Electronic Supplementary Information

Synthesis of Graphene Oxide Dots for Excitation-Wavelength Independent Photoluminescence at High Quantum Yields

Chiao-Yi Teng,[a] Te-Fu Yeh,[a] Kuang-I Lin,[b] Shean-Jen Chen,[b,c] Masahiro Yoshimura,*,[d] and Hsisheng Teng*,[a,b]

[a]Department of Chemical Engineering and Research Center for Energy Technology and Strategy, National Cheng Kung University, Tainan 70101, Taiwan

[b]Center for Micro/Nano Science and Technology, National Cheng Kung University, Tainan 70101, Taiwan

[c]Department of Engineering Science, National Cheng Kung University, Tainan 70101, Taiwan

[d]Promotion Center of Global Materials Research and Department of Materials Science and Engineering, National Cheng Kung University, Tainan 70101, Taiwan

*To whom correspondenec should be addressed. E-mail: hteng@mail.ncku.edu.tw, Tel: 886-6-2385371, Fax:886-6-2344496

Electronic Supplementary Information for :

(1) the XPS analysis results of uGODs;

(2) the PL emission results of uGODs and full-range PL spectra of NGODs;

(3) explanation of the Mott-Schottky equation;

(4) a summary of PL spectra and the full-range PL spectra of BGODs;

(5) the parameter values for PL quantum yield calculation.

1. The XPS analysis results of uGODs

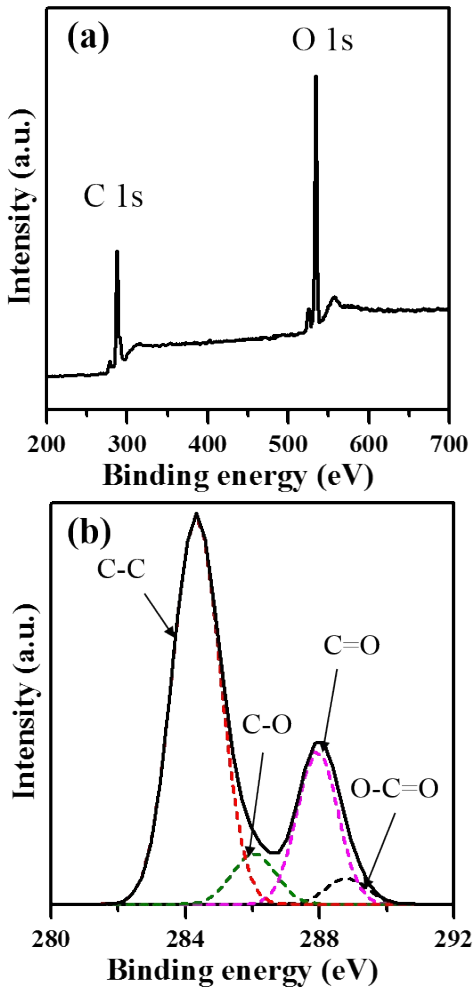

Fig. S1 XPS spectra of uGODs. (a) Full-range spectrum of uGODs. (b) C 1s spectrum of uGODs. C 1s spectrum was decomposed into several peaks (indicated by the dash lines) that were fitted using a Gaussian function.

2. The PL emission results of uGODs and full-range PL spectra of NGODs

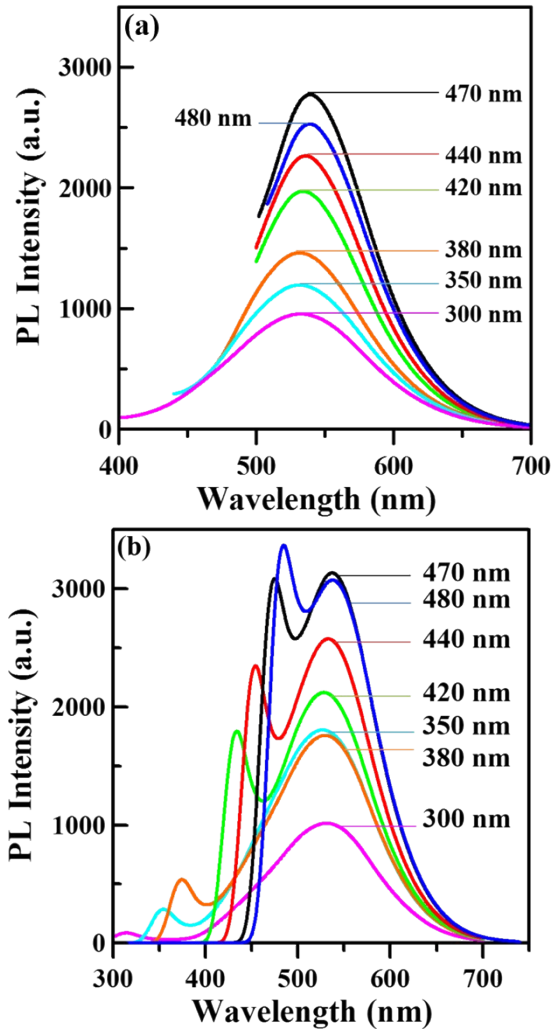

Fig. S2 (a) PL spectra of uGODs excited by irradiation at various wavelengths. (b) Full-range PL spectra of NGODs excited by irradiation at various wavelengths.

