Electronic Supplementary Information

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Open system massive synthesis of narrow-band blue and green fluorescent graphene quantum dots and their application to water sensing

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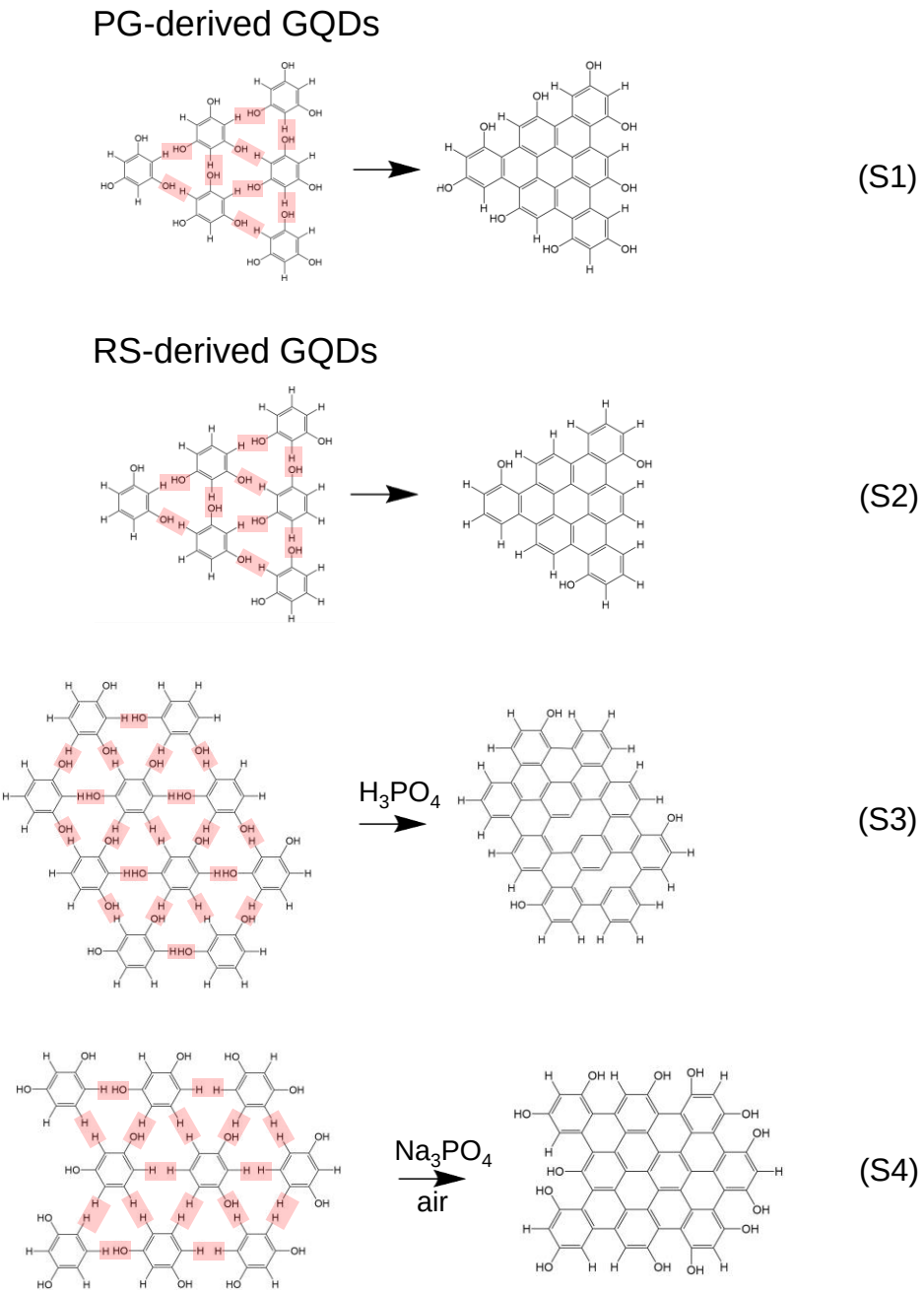

Fig. S1 Formation of GQDs from PG and RS. The solvothermal reactions (S1) and (S2) in ethanol at 200 °C have been reported by Y. L. Yuan el al.[S1,S2] The reactions (S3) and (S4) in ethylene glycol at 190 °C have been reported by S. Ghosh et al.[S3]

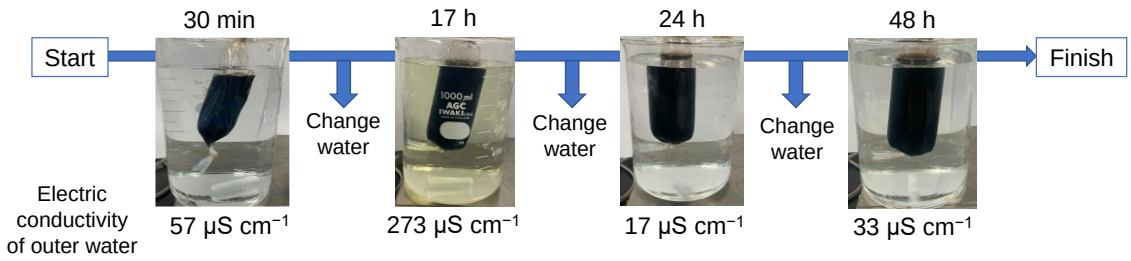

Fig. S2 Purification of PG-GQDs by dialysis.

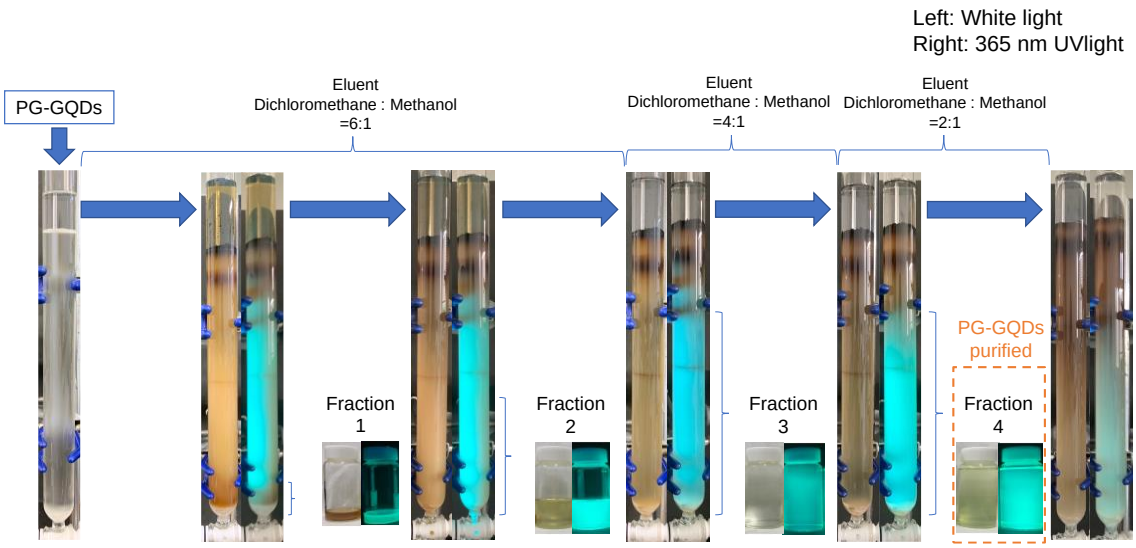

Fig. S3 Purification of PG-GQDs by silica gel column chromatography.

