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Supporting Information

Visual Multiple Color Emission of Solid-State Carbon Dots

Jing Yang, Yong Liu, Jing Wang, Song Wang, Xinzhe Zhou and Huanrong Li**

Dr. J. Yang, Dr. X. Z. Zhou, Prof. H. R. Li
School of Chemical Engineering and Technology, Hebei University of Technology, Tianjin 300130, P.R. China
E-mail: lihuanrong@hebut.edu.cn

Dr. Y. Liu, Prof. J. Wang
School of Chemistry and Chemical Engineering, Sun Yat-sen University, Guangzhou, Guangdong 510275, P. R. China
E-mail: ceswj@mail.sysu.edu.cn

Prof. S. Wang
Hubei Key Laboratory Low Dimensional Optoelectronic Materials and Devices, Hubei University Arts and Science, Xiangyang, Hubei 441053, P. R. China

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Experimental Section

Materials: Laponite (Lap) was purchased from Rockwood Additives Ltd. Citric acid (CA) and thiourea (TU) were purchased from Aladdin. Acetone was purchased from Fuchen (tianjin) reagent Co. Ltd. HCl were purchased from Tianjin Chemical Co. Ltd. All chemicals were commercially available, of analytical grade and were used without any further purification.

Synthesis of SNC/Lap: Multiple color emissive SNC/Lap were synthesized by using different molar ratios of CA to Tu in acetone containing an appropriate amount of Lap at different temperatures (160°C, 180°C, 200°C, 240°C) for different time. Typically, the synthesis method of 1 as follows: 0.95 g Lap were dispersed in 10 mL acetone and was stirred for 0.5 h. Then 1.7 mmol CA and 1 mmol Tu were added into the acetone and stirred for 0.5 h. The mixture was transferred into 50 mL Teflon-lined stainless-steel autoclave and heated at 240 °C for 6 h. The resultant mixture was centrifuged to remove supernatant. Then the precipitation was dried for 12 h under vacuum and followed by fine grind. In the same way, a series of SNC/Lap can be synthesized by adjusting the ratios of CA to Tu, the amount of Lap and the temperature and time of reaction.

The procedure of etching the Lap with hydrochloric acid: 0.05g SNC/Lap was dispersed in 30 mL HCl (1 mol/L) and was stirred over night, Then centrifuged at 11,000 rpm for 20 min, and further purified with a 0.22 μm filter membrane to discard the Lap. The supernatant was collected for further characterization.

LED Fabrication: LED was fabricated by coating the mixture obtained by only mixing the SNC/Lap with silicone in 2:1 mass ratio on a blue chip (450 nm, 3 V, 30 mA, Sanan optoelectronic Co. Ltd.). After vacuum treatment to remove air bubbles, the mixture was coated on the lead frame and solidified under 60 °C for 4 h to produce LED. The LED was operated at 3.0 V with drive current 20 mA.

Characterization: X-ray powder diffraction (XRD) studies were completed with an X-ray powder diffractometer (BRUKER D8 Focus) complying Cu Kα radiation (λ = 1.5418 Å), operating at 40 kV and 40 mA. The IR spectra were obtained on a Bruker Vector 22 spectrometer from 4000 to 400 cm^{-1} at a resolution of 4 cm^{-1} (16 scans collected). The UV spectrum was obtained on an

Agilent Carry 100 UV spectrometer, from 200 to 800 nm. The steady-state luminescence spectra and the lifetime measurements were measured on an Edinburgh Instruments FS920P spectrometer, with a 450 W xenon lamp as the steady state excitation source, a double excitation monochromator (1800 lines mm^{-1}), an emission monochromator (600 lines mm^{-1}) and a semiconductor cooled Hamamatsu RMP928 photo multipliertube. The quantum yield of the samples was measured using a barium sulfate coated integrating sphere (150 mm in diameter) attached to the FS920P. SEM images were obtained from a Nova Nano SEM 450 at an acceleration voltage of 15 kV. TEM images were obtained from a FEI Tecnai G2 F20 transmission electron microscopy. Surface analysis was achieved with a ESCALAB 250Xi x-ray photoelectron spectrometer (XPS).

