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Supporting Information

Highly Fluorescent Ti_3C_2 MXene Quantum Dots for Macrophage Labeling and Cu^{2+} Ion Sensing

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Table S1. The quantum yields up of the as-prepared N, P-MQDs and other material.

Samples	Synthetic method	Wavelength (nm)	Quantum yield (%)	Ref
N, P-MQDs	Hydrothermal	560	20.1	This paper
MQD-100	Hydrothermal	420	9.9	[1]
N-MQDs	Hydrothermal	447	18.7	[2]
s-MQDs	Solvothermal	570	10.7	[3]
MQDs	Intercalation	475	Not given	[4]
Ti_3C_2 QDs	Hydrothermal	450	2.67	[5]
Ti_3C_2 QDs	Hydrothermal	480	7.13	[6]
Ti_3C_2 MQDs	Hydrothermal	509	9.36	[7]

Table S2. The photoluminescence quantum yield (PLQY) and lifetimes of the as-prepared N, P-MQDs, N-MQDs, and P-MQDs.

Samples	PLQY	Lifetime (ns)
P-MQDs	2.4%	4.99
N-MQDs	10.3%	6.02
N, P-MQDs	20.1%	8.54

Table S3. Element content of as-prepared Ti_3C_2 and N, P-MQDs, N-MQDs, and P-MQDs.

Samples	Ti2p (Atomic %)	C1s	O1s	N1s	P2p
Ti_3C_2 pristine	0.59	59.8	39.61	-	-
N, P-MQDs	0.61	20.88	65.05	4.73	8.73
N-MQDs	0.88	27.66	67.95	3.5	-
P-MQDs	0.32	21.77	61.92	-	16

Table S4. Element content of N, P-MQDs before and after quenching.

Samples	Ti2p (Atomic %)	C1s	O1s	N1s	P2p	Cu2p
N, P-MQDs	0.61	20.88	65.05	4.73	8.73	0
N, P-MQDs + 1000 μM Cu^{2+}	1.38	10.26	62.75	2.1	1.78	21.72
N, P-MQDs + 5000 μM Cu^{2+}	1.32	13.68	17.72	3.6	0.63	63.05

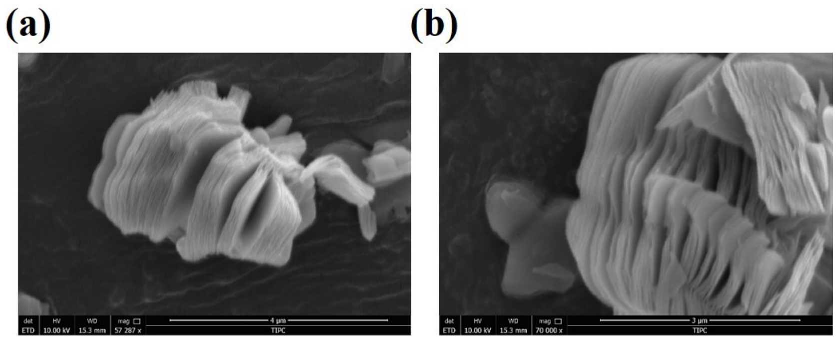

Figure S1. SEM images of as-obtained layered Ti_3C_2 MXene.

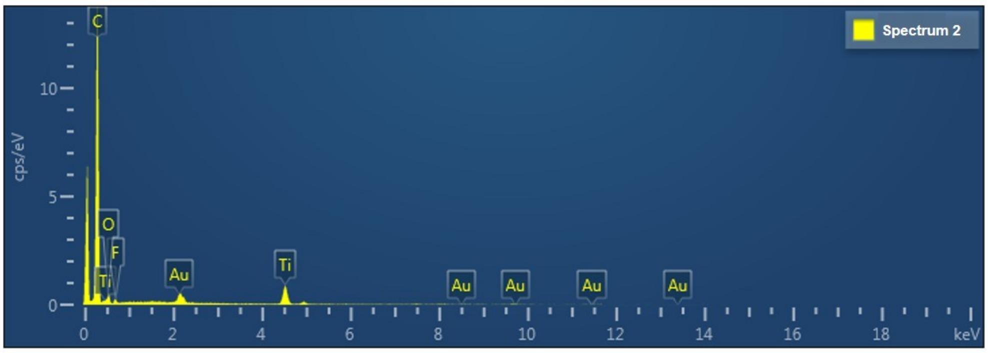

Figure S2. SEM-EDX (Energy-dispersive X-ray spectroscopy) of pristine Ti_3C_2.

