

Supplementary Information

Effects of Elemental Doping on Photoluminescence Properties of Graphene

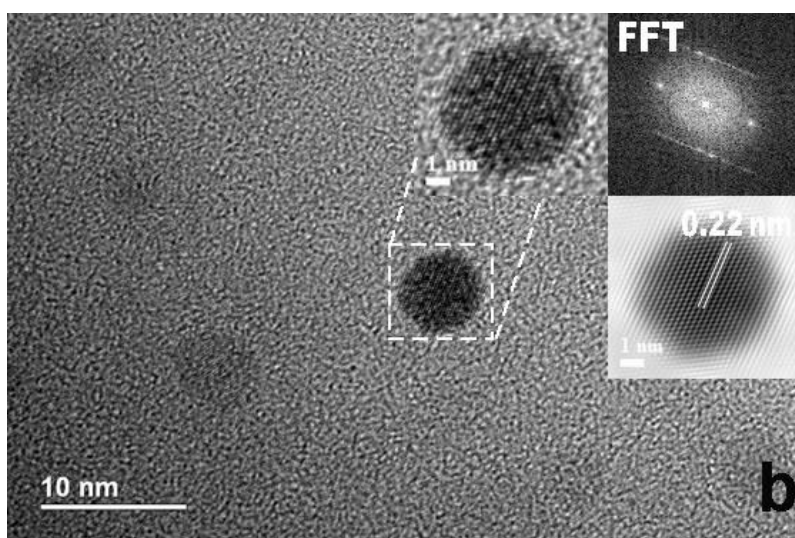
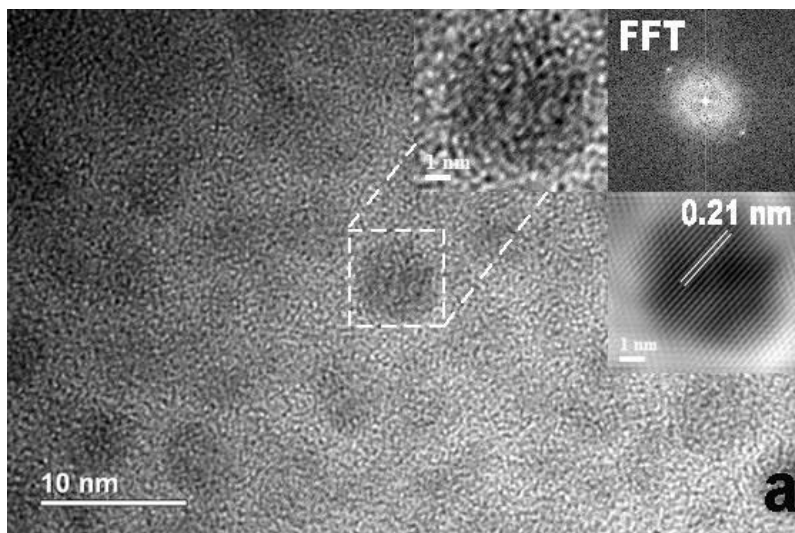
Quantum Dots

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Bragg filtering (Gatan Microscopy Suite GMS 3) was applied to remove noise and analyze inter-plane distances of GQDs and doped-GQDs¹⁻³. Fig. S1 demonstrate HRTEM images, corresponding fast Fourier transform (FFT), and Bragg filtered images of GQDs (a), N-GQDs (b), S-GQDs (c), P-GQDs (d), and B-GQDs (e).