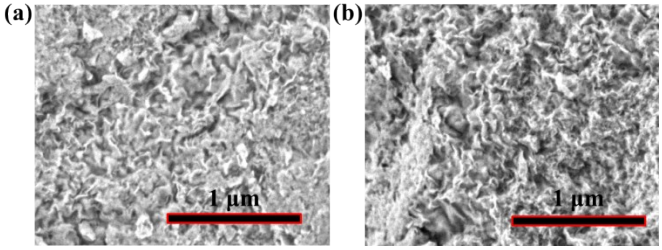

Figure S1. SEM images of (a) Lap and (b) SNC/Lap.

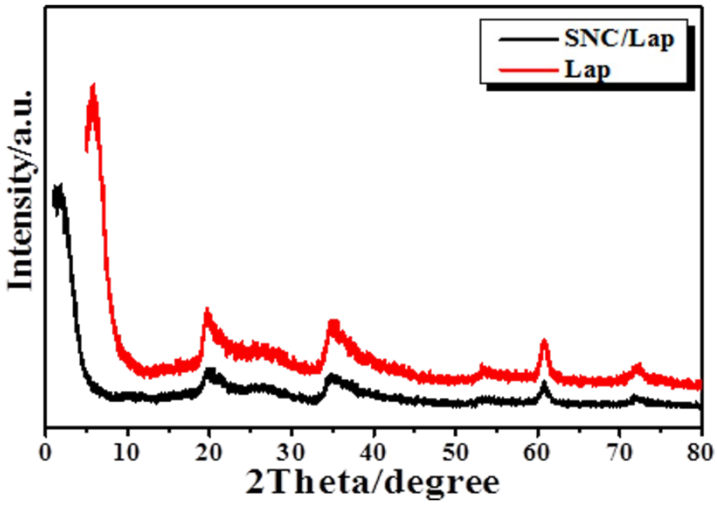

Figure S2. XRD patterns of pristine Lap and ***1.***

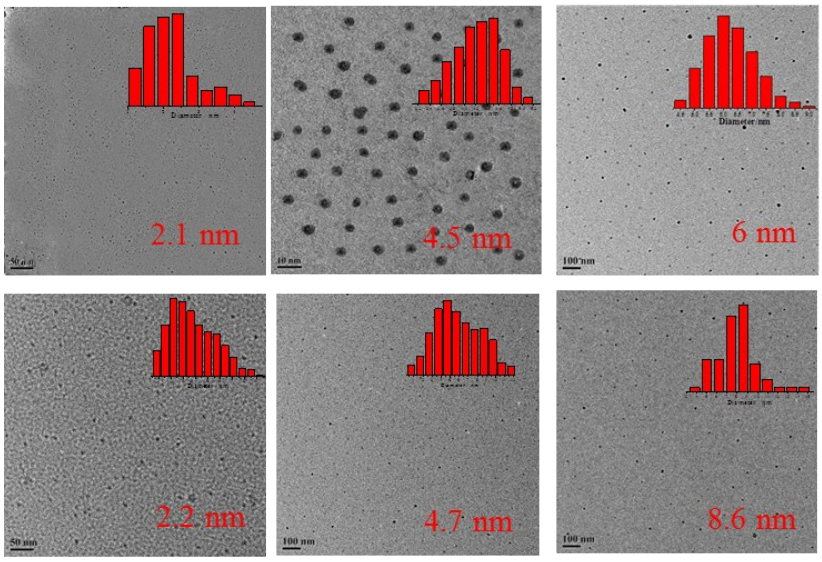

Figure S3. The size distributions of the corresponding e-SNC in Figure 2.

