

Supporting Information

Developing single silane-derived delayed fluorescent carbon dots as donors for energy transfer-based aqueous-phase multicolor afterglow application

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1. Materials and Apparatus

Materials. 1,3-bis(3-aminopropyl)-1,1,3,3-tetramethyldisiloxane, (3-Aminopropyl)trimethoxysilane (1), (3-Aminopropyl)triethoxysilane (2), 3-[Dimethoxy(methyl)silyl]-1-propanamine (3), 3-(diethoxy(methyl)silyl)propan-1-amine (4), (3-Mercaptopropyl)trimethoxysilane (5), trimethoxy(3,3,3-trifluoropropyl)-silan (6), Tetraethyl orthosilicate (TEOS), Fluorescein disodium salt, Rhodamine B, Rhodamine 6G, Sodium alginate, Ferric chloride and Glutathione(Reduced) were purchased from Aladdin Chemical Co., Ltd (Shanghai, China). Aqueous ammonia was purchased from Sinopharm Chemical Reagent Co., Ltd (Shanghai, China). Calcium chloride was purchased from Xilong Scientific Co., Ltd (Guangdong, China). All other common solvents and salts were of analytical grade and used as received.

Mice. Mice were purchased from Qizhen Laboratory Animal Technology Co., Ltd. (Hangzhou, China). All mice were maintained in a specific pathogen-free facility. Animal welfare and experimental procedures were carried out in accordance with national and institutional guidelines for animal care and were approved by the Ethics Committee of Zhejiang University of Technology.

Apparatus. The optical absorption spectra were acquired on a SHIMADZU UV-2700 UV-vis spectrometer coupled with a 1.00 cm quartz cell (Shimadzu Scientific Instruments, Japan). All fourier-transform infrared (FTIR) spectroscopic measurements were performed on a Thermo Nicolet 6700 FT-IR Spectrophotometer using KBr pressed disks (Thermo Fisher Scientific, USA). Photoluminescence (PL) spectra were recorded on a HORIBA FLUOROMAX-4P spectrometer with an integrating sphere attachment (Horiba Jobin Yvon, French). Fluorescence lifetime, phosphorescence lifetime and fluorescence quantum yield were obtained by FLS1000 Steady state and time-resolved Photoluminescence Spectrometer (Edinburg, Britain). Transmission electron microscopy (TEM) was carried out on TECNAI G2 F30 S-TWIN electron microscopy operated at 300 kV (FEI Corporation, Netherlands). XPS spectra were obtained from Thermo Scientific K-Alpha+ X-ray Photoelectron spectrometer (Thermo Fisher Scientific, USA). Raman spectrum were obtained from LabRam HR UV Laser Raman spectrometer (Horiba Jobin Yvon, French).

Fluorescence and Afterglow Bioimaging. Mice were used for in vivo imaging. The mice were anesthetized using isoflurane, and the DF-CDs@SiO₂ was injected into the dorsal areas of mice (100 μL). Before the live imaging, and then the injection site was irradiated under a 365nm UV lamp. The signals were collected after removal of the excitation source using IVIS live imaging system under the bioluminescence mode. All afterglow imaging was carried out on a Photon IMAGER IVIS spectrum with a CCD camera.

