Supporting Information

Insights into Fluorophores of Dual-Emissive Carbon Dots Derived by Naphthalenediol Solvothermal Synthesis

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S1. Purification of Molecular Fluorophores

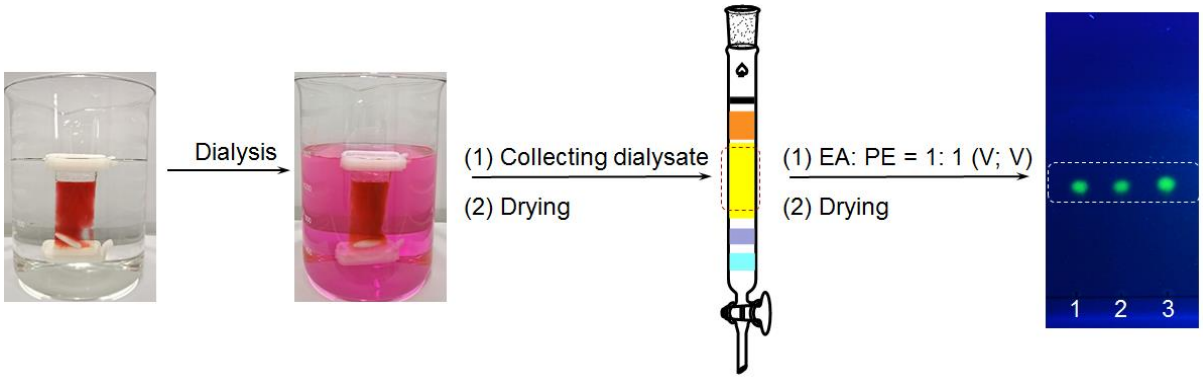

Figure S1 Detail separation route of the molecular fluorophores. The crude carbon dot products were firstly dialyzed against water for 7 days, then the dialysate outside the dialysis bag was collected, dried and sent to silica gel column chromatography. The separation was conducted for three times, each of which only the yellow fraction was collected. By freeze drying, the solid powder of the molecular fluorophores was obtained (totally ~25 mg for 4 reactions and the yield is estimated to be ~13%). The thin layer chromatography (TLC) plate shows only single spots (dashed frame). Numbers 1, 2 and 3 represent three batches.