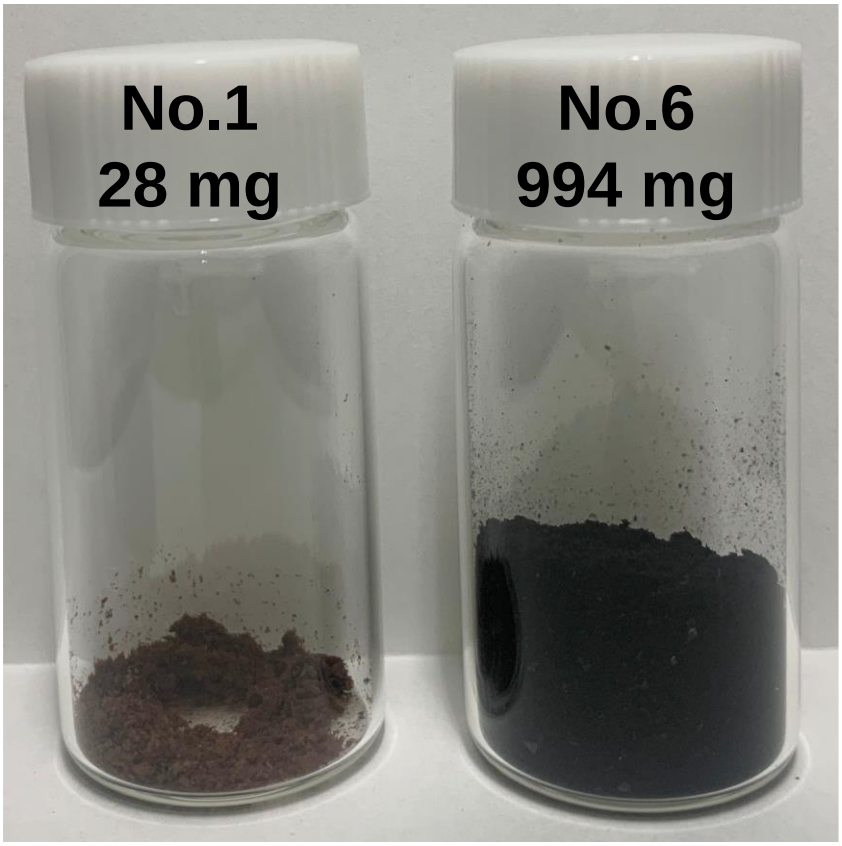

Fig. S4 Photographs of crude PG-GQDs synthesized under the conditions Nos. 1 and 6.

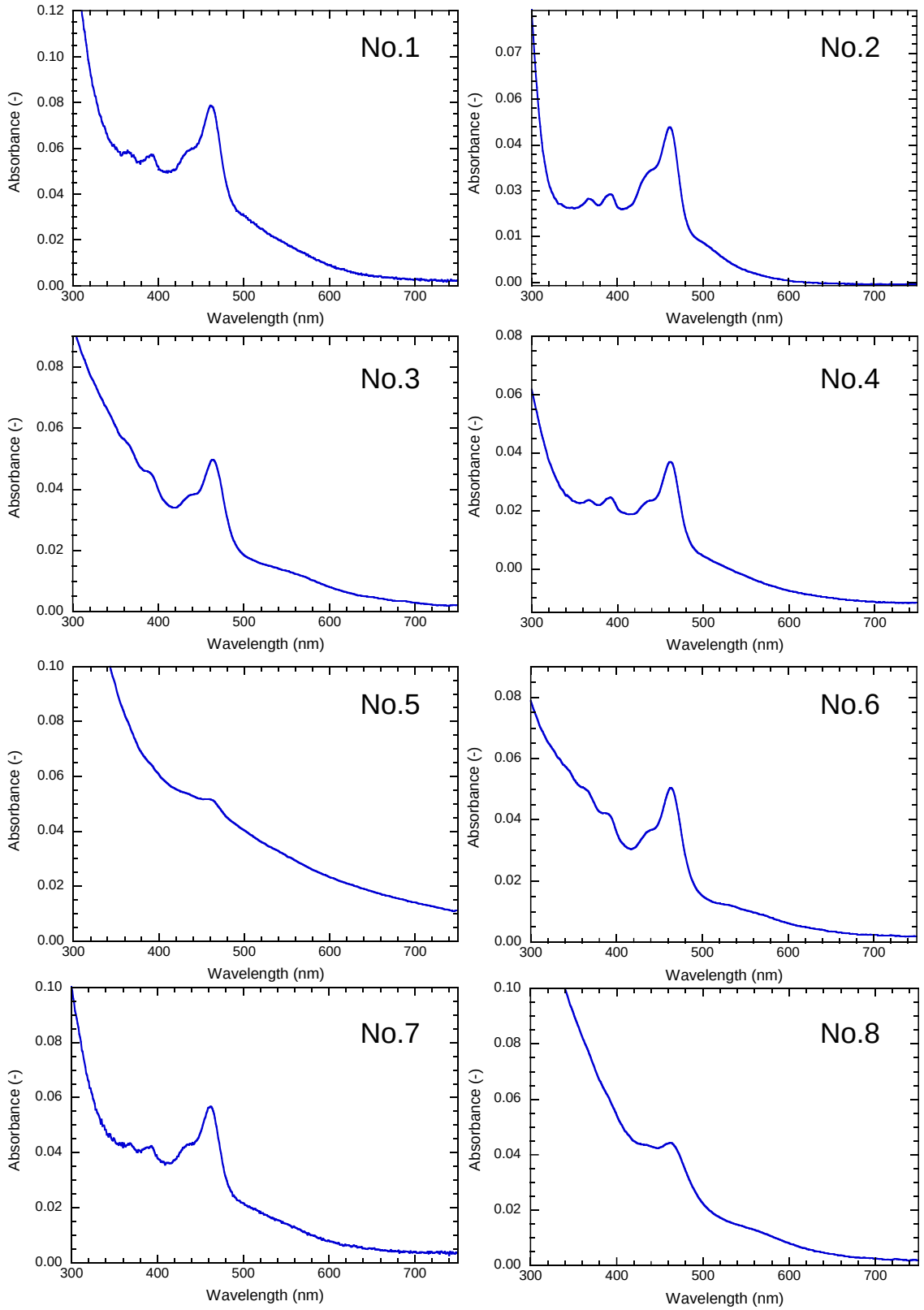

Fig. S5 UV-vis absorption spectra of crude PG-GQDs in EtOH.

