Supporting Information

Achieving 46% efficient white-light emissive carbon dot-based material by enhancing phosphorescence for single-component white-light-emitting diodes

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Materials.

Lycorine hydrochloride (AR) was purchased from Aladdin. Boric acid (AR), poly (vinyl alcohol) (AR) and cyanuric acid (AR) were obtained from Sinopharm Chemical Reagent Co. (China). All chemicals were used without further purification.

Characterizations.

The transmission electron microscopy (TEM) was recorded on A JEOL JEM 2100 TEM system operating at 200 kV (Japan). The X-ray photoelectron spectroscopy (XPS) measurement was performed by using an ESCALAB 250 XPS system (Thermo Electron Corporation, USA). The Fourier transform infrared (FTIR) spectra were recorded on a Bruker Tensor 27 spectrophotometer (Germany). The absorbance spectra of CDs were recorded by using a Shimadzu UV-2600 spectrometer (Japan). The photoluminescence, absolute quantum yield, and phosphorescence lifetime of the CDs and CD@BA powders were measured using Edinburgh FS5 and FLS980 spectrophotometer equipped with a xenon arc lamp (Xe900) and a microsecond flashlamp (μF900), and an integrating sphere. XRD patterns were obtained with a Rigaku 18 KW D/max-2550 using Cu Ka radiation. The phosphorescence spectra were performed at room temperature by Edinburgh FLS5 spectrofluorometer equipped with a microsecond flash-lamp (μF900) with the following settings: total decay time, 4 s; delay time, 0.1 ms; gate time, 1 ms. Digital photographs of CD@BA bulk and CD@BA-0 bulk were taken by Leica microscope DM750.

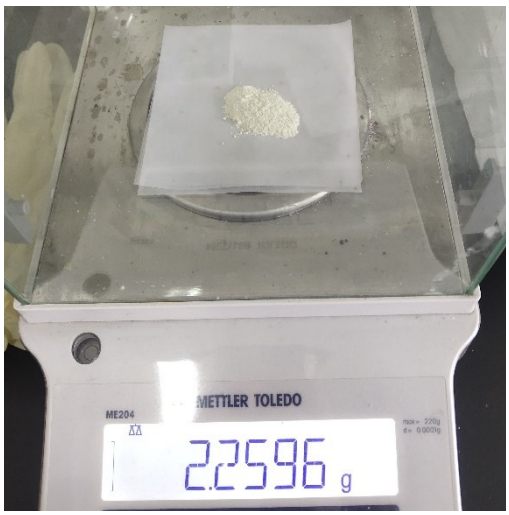

Fig. S1 Gram-scale product, more than 2g of CD@BA powders can be obtained from one-step solid state reaction.

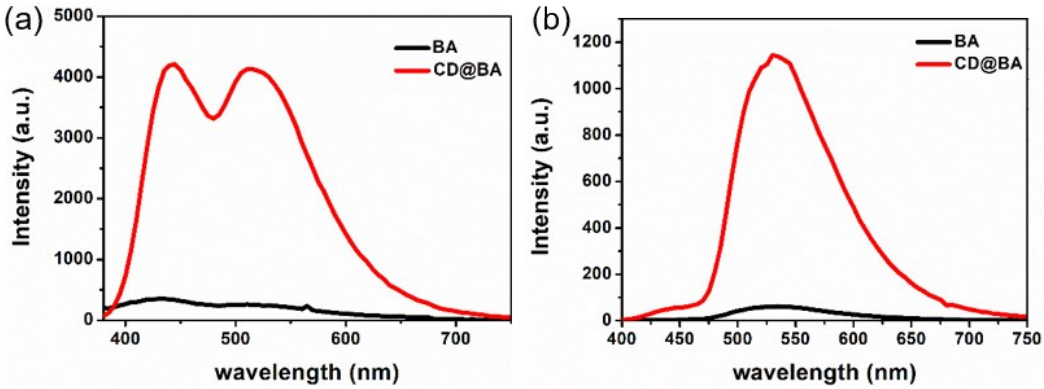

Fig. S2. a) Fluorescence emission spectra of CD@BA and BA powders under 365 nm excitation, respectively. b) phosphorescence emission spectra of CD@BA and BA powders under 365 nm excitation, respectively.