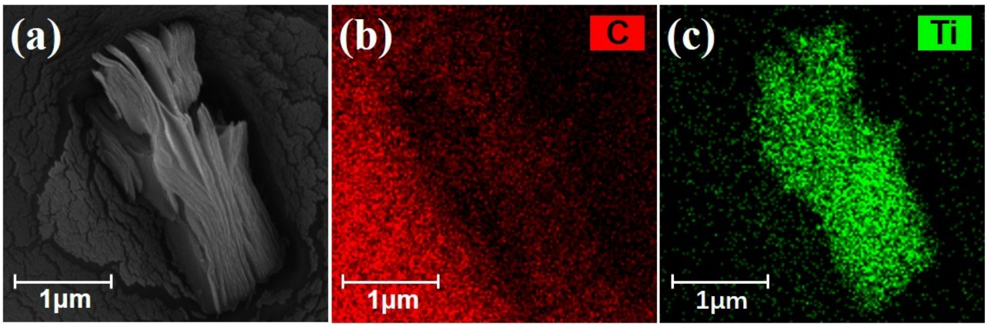

Figure S3. (a-c) SEM-EDS elemental mapping images of the pristine Ti_3C_2 sheet.

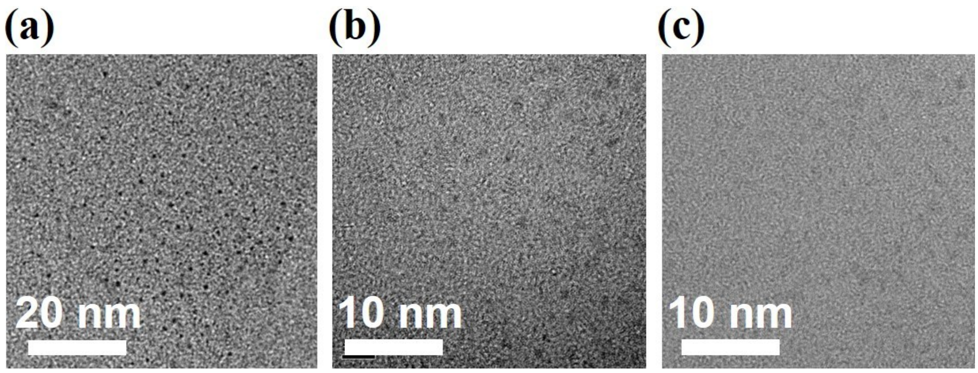

Figure S4.TEM images of (a) N, P-MQDs, (b) N-MQDs, and (c) P-MQDs.

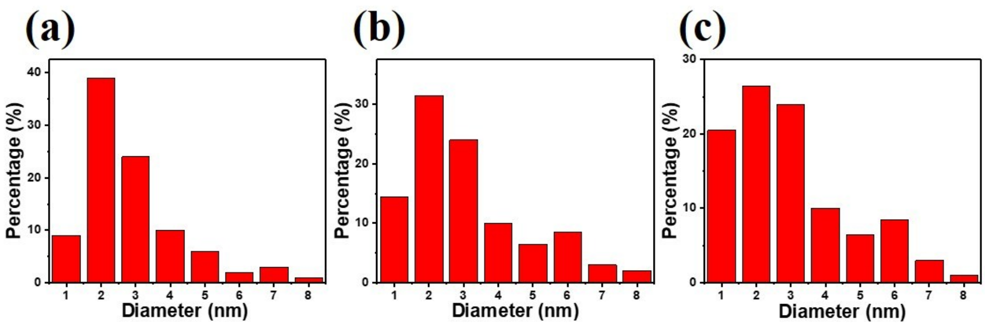

Figure S5. Diameter size distribution of (a) N, P-MQDs, (b) N-MQDs, and (c) P-MQDs.

