Supplementary Information (SI) for Chemical Science.

Supplementary Information

for

Regulating Red-shift Phosphorescence of Carbon Dots via Introducing Magnesium Chloride

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1. Figures

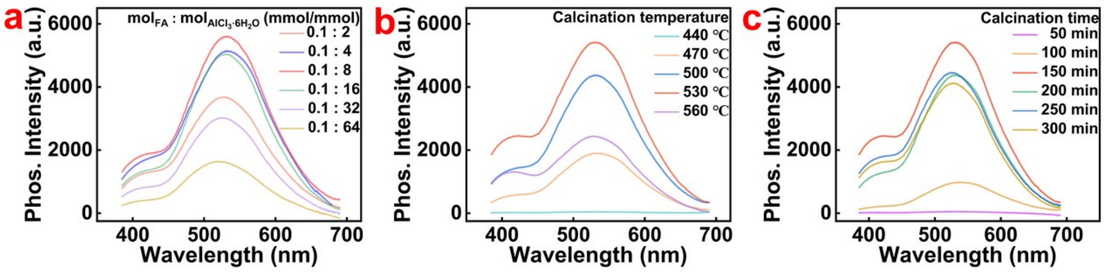

Figure S1 Phosphorescence spectra of $CDs@Al_2O_3$ with varied (a) molar ratios of folic acid to aluminum chloride hexahydrate, (b) calcination temperature or (c) calcination time.

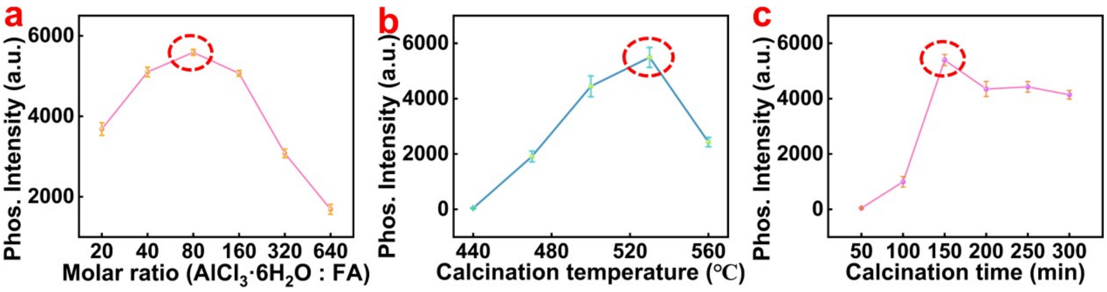

Figure S2 Phosphorescence intensity of $CDs@Al_2O_3$ with different (a) molar ratios of folic acid to aluminum chloride hexahydrate, (b) calcination temperature and (c) calcination time.

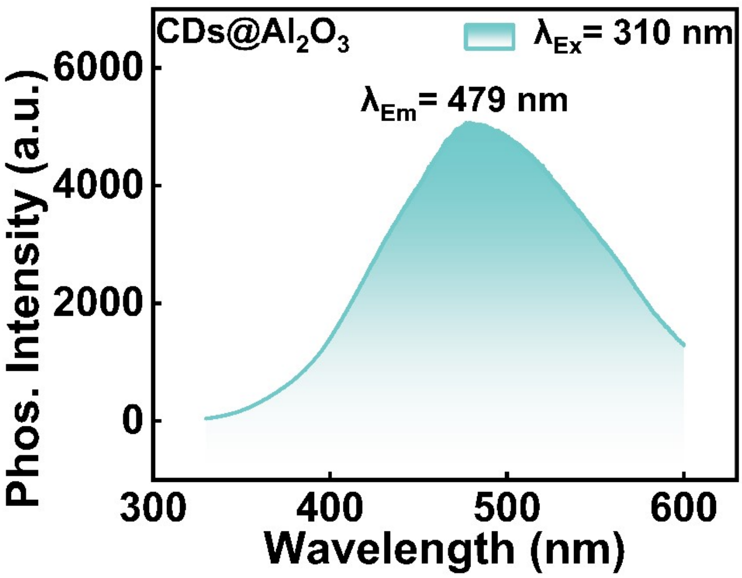

Figure S3 (A) Phosphorescence spectra of $CDs@Al_2O_3$ with the excitation of 310 nm.