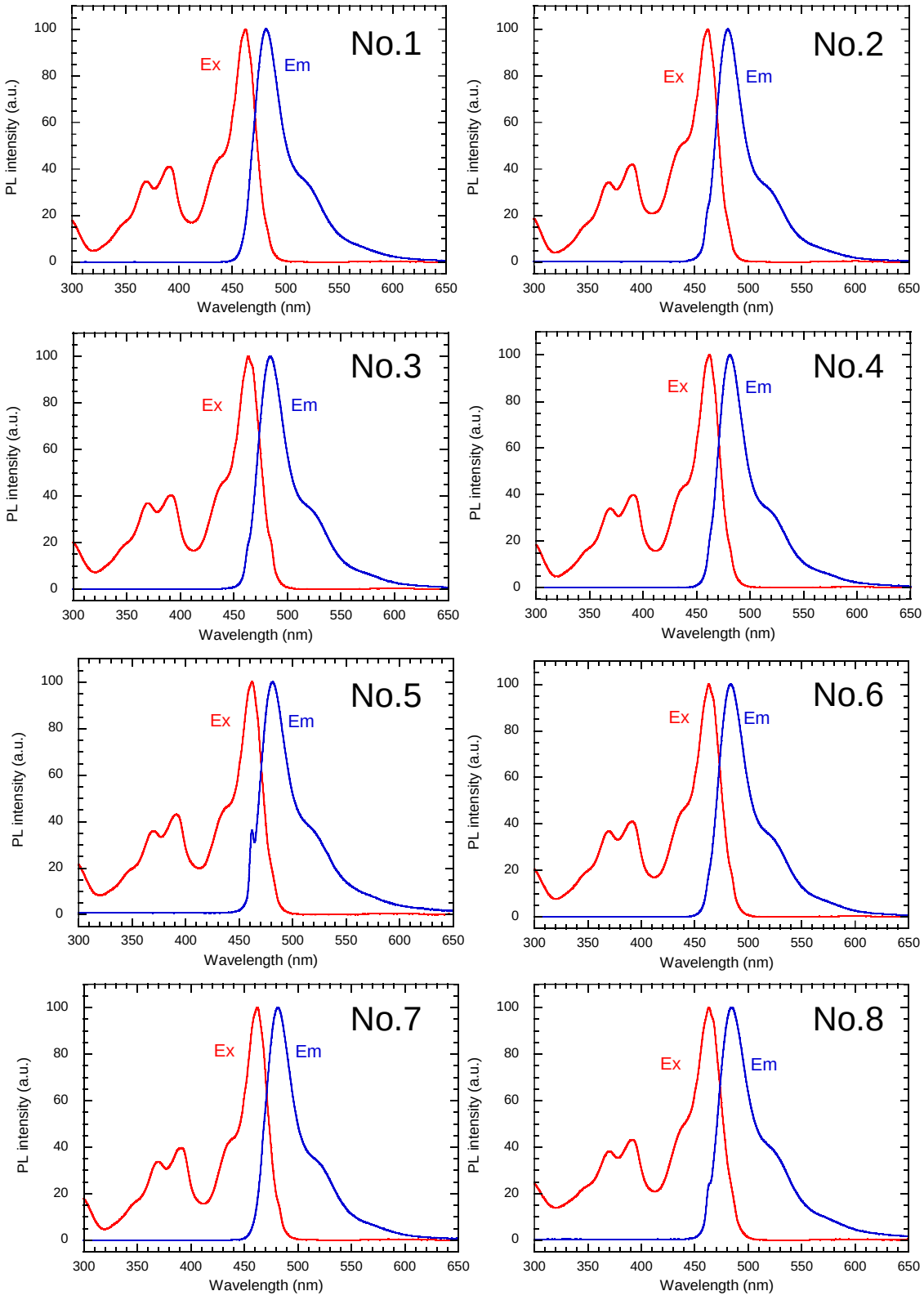

Fig. S6 PL/PLE spectra of crude PG-GQDs in EtOH.

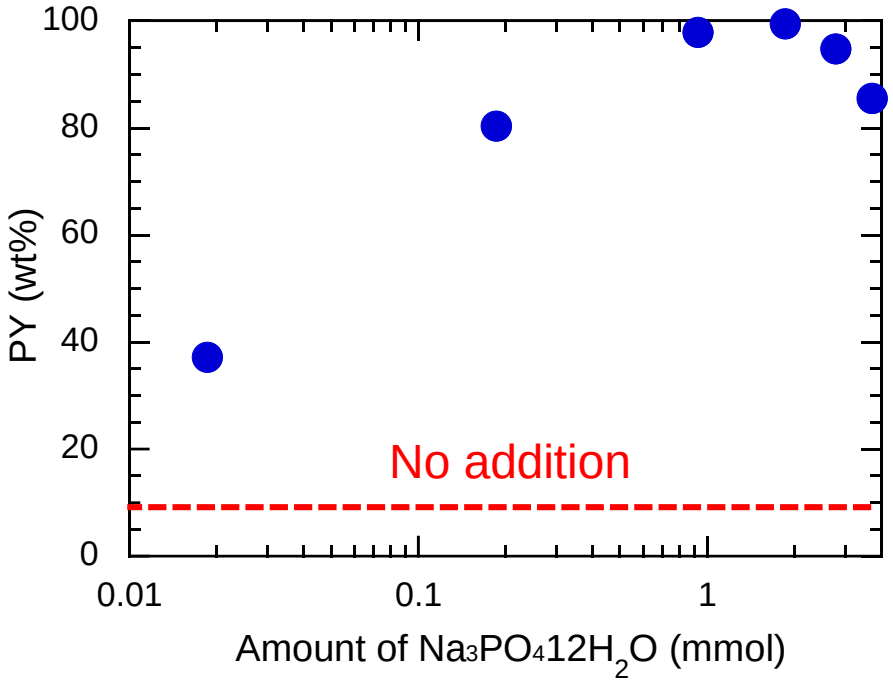

Fig. S7 Change in PY with amount of $Na_3PO_4 \cdot 12H_2O$ catalyst.

Table S1 Change in PY with amount of $Na_3PO_4 \cdot 12H_2O$ catalyst.

Amount of $Na_3PO_4 \cdot 12H_2O$ (mmol)	PY (wt%)
0	2.8
0.0186	37.2
0.186	80.3
0.930	97.8
1.86	99.4
2.79	94.8
3.72	85.5

Table S2 PL properties of three different synthesized and purified PG-GQDs ($Na_3PO_4 \cdot 12H_2O$, air) in EtOH.

	λ_{ex} (nm)	λ_{em} (nm)	fwhm (nm)	PLQY (%)
1	463	483	32	72
2	463	484	32	80
3	464	485	32	73
Average	463	484	32	75