2. Figures

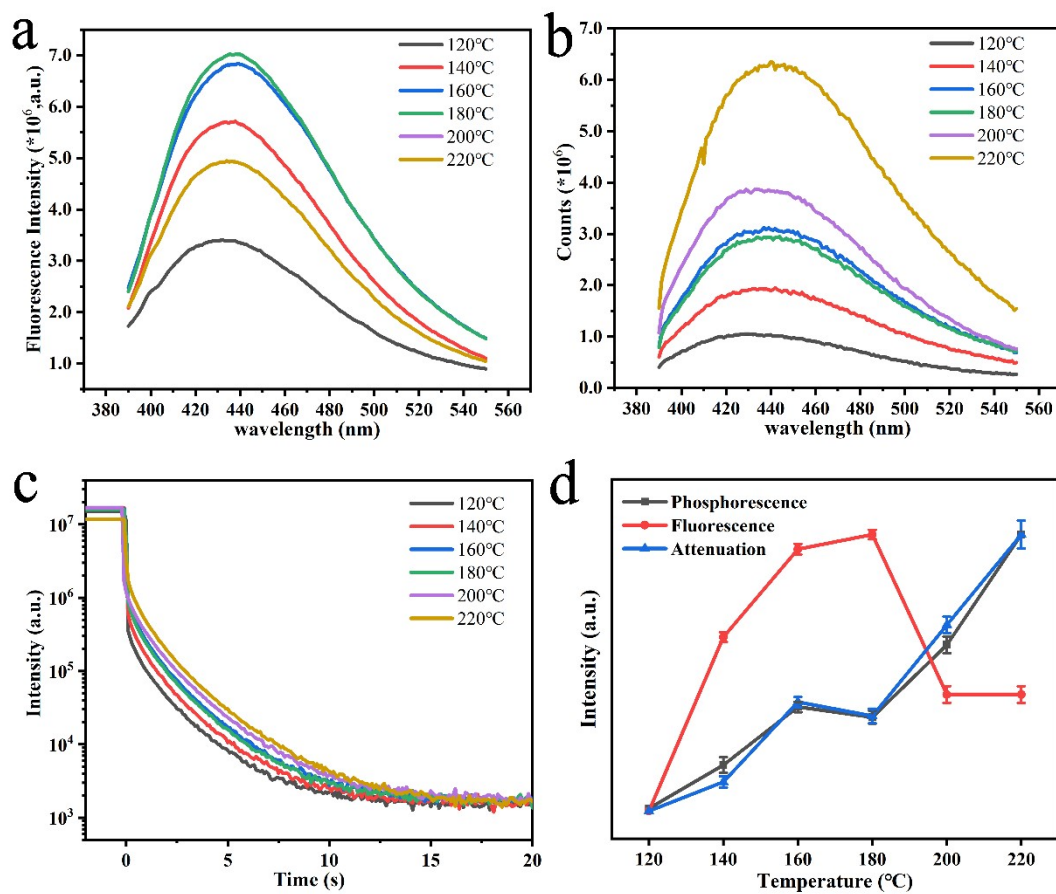


Figure S1. (a~c) Fluorescence spectra, phosphorescence spectra and attenuation curves of different reaction temperatures; (d) Trend plot of intensity change when phosphorescence decays to 5s.

