Electronic Supporting Information

Full color carbon dots through surface engineering for constructing white light-emitting diodes

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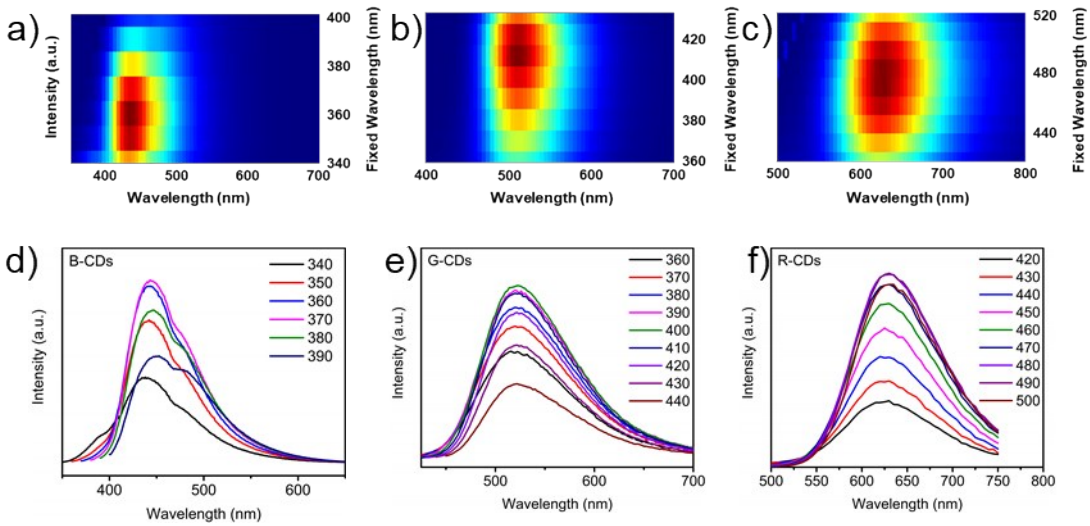

Figure S1. (a-c) Excitation–emission matrix graphs and (d-f) maps for B-CDs, G-CDs and R-CDs to show the excitation-independence of R/G/B-CDs.

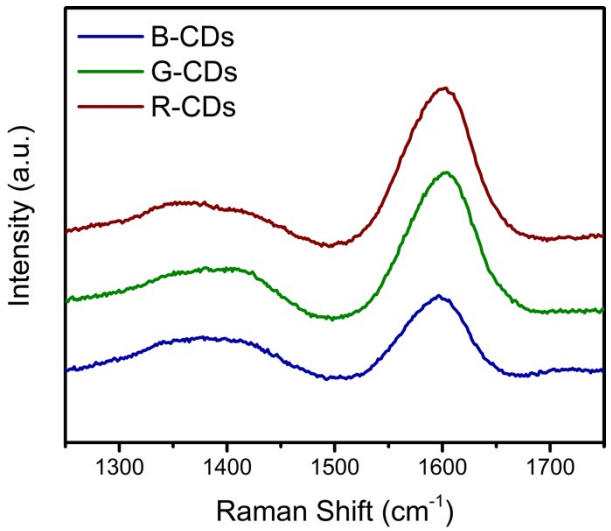

Figure S2. Raman spectra of R/G/B-CDs.

