Electronic Supplementary Material (ESI) for Nanoscale Advances.

Supporting Information

Crystallization-Induced Emission from F-Doping Carbon Dot

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1. Experimental Section

1.1. Materials. *m*-hydroxybenzaldehyde (99.0%), ethanol (99.7%), trifluoroethanol (99.7%), potassium carbonate and potassium bisulphate were purchased from Shanghai Titan Technology Co., LTD. Unless otherwise stated, all raw materials are used as is and no purification is required.

1.2. Synthesis of Multicolor CDs. *m*-Hydroxybenzaldehyde (1.0 g) was mixed with 15 mL trifluoroethanol for ultrasonication. The resulting mixture was then transferred to an autoclave lined with polytetrafluoroethylene. By heating the mixture in an oven at 180 °C for 6 hours and then allowing it to cool naturally to room temperature, a red fluorescent precursor solution was obtained. The CDs products that were filtered underwent purification through column chromatography, with silica gel as the stationary phase and a mixture of ethanol and dichloromethane as the eluent. We used 200-300 mesh silicone, eluted with a mixture of dichloromethane and ethanol (dichloromethane: ethanol = 9:1) and purified by silica gel column chromatography. The F-CDs product was obtained after three rounds of purification. In addition, H-CDs was prepared by the same method using ethanol instead of trifluoroethanol as solvent. After further rotary evaporation drying. The yield of F-CDs and H-CDs were 65.3±1.2% and 37.2±1.5%, respectively.

1.3. Preparation of CDs-LEDs. Take 0.2 g of F-CDs and evenly place them in a cylindrical stainless steel mold with a diameter of 13 mm. A semi-transparent fluorescent film was prepared by unidirectional extrusion under operating conditions of 16 MPa at room temperature. Cut it into rectangles and place it on a blue LED chip (460 nm) to prepare a white LED.

1.4. Characterization. Transmission electron microscopy (TEM) image was carried out using a FEI Tecani G2 F20 operating at an acceleration voltage of 200 kV. UV-vis spectra were recorded with a Shimadzu UV-2600 spectrometer. Fluorescence measurements were collected using a Shimadzu fluorescence spectrophotometer RF-6000. The Fourier transform infrared (FT-IR) spectra were obtained in transmission mode on a Thermal Scientific Nicolet iS5 spectrometer (Waltham, MA, USA) with the KBr pellet technique, and 8 scans at a resolution of 1 cm^{-1} were accumulated to obtain one spectrum. X-ray photoelectron spectroscopy (XPS) was investigated by using K-Alpha spectrometer with a mono X-Ray source Al Kα excitation (1486.6 eV). Binding energy calibration was based on C1s at 284.7 eV. Use HORIBA Scientific LabRAM HR Evolutio for Raman analysis. A 290 nm (<1 ns) and a 485 nm (<200 ps) nano-LED light source were used to excite the samples. The ^{1}H NMR and ^{13}C NMR spectra were obtained from Bruker Avance NEO 400 MHz in Germany. CIE chromaticity coordinate was measured by KONICA MINOLTA CS-150 colorimeter. Quantum yield (QY) measurements were conducted using a FLS1000 spectrometer (Techcomp, Livingston, Edinburgh, UK). Rhodamine B (QY = 56% in ethanol) for the red emission (Ex = 510 nm). Time-resolved PL decay data of carbon dots were obtained on Edinburgh Fluorescence Spectrometer (FLS920P) full-featured fluorescence spectroscopy system with an integrating sphere.

