

One pot selective synthesis of water and organic soluble carbon dots with green fluorescent emission

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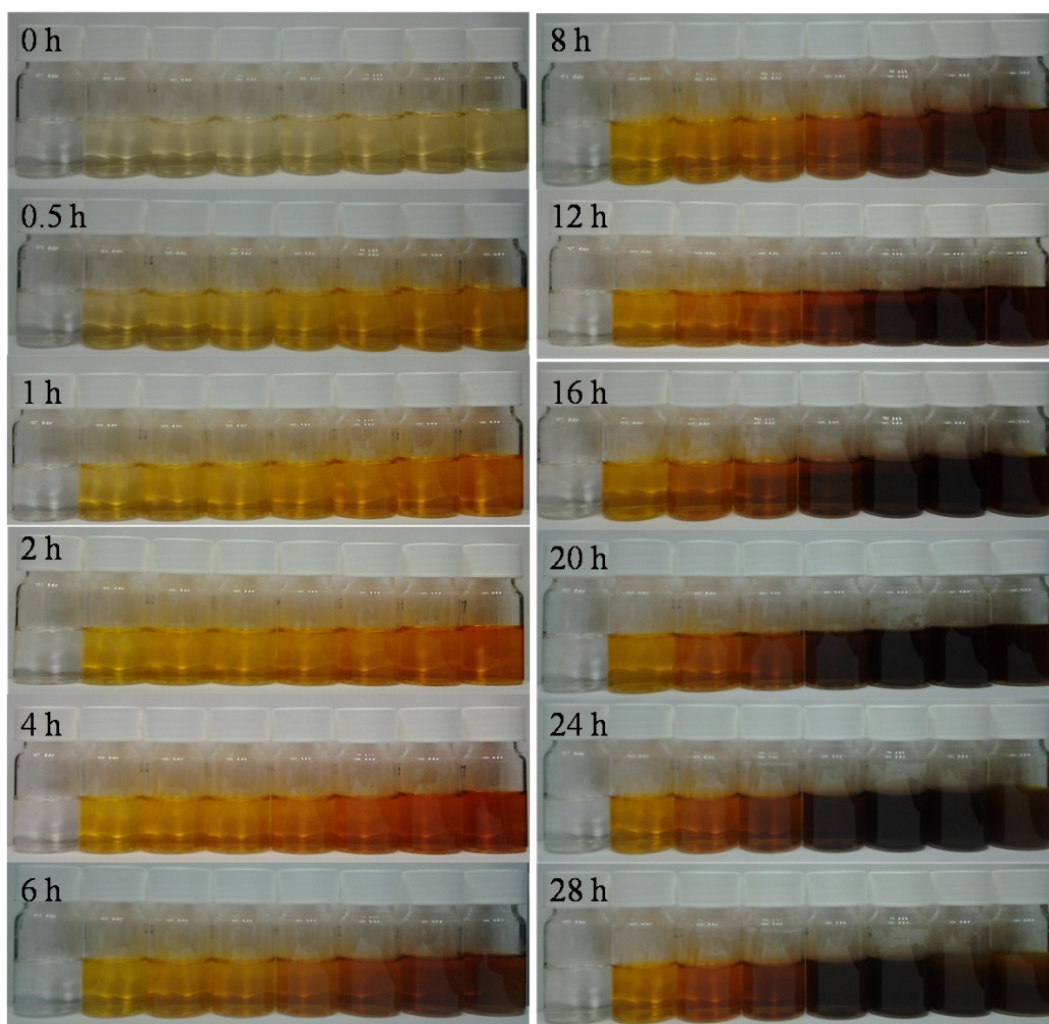


Figure S1. The colour changes of CPC aqueous solutions with NaOH at different reaction times from 0 to 28h. Various concentrations of NaOH were used (from left to right bottles): 0.0, 15, 30, 45, 90, 180, 270, and 360 mM.