S2. HPLC-ESI-MS Analysis of ECNO

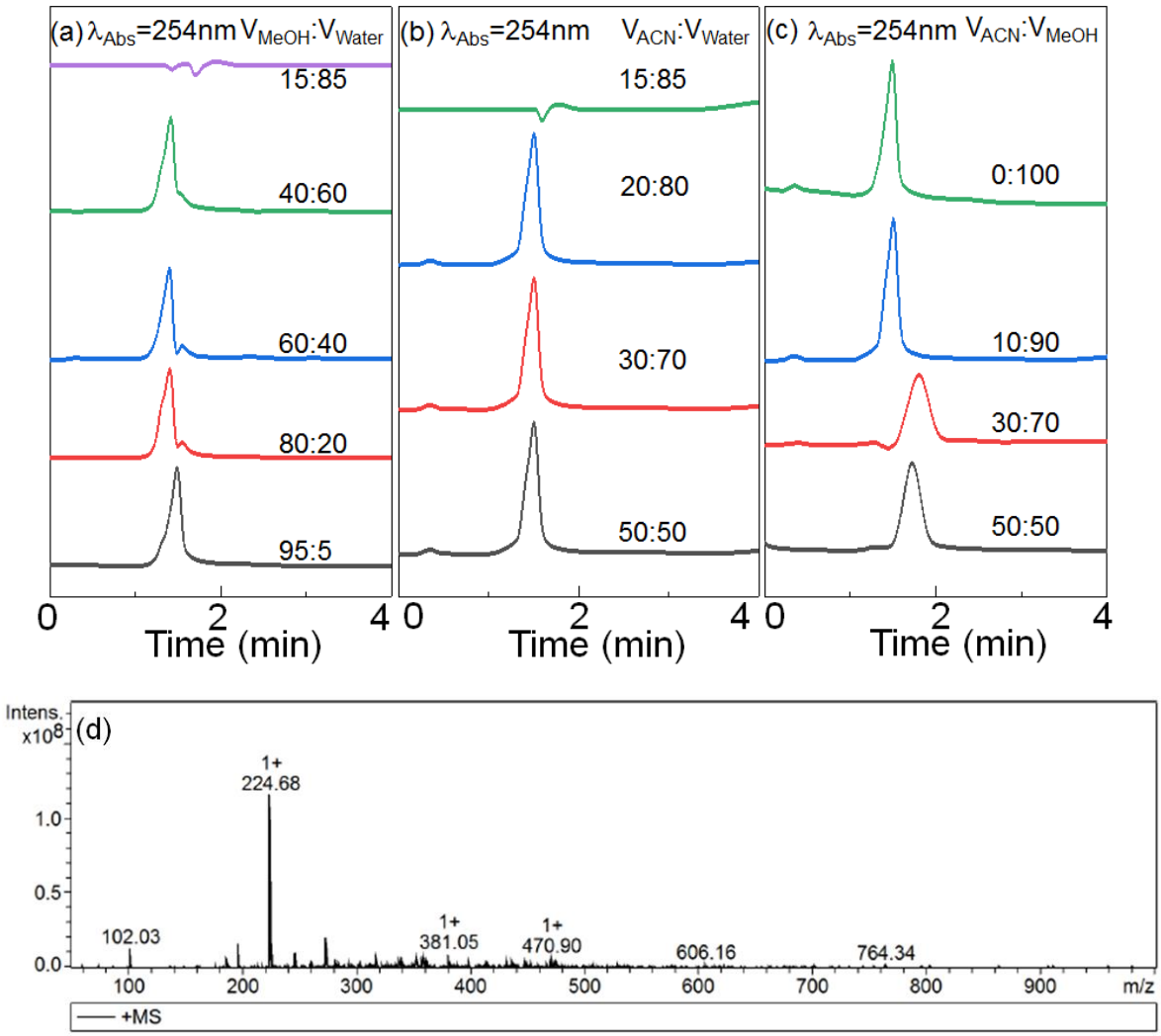

Figure S2 (a-c) HPLC profile of the ECNO solution in methanol/water (a), acetronile/water (b) and acetronile/methanol (c). (d) HPLC-ESI-MS of ECNO showing molecular ion peak with m/z (ESI^+) = 224.68 and indicating a small molecular feature.