2. Supporting Figures

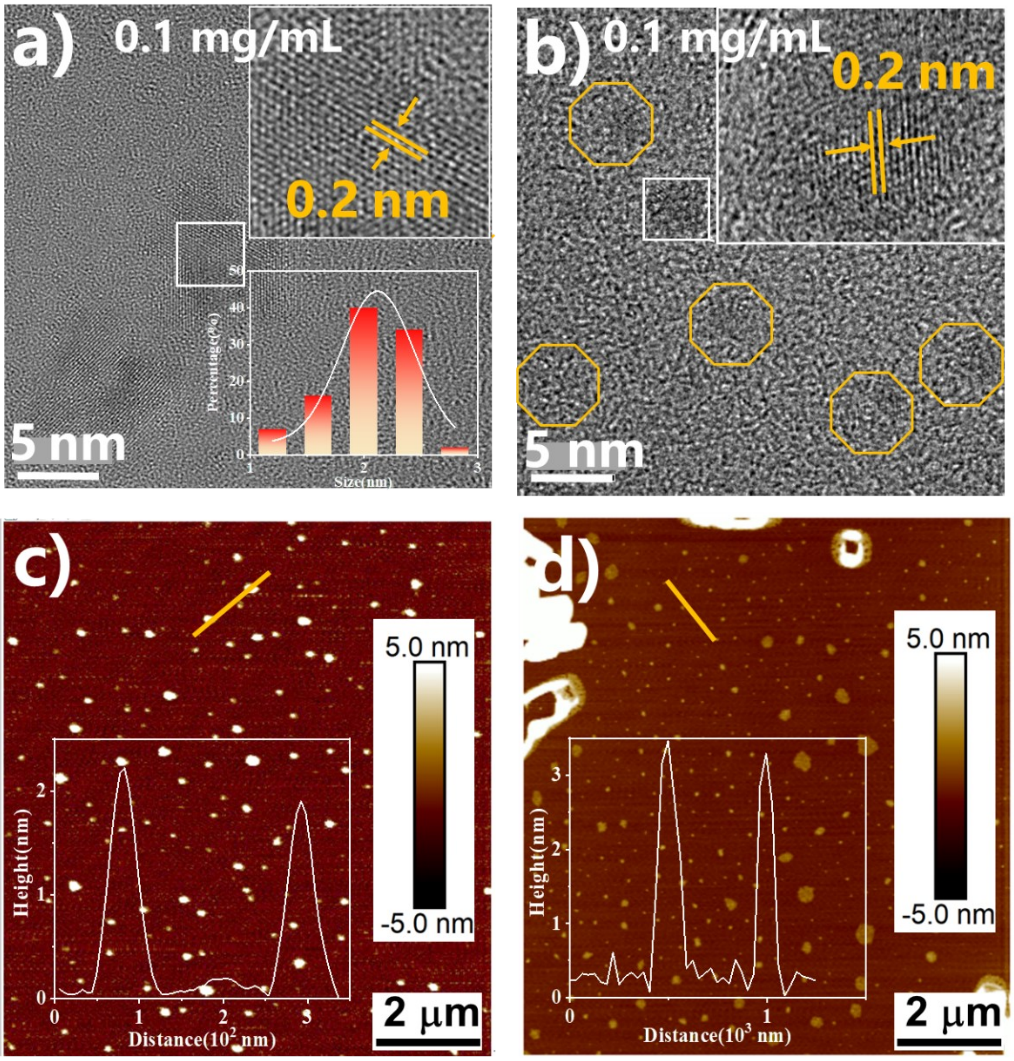

Figure. S1 HR-TEM images of a) F-CDs and b) H-CDs. AFM images of c) F-CDs and d) H-CDs.