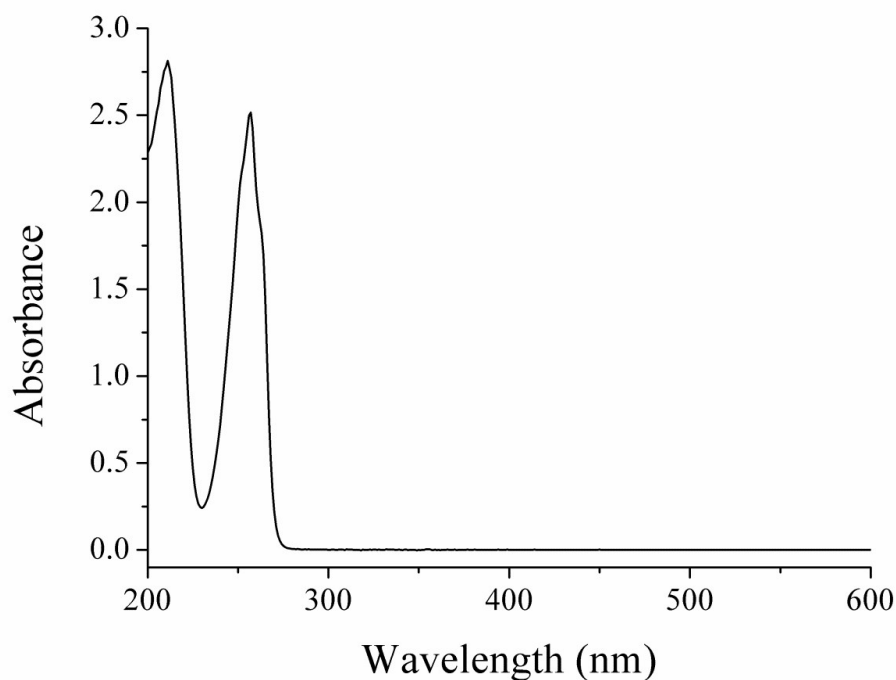


Figure S2. UV-vis absorption spectrum of pure CPC.

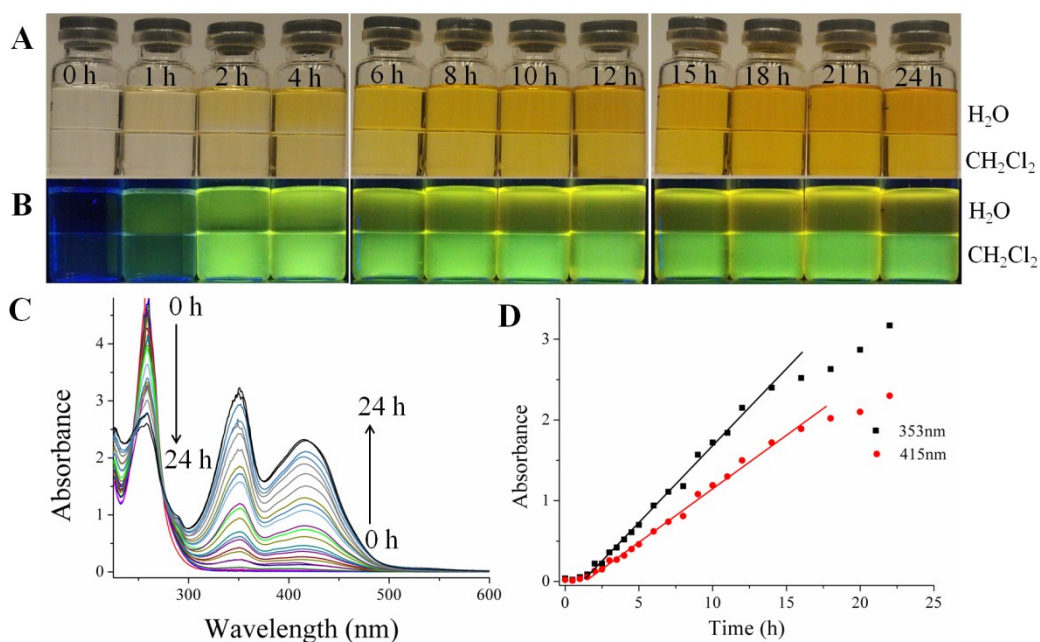


Figure S3. Photographic images of organic solutions of OCDs (bottom) at different reaction times (0–24 h) under (A) daylight and (B) UV irradiation at 365 nm. (C) Absorption spectra of OCDs in reaction solution at different times. (D) Absorption changes of the solution at 353 and 415 nm against time.