S3. HR-FTMS Analysis of ECNO

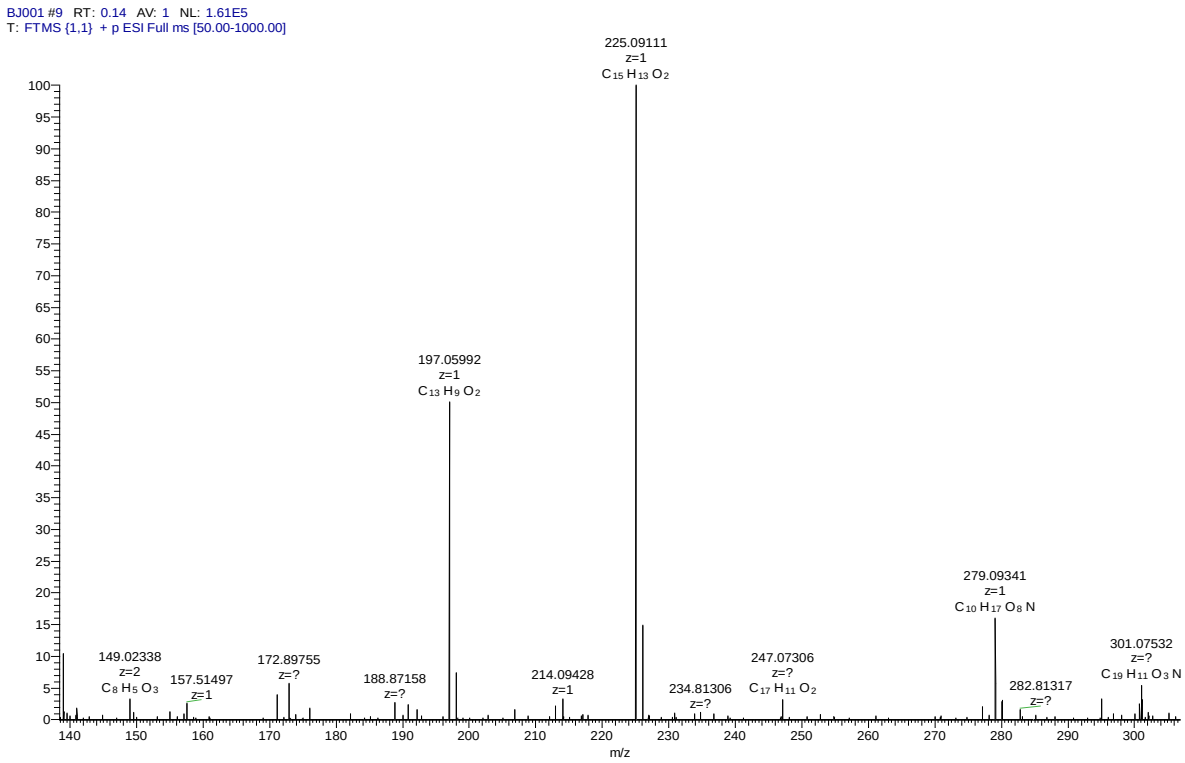

Figure S3 High-resolution mass spectrum of ECNO showing molecular ion peak with m/z (ESI^+) = 225.0911 and indicating molecular formula $C_{15}H_{13}O_2$.