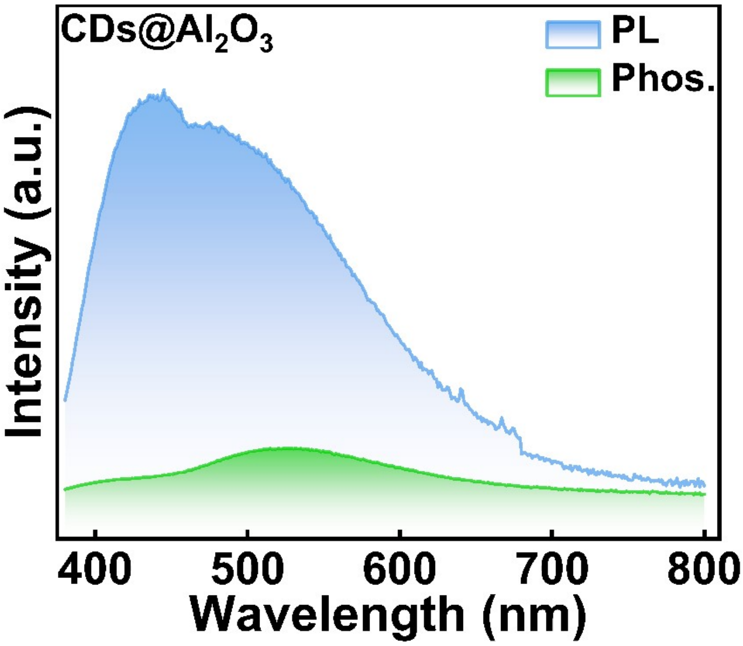

Figure S4 Photoluminescence spectra and phosphorescence spectra of CDs@Al_2O_3 with an excitation of 365 nm.

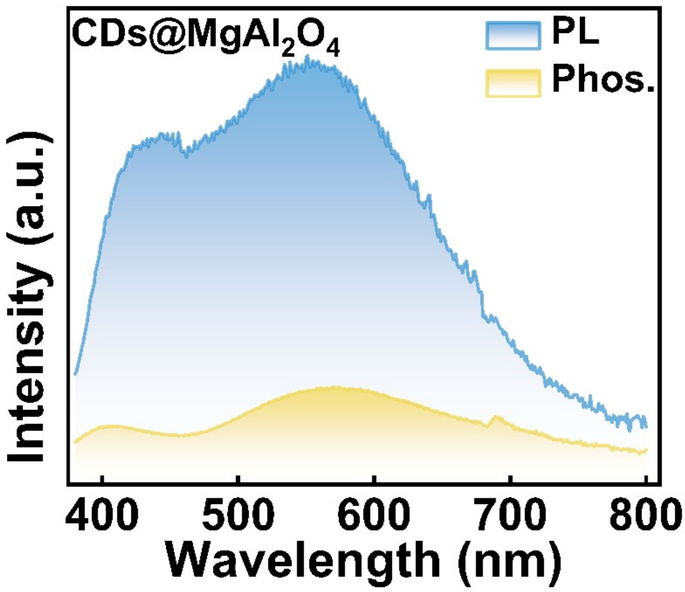

Figure S5 Photoluminescence spectra and phosphorescence spectra of CDs@$MgAl_2O_4$ with an excitation of 365 nm.

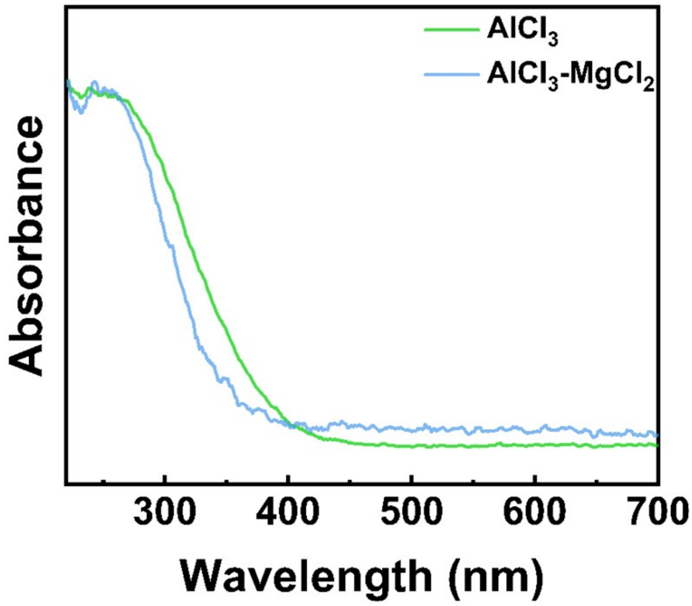

Figure S6 UV-vis absorption spectra of $AlCl_3$ and $AlCl_3$-$MgCl_2$.