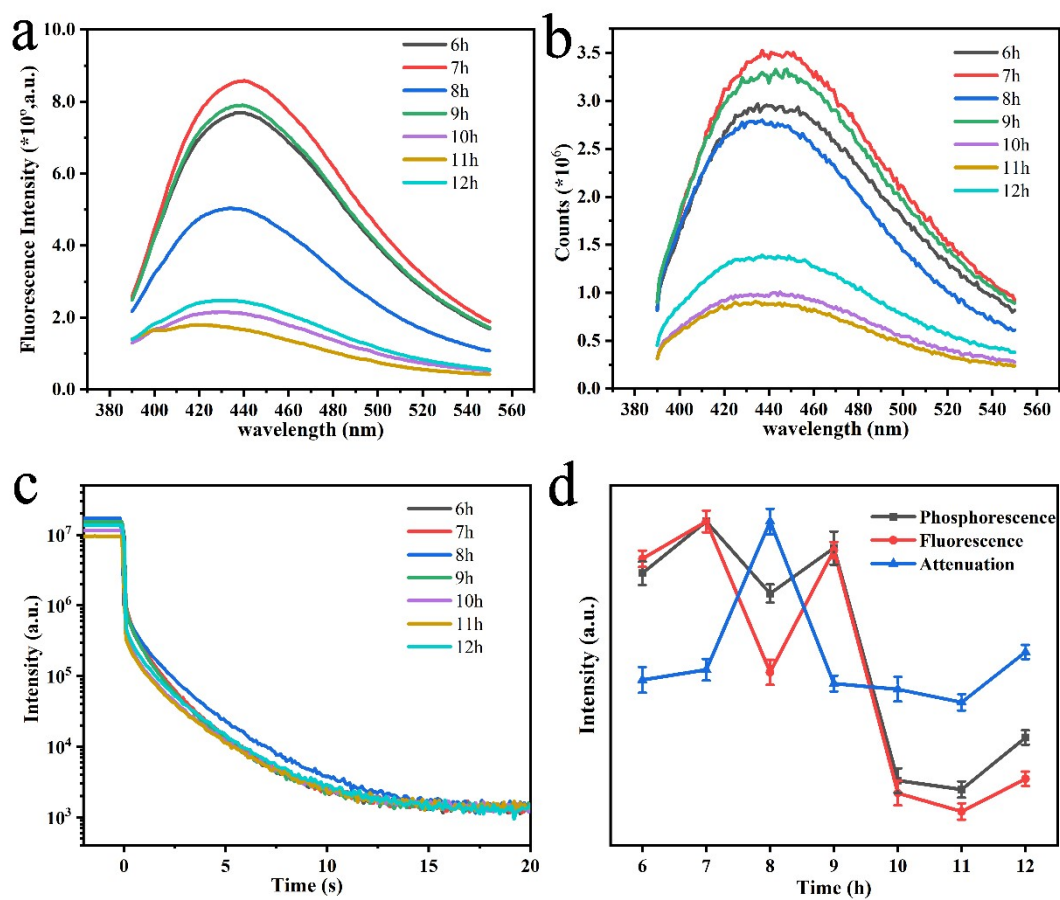
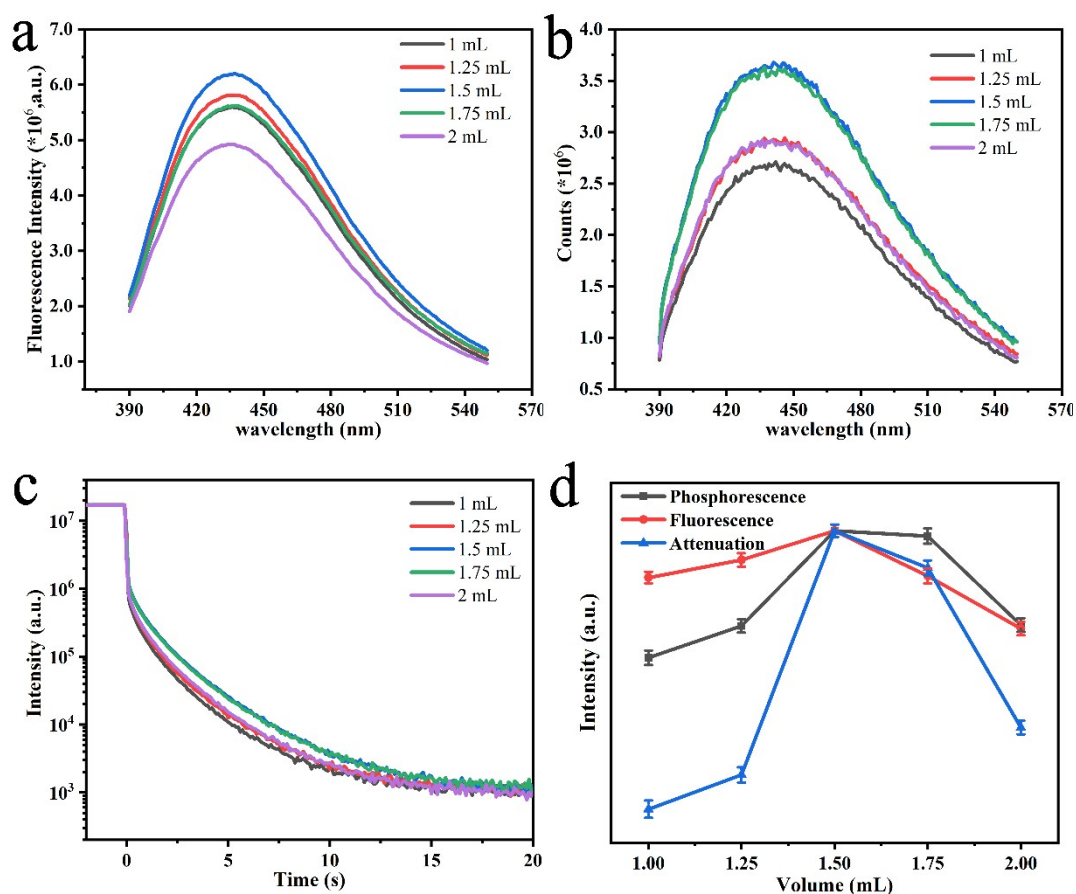