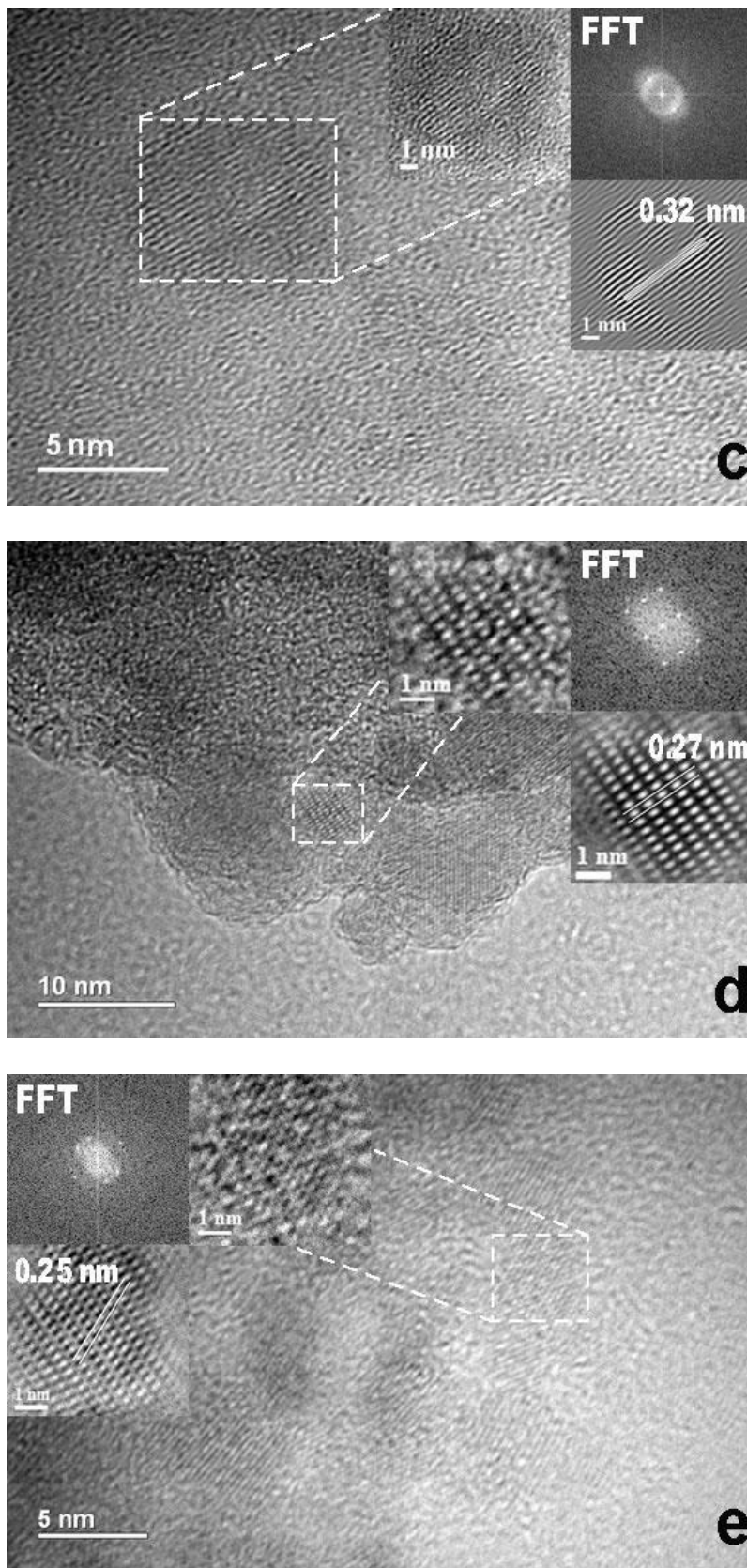


Fig. S1. TEM images of GQDs (a), N-GQDs (b), S-GQDs (c), P-GQDs (d) and B-GQDs (e), and their selected HRTEM images, fast Fourier transform (FFT), and Bragg filtered images.