S4. ^{1}H NMR Spectrum of ECNO

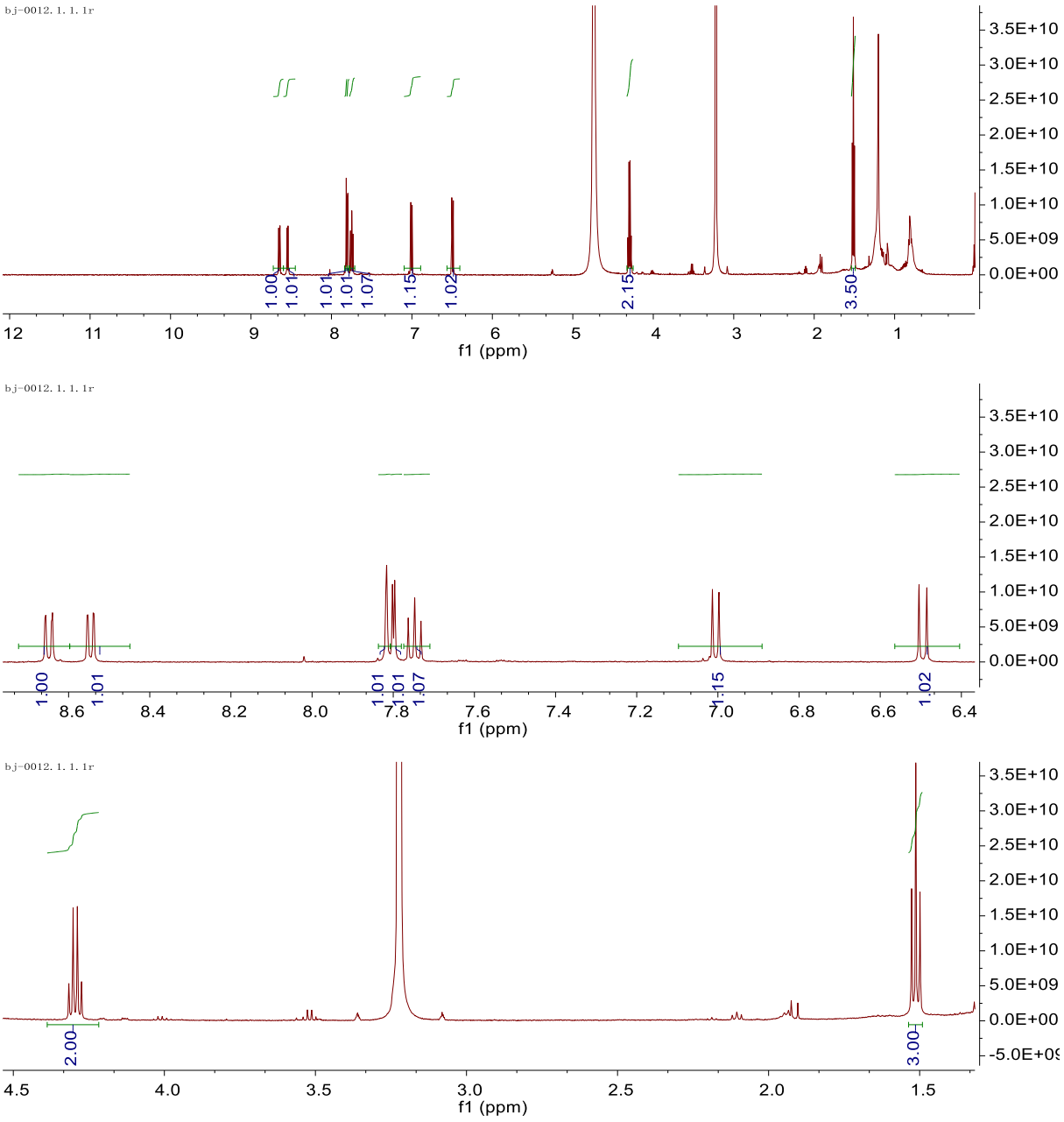

Figure S4 ^{1}H NMR spectra of ECNO (signals around 3.2 ppm and 4.7 ppm comes from H_2O and methanol. The signals in 0.5-1.4 ppm are from residual eluent of petroleum ether. Upper, full spectrum; middle, aromatic region; lower, aliphatic region.

