Supplementary Information

Ultralong afterglow of heavy-atom-free carbon dots with a phosphorescence lifetime of up to 3.7 s for encryption and fingerprinting description

Xinlei Zhang, Xia Liu, Peng Liu, Bohan Li, Yan Xu*

Department of Chemistry, College of Sciences, Northeastern University, Shenyang, Liaoning 110819, China.

*Corresponding Authors:

xuyan@mail.neu.edu.cn (Yan Xu);

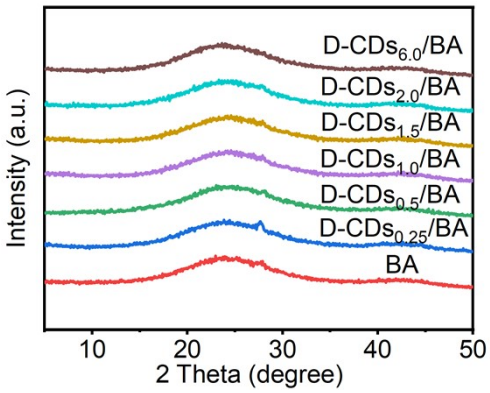

Fig. S1. The experimental PXRD patterns of as-prepared BA and D-CDs$_x$/BA (X = 0.25, 0.5, 1.0, 1.5, 2.0, 6.0) samples.

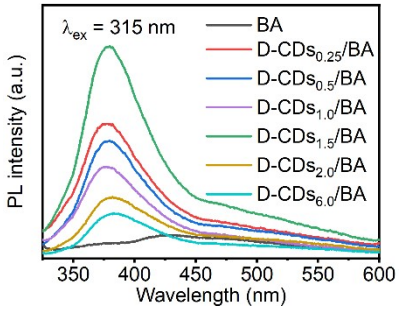

Fig. S2. Fluorescence emission spectra of D-CDs$_x$/BA with different D-CDs contents.

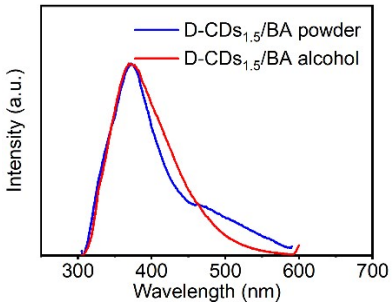

Fig. S3. Fluorescence emission spectra of D-CDs$_{1.5}$/BA powder and in alcohol

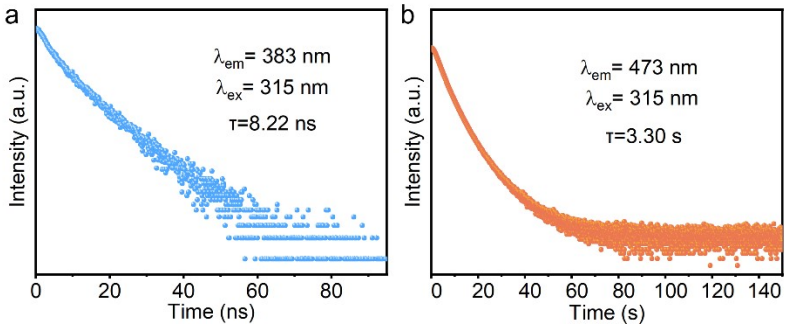

Fig. S4. Time-resolved delay spectra measured at (a) 383 nm and (b) 473 nm for different lifetimes.

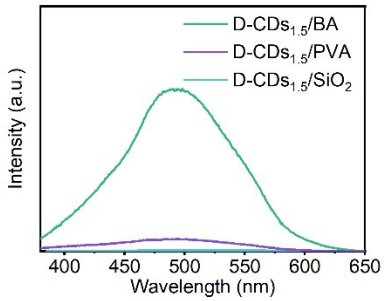

Fig. S5. Afterglow spectra of D-CDs mixed into different matrices.

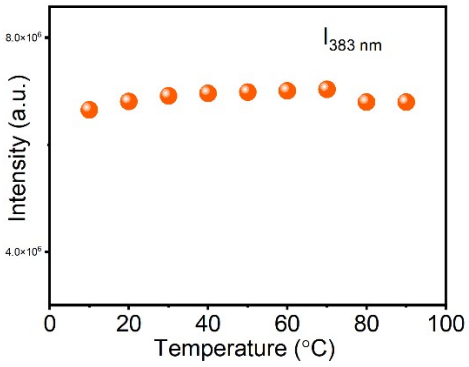

Fig. S6. Temperature-dependent emission intensity variation of D-CDs$_{1.5}$/BA with excitation wavelength of 315 nm.

Table S1 The time resolved phosphorescence decay components of the D-CDs$_{1.5}$/BA

Em.	Ex.	T1 (s)	A1	A1' (%)	T_{avg} (s)[a]
473	315	3.30	7.60	100	3.30
473	254	3.66	9.15	100	3.66
473	365	2.78	9.43	100	2.78

[a]The average lifetimes were calculated using the equation：

$$\tau_{avg} = (A_1' * \tau_1 * \tau_1) / (A_1' * \tau_1)$$

Table S2 Comparison of lifetime of CD-based RTP materials under UV light

Materials	Lifetime (s)	PQY (%)	References
CDs and boric acid	3.66	12.67	This work
CDs and PVA	2.43	7.51	1
CDs and boric acid	2.26	17.5	2
CDs and urea	0.21	30	3
CDs and boric acid	0.44	17.61	4

References

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2. W. Li, W. Zhou, Z. Zhou, H. Zhang, X. Zhang, J. Zhuang, Y. Liu, B. Lei and C. Hu, *Angew. Chem., Int. Ed.*, 2019, **58**, 7278-7283.
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