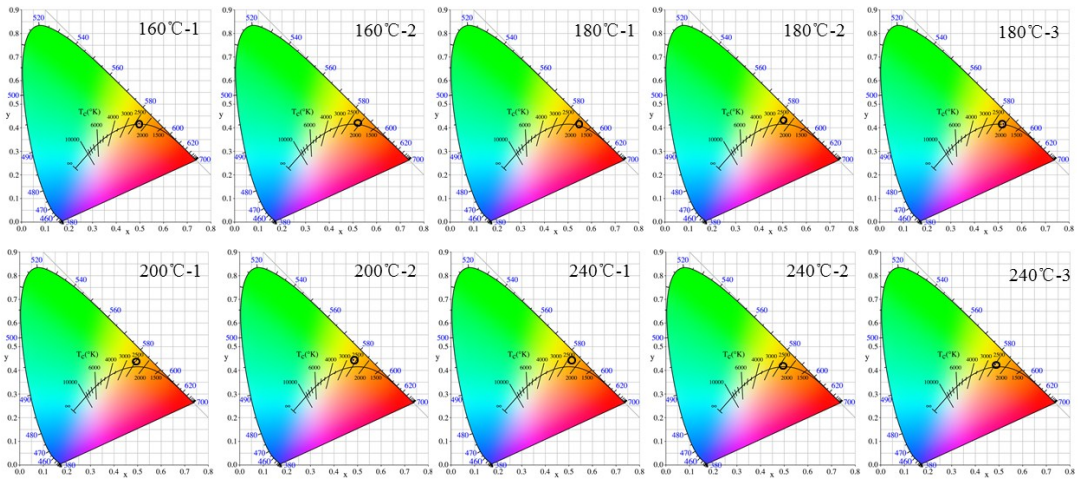

Figure S4. The corresponding emission colors of part of the samples in Figure 3 in the manuscript in the CIE 1931 chromaticity diagram.

