

Supporting Information

Highly Fluorescent Carbon Dots as a Potential Fluorescence Probe for Selective Sensing of Ferric Ions in Aqueous Solution

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Materials

Oxalis corniculata leaves were procured from the Yeungnam University Campus, Republic of Korea. The analytical grade of metal salts such as AlCl_3 , CaCl_2 , $\text{Cd}(\text{CH}_3\text{OO})_2$, $\text{Co}(\text{OOCH}_3)_2$, CrCl_3 , CuCl_2 , FeCl_3 , HgCl_2 , MnSO_4 , NiCl_2 , $\text{Pb}(\text{NO}_3)_2$, and ZnCl_2 was purchased from Ducksan chemicals, Republic of Korea. Quinine sulfate and sulfuric acid (H_2SO_4) were purchased from Sigma-Aldrich, Republic of Korea. All the chemicals were used as received and the de-ionized (DI) water was used throughout the experiments.

Instrumentation Methods

The *Oxalis corniculata*-derived carbon dots (*O*-CDs) were characterized by various physicochemical techniques such as X-ray diffraction (XRD), Raman spectroscopy, Attenuated total reflectance-Fourier transform infrared (ATR-FTIR) spectroscopy, X-ray photoelectron spectroscopy (XPS), field emission scanning electron microscopy (FESEM) with energy-dispersive X-ray (EDX) spectroscopy, High-resolution transmittance electron microscopy (HRTEM), Ultraviolet-visible (UV-vis) absorption spectroscopy and fluorescence spectroscopy. The XRD measurements were carried out using a PANalytical X'Pert³ MRD diffractometer with monochromatized Cu K α radiation ($\lambda = 1.54 \text{ \AA}$) at 40 kV and 30 mA and were recorded in the range from 10 to 80° (2θ). Raman spectrum was recorded on the XploRA Micro-Raman spectrophotometer (Horiba) with the range between 50 and 4000 cm^{-1} at the core research support center for natural products and medical materials of Yeungnam University. ATR-FTIR spectra were recorded in transmittance mode on a Perkin Elmer Spectrum Two in the wavenumber range from 400 to 4000 cm^{-1} by the addition of 8 scans at a resolution of 8 cm^{-1} . XPS spectra were achieved using a K-Alpha (Thermo Scientific). CasaXPS software was used

for the deconvolution of the high-resolution XPS spectra. FESEM with EDX spectral analysis was carried out on a Hitachi S-4800 equipped with EDX at an accelerating voltage of 10 kV. HRTEM images were performed with an FEI-Tecnai TF-20 transmission electron microscope with an operating accelerating voltage of 200 kV. UV-vis absorption spectra were recorded from 200 to 700 nm using an OPTIZEN 3220UV spectrophotometer. Excitation and emission fluorescence spectra were recorded using a Hitachi F-7000 fluorescence spectrophotometer. The excitation wavelength was varied to determine the maximum emission intensity was achieved by varying the excitation wavelength. The slit width was fixed at 5 nm and the scan speed was set to 400 nm/min.

Quantum Yield Measurement of Hydrophilic O-CDs

The quantum yield (QY) of the synthesized O-CDs was calculated by using quinine sulfate in 0.1 M H₂SO₄ (QY_R is 0.54) as a standard reference and was calculated using the following equation (1):

$$\text{Quantum yield (QY)} = \text{QY}_R \frac{I_S A_R (n_S)^2}{I_R A_S (n_R)^2} \quad (1)$$

where, “I” is the measured integrated fluorescent emission intensity, “n” is the refractive index of the solvent, and “A” is the absorbance (intensity). The subscript “R” and “S” refer to the known fluorescent reference and standard for the synthesized sample, respectively.

Photobleaching and Prolong Stability Measurements of Hydrophilic O-CDs

The photobleaching stability of the synthesized *O*-CDs was examined under UV light (365 nm) irradiation for 75 min with an interval of every 25 min. The fluorescence intensity of the *O*-CDs aqueous solution was measured before and after UV-light irradiation. The *O*-CDs were stored for a long time and the fluorescence intensity of the aqueous *O*-CDs was measured at different storage times to determine the long-term stability of the *O*-CDs.

Sensing of Metal Ions Using the Hydrophilic O-CDs

Sensing of Fe^{3+} ion was performed using a 1 cm path length quartz cell at room temperature with a fluorescence excitation wavelength of 360 nm. The fluorescence emission spectra for the mixture of *O*-CDs (0.5 mL) and DI water (0.5 mL) were measured as a blank. The selectivity for Fe^{3+} sensing of *O*-CDs was confirmed by adding 0.5 mL of twelve different common metal ions solutions (Al^{3+} , Ca^{2+} , Cd^{2+} , Co^{2+} , Cr^{3+} , Cu^{2+} , Fe^{3+} , Hg^{2+} , Mn^{2+} , Ni^{2+} , Pb^{2+} and Zn^{2+} ions) with a concentration of 1 mM to 0.5 mL of the aqueous *O*-CDs solution. The fluorescence emission spectra were recorded after reaction for 20 seconds at room temperature by adopting the same procedure as that of a blank sample. Then, the sensitivity of Fe^{3+} ion in the presence of *O*-CDs was conducted as follows; 0.5 mL of *O*-CDs was taken in the quartz cell, followed by the addition of 0.5 mL of various concentrations of Fe^{3+} ion (10–50 μM), the fluorescence intensity was recorded after 20 seconds of interaction time.