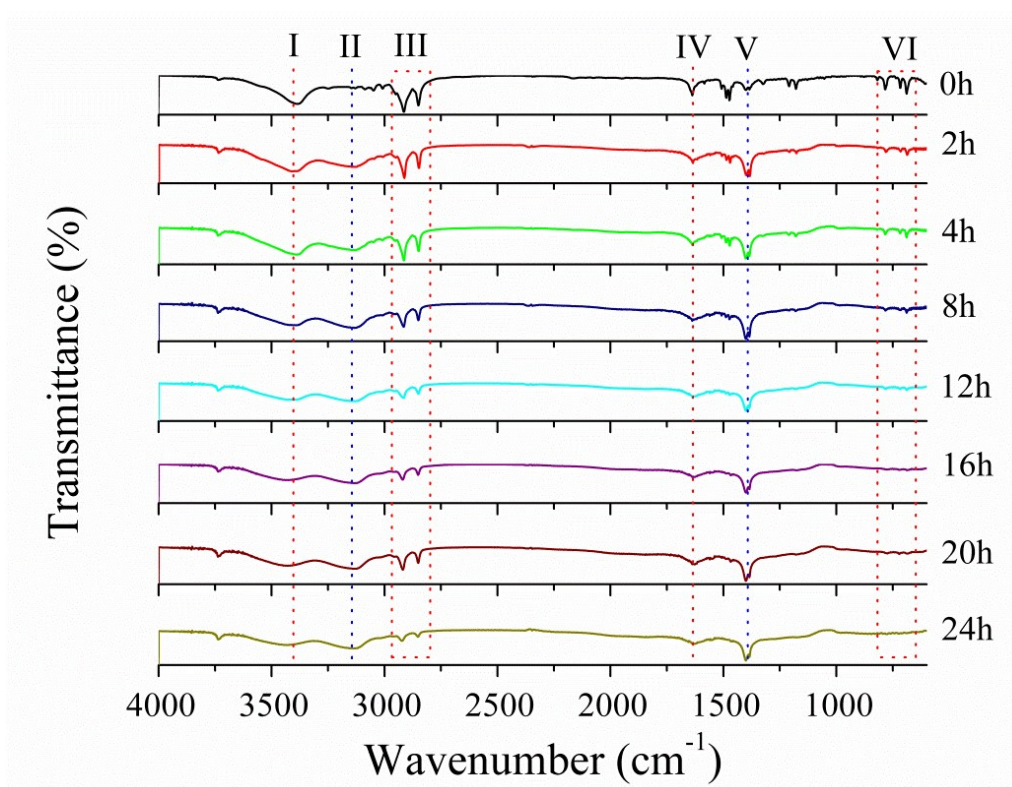


Figure S4. The FTIR spectra of samples at different reaction times (0–24 h). Aliquots of reaction mixture were taken out at different time intervals. The reaction was quenched by adding small amounts of HCl to each aliquot and adjusted to pH 7.0. It was then vacuum-dried at 45°C before IR measurements. Peak I: $\nu_{\text{O-H}}$ of residual water and CDs, Peak II: $\nu_{\text{O-H}}/\nu_{\text{N-H}}$ of CDs, Peak III: $\nu_{\text{C-H}}$ of CPC, Peak IV: $\nu_{\text{C=N}}$ of CPC, Peak V: $\delta_{\text{C-N}}$ of CDs, Peak VI: $\delta_{\text{C-H}}$ of CPC.