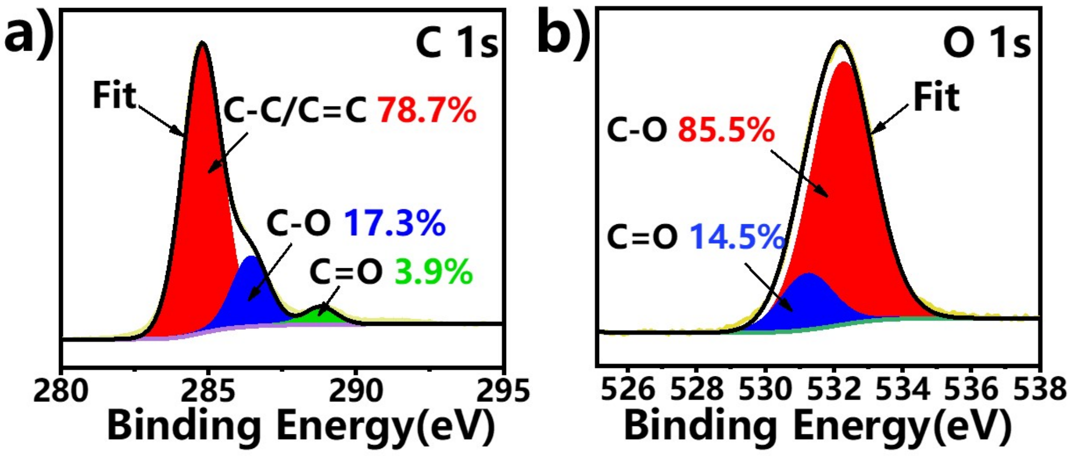

Figure. S2 XPS high-resolution a) C 1s and b) O 1s spectra for H-CDs, respectively.

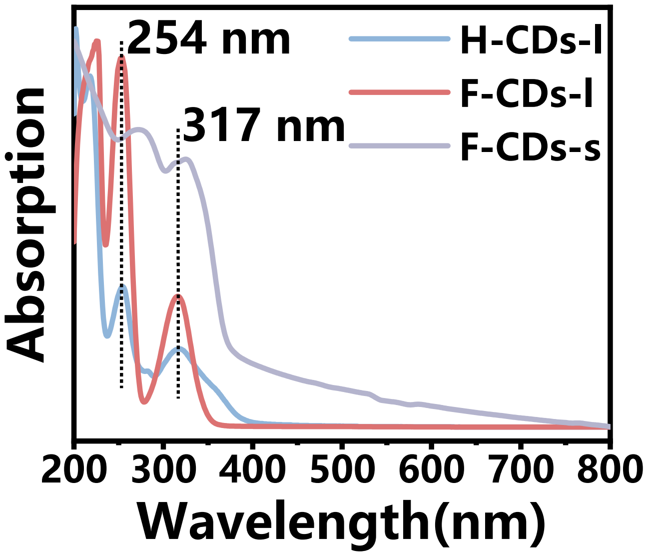

Figure. S3 UV/Vis absorption spectra of H-CDs in solution-state (H-CDs) and F-CDs in solution-state (F-CDs-l) and in solid-state(F-CDs-s).

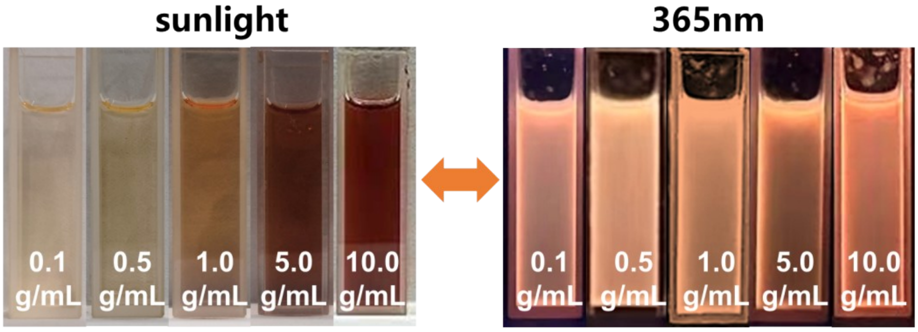

Figure. S4 Photographs for F-CDs solutions with different concentrations under sunlight and UV light (365 nm).

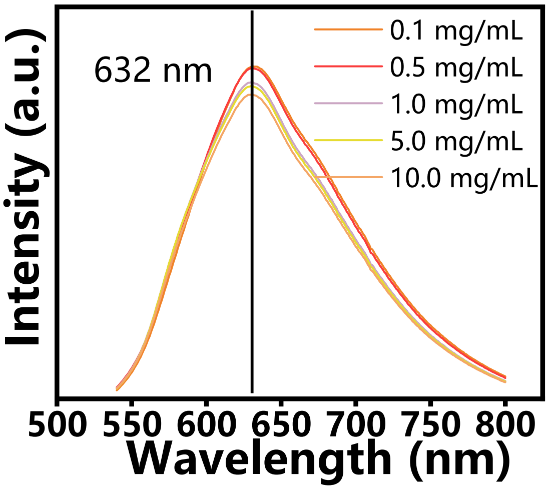

Figure. S5 PL emission spectra of F-CDs solutions with different concentrations.

