Carbon Dots *versus* Nano-Carbon/Organic Hybrids – Divergence between Optical Properties and Photoinduced Antimicrobial Activities

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Supplementary Materials

1. Preparation of PEI-CDots[1,2]

Commercially acquired sample of carbon nanopowders (20-40 nm in size, 2 g) was refluxed in concentrated nitric acid (8 M, 200 mL) for 48 h. The reaction mixture was cooled back to ambient temperature, and centrifuged at 1,000 *g* to discard the supernatant. The residue was re-dispersed in deionized water, dialyzed in a membrane tubing (molecular weight cut-off

~500) against fresh water for 48 h, and then centrifuged at 1,000 *g* to retain the supernatant as an aqueous dispersion of small carbon nanoparticles. The nanoparticles could be recovered from the dispersion by removing water via evaporation.

The surface functionalization of the small carbon nanoparticles with oligomeric polyethylenimine (PEI, average molecular weight ~600, branched) for PEI-CDots was accomplished via microwave-assisted thermal processing. In a representative experimental protocol, the carbon nanoparticles (100 mg) as an aqueous slurry were mixed with PEI (2 g) and ethanol (2 mL) in a scintillation vial, and the resulting mixture was sonicated in an ultrasonic cleaner (VWR 250D) at 40 ℃ for 1 h, followed by a complete removal of solvent via evaporation for a solid mixture. Separately, a bath of silicon carbide (150 g) in a silica crucible casting dish (about 8 cm in diameter and 2.5 cm in height) was prepared and pre-heated in a conventional microwave oven at 500 W for 3 min. Several rounds of microwave heating treatments were as follows: (1) the vial containing the solid mixture was immersed in the pre-heated silicon carbide bath for microwave irradiation at 1,000 W for 3 min; (2) the sample vial was taken out of the bath for being cooled in the ambient, and more PEI (1 g) and ethanol (2 mL) were added and mixed well, followed by the removal of ethanol, and then microwave irradiation the same as in (1); (3) a repeat of (2) but with the microwave irradiation at 500 W for 8 min; and (4) a repeat of (3). After the microwave treatments, the reaction mixture was cooled to ambient temperature and dispersed in deionized water with vigorous sonication. The resulting aqueous dispersion was centrifuged at 5,000 *g* to collect the supernatant, followed by dialysis (molecular weight cut-off ~1,000) against fresh water for up to 24 h to obtain the PEI-CDots in an aqueous solution.

2. Characterization and Properties of PEI-CDots

The proton NMR (500 MHz) results of PEI-CDots in D_2O show very broad peaks around 2.7, 2.6, and 2.4 ppm.

Shown in Figures S1 and S2 are typical AFM and TEM images for PEI-CDots,[3] and shown in Figure S3 are optical spectroscopy results.[3]

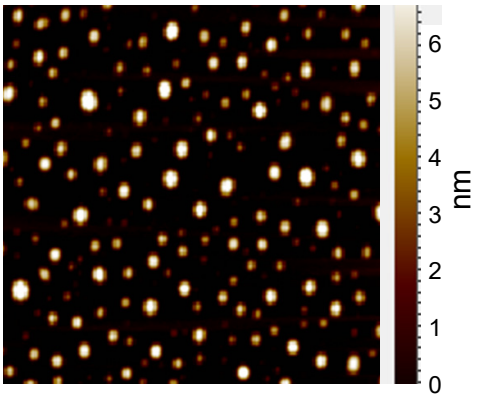

Figure S1. Representative AFM images for PEI-CDots.

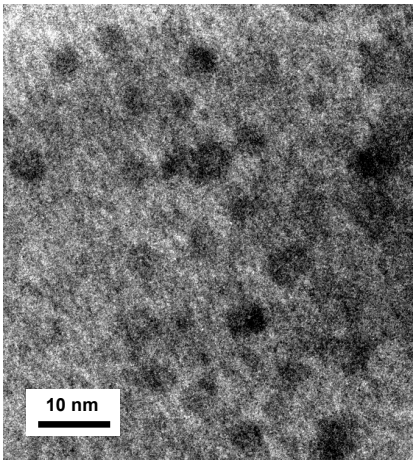

Figure S2. Representative TEM imaging results for PEI-CDots.

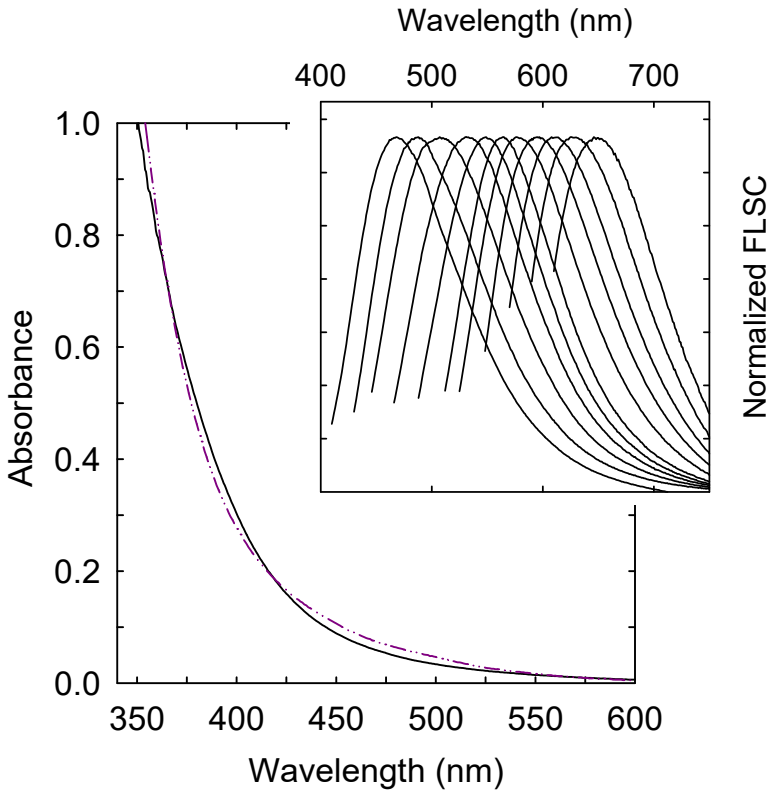

Figure S3. Absorption spectrum of PEI-CDots in aqueous solution (solid line) is compared with that of the aqueous dispersed small carbon nanoparticles (dash-dot-dot line). Inset: Fluorescence spectra of PEI-CDots at different excitation wavelengths (from left to right with excitation at 400 nm and in 20 nm increments).

References

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