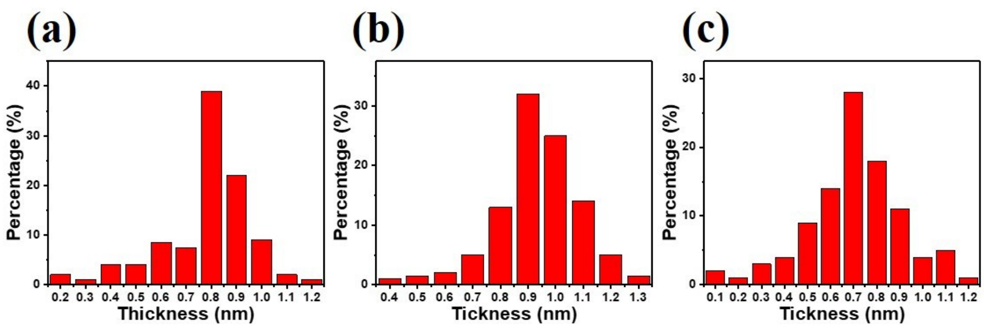

Figure S6. Thickness distribution of (a) N, P-MQDs, (b) N-MQDs, and (c) P-MQDs.

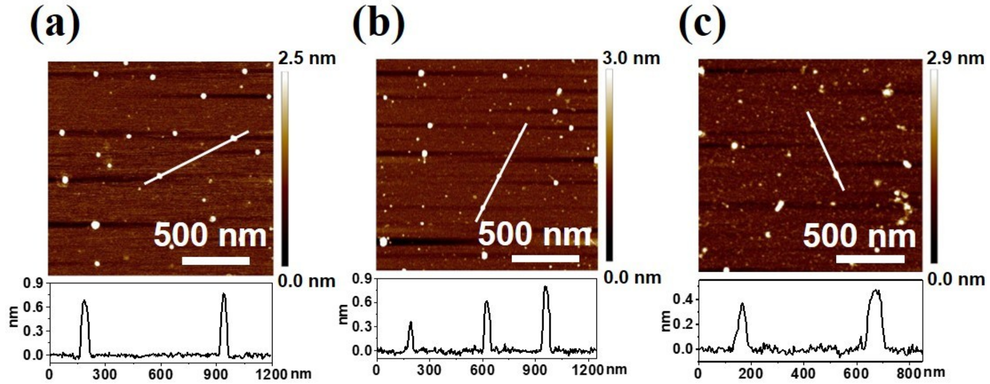

Figure S7. AFM images of the prepared (a) N, P-MQDs, (b) N-MQDs, and (c) P-MQDs. Insets are height profiles of corresponding lines.