Characterizations of the Synthesized Hydrophilic O-CDs

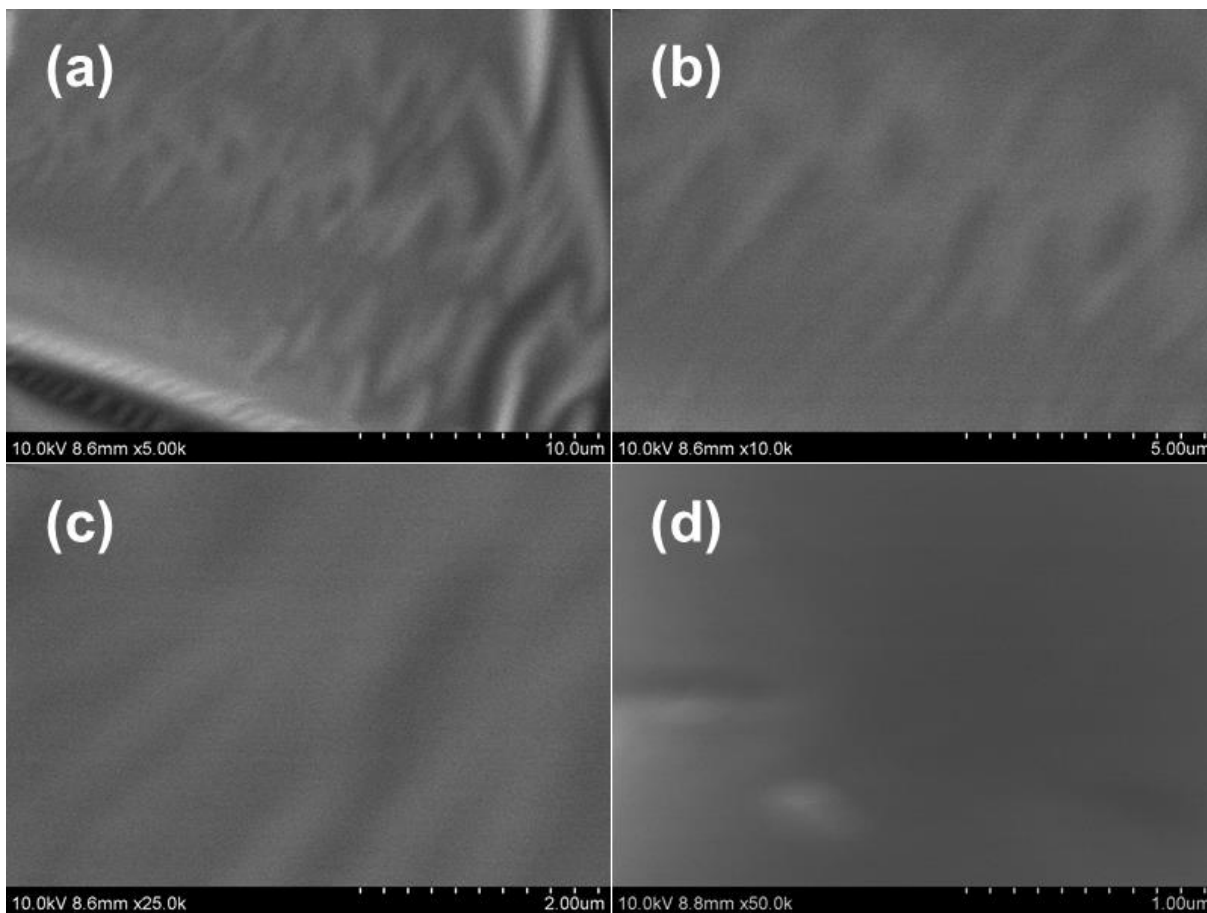


Figure S1 (a-d) FESEM images with different magnifications of the synthesized hydrophilic *O*-CDs.