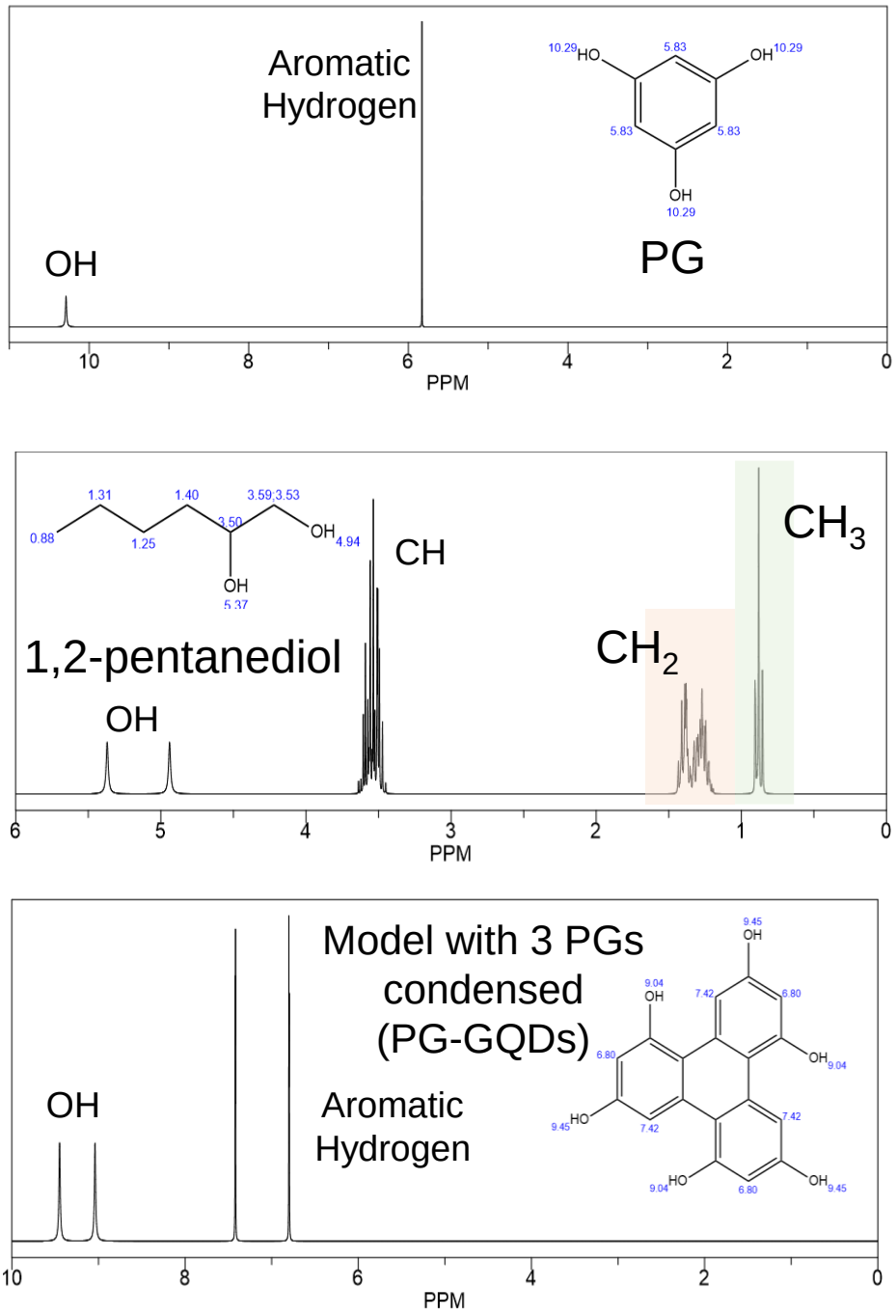

Fig. S8 Simulated ^{1}H-NMR spectra of PG, 1,2-pentanediol, and the molecule formed by dehydration condensation of three PG molecules.

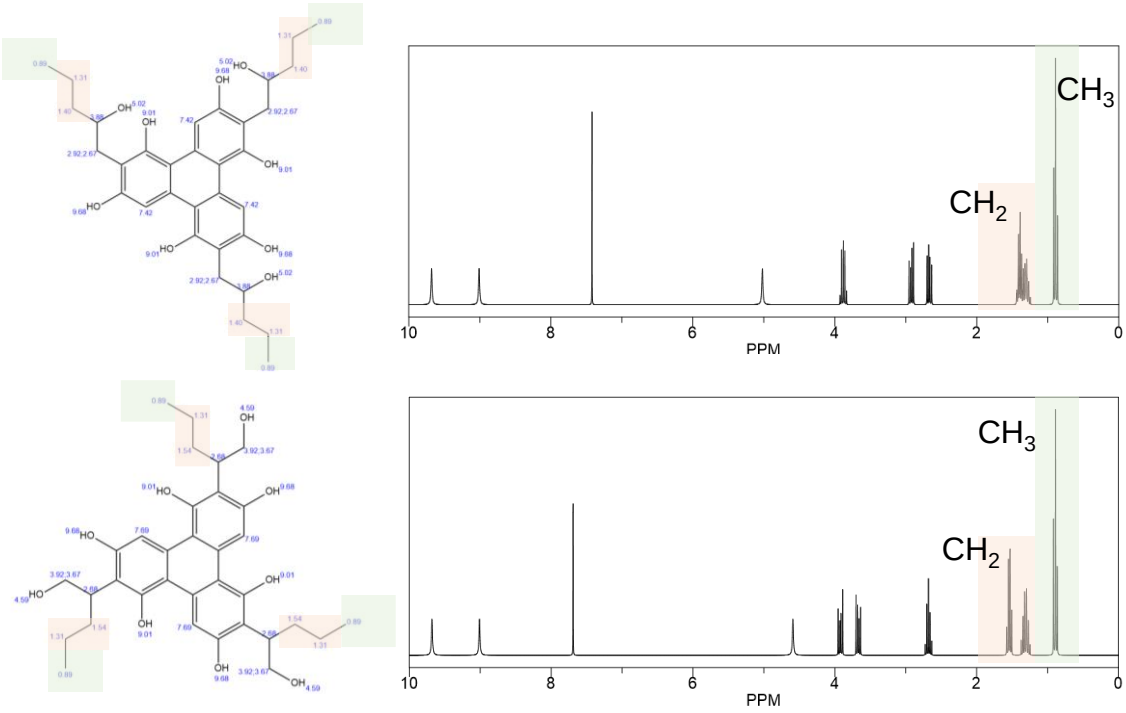

Fig. S9 Simulated ^{1}H-NMR spectra of the dehydration-condensed structure of three PG molecules bonded to three 1,2-pentanediol molecules.

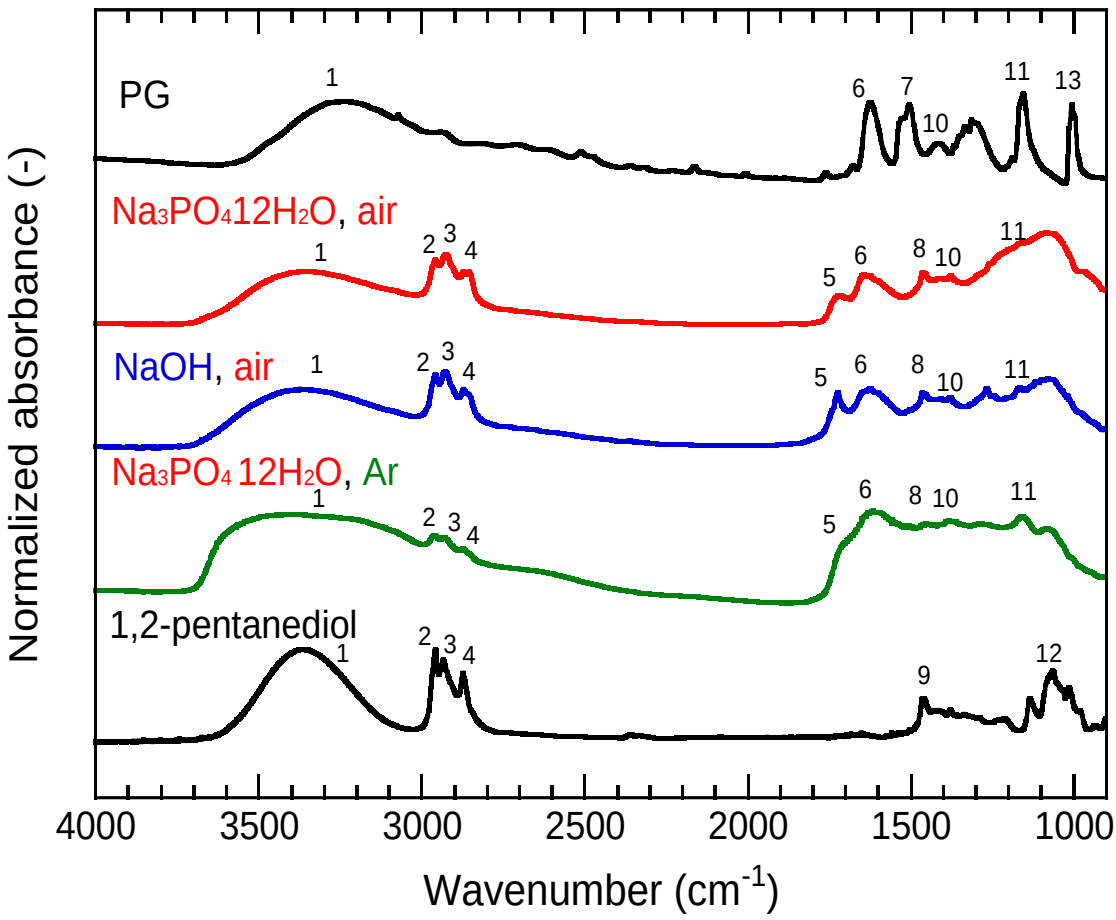

Fig. S10 FT-IR spectra of PG, purified PG-GQDs, and 1,2-pentanediol.

Table S3 Assignments of FT-IR absorption peaks shown in Fig. S10.