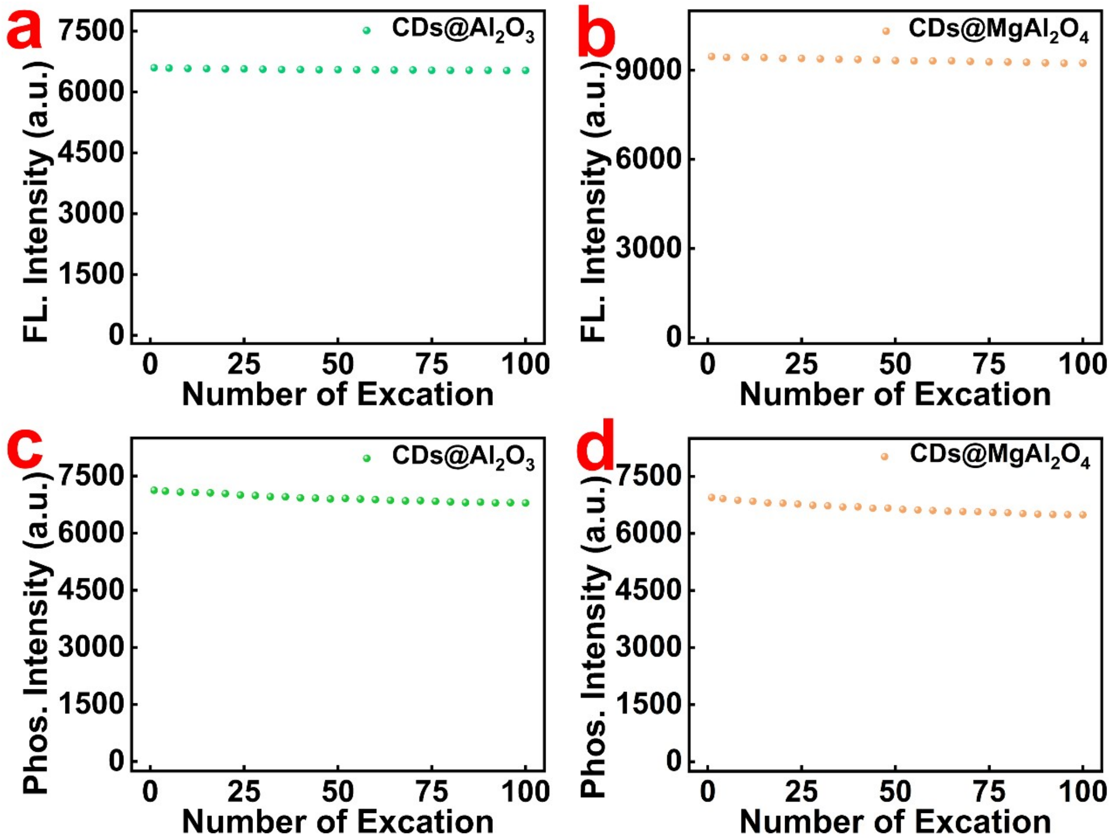

Figure S7 (a) Fluorescence and (c) phosphorescence intensity of CDs@Al_2O_3 with continuous excitations; (b) Fluorescence and (d) phosphorescence intensity of CDs@$MgAl_2O_4$ with continuous excitations.

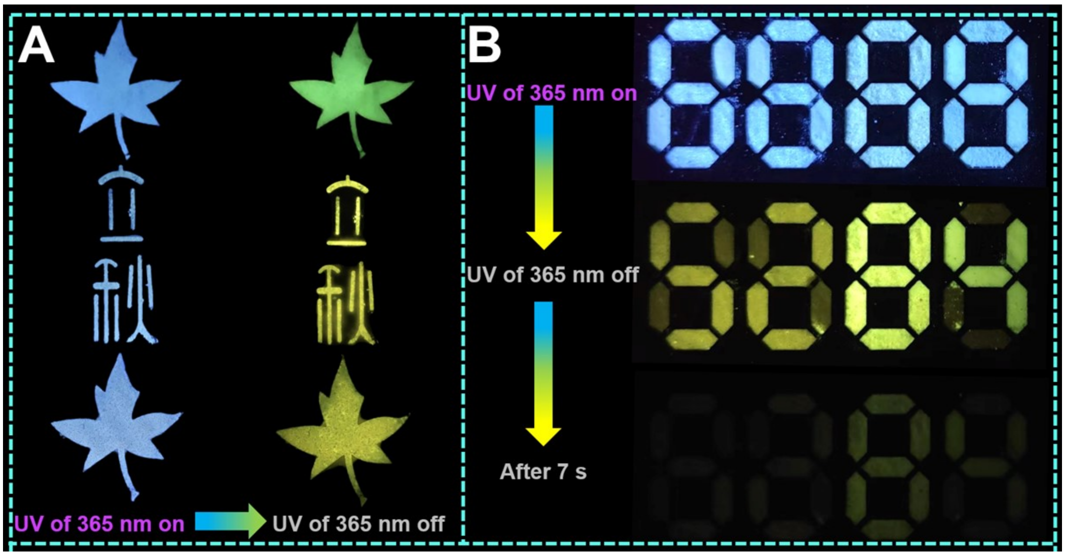

Figure S8 (a) Images of patterns painted using CDs@Al_2O_3 and CDs@$MgAl_2O_4$ with UV on and off; (B) Images of designed code using CDs@Al_2O_3 and CDs@$MgAl_2O_4$ with UV on and off.

