Supporting Information

Bright Solid-State Luminescence and High-Temperature Resistance of Ga-Doped Carbon Dots with Ultra-Wideband White Emission for Light-Emitting Diodes

Xiao Gao, Hongquan Yu*, Zhanwen Han, Baojiu Chen*, Jiashi Sun, Xiangping Li

Department of Physics, Dalian Maritime University, Dalian 116026, Liaoning, China

*Corresponding author: **Hongquan Yu and Baojiu Chen**

Address: No. 1, Linghai Road, Dalian116026, Liaoning, P.R. China

E-mail: yuhq7808@126.com (H. Yu); bjchen@dlmu.edu.cn (B. Chen)

Tel/ Fax: +86-411-84728909

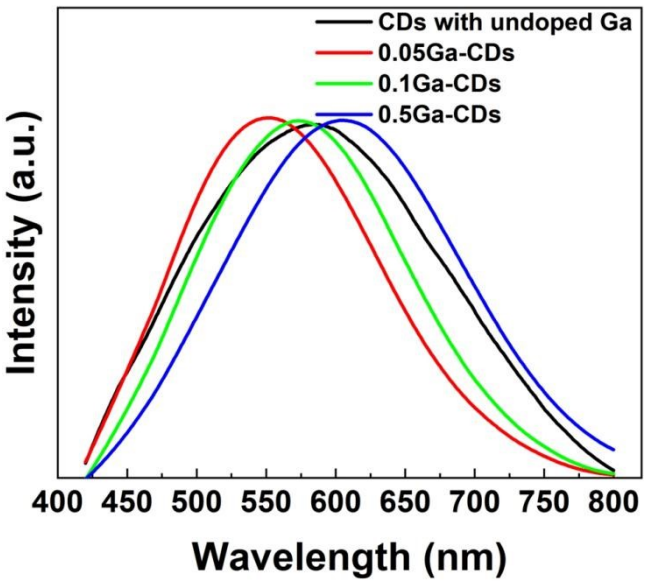

Fig. S1. PL spectra of the CDs with undoped Ga, 0.05 Ga CDs, 0.1 Ga CDs and 0.5 Ga CDs under 365 nm excitation.

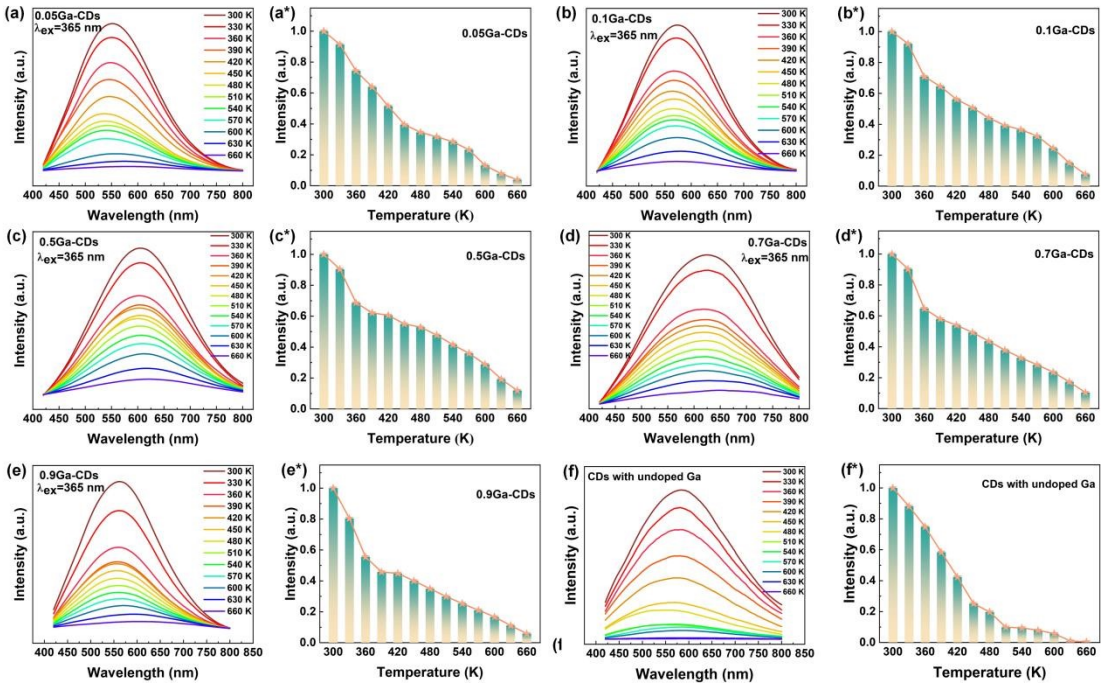

Fig. S2. Temperature dependence of PL spectra and integral emission intensity of the (a, a*) 0.05Ga-CDs, (b, b*) 0.1Ga-CDs, (c, c*) 0.5Ga-CDs, (d, d*) 0.7Ga-CDs, (e, e*) 0.9Ga-CDs and (f, f*) CDs with undoped Ga under 365 nm excitation.