Peak	Wavelength (cm^{-1})					Assignment
	PG	$Na_3PO_4 \cdot 12H_2O$, air	NaOH, air	$Na_3PO_4 \cdot 12H_2O$, Ar	1,2-pentanediol	
1	3100-3600	ν(O-H)				
2		2959	2959	2960	2959	$\nu_{as}(CH_3)$
3		2926	2929	2931	2934	$\nu_{s}(CH_3)$
4		2873	2873	2874	2873	$\nu_{s}(CH_2)$
5		1717	1725	1704		ν(C=O)
6	1626	1645	1626	1627		ring(C=C)
7	1506					ring semicircle stretching
8		1464	1466	1464		ring semicircle stretching
9					1466	$\delta(CH_2)$
10	1415	1410	1409	1408		δ(O-H)
11	1156	1162	1166	1160		ν(C-O)
12					1066	ν_{as}(C-C-O)
13	1008					δ(C-H)

ν=stretching, δ=deformation or bending, as=asymmetric, s=symmetric

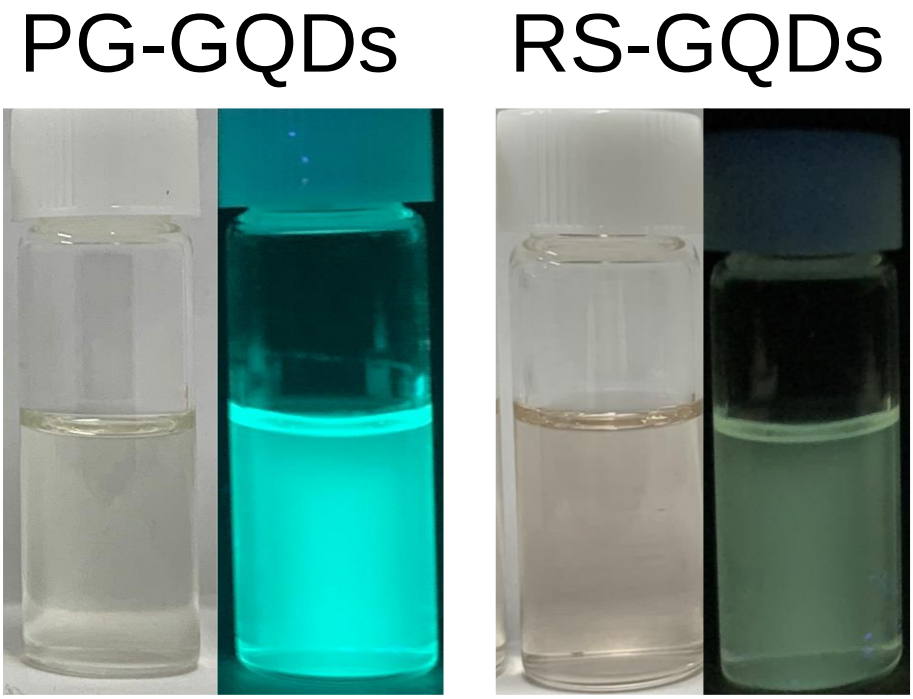

Fig. S11 Photographs of purified PG-GQDs and RS-GQDs in EtOH under white light and 365 nm UV light.

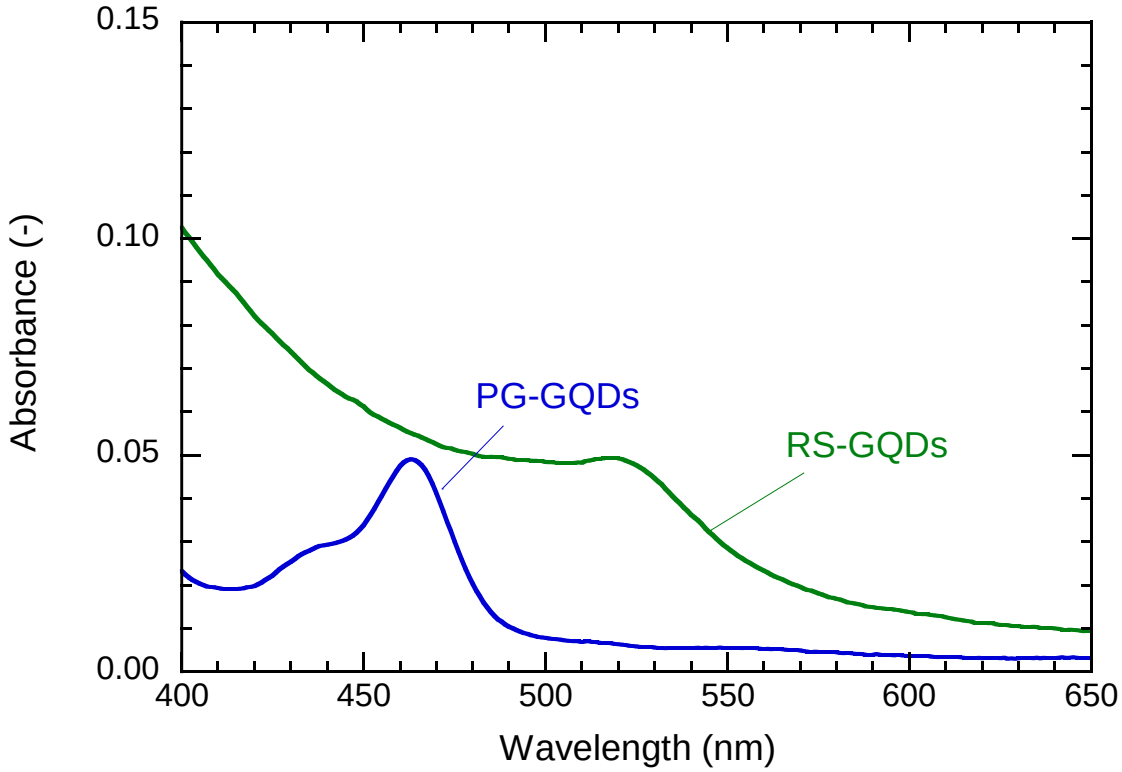

Fig. S12 UV-vis absorption spectra of purified PG-GQDs and RS-GQDs in EtOH.

Table S4 Optical properties of purified PG-GQDs and RS-GQDs in EtOH.

	Absorption wavelength (nm)	Excitation wavelength (nm)	Emission wavelength (nm)	fwhm (nm)	PLQY (%)
PG-GQDs	463	463	483	32	75
RS-GQDs	518	524	542	40	13