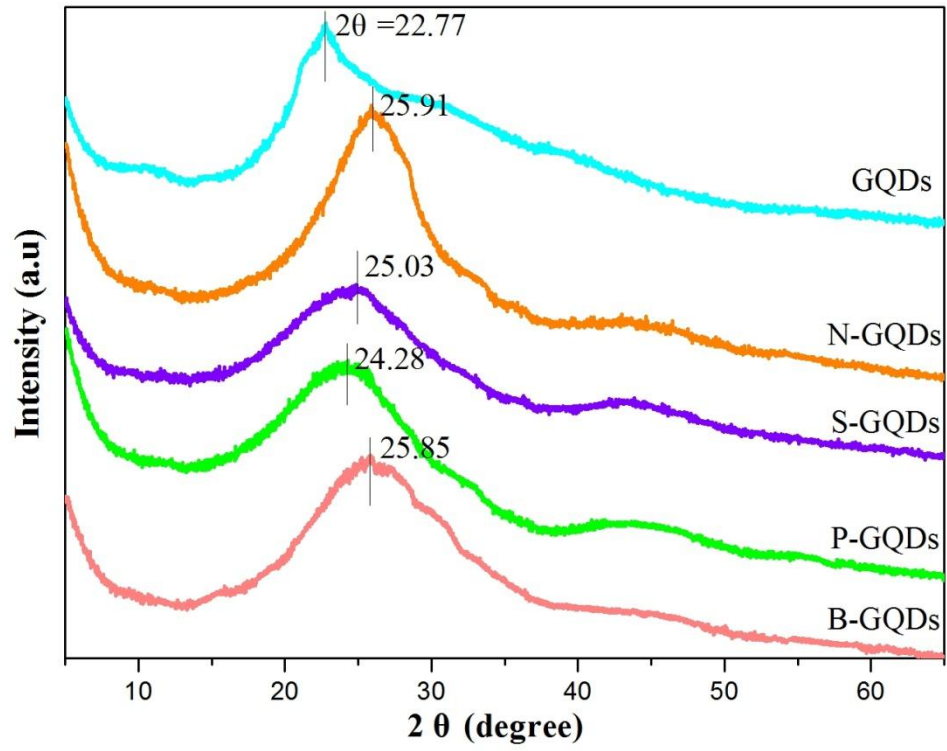


Fig. S2. XRD patterns of GQDs, N-GQDs, S-GQDs, P-GQDs and B-GQDs.

Table S1. The locations of D band, G band and I_D/I_G ratio of GQDs and doped GQDs.

Samples	D band	G band	I_D/I_G
GQDs	1330	1592	1.01
N-GQDs	1333	1572	0.88
S-GQDs	1343	1587	0.86
P-GQDs	1330	1593	0.98
B-GQDs	1330	1588	1.21

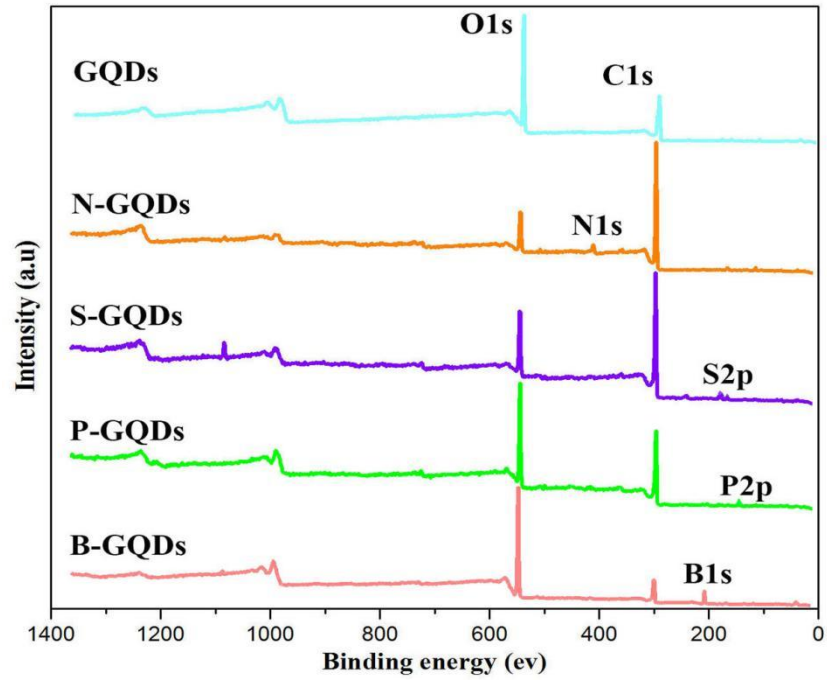


Fig. S3. Survey XPS spectra of GQDs, N-GQDs, S-GQDs, P-GQDs, and B-GQDs.

Table S2. The binding energies of the C1s spectra of GQDs and doped-GQDs.

Samples	C=C	C-O	C=O	O-C=O	C-N	C-S	C-P	C-B
GQDs	284.6	285.3	286.5	288.6				
N-GQDs	284.6	285.5	286.8		285.1			
S-GQDs	284.6	285.2	286.5	289.0		285.2		
P-GQDs	284.6	285.1	286.4	288.6			285.1	
B-GQDs	284.6	285.5	286.5	288.3				283.7