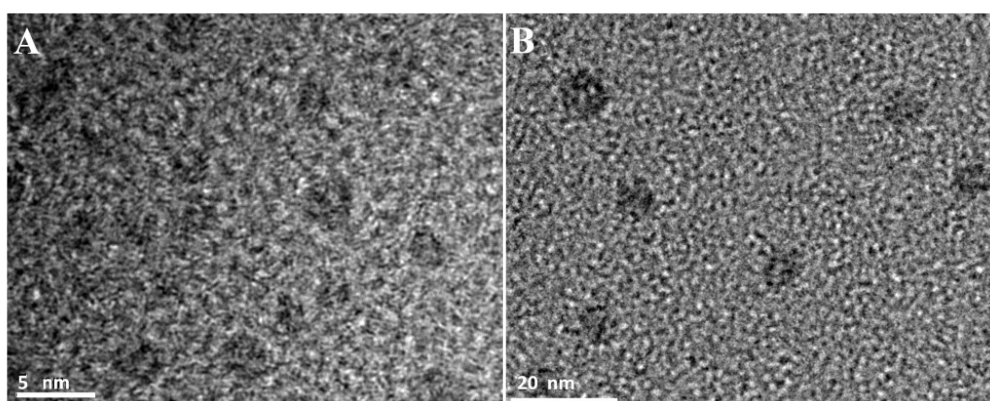


Figure S5. HRTEM images of (A) WCDs and (B) OCDs.

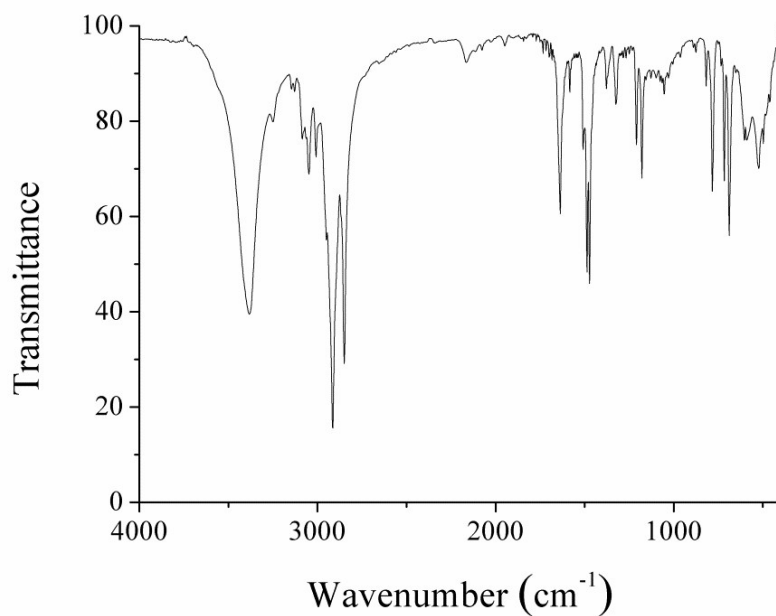


Figure S6. FTIR spectrum of CPC.

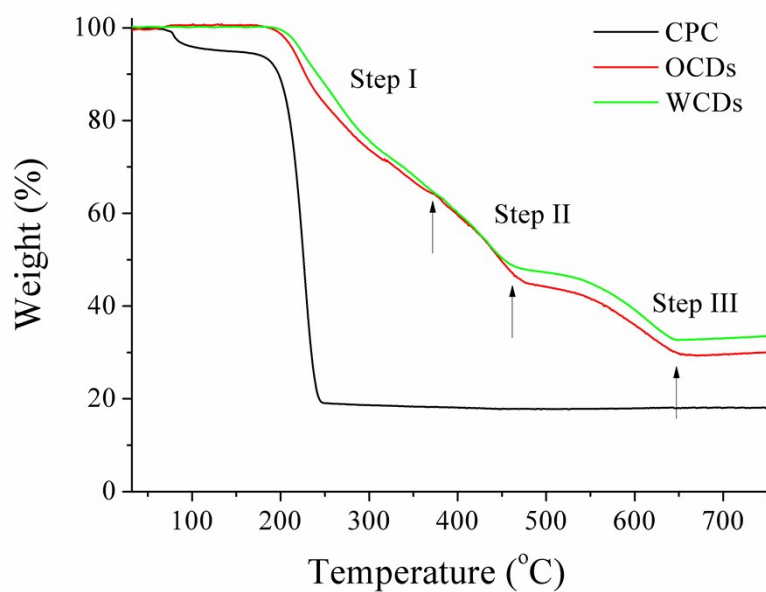


Figure S7. TGA curves of CPC, OCDs and WCDs. TGA was performed in nitrogen atmosphere.