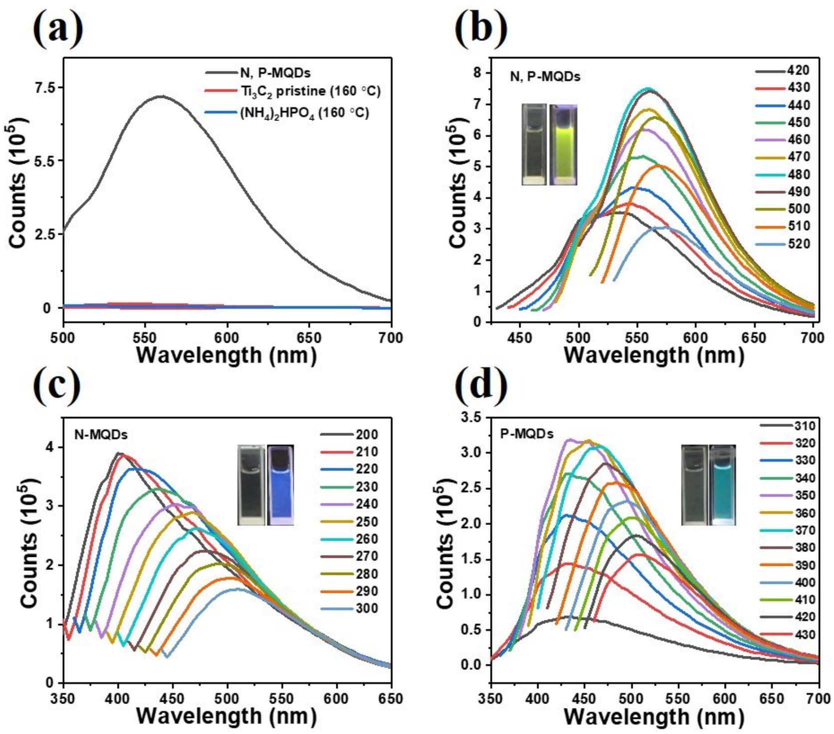

Figure S8. Photoluminescence spectra of (a) Photoluminescence spectra (UV light 480 nm) of N, P-MQDs, diammonium phosphate (120 °C, 12 h) and Ti_3C_2 (120 °C, 12 h, without acid treated); (b) N, P-MQDs, (c) N-MQDs, and (d) P-MQDs. Insets are photographs under UV light (365 nm).

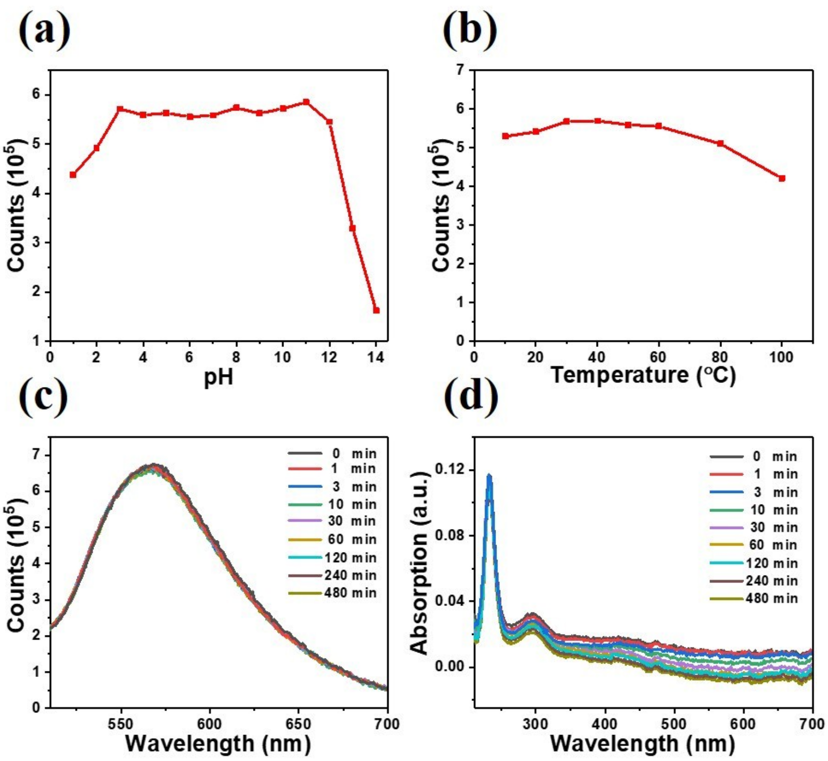

Figure S9. Fluorescence intensity variation of the N, P-MQDs as a function of (a) pH, (b) temperature, and (c) time under 480 nm light illumination; (d) time-dependent absorption changes of the N, P-MQDs.