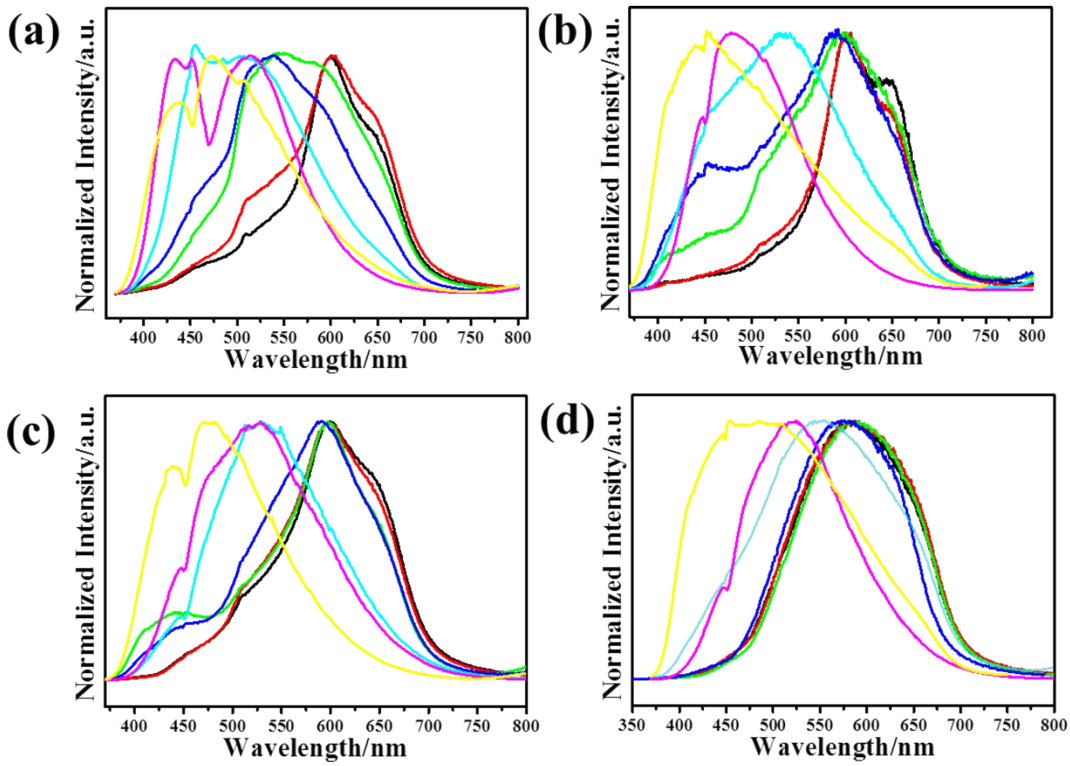

Figure S5. The PL emission spectra of SNC/Lap prepared at different molar ratios of CA to Tu and different reaction temperatures ((a) 160°C, (b) 180°C, (c) 200°C and (d) 240°C , 1 mmol Tu, 0 mmol CA (black line); 1 mmol Tu, 0.08 mmol CA (red line); 1 mmol Tu, 0.3 mmol CA (green line); 1 mmol Tu, 0.7 mmol CA (blue line); 1 mmol Tu, 2 mmol CA (cyan line); 1 mmol Tu, 2.5 mmol CA (magenta line); 0 mmol Tu, 1 mmol CA (yellow line)).

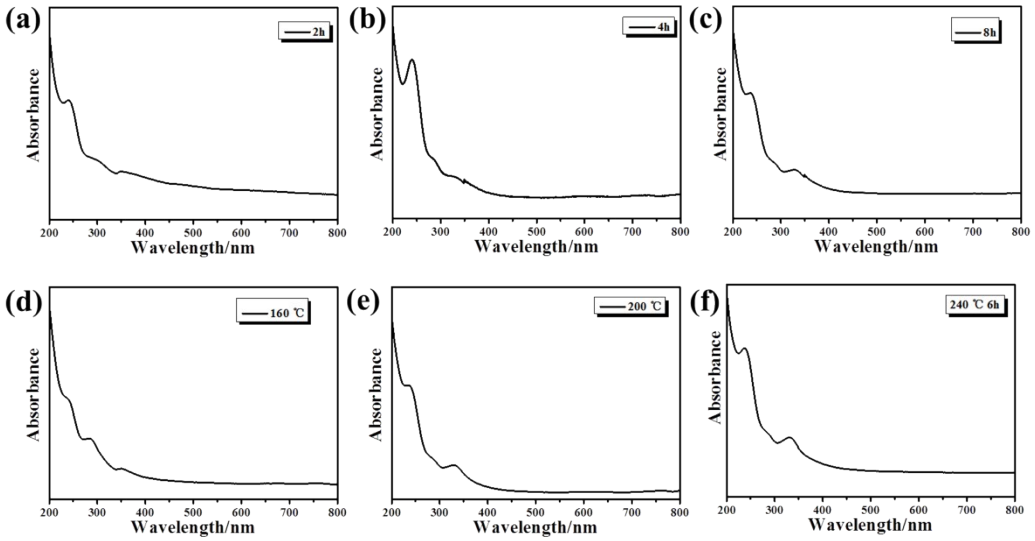

Figure S6. The absorption spectra of the typical SNC/Lap prepared by heating 1 at 240 °C for 2 h (a), 4 h (b), 6 h (f) and 8 h (c), as well as the typical SNC/Lap prepared by heating 1 at 160 °C (d), 200 °C (e) and 240 °C for 6 h.