S5. ^{13}C NMR Spectrum of ECNO

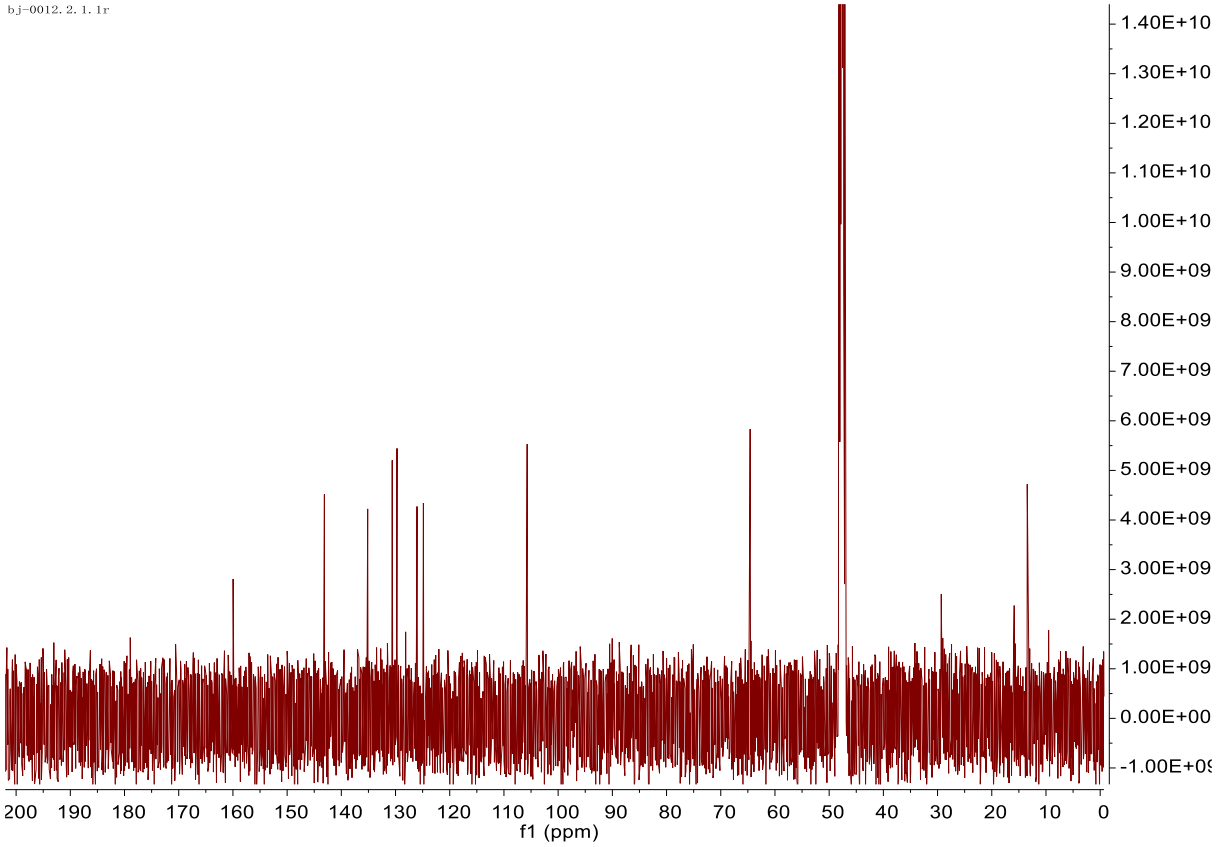

Figure S5 ^{13}C NMR spectra of ECNO (signals around 47 ppm comes from methanol).