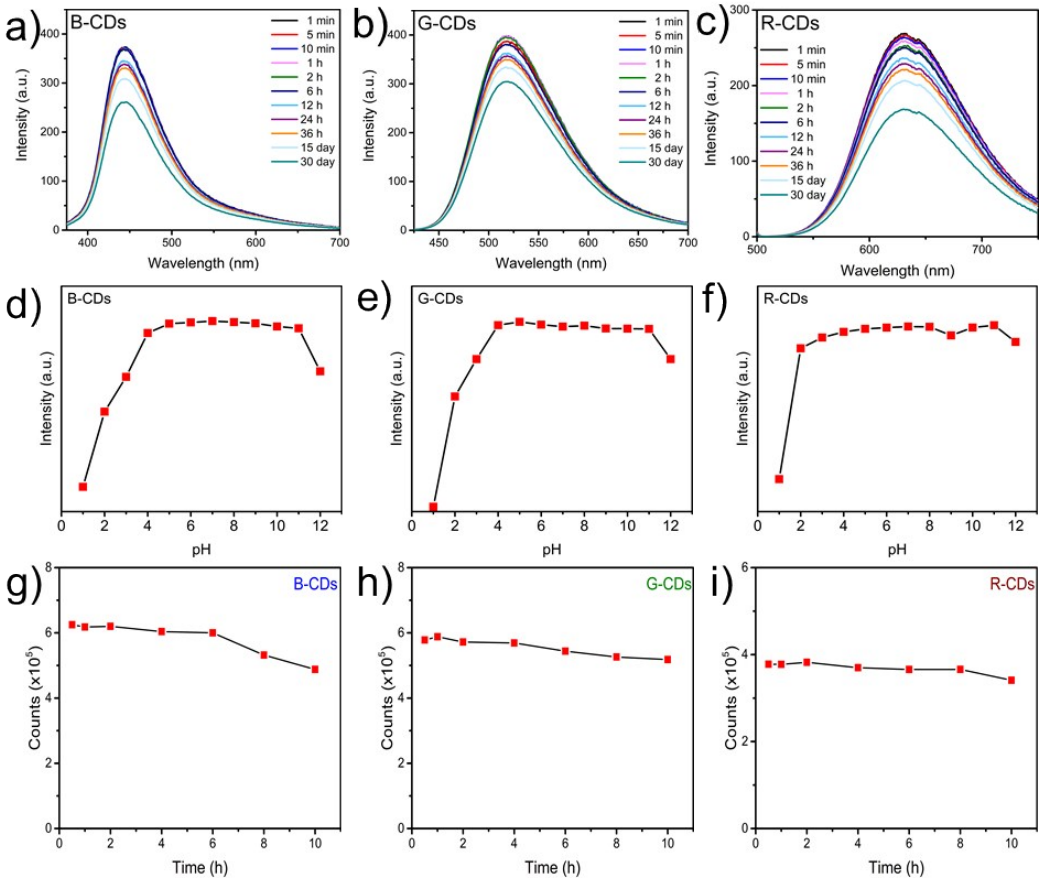

Figure S3. (a-c) Decay of photoluminescence (PL) spectra of (a) B-CDs, (b) G-CDs and (c) R-CDs stewing from 1 min to 30 day. PL stability of (d) B-CDs, (e) G-CDs and (f) R-CDs in different pH environment, and chemical stability in 0.1 M H_2O_2 with different time (g-i).

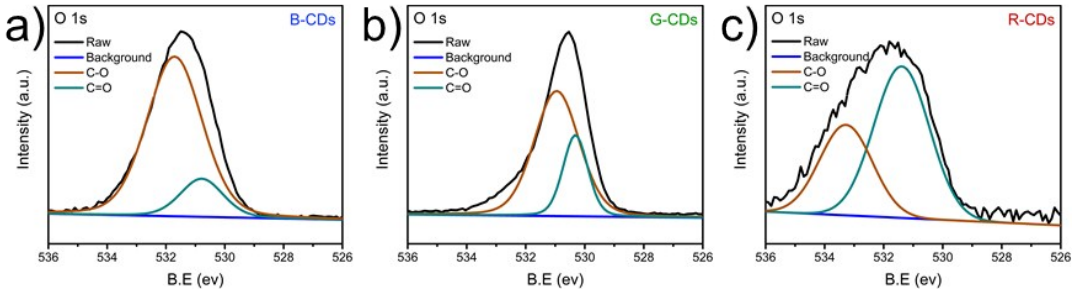

Figure S4. (a-c) High resolution XPS spectra of (a) B-CDs, (b) G-CDs and (c) R-CDs.