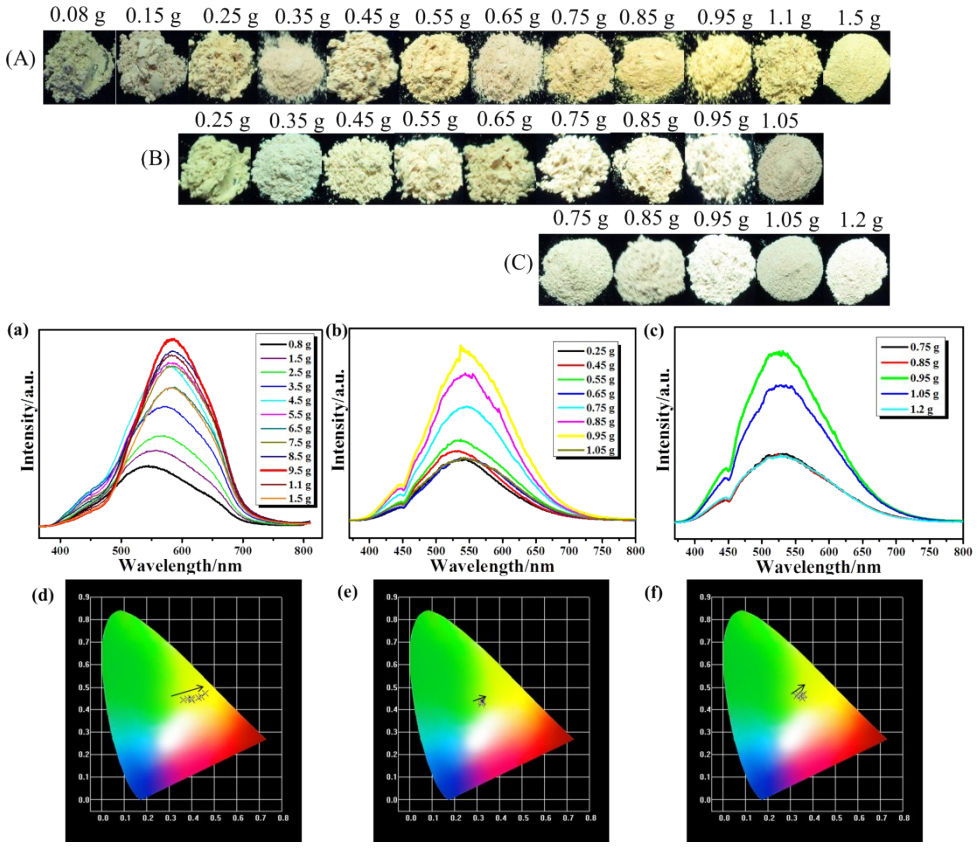

Figure S7. The digital photos of the SNC/Lap prepared by heating 1 mmol Tu and (A) 1.7 mmol, (B) 2.5 mmol and (C) 3 mmol CA in 10 mL acetone containing different amounts of Lap at 240°C for 6 h taken under 365 nm UV light. (a), (b) and (c) are their PL emission spectra, respectivaly.

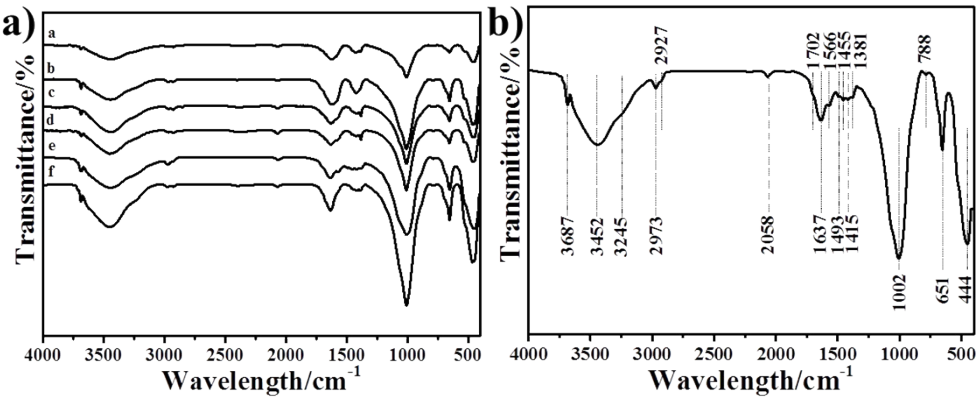

Figure S8. FT-IR spectra of the SNC/Lap prepared by heating 1 mmol Tu and 1.7 mmol CA at 240 °C for 2 h, 4 h, 6 h, 8 h and 1 mmol Tu and 0.7 mmol CA at 240 °C for 6 h as well as 1 mmol Tu and 0.7 mmol CA at 160 °C for 6 h in a) from top to dwon, respectively, and b) ***1***.