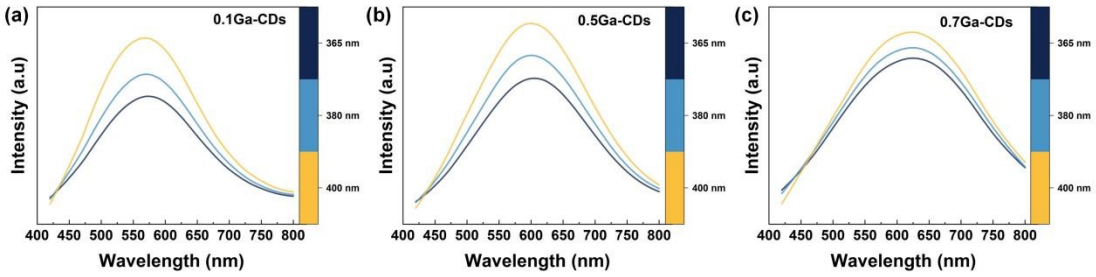

Fig. S3. PL spectra of 0.1Ga CDs, 0.5Ga CDs, and 0.7Ga-CDs, respectively, phosphors under different excitation lights.

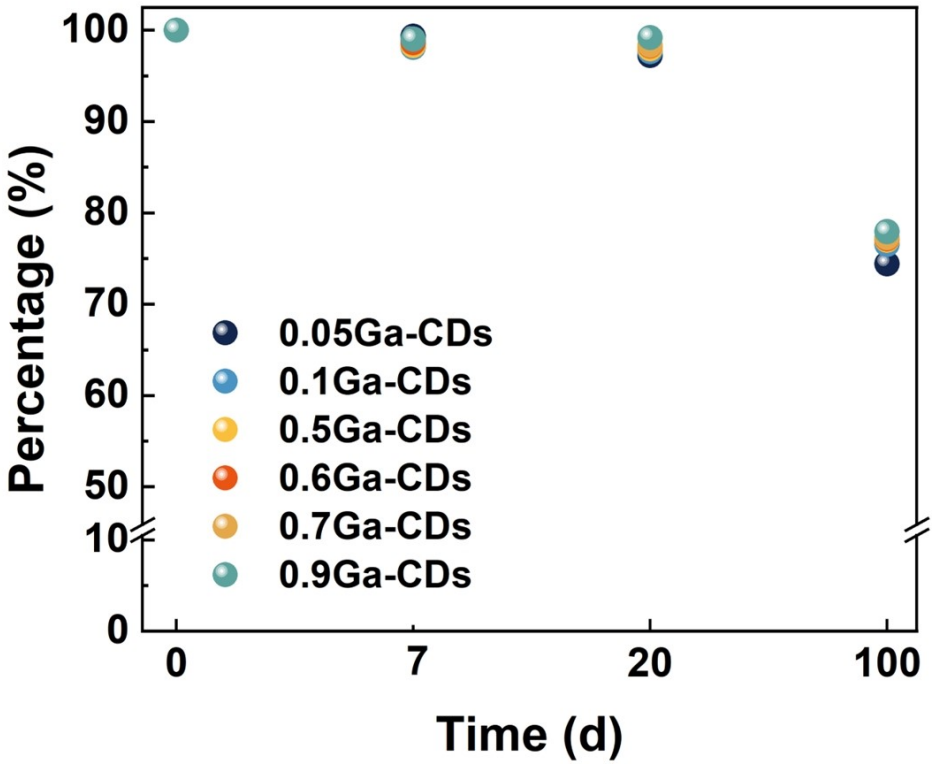

Fig. S4. Strength map for 100 days under natural conditions.