S6. DEPT-90 and DEPT-135 Spectra

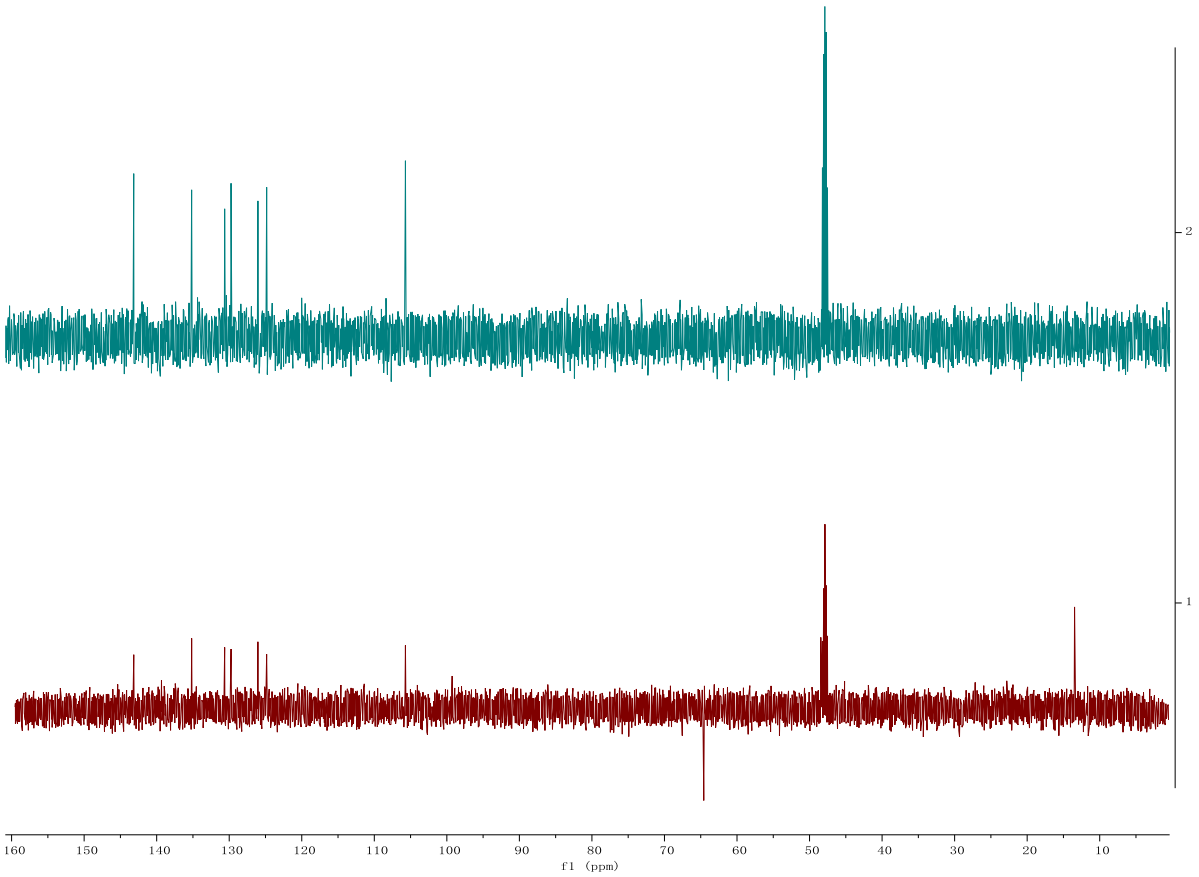

Figure S6 DEPT-90 (upper) and DEPT-135 (lower) spectra of ECNO. DEPT-90 reveals information about methine (CH) carbon while DEPT-135 gives signals for other three types of carbon atoms such as methine (CH), methylene (CH_2) and methyl (CH_3). Methine (CH) carbon peaks appear at δ 143.2, 135.2, 130.6, 129.7, 125.0, 124.9 and 105.7 ppm. Methine (CH) and methyl (CH_3) carbon have positive signals whereas methylene (CH_2) carbon has negative signals in DEPT-135 that allows differentiation between them. Signals at 13.5 and 64.5 ppm appear in DEPT-135 while absent in DEPT-90, which correspond to methyl (CH_3) and methylene (CH_2) carbon respectively. Absence of signals relative to ^{13}C NMR in DEPT-90 and DEPT-135 is an indication of quaternary carbon.

S7. Possible Mechanism of the Formation of ECNO

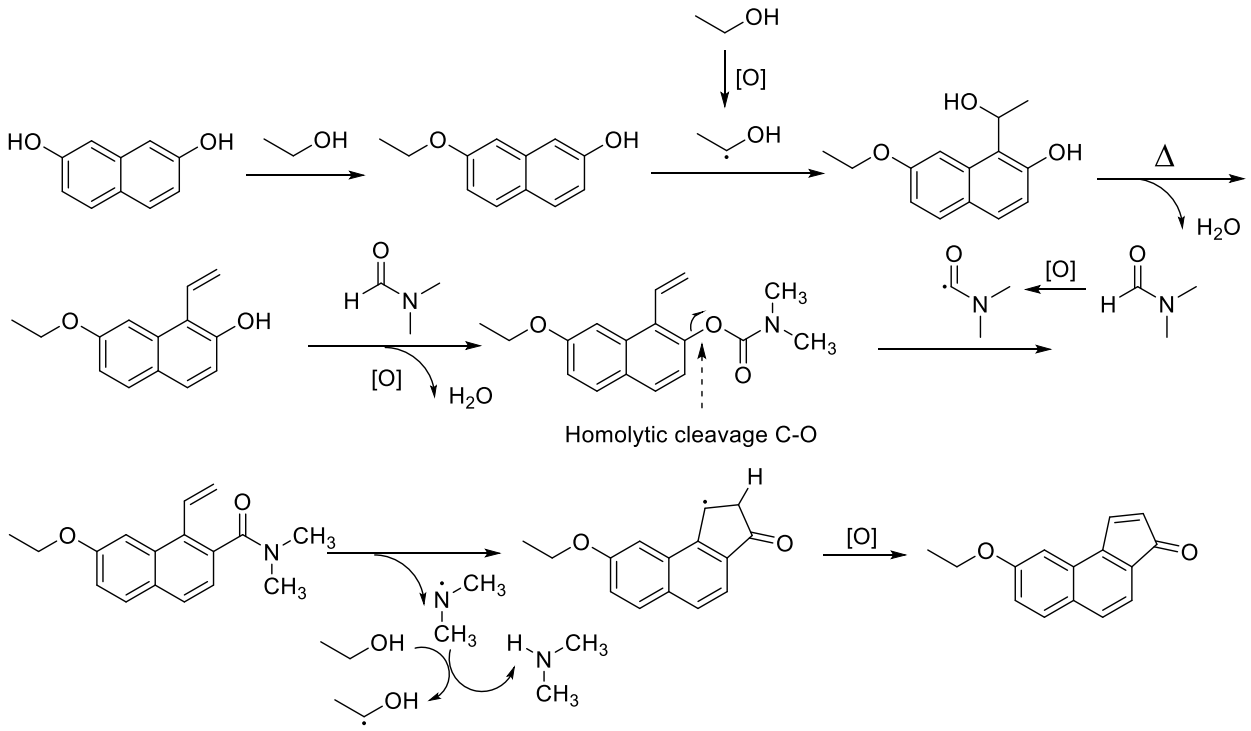

Figure S7 Possible mechanism of the formation of ECNO.