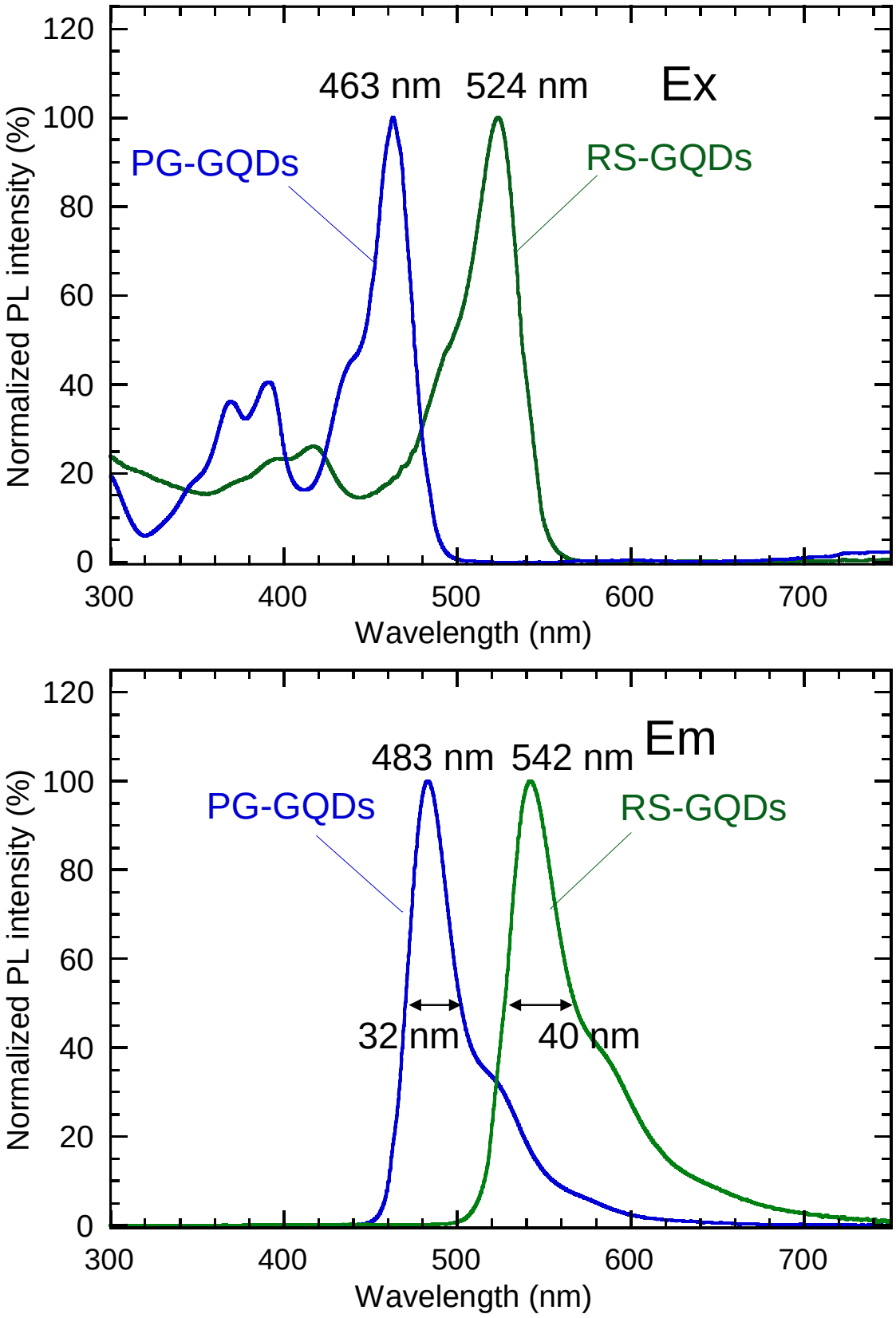

Fig. S13 PL/PLE spectra of purified PG-GQDs and RS-GQDs in EtOH.

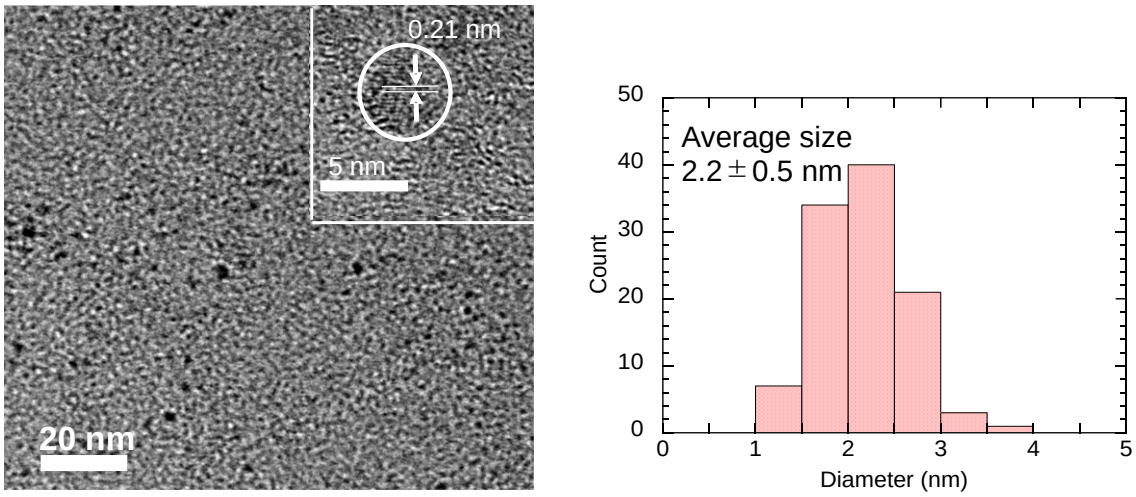

Fig. S14 FE-TEM images of RS-GQDs and their size distribution.

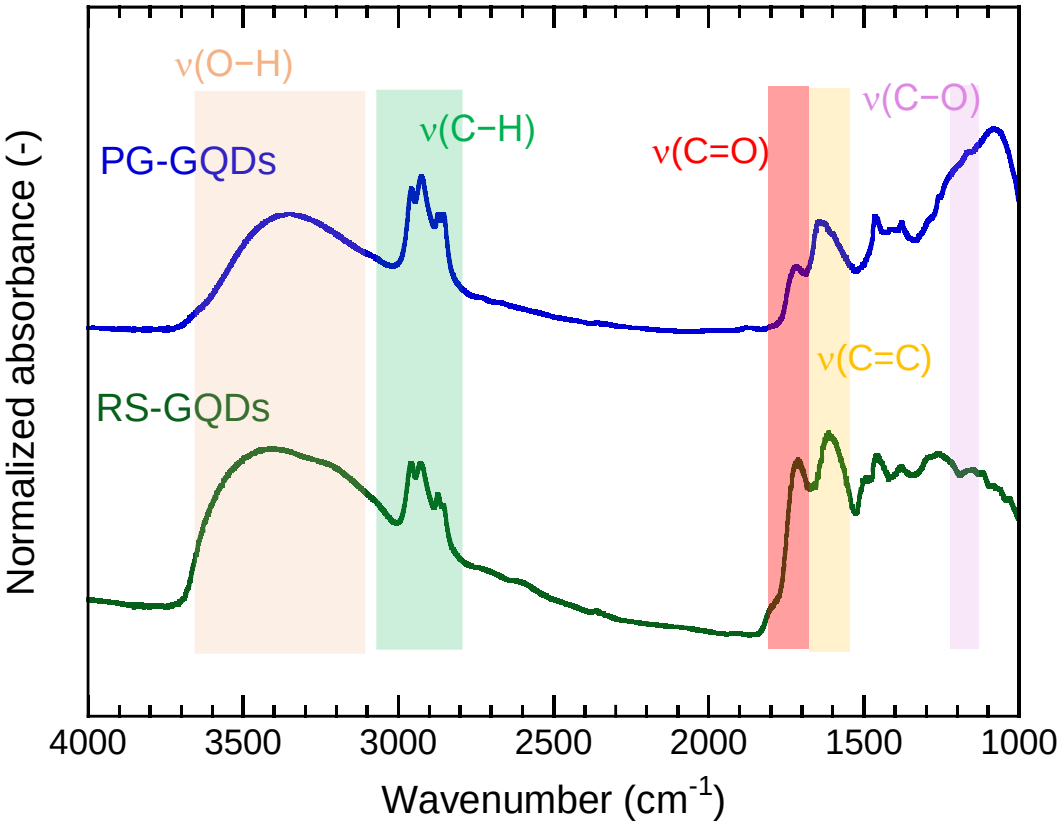

Fig. S15 FT-IR spectra of purified PG-GQDs and RS-GQDs.