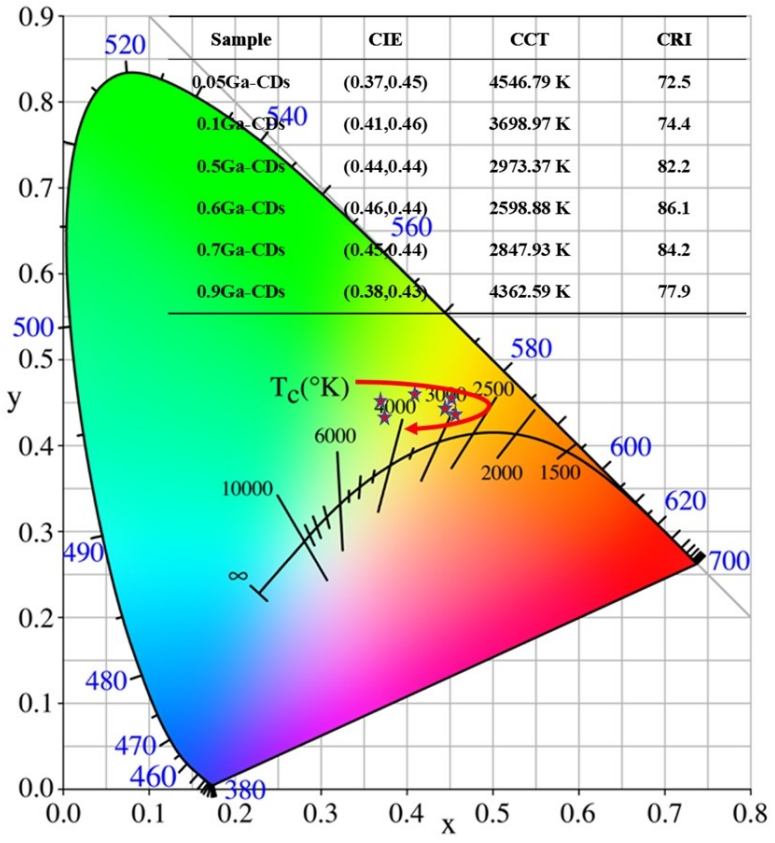

Fig. S5. Calculate the PL emission color coordinates, CCT,CRI in the CIE 1931 chrominance diagram.

Table S1. The excitation and emission peak and FWHM values of the CDs doped with different metal elements.

Materials	E_x/E_m (nm)	FWHM (nm)	Ref.
Eu-CDs	350/465	151	[56]
Tb-CDs	320/450	112	[57]
La-CDs	350/460	143	[58]
Cu-CDs	340/410, 470	110	[59]
Mn-CDs	365/482	92	[60]
Al-CDs	345/415	75	[61]
Ag-CDs	300/358	92	[62]
Fe-CDs	360/430	73	[63]
Zn-CDs	365/460	118	[64]
CDs with undoped Ga	365/581	193	This work
0.05Ga-CDs	365/550	173	This work
0.1Ga-CDs	365/575	178	This work
0.5Ga-CDs	365/600	199	This work
0.6Ga-CDs	365/650	262	This work
0.7Ga-CDs	365/625	237	This work
0.9Ga-CDs	365/560	193	This work

Table S2. Comparison of the PLQY of Ga-doped CDs with different Ga concentrations at 0 days and after 100 days in natural environment.

Sample	0day-PLQY (%)	100day-PLQY (%)
0.05Ga-CDs	9.77	3.88
0.1Ga-CDs	9.01	3.07
0.5Ga-CDs	9.76	3.65
0.6Ga-CDs	10.75	6.33
0.7Ga-CDs	11.79	6.51
0.9Ga-CDs	15.85	10.33

Sample	C1s		O1s	
0.05Ga-CDs	C=C/C-C	45.23	C=O	34.39
	C-O	29.39	B-O	23.24
	C=O	25.38	C-O	22.04
			Ga-O	20.33
0.6Ga-CDs	C=C/C-C	37.70	C=O	24.21
	C-O	34.07	B-O	29.57
	C=O	28.23	C-O	27.63
			Ga-O	18.59
0.9Ga-CDs	C=C/C-C	42.57	C=O	31.51
	C-O	31.90	B-O	26.65
	C=O	25.53	C-O	23.61
			Ga-O	18.23

Table S4. Chemical bond content (%) of 0.05Ga-CDs, 0.6Ga-CDs, 0.9Ga-CDs.

Table S5. The fluorescence lifetimes of the Ga-doped CDs with different Ga concentrations.

Sample	A1 (%)	τ_1 (s)	A2 (%)	τ_2 (s)	τ_{avg} (ns)
0.05Ga-CDs	0.77387	0.0883	0.2178	0.81791	0.61563
0.1Ga-CDs	0.85712	0.04347	0.13874	0.75096	0.5646
0.5Ga-CDs	0.87111	0.04402	0.12489	0.89263	0.67544
0.6Ga-CDs	0.87569	0.04193	0.11194	0.7077	0.49685
0.7Ga-CDs	0.88378	0.04458	0.10959	0.80934	0.57412
0.9Ga-CDs	0.89606	0.04301	0.10074	0.83541	0.58652