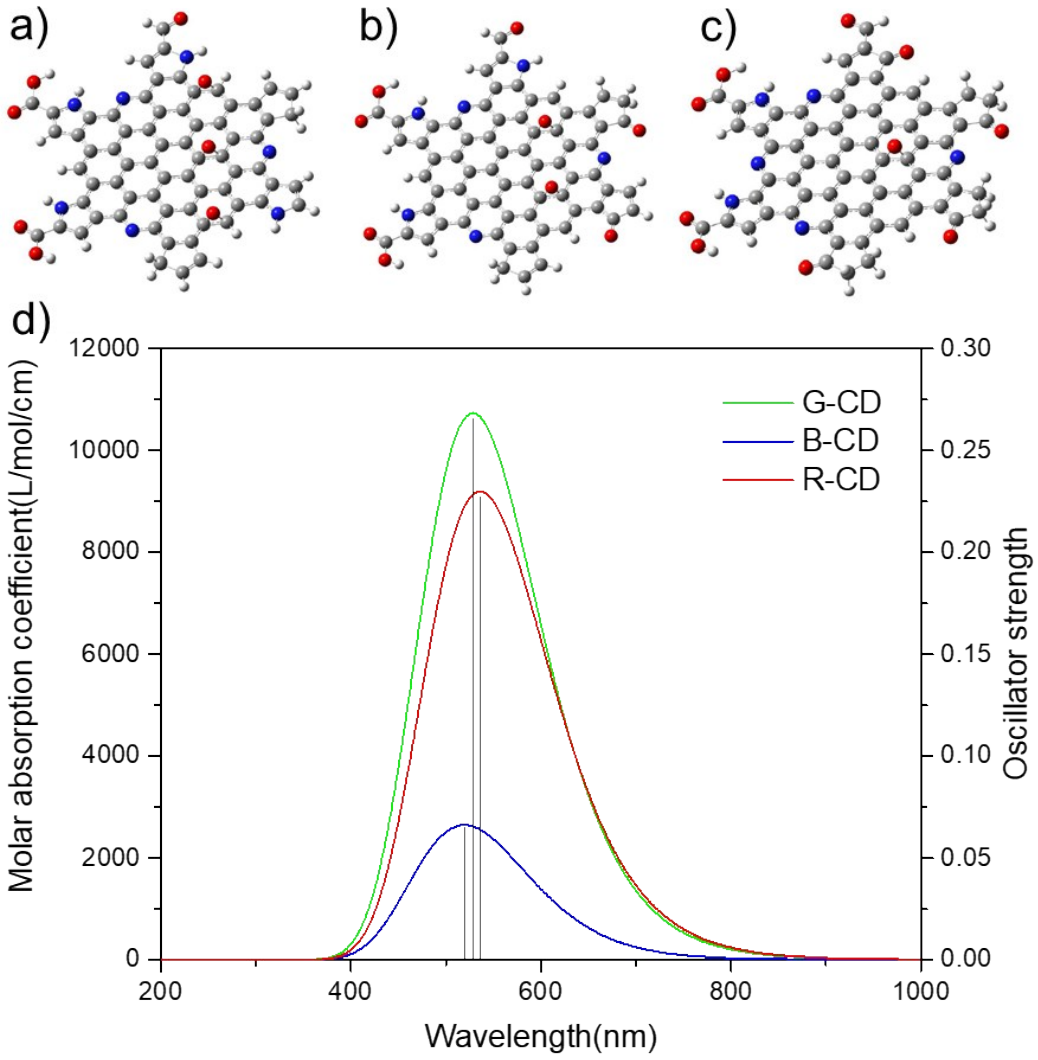

Figure S5. Carbon dot structures corresponding to the (a) blue, (b) green and (c) red emissions. On each structure, the contents of pyridinic, pyrrolic N, C=O, -COOH, -OH, C-N/C=N are based on the experimental results. Bright gray, dark gray, blue and red spheres represent hydrogen, carbon, nitrogen and oxygen atoms, respectively. (d) Emission spectra of R/G/B-CDs corresponding to the three carbon dots containing different radicals and nitrogen bond structures as shown in (a-c).