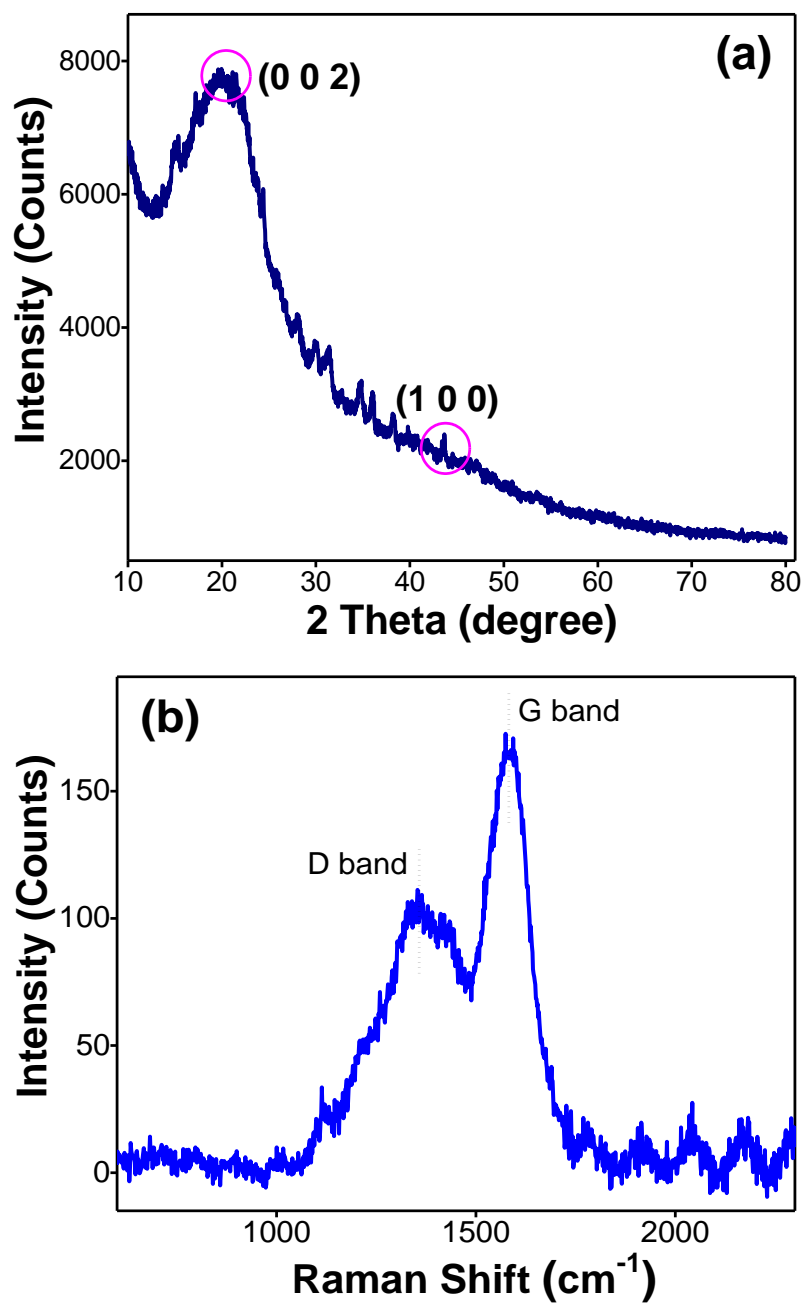


Figure S2 (a) XRD pattern and (b) Raman spectrum of the synthesized hydrophilic *O*-CDs.

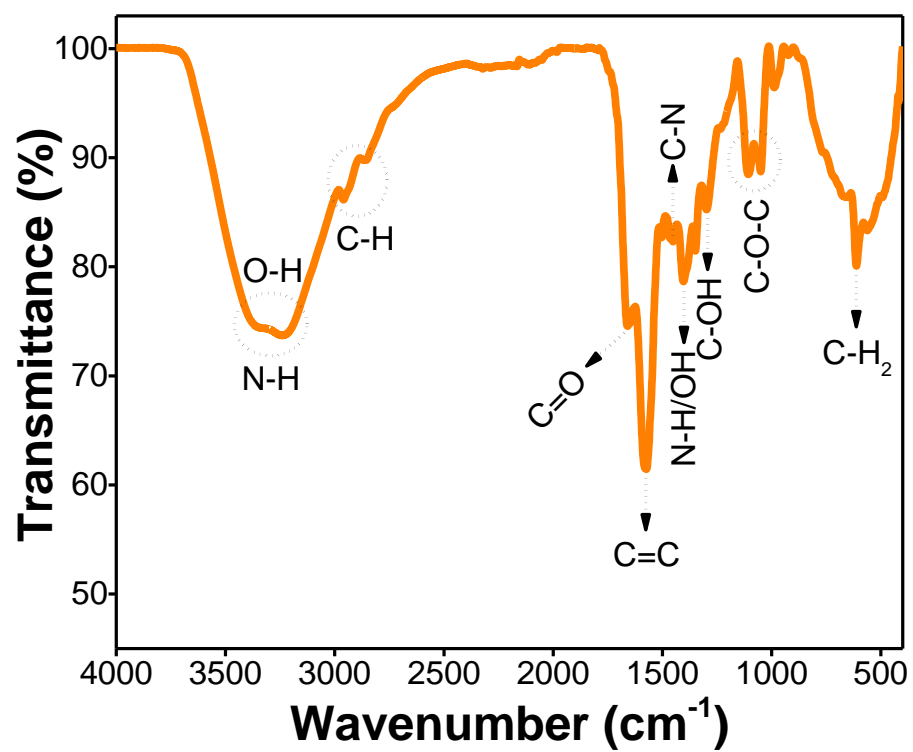


Figure S3 ATR-FTIR spectrum of the synthesized hydrophilic *O*-CDs.