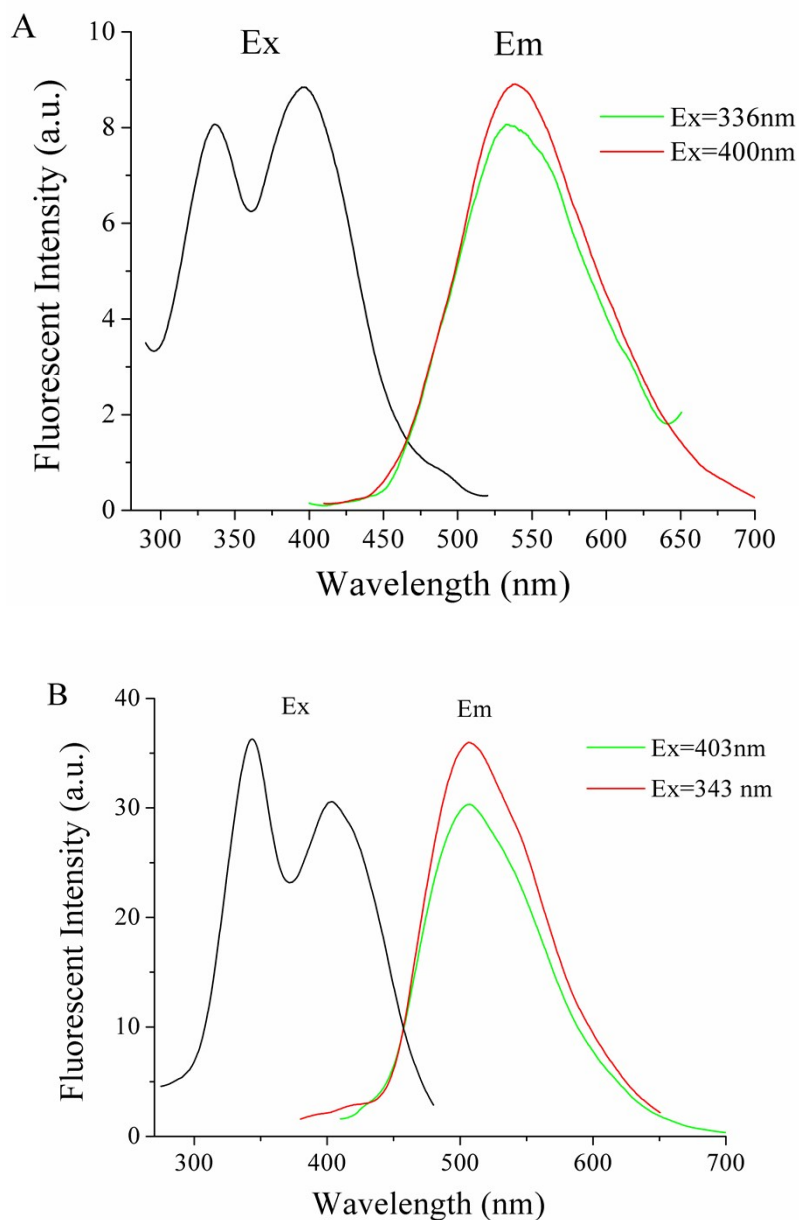


Figure S8. The excitation (Ex) and emission (Em) spectra of (A) WCDs and (B) OCDs.