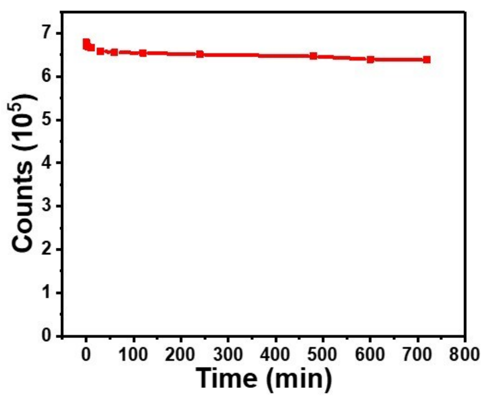

Figure S10. Fluorescence intensity variation of the N, P-MQDs vs. time

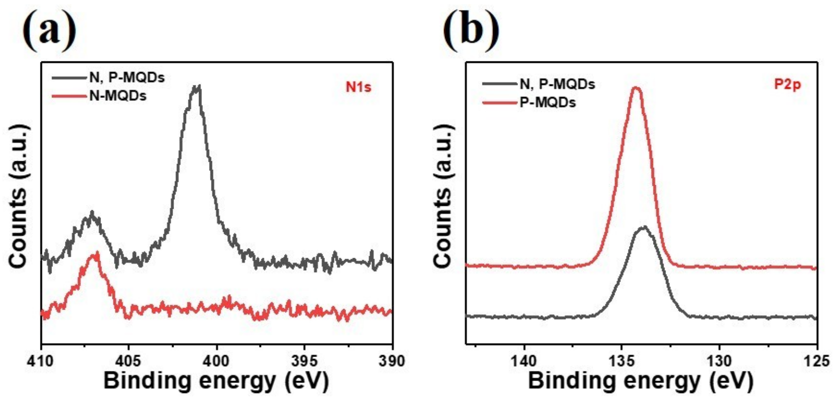

Figure S11. High-resolution XPS spectra (a) N1s spectrum for the N, P-MQDs and N-MQDs, and (b) P2p spectrum for the N, P-MQDs and P-MQDs.

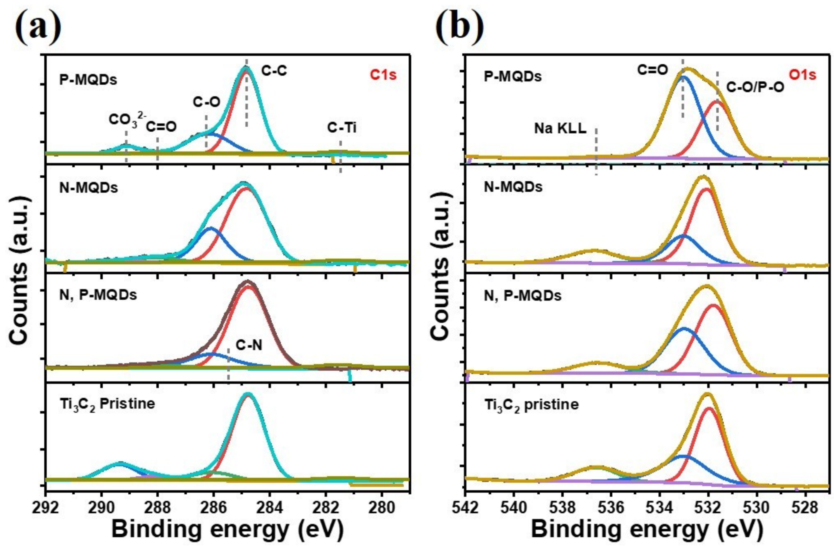

Figure S12. High-resolution XPS spectra of (a) C1s, (b) O1s for the pristine Ti_3C_2, N, P-MQDs, N-MQDs, and P-MQDs.