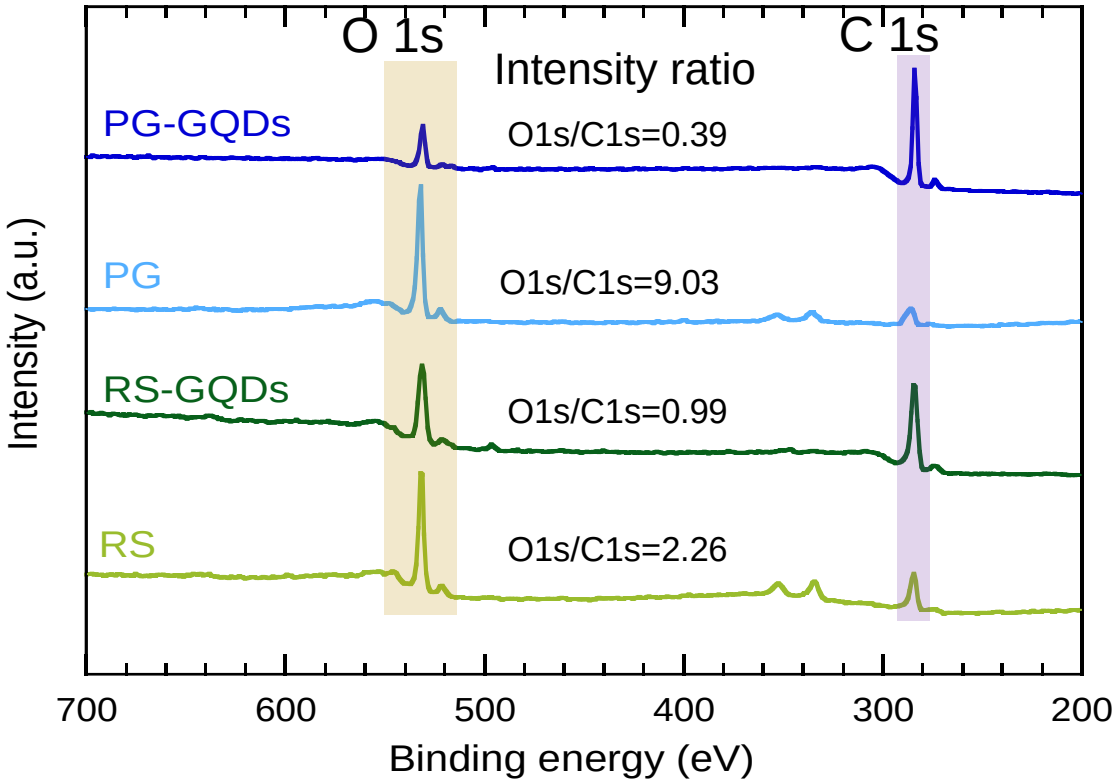

Fig. S16 Wide scan XPS spectra of PG, PG-GQDs, RS, and RS-GQDs.

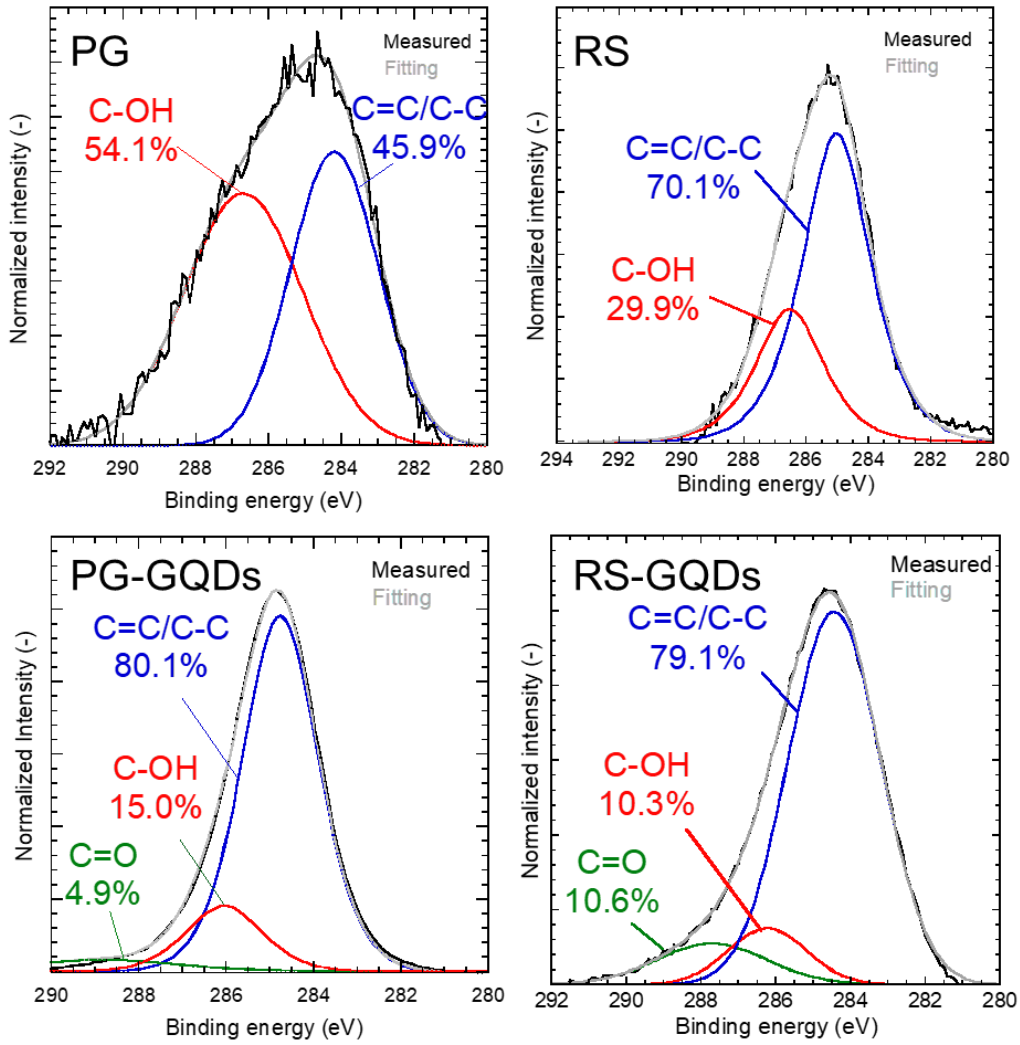

Fig. S17 Narrow scan C 1s XPS spectra of PG, PG-GQDs, RS, and RS-GQDs.