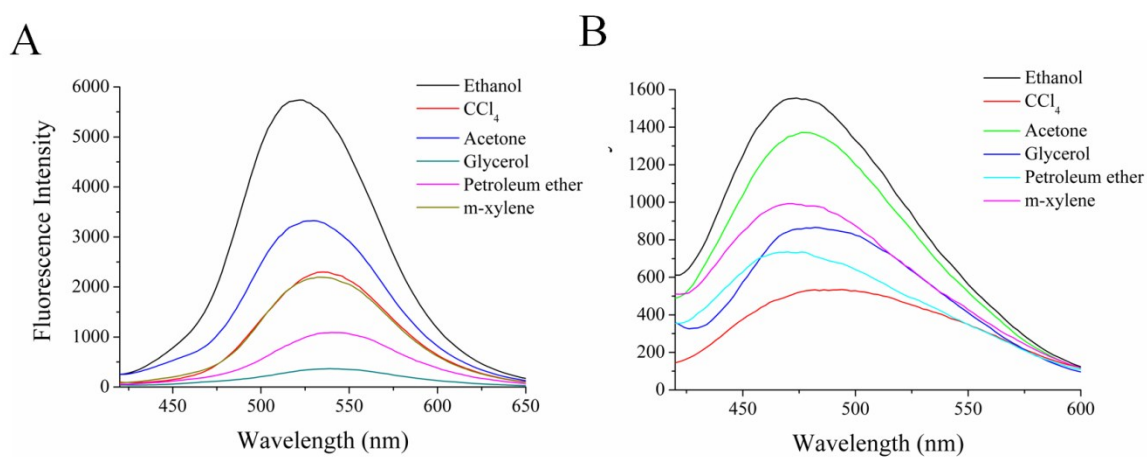


Figure S9. The PL spectra of (A) WCDs and (B) OCDs in different organic solvents

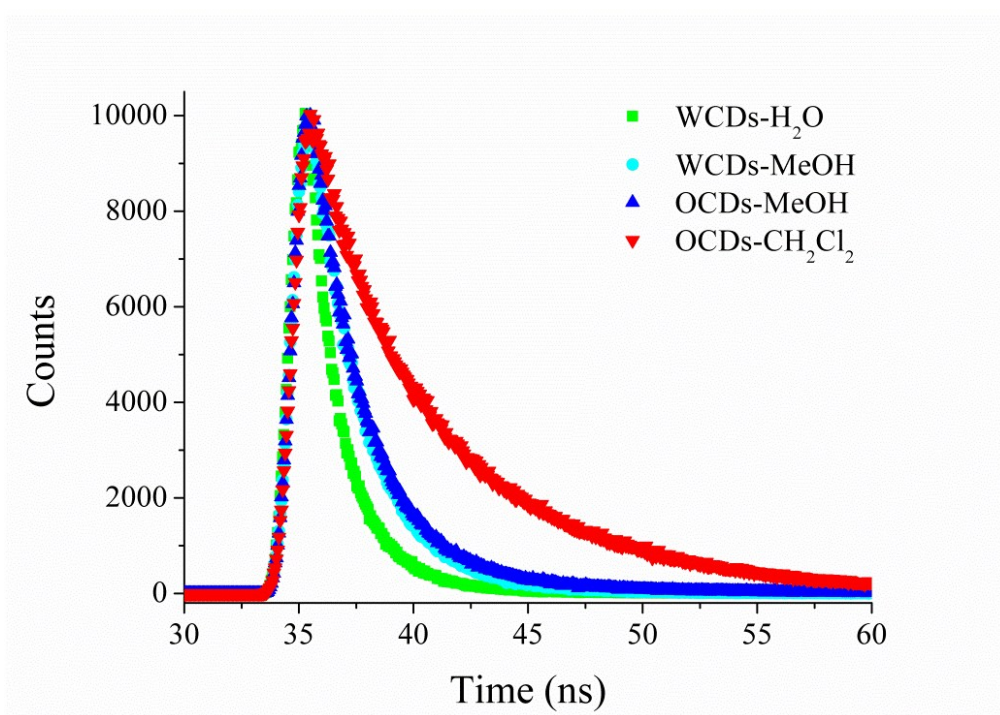


Figure S10. Time-resolved spectra of WCDs in water (H₂O) and methanol (MeOH) and OCDs in CH₂Cl₂ and MeOH. The excitation/emission wavelengths are 390/520 nm.