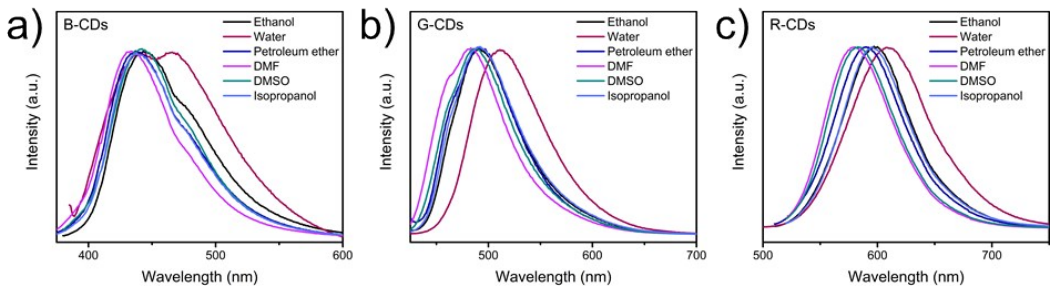

Figure S6. (a-c) Normalized PL spectra of (a) B-CDs, (b) G-CDs and (c) R-CDs in different solvents (ethanol, water, petroleum ether, DMF, DMSO and isopropanol).

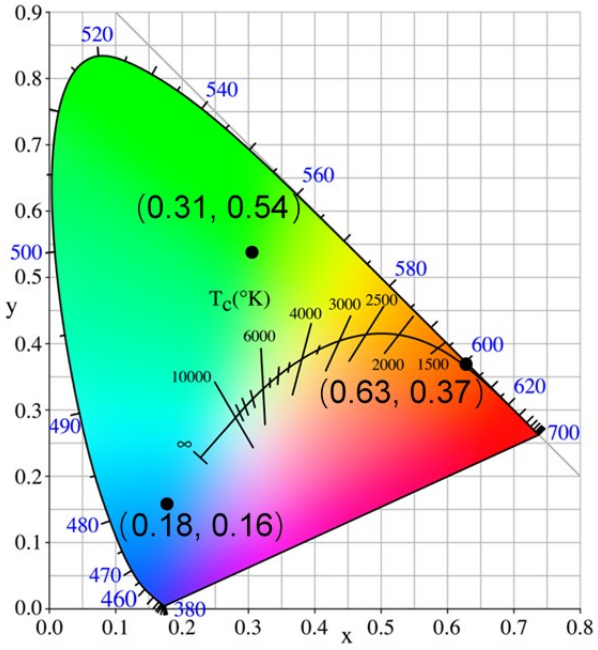

Figure S7. CIE color coordinates of B-CDs, G-CDs and R-CDs.

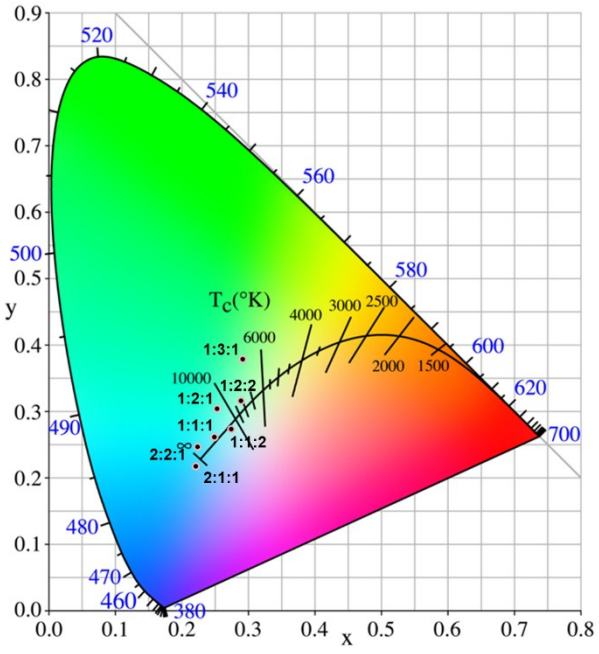

Figure S8. CIE color coordinates of R/G/B-CDs/PVP composites with different ratios of B-CDs, G-CDs and R-CDs.

Table S1. QY of the as-prepared CDs.

Samples	QY
B-CDs	8.6%
G-CDs	24.3%
R-CDs	24.7%

Table S2. Content of C, N, O (at%) in B-CDs, G-CDs and R-CDs.