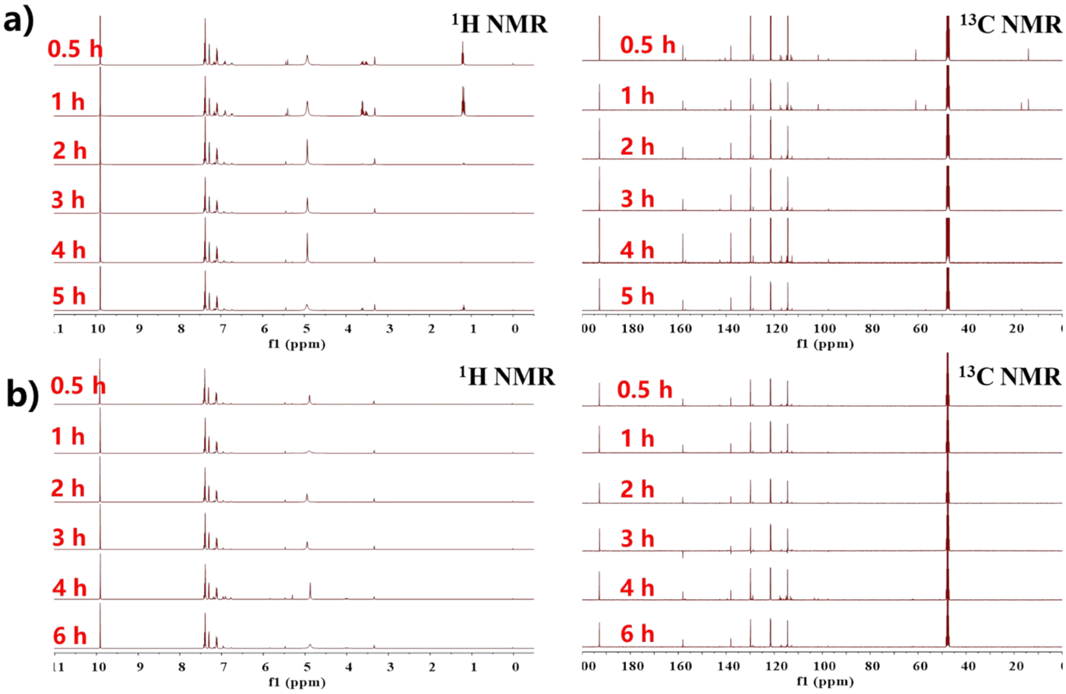

Figure. S6 ^{1}H-NMR and ^{13}C-NMR spectra of a) H-CDs and b) F-CDs at different reaction times in MeOD.

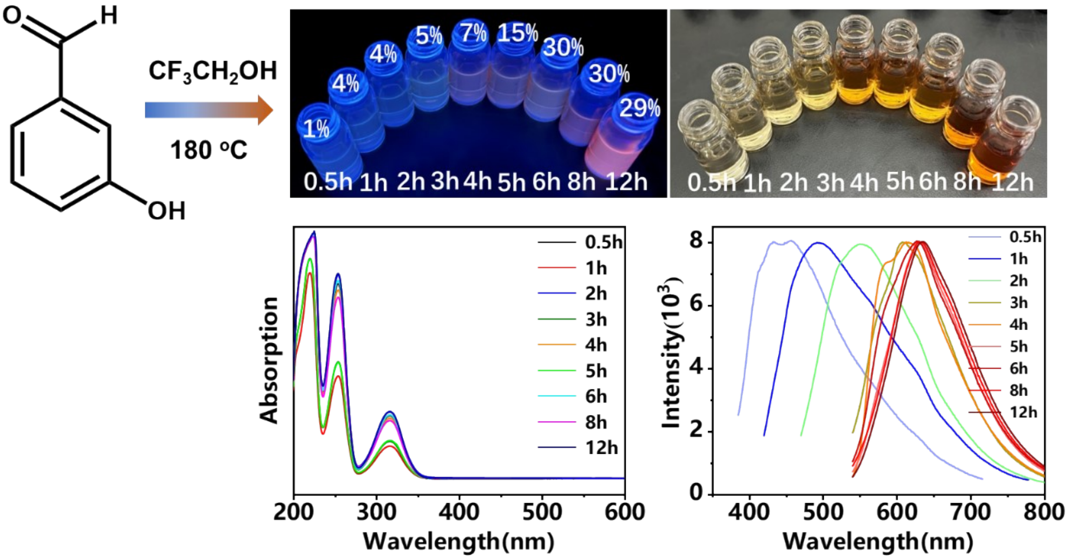

Figure. S7 Photographs for F-CDs under UV light (left) and daylight (right) at different reaction times. PL emission spectra for F-CDs at different reaction times.