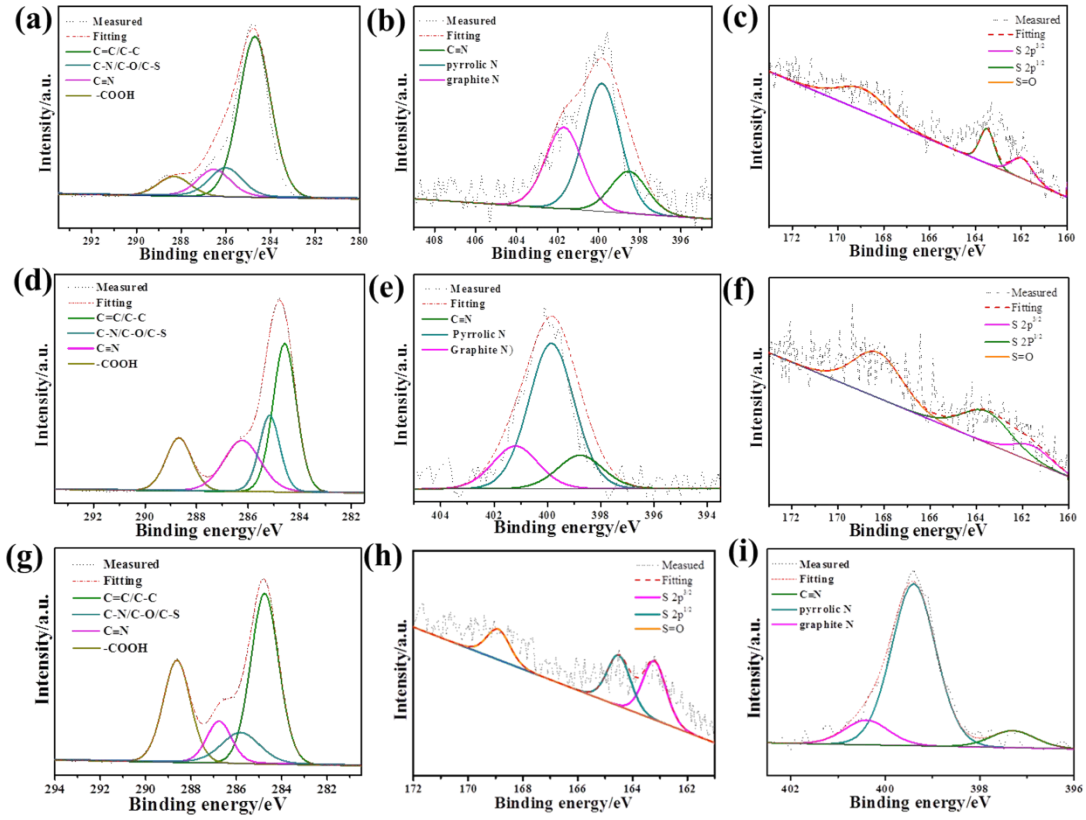

Figure S9. The high-resolution XPS spectra of the typical SNC/Lap prepared by heating ***1*** at (a-c) 160 °C, (d-f) 200 °C for, and (g-i) 240 °C for 6h, respectively.