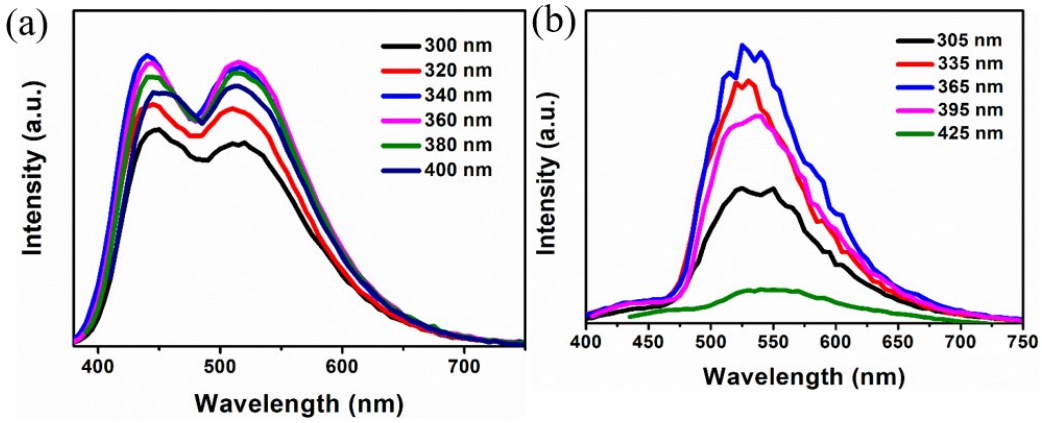

Fig. S3 a) Fluorescence emission spectra of CD@BA powders under different excitation wavelengths, respectively.

b) Phosphorescence emission spectra of CD@BA powders under different excitation wavelengths, respectively.

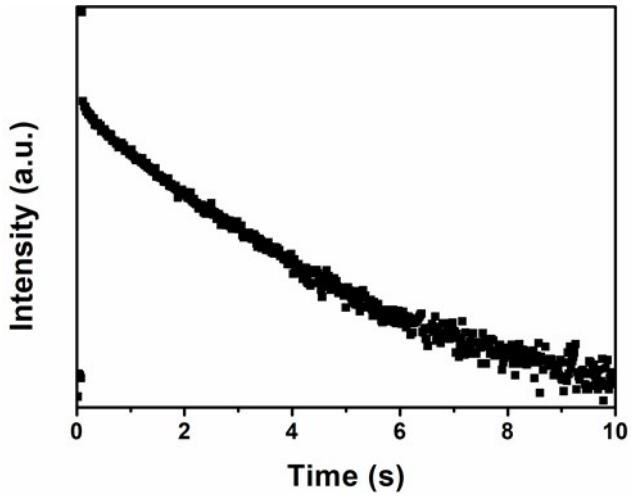

Fig. S4 Phosphorescence decay curve and lifetimes of CD@BA powders monitored at 520 nm.

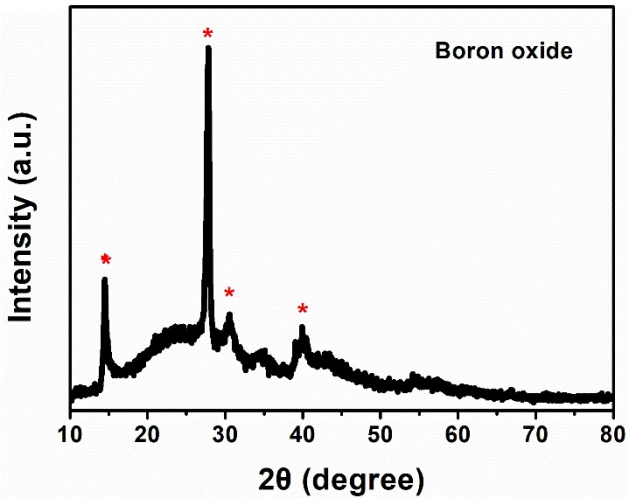

Fig. S5 XRD patterns of CD@BA powders.