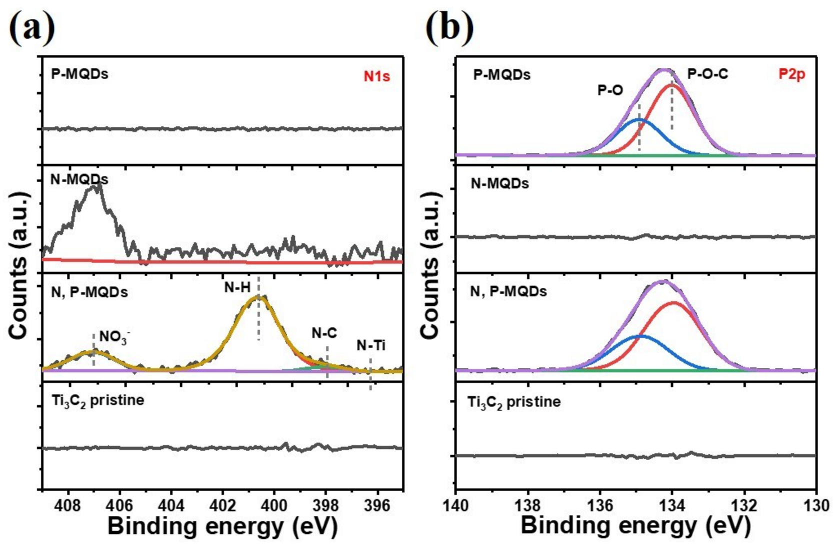

Figure S13. High-resolution XPS spectra of (a) N1s, (b) P2p for the pristine Ti_3C_2, N, P-MQDs, N-MQDs, and P-MQDs.

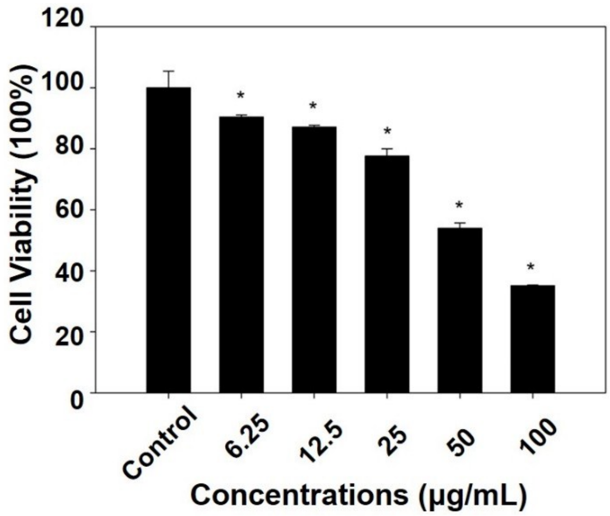

Figure S14. The cellular viability. THP-1 macrophages were exposed to various concentrations of N, P-MQDs for 24 h. After exposure, the cellular viability was measured by using CCK-8 assay.

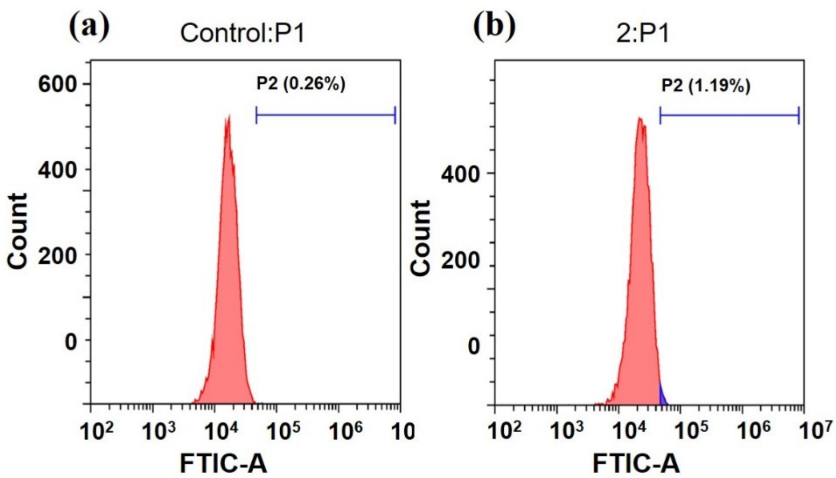

Figure S15. Flow cytometry analysis of THP-1 macrophages exposed to 25 μg/mL N, P-MQDs for 24 h. The percentage increase of cells with green fluorescence.