Element	B-CDs	G-CDs	R-CDs
C	66.88	63.3	75.32
N	18.36	20.22	18.92
O	14.76	16.48	5.76

Table S3. Content of C species (at%) in B-CDs, G-CDs and R-CDs.

C configuration	B-CDs	G-CDs	R-CDs
C=C/C-C	0.280	0.293	0.408
C-N/C=N	0.538	0.474	0.476
C-O	0.164	0.175	0.039
C=O	0.018	0.058	0.077

Table S4. Content of N species (at%) in B-CDs, G-CDs and R-CDs.

N configuration	B-CDs	G-CDs	R-CDs
Graphitic N	0.086	0.192	0.161
Pyrrolic N	0.461	0.408	0.281
Pyridinic N	0.453	0.400	0.559

Table S5. Content of O species (at%) in B-CDs, G-CDs and R-CDs.

O configuration	B-CDs	G-CDs	R-CDs
C=O	0.155	0.263	0.639
C-O	0.845	0.737	0.361

Table S6. CIE color coordinates of R/G/B-CDs/PVP composites with different ratios of B-CDs, G-CDs and R-CDs.

Ratio (B-CDs : G-CDs : R-CDs)	***X***	***Y***
1:1:1	0.25	0.26
1:2:2	0.29	0.32
1:2:1	0.25	0.30
2:1:1	0.22	0.22
2:2:1	0.22	0.25
1:1:2	0.28	0.27
1:3:1	0.29	0.38

Table S7. QY of the as-prepared CDs.

Samples	QY
B-CDs@PVP	6.5%
G-CDs@PVP	21.1%
R-CDs@PVP	14.6%

Table S8. QY of R-CDs for different reaction time.

Time (h)	QY
8	13.3%
12	18.8%
16	24.7%
20	11.2%
30	3.4%

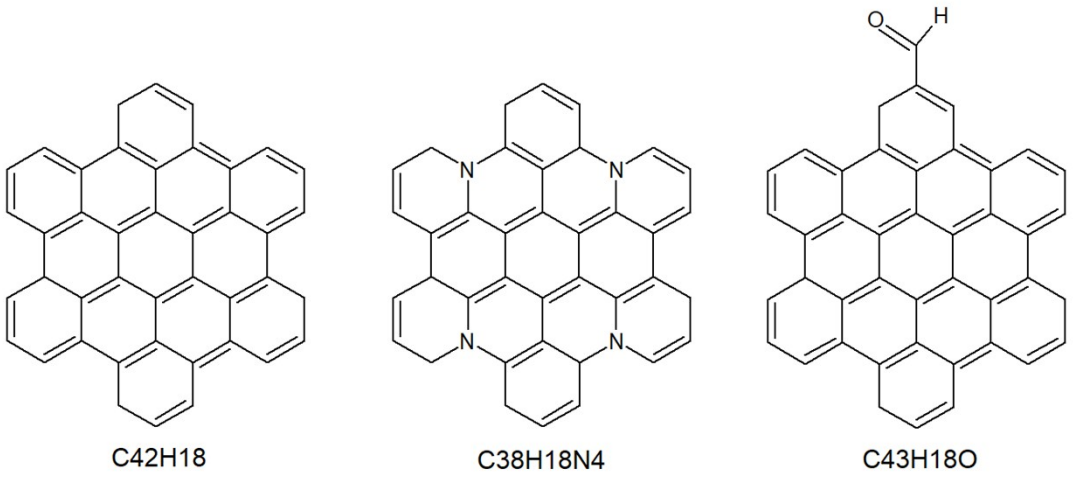

Figure S9. The emission wavelength of $C_{42}H_{18}$ is 450.3nm, the emission wavelength of $C_{38}H_{18}N_4$ is >2000nm, the emission wavelength of $C_{43}H_{18}O$ is 401nm.