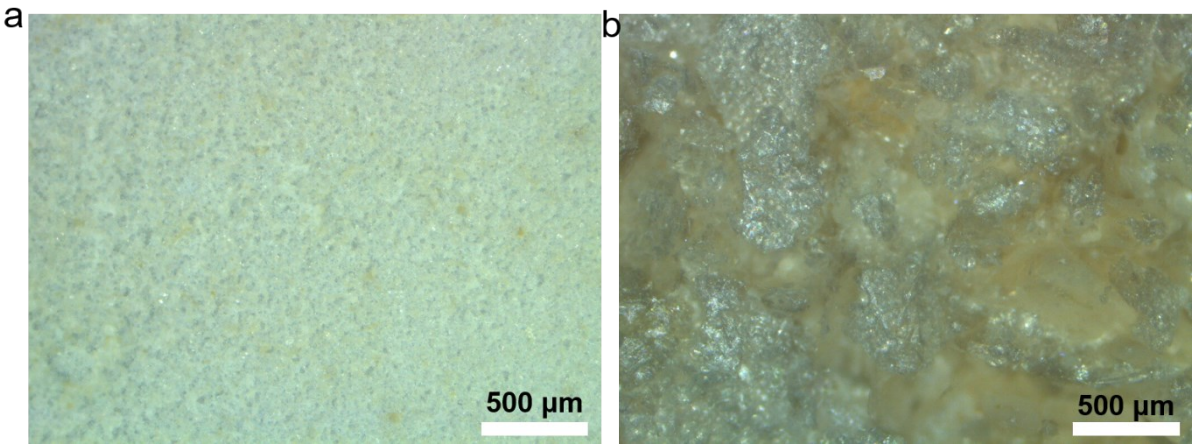

Fig. S6 Digital photographs of CD@BA bulk and CD@BA-0 bulk taken by optical microscope.

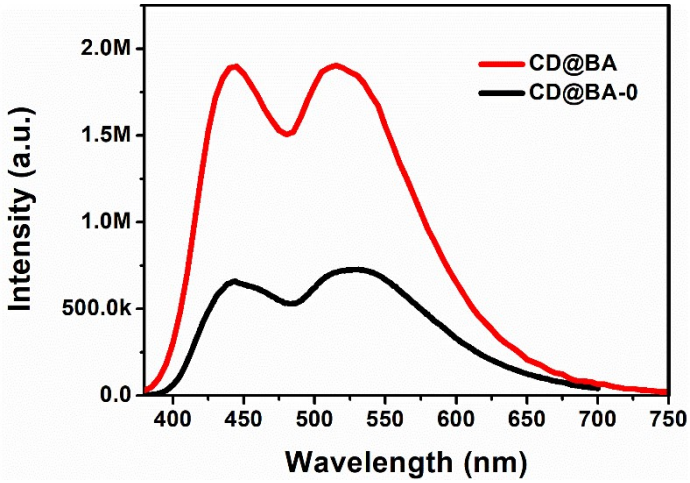

Fig. S7 Fluorescence emission spectra of CD@BA and CD@BA-0 powders, respectively.