Figure S2. (a~c) Fluorescence spectra, phosphorescence spectra and attenuation curves of different reaction time; (d) Trend plot of intensity change when phosphorescence decays to 5s.

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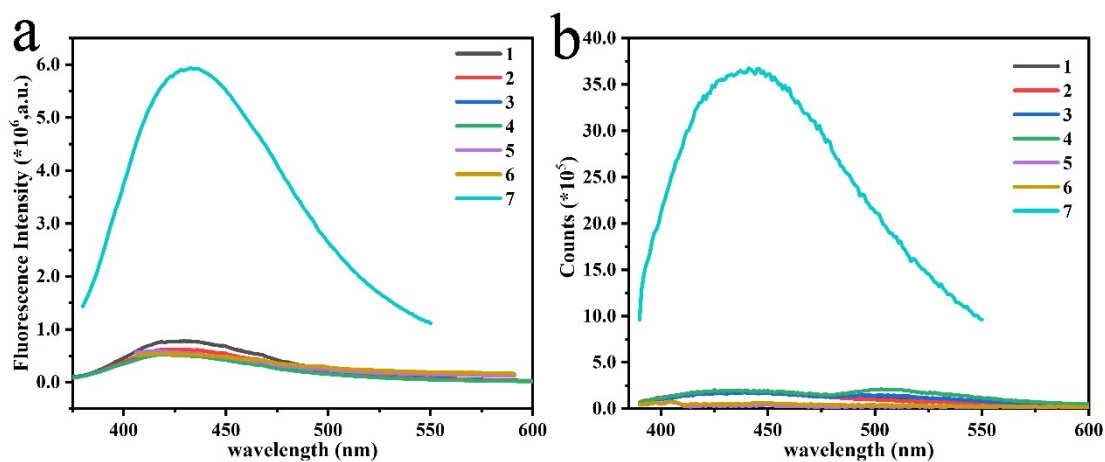


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3 **Figure S3.** (a-c) Fluorescence spectra, phosphorescence spectra and attenuation curves of different amounts of TEOS;

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(d) Trend plot of intensity change when phosphorescence decays to 5s.



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6 **Figure S4.** Fluorescence spectra (a) and phosphorescence spectra (b) of CDs@SiO₂ synthesized by six silanes as7 precursors and DF-CDs@SiO₂ (7).