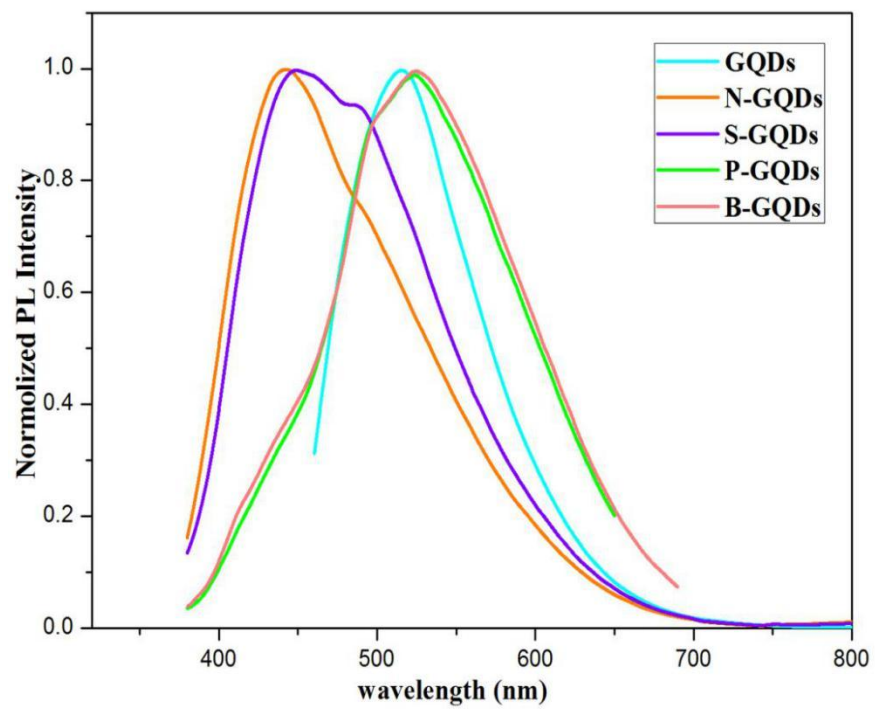


Fig. S4. Locations of PL prominent emission peaks of GQDs, N-GQDs, S-GQDs, P-GQDs and B-GQDs with an excitation wavelength of 360 nm.

Table S3. The wavelength of maximum emission of GQDs and doped-GQDs refluxing in HNO₃ for 8 h and 32 h.

Samples	Excitation Wavelength (nm)		Maximum Emission Wavelength (nm)	
	8 h	32 h	8 h	32 h
N-GQDs	360	500	443.6	555.4
S-GQDs	360	460	447.8	525.4
P-GQDs	360	500	526.8	555.8
B-GQDs	360	500	525.2	557.4

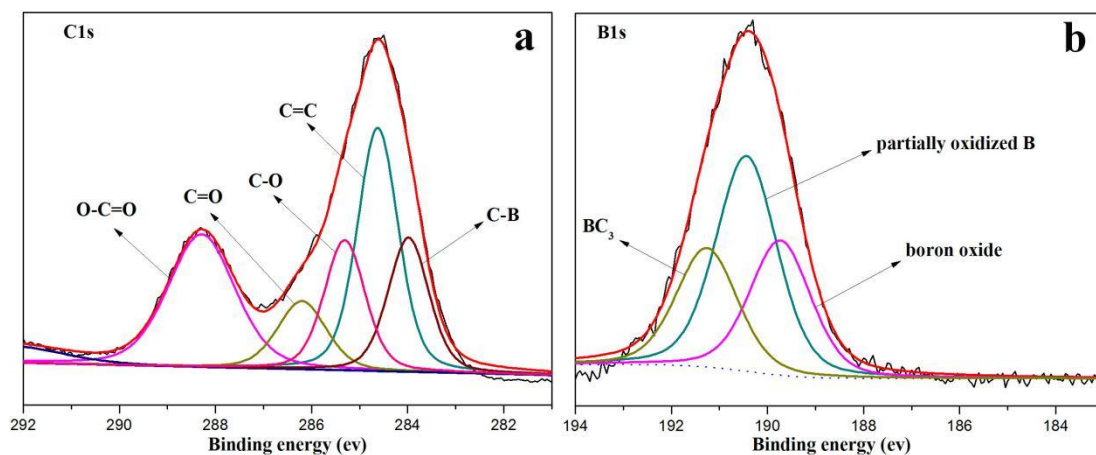


Fig. S5. C1s (a) and B1s (b) spectrum of B-GQDs refluxed in HNO₃ for 32 h.

References

1. S. Godefroo, M. Hayne, M. Jivanescu, A. Stesmans, M. Zacharias, O. I. Lebedev, G. Van Tendeloo and V. V. Moshchalkov, *Nature Nanotechnology*, 2008, **3**, 174-178.
2. M. A. Zurbuchen, G. Asayama, D. G. Schlom and S. K. Streiffer, *Physical Review Letters*, 2002, **88**, 107601.
3. M. J. Hytch, E. Snoeck and R. Kilaas, *Ultramicroscopy*, 1998, **74**, 131-146.