S8. Purification of C-dots

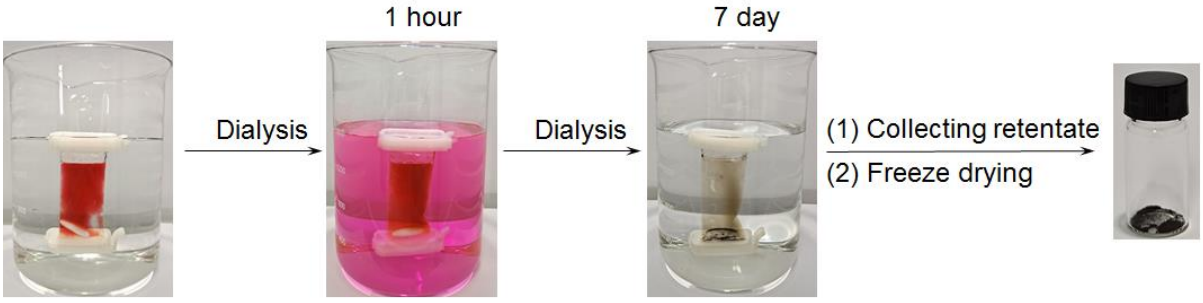

Figure S8 Detail separation route of C-dots. The crude carbon dot products were dialyzed against water for 7 days, then the retentate fraction was collected and freeze-dried for further analysis (totally ~10 mg for 4 reactions and the yield is estimated to be ~5%).

S9. Narrow-Band Emission Carbon Dots

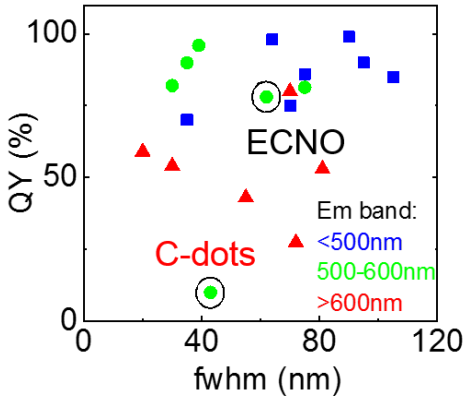

Figure S9 The summarized fwhm and QY values of carbon dots from selected publications. Blue cubes, green circles and red triangles represent that the emission peak is < 500 nm, 500-600 nm and > 600 nm, respectively. The cited data and references are presented in **Table S1**.

Table S1. Emission parameters of narrow band carbon dots in recent publications.

Emission color	λ_{em} (nm)[a]	fwhm (nm)[b]	QY (%)[c]	Ref
Blue	440	20	21	[1]
Blue	450	100	6.7	[2]
Red	610	82	20.6	[3]
Green	550	110	28.9	[4]
Red	620	85	12.9	[5]
Red	630	120	26.2	[6]
Orange	590	95	21	[7]
Red	650	81	53	[8]
Blue	450	100	74	[9]
Green	560	160	13.4	[10]
Blue	500	90	9.4	[11]
Green	550	120	16.5	[12]
Blue	430	70	75	[13]
Green	512	75	81.4	[14]
Red	620	72	27.4	[15]
Red	630	70	80	[16]
Red	715	55	43	[17]
Orange	600	30	82	[18]
Red	598	30	54	[19]
Red	660	20	59	[20]
Blue	425	95	90	[21]
Blue	420	105	85	[22]
Blue	430	64	98	[23]
Blue	430	75	86	[24]
Blue	410	90	99	[25]
Green	535	35	90	[26]
Blue	400	35	70	[27]
Green	519	39	96	[28]

[a]Central emission wavelength; [b]Emission spectral width; [c]Emission quantum yield.

S10. Photostability Tests

Photostability tests were carried out by transferring 10 mL of ECNO or C-dot solution (1mg/mL) into glass vials, and exposed to a xenon lamp (PLS-SXE 300 W) at a constant light intensity of 65 mW/cm^2 without filter. The samples were taken out at irradiation time of 0, 2, 4, 6, 8, and 10 hours and wrapped with aluminum foil, and then these sample were to conduct absorption and emission measurements to test the photostability.

