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Supporting Information

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Bandgap-Like Strong Fluorescence in Functionalized Carbon Nanoparticles**

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Supporting Information (total 3 pages)

1. More Experimental Details

Materials. The diamine-terminated oligomeric poly(ethylene glycol) or PEG_{1500N}, $H_2NCH_2CH_2CH_2(OCH_2CH_2)nCH_2NH_2$ (n ~ 35), and thionyl chloride were supplied by Aldrich. Sephadex G-100™ gel was provided by GE Healthcare. Invitrogen aqueous compatible Qdot 525 ITK™ amino (PEG) CdSe/ZnS QDs sample (commonly referred to as "QD525PEG" in the literature) was purchased from the company. Water was deionized and purified by being passed through a Labconco WaterPros water purification system.

Measurements. UV/vis absorption spectra were recorded on a Shimadzu UV2101-PC spectrophotometer. Fluorescence spectra were obtained on a Spex Fluorolog-2 emission spectrometer equipped with a 450 W xenon source and a detector consisting of a Hamamatsu R928P photomultiplier tube (PMT) operated at 950 V. Fluorescence decays were measured on a time-correlated single photon counting (TCSPC) setup with a Hamamatsu stabilized picosecond light pulser (PLP-02) for 407 nm excitation (<100 ps pulses at 1 MHz repetition rate), coupled with a Phillips XP2254/B PMT in a thermoelectrically cooled housing as detector for an overall instrument time resolution better than 500 ps.

Fluorescence quantum yields were measured by using quinine sulfate in 0.1 M H_2SO_4 solution (Φ_F = 0.54) and 9,10-bis(phenylethynyl)-anthracene in cyclohexane (Φ_F = 1.0) as fluorescence standards. The absorbance (optical density < 0.1 to minimize inner-filter effects) at the excitation wavelength was matched between the sample and the standard. The observed fluorescence spectra were corrected for nonlinear instrument response before the integration of their total intensities for the calculation of fluorescence quantum yields.

Transmission electron microscopy (TEM) imaging was performed on a Hitachi HD-2000 scanning TEM system in both transmission and Z-contrast modes. Atomic force microscopy (AFM) images were obtained in the acoustic AC mode on a Molecular Imaging PicoPlus AFM system equipped with a multipurpose scanner and a NanoWorld Pointprobe NCH sensor. The height profile analysis was assisted by using the SPIP software distributed by Image Metrology.

Fluorescence imaging was carried out on a Leica laser scanning confocal fluorescence microscope (DM IRE2, with Leica TCS SP2 SE scanning system) equipped with an argon ion laser (JDS Uniphase). The specimens were prepared by vigorously diluting each sample solution and then dropping the solution onto a glass slide, followed by drying in ambient. The same instrumental conditions were carefully maintained when different specimens were compared. The fluorescence images were processed and analyzed by using the NIH ImageJ software.

2. AFM Results

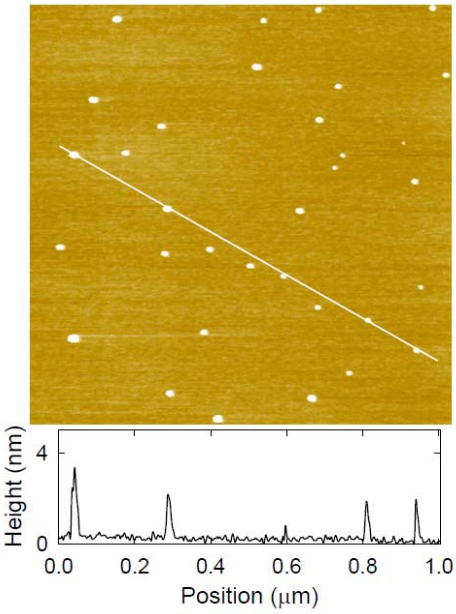


Figure S1. AFM topography images of carbon dots in the most fluorescent fraction.

3. Visual Comparisons of Carbon Dots with Fluorescein in Solutions

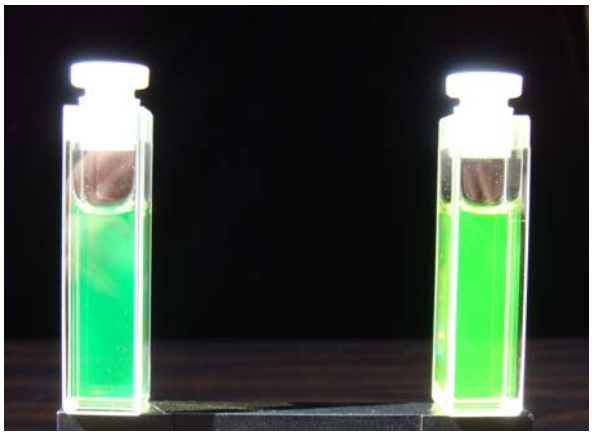
An aqueous solution of the most fluorescent carbon dots fraction and an ethanol solution of fluorescein (fluorescence quantum yield $\Phi_F = 0.79$) of matching optical density at 440 nm and 490 nm, respectively, were compared under different light conditions for visual appreciation. A Sony Cyber-Shot DSC-T20 digital camera was used for the photographs.