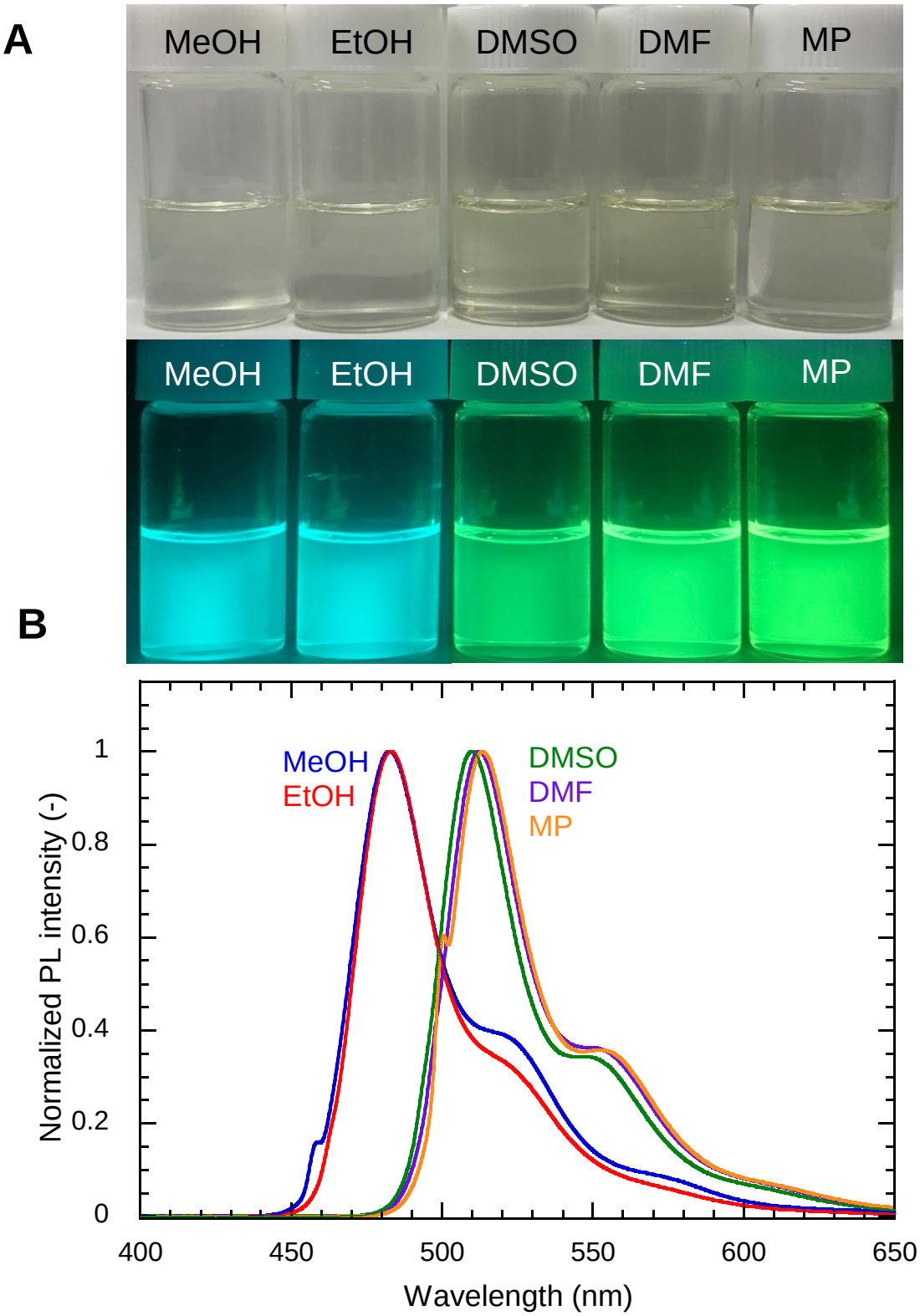

Fig. S18 (A) Photographs of purified PG-GQDs in solvents with different polarities under white light and 365 nm UV light and (B) their PL spectra.

Table S5 PL properties of purified PG-GQDs in solvents with different polarities.

Dispersion	$E_T(30)$ (kcal mol^{-1})	λ_{ex}(nm)	λ_{em} (nm)	fwhm (nm)	PLQY (%)
MP	42.2	500	514	33	96
DMF	43.2	498	513	32	94
DMSO	45.1	494	511	30	79
EtOH	51.9	463	484	32	80
MeOH	55.4	458	483	34	97
Water (pH 7)	63.1	444	474	50	6
Water (pH 9)		428	465	50	30
Water (pH 11)		428	465	49	60
Water (pH 13)		428	466	49	52

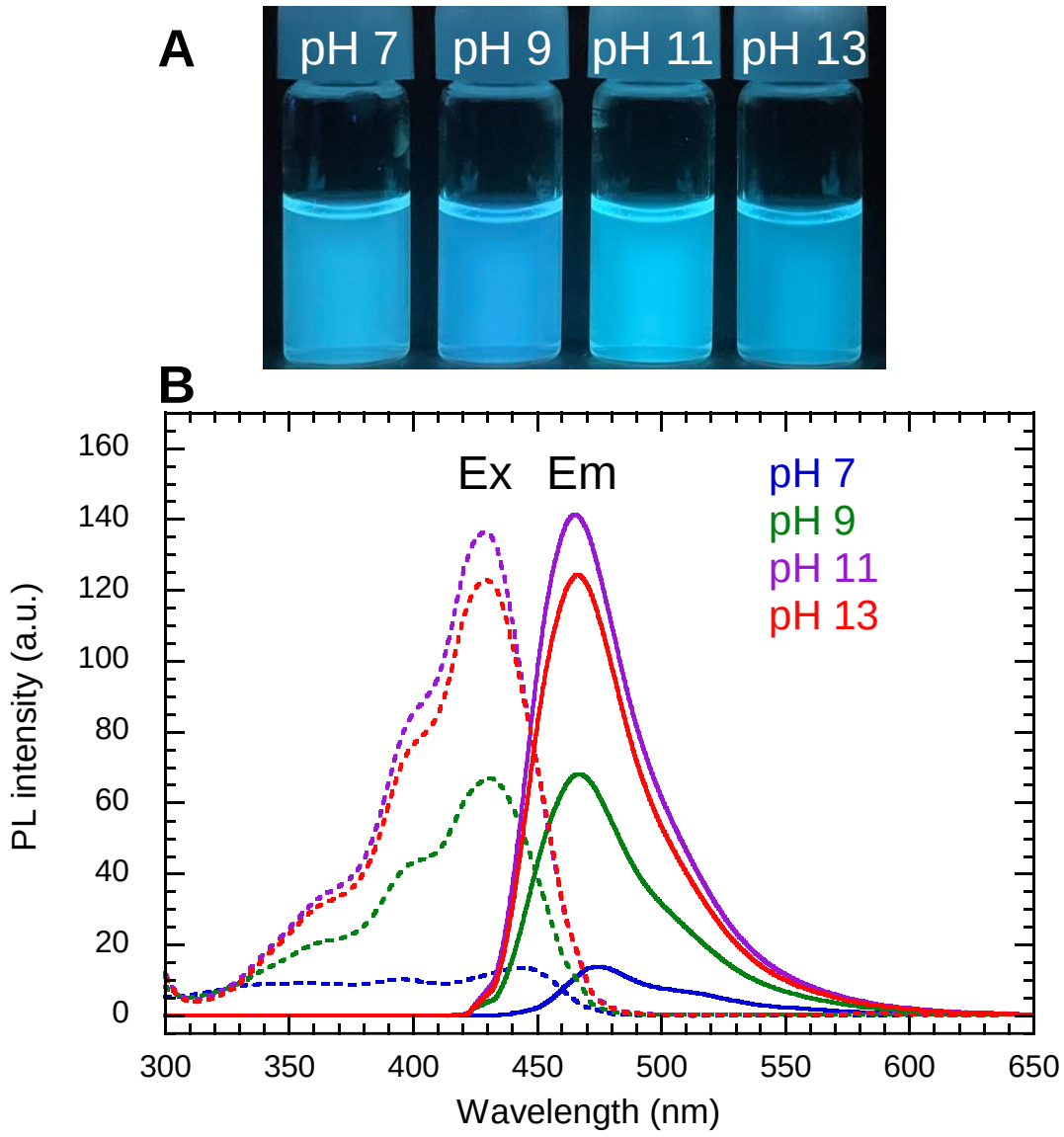

Fig. S19 (A) Photographs of purified PG-GQDs in water at different pH and (B) their PL/PLE spectra.

References

S1 F. L. Yuan, T. Yuan, L. Z. Sui, Z. B. Wang, Z. F. Xi, Y. C. Li, X. H. Li, L. Z. Fan, Z. A. Tan and A. M. Chen, *Nat. Commun.*, 2018, **9**, 2249.

S2 F. L. Yuan, P. He, Z. F. Xi, X. H. Li, Y. C. Li, H. Z. Zhong, L. Z. Fan and S. H. Yang, *Nano Res.*, 2019, **12**, 1669−1674.

S3 S. Ghosh, H. Ali and N. R. Jana, *ACS Sustainable Chem. Eng.*, 2019, **7**, 12629−12637.