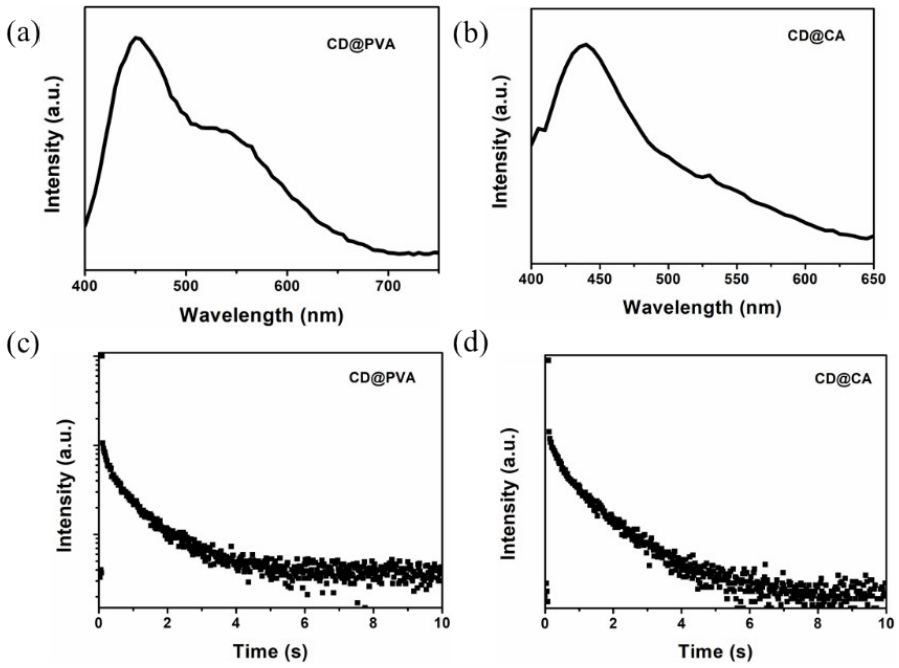

Fig. S8 a) Fluorescence emission spectra of CD@PVA under 365 nm excitation. b) fluorescence emission spectra of CD@CA under 365 nm excitation. c) Phosphorescence decay curve and lifetimes of CD@PVA monitored at 520 nm. d) Phosphorescence decay curve and lifetimes of CD@CA monitored at 520 nm.

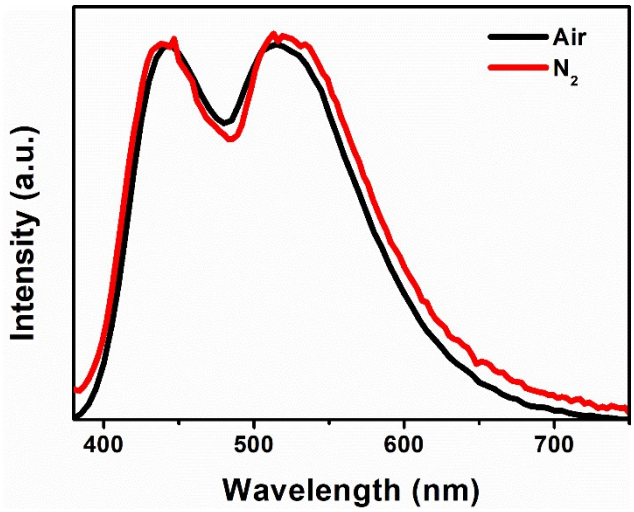

Fig. S9 Fluorescence emission spectra of CD@BApowders at air and nitrogen, respectively.

Table S1 Comparison of quantum efficiencies of white emissive phosphors under UV light

Luminescent materials	Photoluminescence	PQY	QY	References
CDs	Fluorescence/phosphorescence	30%	46%	This work
CDs	Fluorescence/phosphorescence	6%	25%	1
CDs	Fluorescence/phosphorescence	23%	41%	2
CDs	Fluorescence	/	10%	3
CDs	Fluorescence	/	39%	4
Carbon Nanodots	Fluorescence	/	12%	5
CDs	Fluorescence	/	6.8%	6
Organic crystal material	Fluorescence/phosphorescence	11%	16.6%	7
Organic crystal material	Phosphorescence/phosphorescence	28.6	28.6	8

Table S2 The time resolved phosphorescence decay components of the CD. Where α_i, τ_i are the amplitude and decay time (s)[a].

Sample	T_1 (s)	A_1 (%)	T_2 (s)	A_2 (%)	T_{avg} (s)
CD@BA	0.4248	6.65	1.779	93.35	1.76
CD@PVA	0.2154	16.69	1.071	83.31	1.04
CD@CA	0.2597	20.55	1.199	79.45	1.15

[a] The average lifetimes were calculated using the equation:$\tau_{ave} = \sum \alpha_i \tau_i^2 / \sum \alpha_i \tau_i$

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