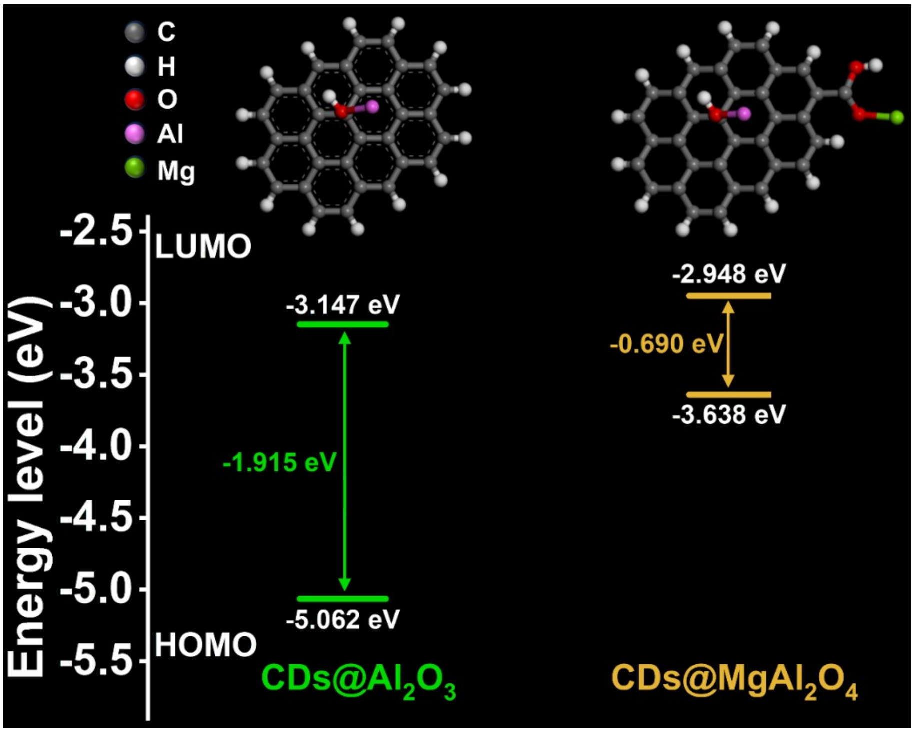

Figure S9. Two configurations and the corresponding HOMO and LUMO of CDs@Al_2O_3 and CDs@$MgAl_2O_4$.

2. Tables

Table S1. Fluorescent Commission International de l'Eclairage (CIE) coordinates of CDs@Al_2O_3 and CDs@$MgAl_2O_4$

Sample	CIE
CDs@Al_2O_3	(0.135, 0.094)
CDs@$MgAl_2O_4$	(0.136, 0.119)

Table S2. Phosphorescent Commission International de l'Eclairage (CIE) coordinates of CDs@Al_2O_3 and CDs@$MgAl_2O_4$

Sample	CIE (Phos. λ_{ex} = 365 nm)	CIE (Phos. λ_{ex} = 420 nm)
CDs@Al_2O_3	(0.154, 0.400)	(0.331, 0.432)
CDs@$MgAl_2O_4$	(0.349, 0.426)	（0.426, 0.424）

Table S3. Time resolved phosphorescence decay of CDs@Al_2O_3 (λ_{ex} = 365 nm and λ_{em} = 523 nm), CDs@$MgAl_2O_4$ (λ_{ex} = 365 nm and λ_{em} = 552 nm) , where *B* and τ are the amplitude and decay time (ms)[a]

Sample	τ_1 (ms)	B_1	τ_2 (ms)	B_2	τ_3(ms)	B_3	τ_{ave} (ms)
CDs@Al_2O_3	46.38	1596.06	302.71	1040.33	1162.61	308.77	128.69
CDs@$MgAl_2O_4$	38.59	868.66	195.80	611.14	819.65	198.39	500.34

Average lifetime was calculated by using the equation of $\tau_{ave}=\sum B_i\tau_i^2/\sum B_i\tau_i$.

Table S4. The contents of each element and the proportion of C-C/C=C in CDs@Al_2O_3 and CDs@$MgAl_2O_4$ by XPS

Sample	C	O	Al	Mg	C-C/C=C
CDs@Al_2O_3	21.18 %	51.36 %	27.46 %	——	67.11 %
CDs@$MgAl_2O_4$	22.77 %	47.97 %	21.48 %	7.77 %	78.21 %