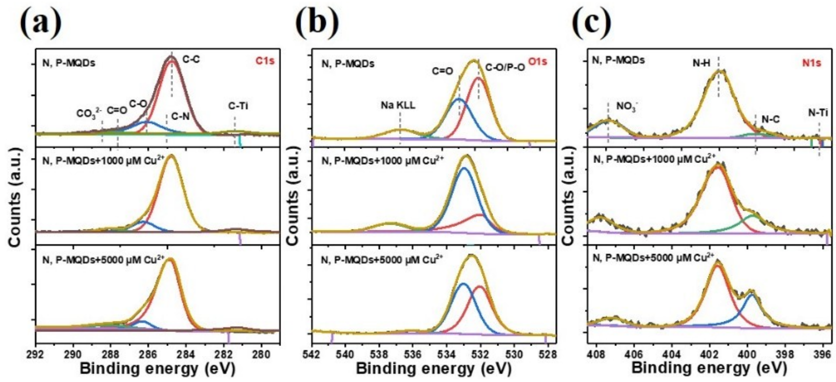

Figure S16. High-resolution XPS spectra for N, P-MQDs before and after quenching process: (a) C1s, (b) O1s, (c) N1s.

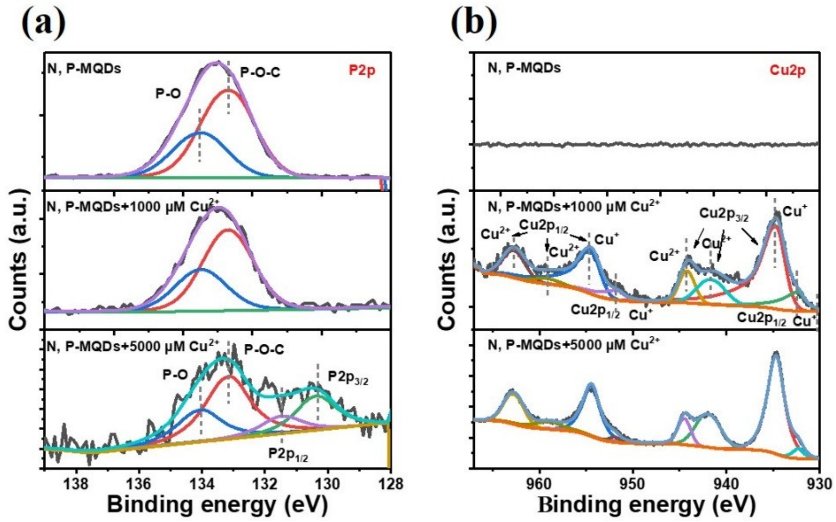

Figure S17. High-resolution XPS spectra for N, P-MQDs before and after quenching process: (a) P2p, (b) Cu2p.

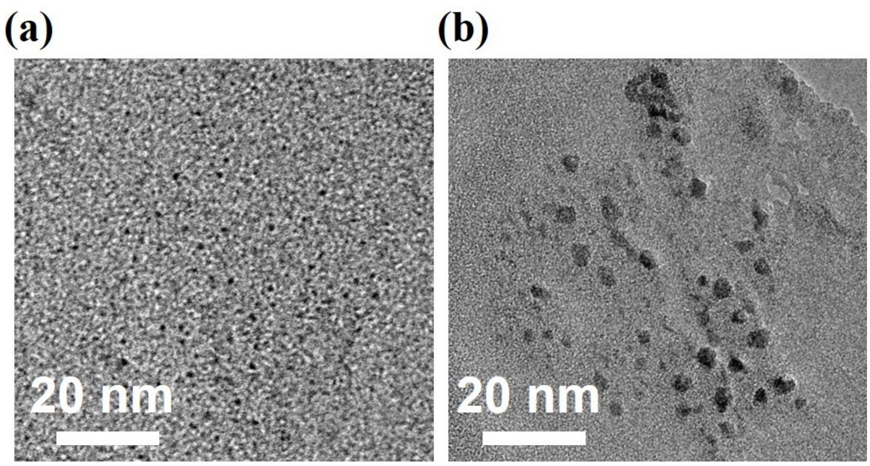

Figure S18. TEM images for N, P-MQDs before (a) and after (b) quenching by Cu^{2+}.

Supplementary references

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