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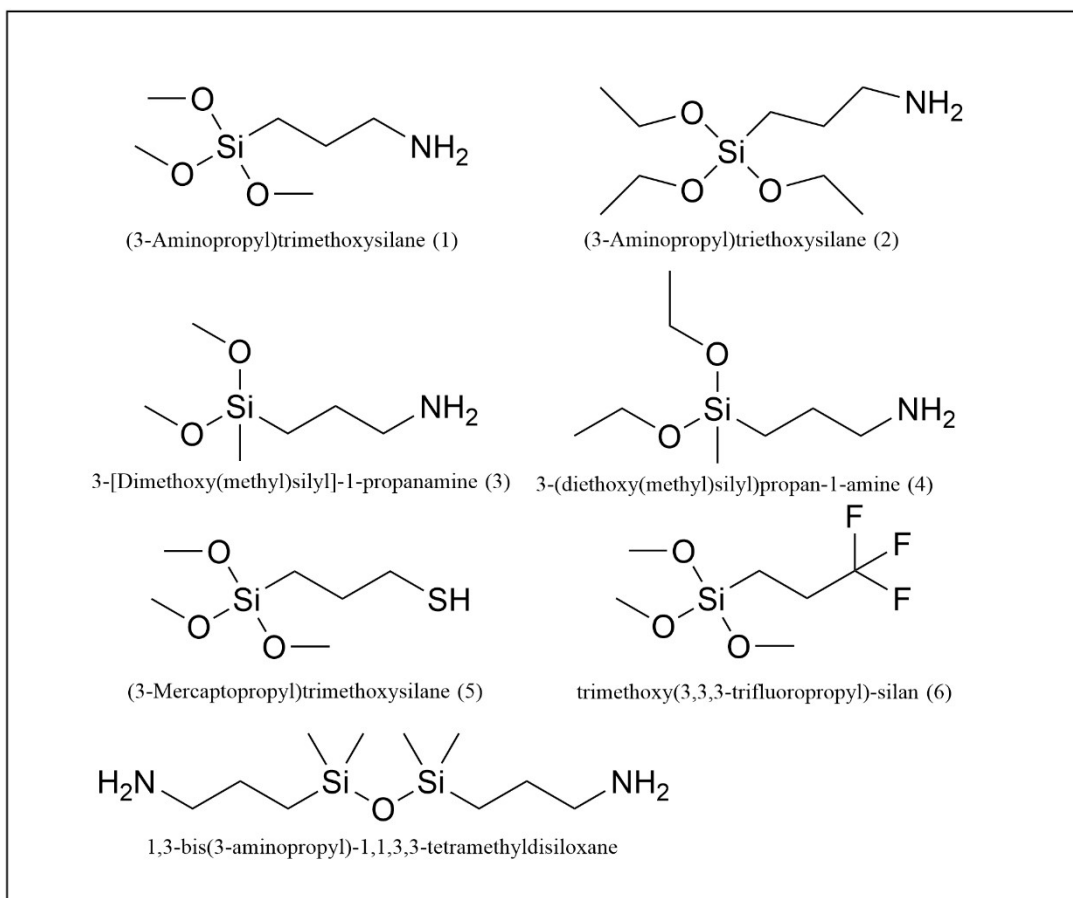


Figure S5. Structural for different silane reagents.

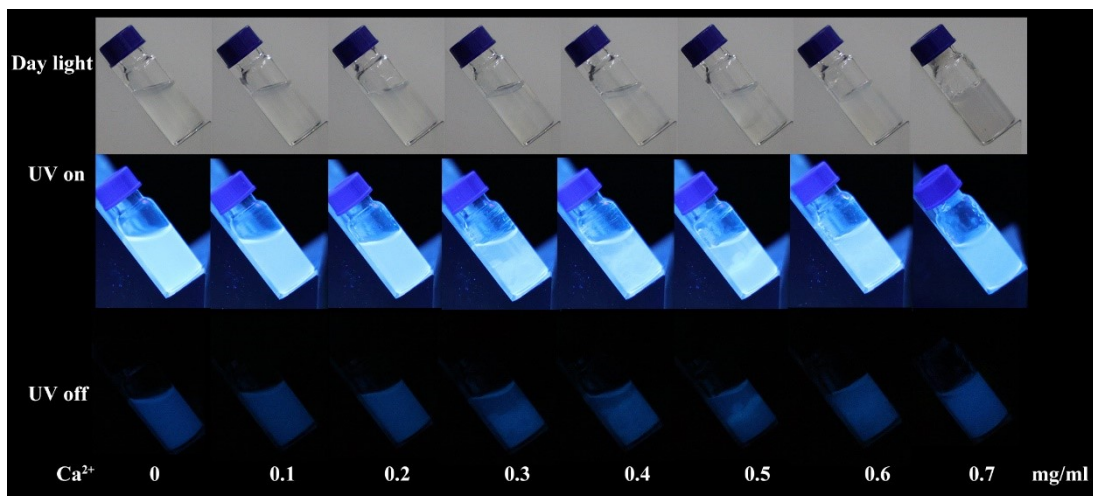


Figure S6. DF-CDs@SiO₂-Ga²⁺-gel prepared by adjusting calcium concentration without adding SA