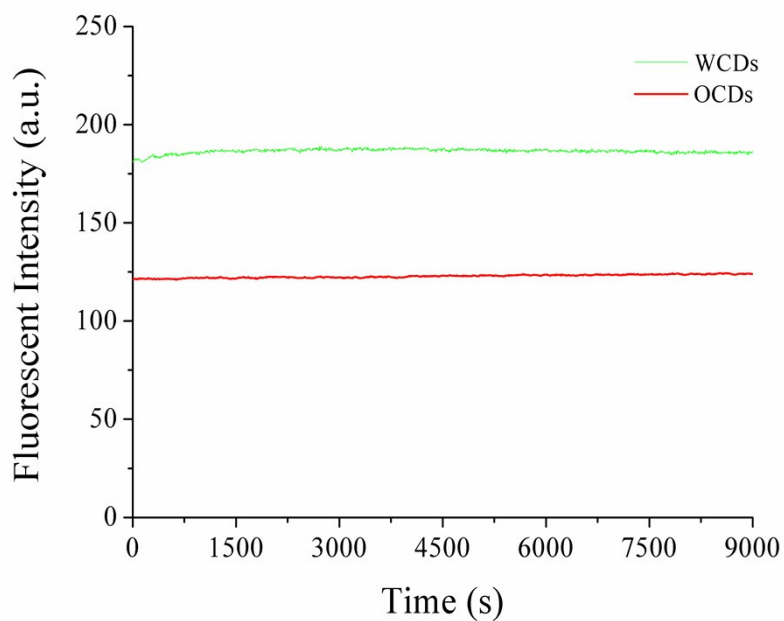


Figure S11. The photostability of WCDs (green line) and OCDs (red line) under continuous UV irradiation. The excitation/emission wavelengths for WCDs and OCDs are 340/540 nm and 340/510 nm, respectively.

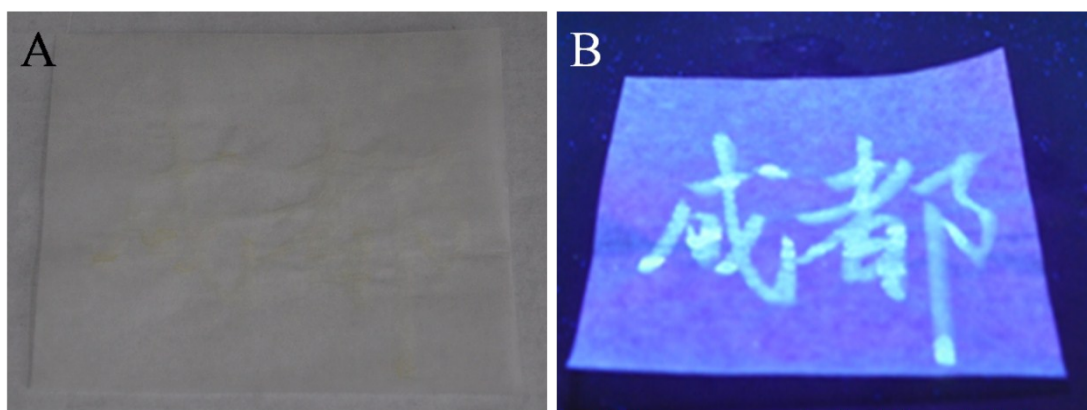


Figure S12. WCDs marked fluorescent characters on a weight paper under (A) daylight and (B) UV lamp (365 nm).

Table S1. Elemental analyses of WCDs and OCDs

Type of CDs	C (%)	O (calculated %)	N (%)	H (%)
WCDs	75.20	9.44	3.69	11.67
OCDs	77.46	6.59	3.93	12.02

Table S2. Fluorescence lifetime of WCDs and OCDs at excitation/emission wavelengths of 390/520 nm.