Photographed under Room Light:

Figure S2. Photos under room light.
Left: The aqueous carbon dots solution;
Right: The fluorescein solution.

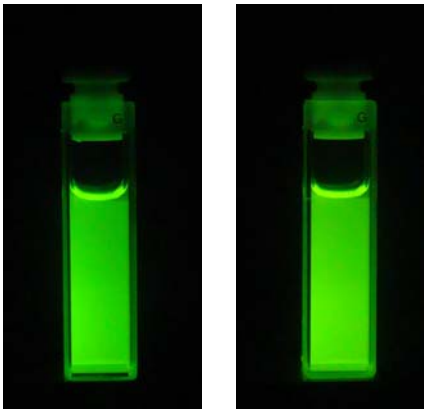
Photographed under Sunlight:

Figure S3. Photos under sunlight.
Left: The aqueous carbon dots solution;
Right: The fluorescein solution.



Photographed with Monochromated Light:

Figure S4. Monochromated light for excitation and photographed through a 530 nm cutoff filter.
Left: The aqueous carbon dots solution, 440 nm excitation;
Right: The fluorescein solution, 490 nm (the absorption maximum) excitation.



4. Excitation Spectra

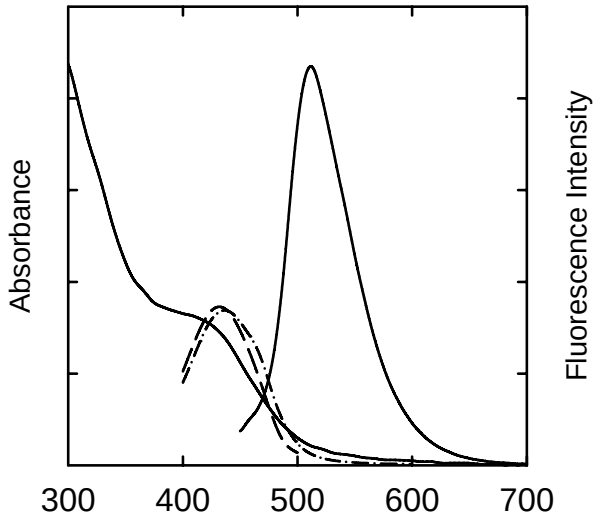


Figure S2. Absorption and fluorescence spectra (both solid line) of the most fluorescent fraction, and the corresponding excitation spectra monitored at emission wavelengths of 510 nm (dash line) and 610 nm (dash-dot line).

5. The Colored Version of Figure 5

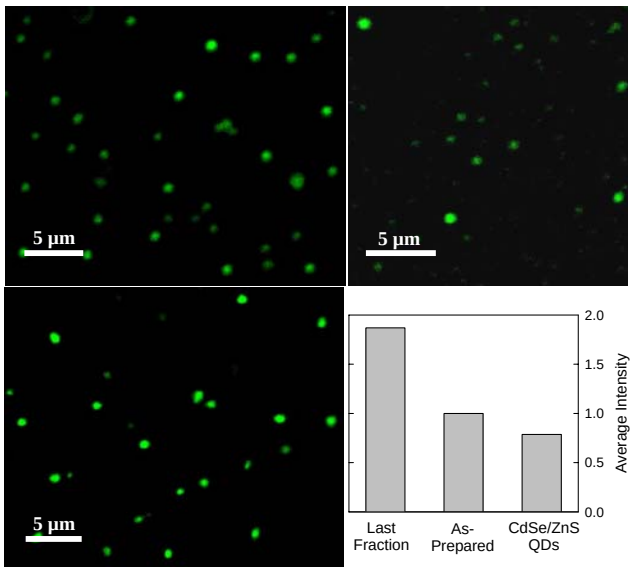


Figure 5. Fluorescence microscopy images (458 nm excitation) of carbon dots in as-prepared sample (upper left) and in the most fluorescent fraction (lower left), and images of Invitrogen QD525PEG QDs (upper right). The bar-chart comparison was based on averaging 300 most fluorescent dots in each of the three samples.