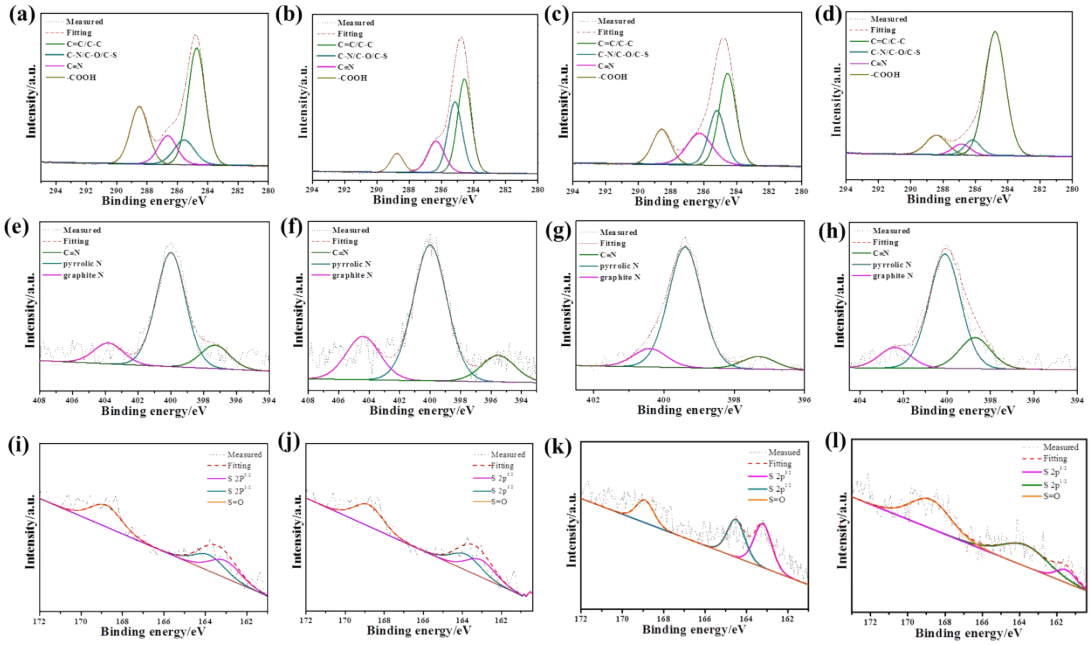

Figure S10. The high-resolution XPS spectra of the typical SNC/Lap prepared by heating ***1*** at 240 °C for 2 h (a, e and i), 4 h for (b, f and j), 6 h for (e, g and k) and 8 h (i, h and l) , respectively.

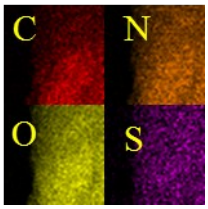

Figure S11. The mapping analysis of ***1***.

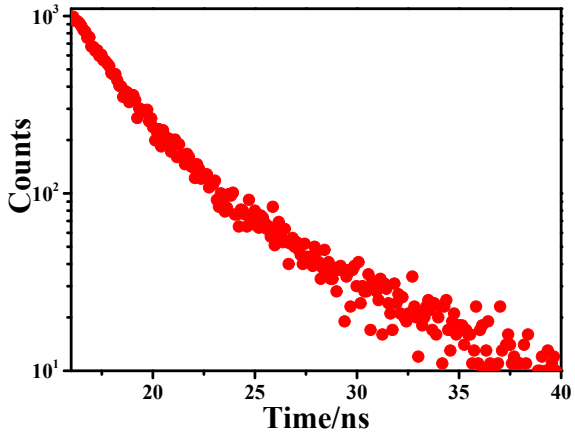

Figure S12. The fluorescence decay curve of ***1***.

Table S1. The detail synthesis conditions of SNC/Lap in Figure 2a.

Simple	Lap	Acetone	CA	Tu	CA/Tu
1	0.35 g	10 mL	0 mmol	1 mmol	0
2	0.35 g	10 mL	0.05 mmol	1 mmol	0.05
3	0.35 g	10 mL	0.08 mmol	1 mmol	0.08
4	0.35 g	10 mL	0.3 mmol	1 mmol	0.3
5	0.35 g	10 mL	0.7 mmol	1 mmol	0.7
6	0.35 g	10 mL	1.2 mmol	1 mmol	1.2
7	0.35 g	10 mL	1.7 mmol	1 mmol	1.7
8	0.35 g	10 mL	2 mmol	1 mmol	2
9	0.35 g	10 mL	2.5 mmol	1 mmol	2.5
10	0.35 g	10 mL	1 mmol	0 mmol	/

Table S2. The lifetime of the samples in Figure 3.

Time	2 h	4 h	6 h	8 h
$\tau_{SNC/Lap}$	2.00 ns	3.10 ns	3.95 ns	4.05 ns

Table S3. The lifetime of the samples prepared by heating ***1*** different temperature for 6 h.

Temperature	160 °C	200 °C	240 °C
$\tau_{SNC/Lap}$	2.75 ns	3.08 ns	3.95 ns