3. Explanation of the Mott-Schottky equation

To identify the electronic band characteristics of graphene-based quantum dots, we deposited the QDs on the FTO substrate and determined the conductivity types and Fermi level (E_F) potentials of the films using electrochemical impedance spectroscopic analysis along with the Mott-Schottky equation,[1,2] that is

$$\frac{1}{C^2} = \frac{2}{e\varepsilon\varepsilon_0 N_D}(E - E_F - \frac{kT}{e}) \qquad \text{for n-type conductivity}$$

$$\frac{1}{C^2} = -\frac{2}{e\varepsilon\varepsilon_0 N_A}(-E + E_F + \frac{kT}{e}) \qquad \text{for p-type conductivity}$$

where C represents the capacitance of the space–charge region, ε_0 is the vacuum permittivity, ε is dielectric constant of semiconductors, e is the electron charge, E is applied potential, E_F is the Fermi level potential, k is the Boltzmann constant, T is the absolute temperature, and N_A (N_D) is acceptor density (or donor density). The temperature term is generally small and can be neglected. The capacitance values of the space–charge region obtained at various applied potentials. According to the Mott-Schottky equation, a linear relationship of $1/C^2$ vs. E can be observed. A negative slope of straight line represents p-type conductivity, which is contrast to n-type conductivity with a positive slope of straight line.

References

1. J. N. Nian, C. C. Tsai, P. C. Lin and H. Teng, *J. Electrochem. Soc*., 2009, **156**, H567-H573.
2. I. H. Toor, *J. Electrochem. Soc*., 2011, **158**, C391-C395.

4. **A summary of PL spectra and the full-range PL spectra of BGODs**

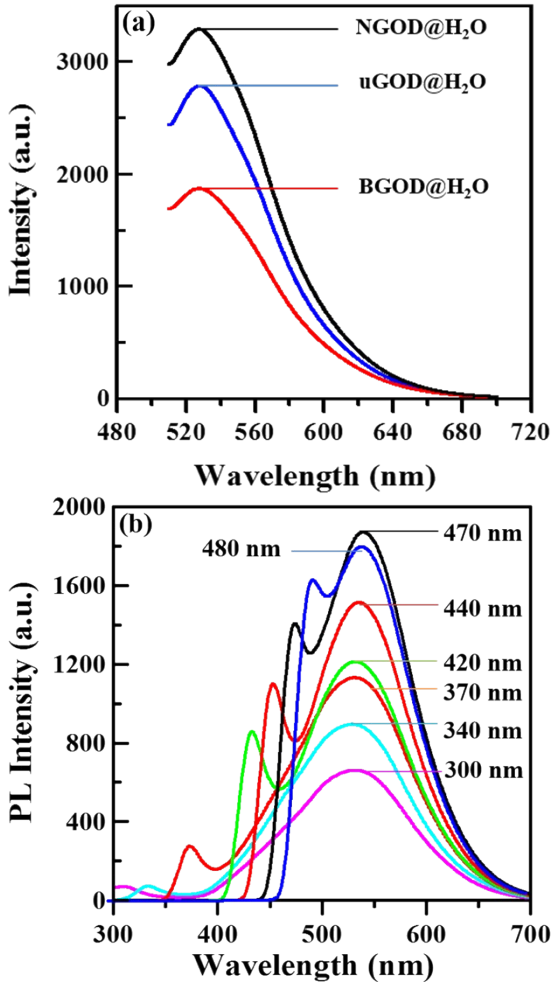

Fig. S3 (a) PL spectra of the NGOD, uGOD, and BGOD suspensions under irradiation at 470 nm. (b) Full-range PL spectra of BGODs excited by irradiation at various wavelengths.

5. The parameter values for PL quantum yield calculation

Sample	Integrated emission intensity (I)	Absorption intensity at 470 nm (A)	Refractive index of solvents (η)	Quantum yield (QY)
Fluorecein (in ethanol)	145781	0.071	1.36 (ethanol)	0.790
uGOD (in water)	33281	0.076	1.33 (water)	0.161
NGOD (in water)	39872	0.068	1.33 (water)	0.215
uGOD-SLP (in water)	79435	0.069	1.33 (water)	0.423
NGOD-SLP (in water)	87914	0.065	1.33 (water)	0.497