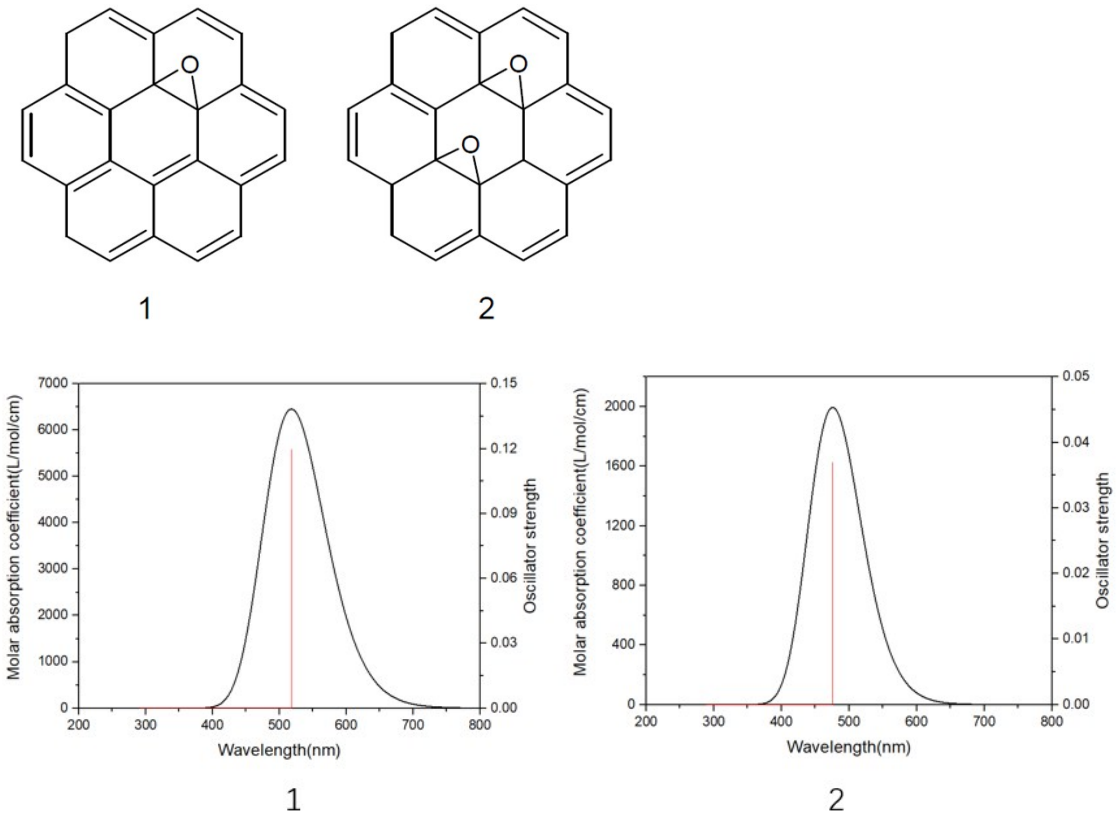

Figure S10. Effect of epoxy group on the PL emission on the CDs: The excitation wavelength is ~250 nm. As increase the number of epoxy group, the emission wavelength decreased from 517.57 nm to 475.42 nm.

