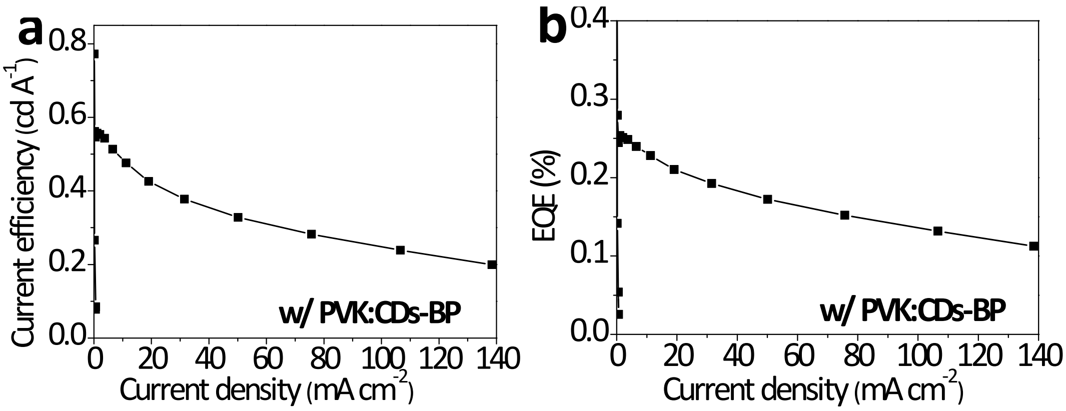


Figure S17. (a) Current efficiency and (b) EQE profiles measured for the LED device based on PVK:CDs-BP film.

Table S1. Bi-exponential fitting results[b] for transient PL of CQDs-FR and CQDs-BP in acetone solution.

CDs[a]	τ_1 (ns)	A_1 (%)	τ_2 (ns)	A_2 (%)	τ_{avg} (ns)
CDs-FR	3.91	57.25	7.70	42.75	6.17
CDs-BP	2.03	88.65	3.35	11.35	2.32

[a]τ_{avg} is calculated using the equation $\tau_{avg} = \frac{\sum A_i \tau_i^2}{\sum A_i \tau_i}$

Table S2. Summary of the electroluminescence (EL) performances of recently reported CDs-LEDs with cyan/yellow or near cyan/yellow light.

LEDs	V_{on}(V)	L_{max}(cd/m^2)	η_{max}(cd/A)	color	CIE	PLQY(%)	Ref.
CDs-LED	9.9	220	/	yellow-green	0.30,0.65	16.7	[1]
CDOFs	3.3	1818	4.4	yellow	0.64,0.30	42.3	[2]
Y-LEDs	2.6	~10^3	15.78	yellow	0.44,0.53	12.16	[3]
G-LED	5.6	227	0.47	green	0.33,0.56	54.6	[4]
C-LED	~6.0	~800	4.18	cyan	0.18,0.21	13.14	[5]
G-LED	3.7	2023	5.51	green	0.27,0.43	11.73	
RT-CDs-LEDs	3.3	2967	1.38	yellow	0.57,0.42	80.56	[6]
PVK:CDs	/	681	0.54	green	0.35,0.53	16.2	[7]
G-LEDs	3.7	4762	5.11	green	/	72	[8]
Y-LEDs	3.5	2784	2.31	yellow	/	62	
CD-LEDs	5	61	0.018	cyan	0.21,0.16	40	[9]
O-LED	3.1	9450	1.57	orange	0.36,0.52	25	[10]
G-LED	3.6	4236	2.34	green	0.57,0.42	20	
WLED	/	/	/	white	0.33,0.35	97.2	[11]
B	4.7	136	0.084	blue	0.19,0.20	75	[12]
G	4.5	93	0.045	green	0.31,0.47	73	
Y	4.2	60	0.02	yellow	0.37,0.52	58	
O	3.9	65	0.027	orange	0.46,0.48	53	
R	3.7	12	0.0028	red	0.55,0.41	12	
CD-LEDs.	~4.0	579	/	red	0.692,0.307	52.35	[13]

PVK:CDs-FR	4.0	454	0.35	cyan	0.25,0.29	43.1	This work
PVK:CDs-BP	4.5	276	0.56	yellow	0.44,0.51	30.9	

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