Figure S10 The experimental setup of photostability test.

S11. Polymer Composite Film Preparation

Poly(vinyl pyrrolidone) (PVP) casting film. 100 μL of ECO ethanol solution (1mg/mL) and 1 mL of PVP (MW= 1,300,000 g/mol, SINOPHARM) aqueous solution (50 mg/mL,) were vortex mixed (IKA, Staufen, Germany)) homogeneously for 60 min. Then 100 μL of mixed solution was cast onto quartz slides and dried overnight under ambient conditions to obtain the composite films.

Poly(vinyl pyrrolidone) (PVA) casting film. 100 μL of ECO ethanol solution (1mg/mL) and 1 mL of PVA (PVA 124, MW = 105 kDa, SINOPHARM) aqueous solution were vortex mixed homogeneously for 60 min. Then 100 μL of mixed solution was cast onto quartz slide and dried overnight under ambient conditions to obtain the composite films.

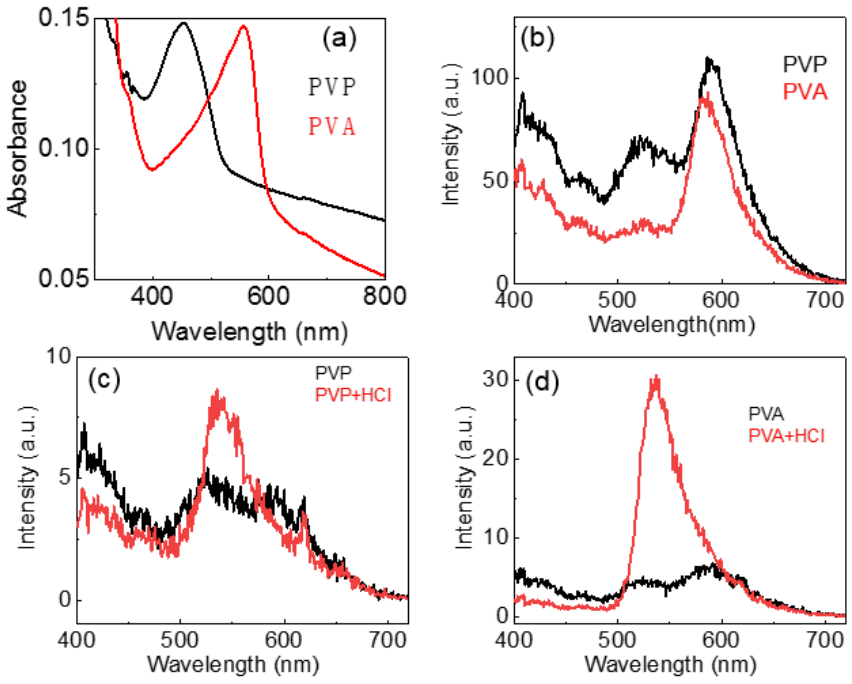

Figure S11 (a) The absorption spectra of ECNO in PVP (black) and PVA (red) casting film. (b) The PL emission spectra of ECNO in PVP (black) and PVA (red) casting film. (c, d) The PL emission spectra of ECNO/PVP (c) and ECNO/PVA (d) film before (black) and after (red) HCl fuming.

S12. Ink-Jet Printing of Anti-Counterfeiting Pattern

Printing tests were performed on an HP inkjet office printer (HP 1020) with the customized HP803 black ink cartridges. The filled inks (black) from the inkjet cartridge were removed, and the cartridge was washed extensively with ethanol and water. 1 mL of ECNO/PVP ethanol solution (see **Supporting Information S11**) were then loaded in the clean black ink cartridge to perform the printing experiments.

S13. Fabrication of C-dots/Epoxy Nanocomposites and White LEDs (WLEDs)

To fabricate the C-dots/epoxy nanocomposites, a certain amount of C-dots, epoxy (CYD-128) and curing agent (D230) were mixed by vortex mixers, and then the mixture was casted into a mold and thermally cured at 100 °C for 4 h. To fabricate the WLEDs, the CDs/epoxy mixture was casted onto UV-LED chips (Led World, 365 nm, 1 W), then the coating layer was cured at 100 °C for 4 hours.

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