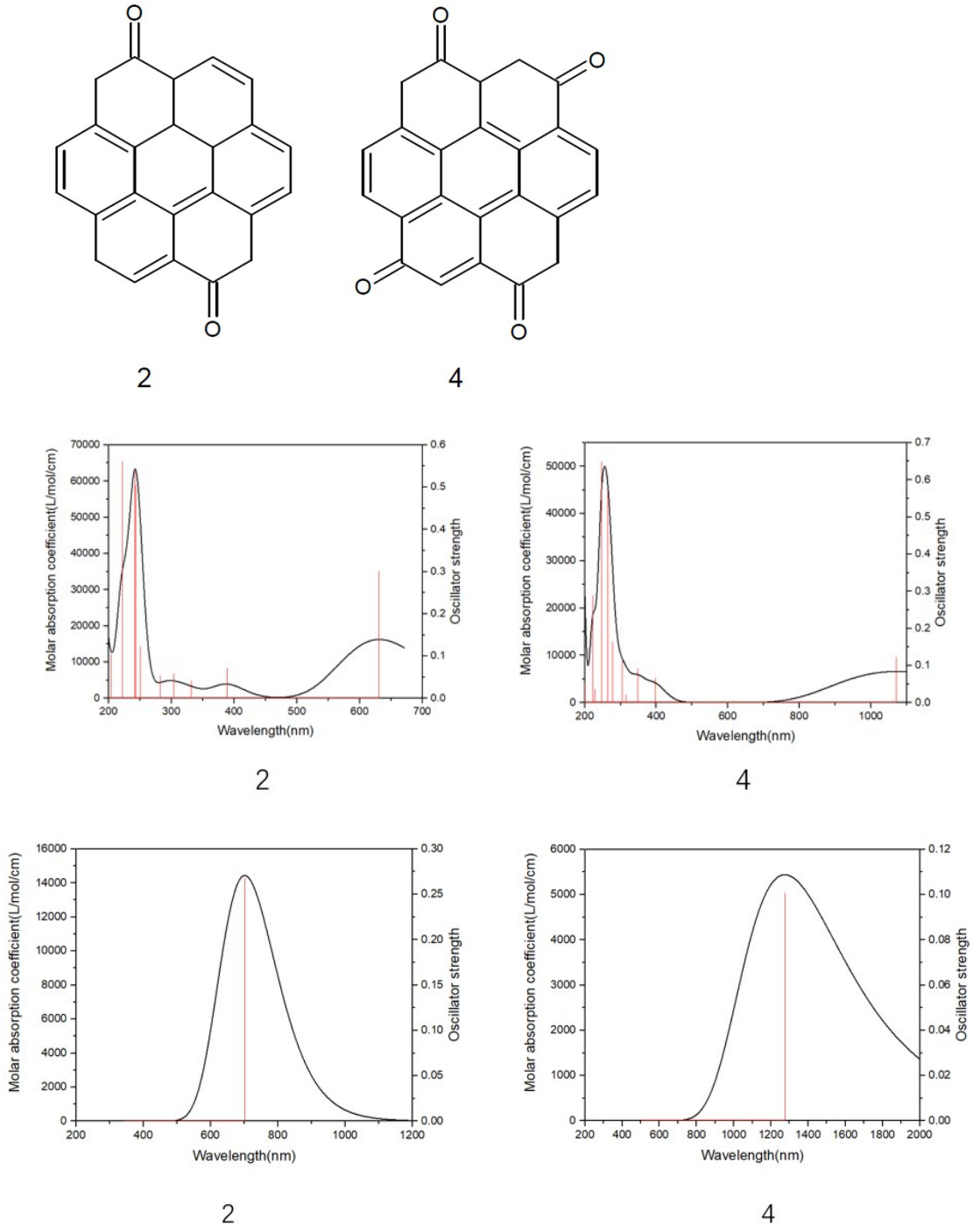

Figure S11. Effect of C=O bond structure on the PL emission on the CDs: The excitation wavelength is ~250 nm. As increase the number of C=O, the emission wavelength increases.

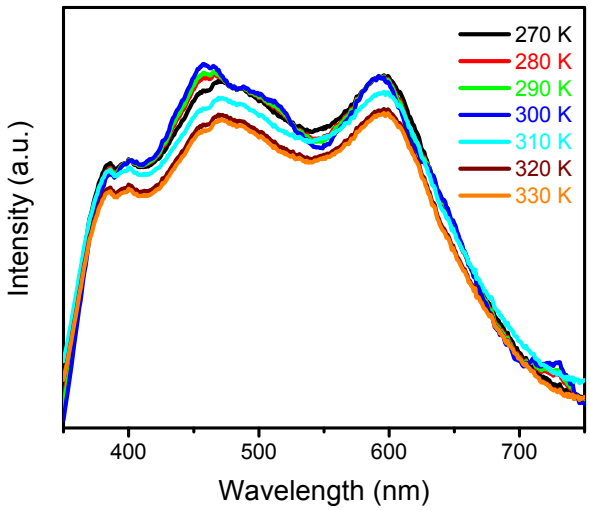

Figure S12. The temperature-dependent PL spectra of the white LEDs.