Type of CDs	τ_1 /ns (%)	τ_2 /ns (%)	τ_3 /ns (%)	τ_{average} /ns
WCDs in H ₂ O ^a	0.38 (20.81)	1.60 (71.76)	3.89 (7.43)	1.52
OCDs in CH ₂ Cl ₂ ^b	2.30 (16.30)	7.00 (83.70)	–	6.23
WCDs in MeOH ^b	2.07 (87.94)	4.27 (12.06)	–	2.34
OCDs in MeOH ^b	2.20 (86.46)	6.70 (13.54)	–	2.81

^aThree-exponential fit of the fluorescence decay curve.

^bTwo-exponential fit of the fluorescence decay curve.

Table S3. Comparison of the preparation of CDs using hydrothermal method with our proposed method

Property	Hydrothermal method ¹	Method in this work
External applied energy	Yes	No
Reaction time	2 h	Tuneable between 0 and 24 h
Reaction temperature	High, 180 °C	Low, 20–25 °C

Reaction pressure	High	Ambient
Reaction capacity	Smaller	Larger
Quantum yield	1.2% (in water), 3.5% (in CHCl ₃)	7.2% (in water), 16.7% (in CH ₂ Cl ₂)

Measurement of quantum yield

Quantum yield (Φ_S) of the CDs sample was determined by a comparative method. Quinine sulfate ($\Phi_R = 0.54$) in 0.10 M H₂SO₄ (refractive index, $\eta = 1.33$) was selected as the reference to determine the Φ_S of the CDs samples in distilled water (for WCDs) and CH₂Cl₂ (for OCDs) at different concentrations. All the absorbances of the solutions at the excitation wavelength (λ_{ex}) were recorded on a Varian Cary 300 Scan UV-vis absorption spectrophotometer (Palo Alto, CA, USA). PL spectra of CDs were measured by a Perkin Elmer LS55 spectrofluorometer (Waltham, MA, USA). The λ_{ex} /integrated PL intensity area under the PL curve in the wavelength range were 340/360-650 nm for WCDs and OCDs samples. Graphs of integrated PL intensity against absorbance were plotted. The Φ_S of the CDs samples were calculated as follows:

$$\Phi_S = \Phi_R \left(\frac{Grad_S}{Grad_R} \right) \left(\frac{\eta^2 S}{\eta^2 R} \right)$$

where the subscripts S and R denote the sample and reference, respectively. $Grad$ is the gradient from the plot of integrated PL intensity against absorbance, and η is the refractive index of the solvent. In order to minimise the self-absorption effect, the absorbances in the 10-mm path length fluorescence cuvette should never exceed 0.10 at the excitation wavelength.^{2,3}

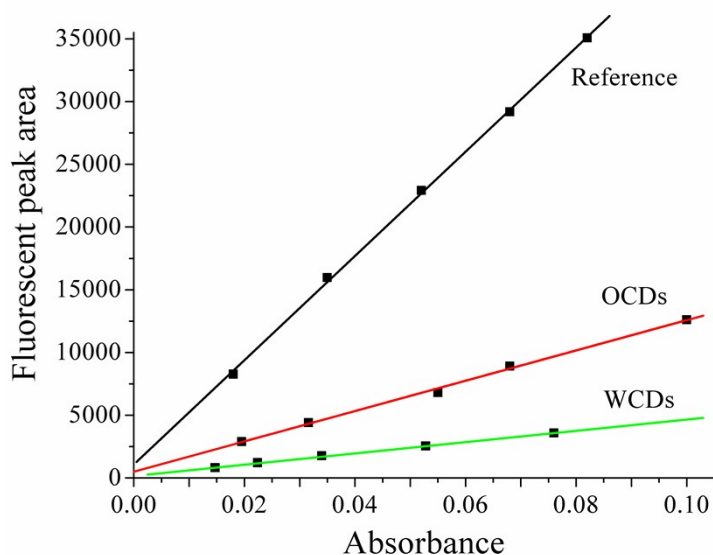


Figure. S13. Plots of integrated fluorescence intensity against absorbance of quinine sulfate, OCDs and WCDs.

References

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