Figure. S8 Photographs for F-CDs solid state under daylight and UV light (365 nm) at different reaction times, respectively.

Figure. S9 Photographs of different isomers of hydroxybenzaldehyde as raw materials under sunlight and UV light (365 nm).

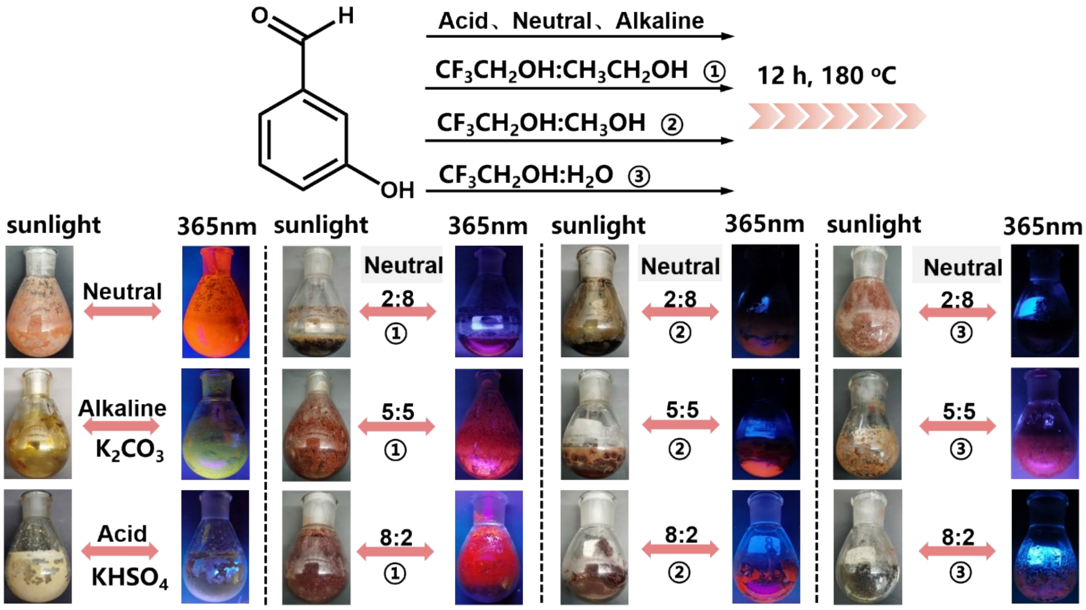

Figure. S10 Photographs of CDs prepared in different reaction environments under sunlight and UV light (365 nm).

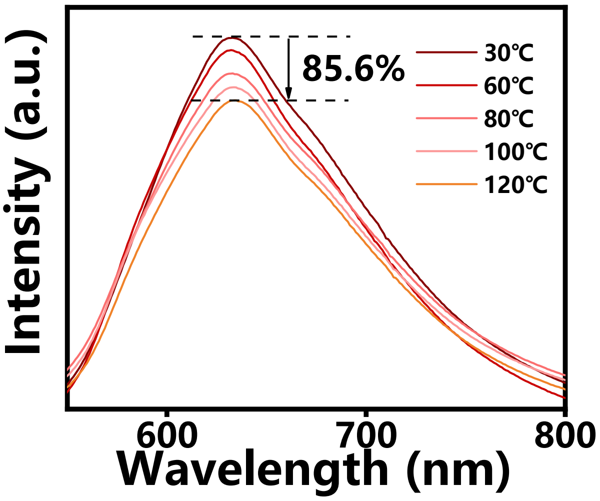

Figure. S11 PL emission spectra of F-CDs in a oil bath at different temperatures in ethanol solution.