

A ratiometric fluorescence sensor based on gold silver nanoclusters and tungsten disulfide quantum dots with simple fabrication for the detection of copper ions in river water

Zhiya Wang ^a, Rong Liu ^{a,b*}, Zhifang Fu ^a, Xin Yi ^a, Yongjun Hu ^{a*}, Changhui

Liu ^a, Dong Pan ^c, Zhaoyang Wu ^{b*}

^a Hunan Provincial Key Lab of Dark Tea and Jin-hua, College of Chemistry and Material Engineering, Hunan City University, Yiyang, 413000, P. R. C

^b State Key Laboratory for Chemo/Biosensing and Chemometrics, College of Chemistry and Chemical Engineering, Hunan University, Changsha 410082, P. R. C

^c Zhejiang Addenda Advance Energy Material Co. LTD, Huzhou 313000, P. R. C

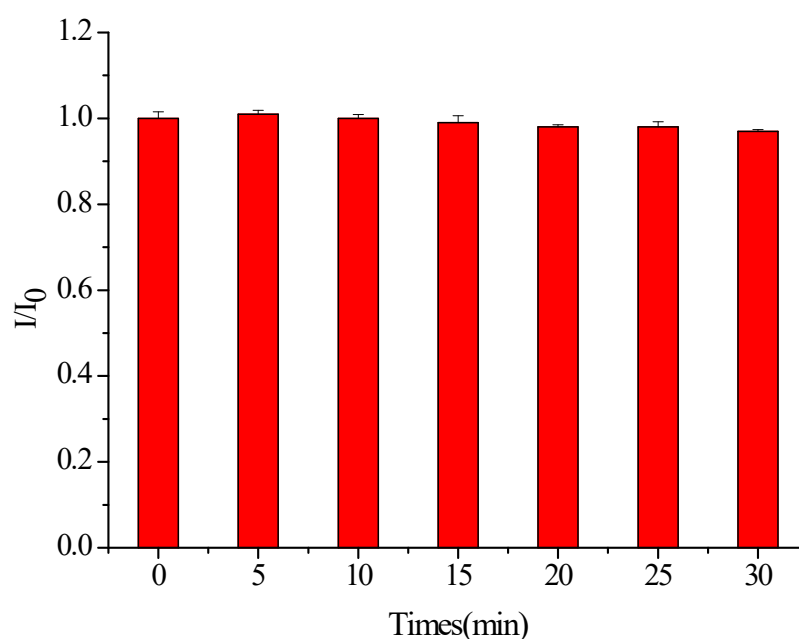


Fig.S1 The photostability of WS QDs with irradiation under a 300 W Xe lamp for 0.5 h.

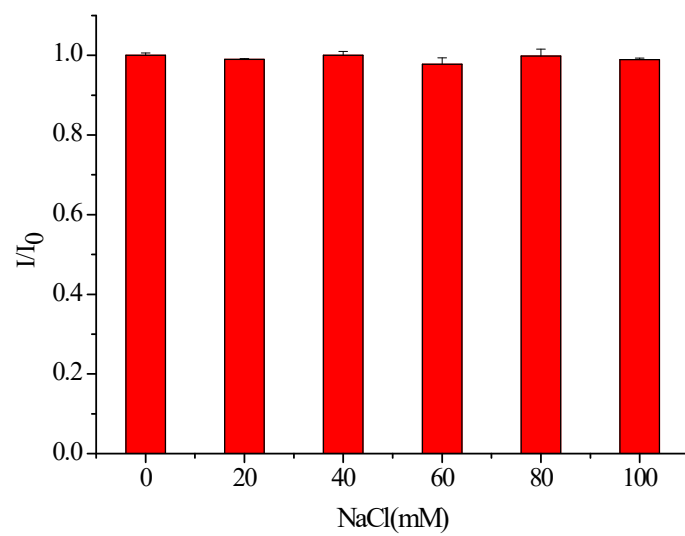


Fig.S2 The fluorescence intensity of WS_2 QDs over the NaCl concentration range of 0 to 100 mM.

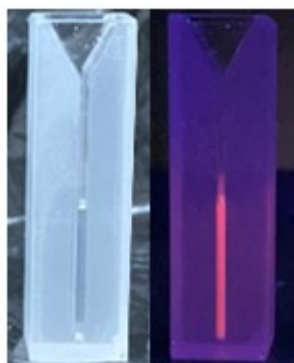


Fig.S3 Photographs of AuAgNCs under visible light (left) and 365 nm UV (right).

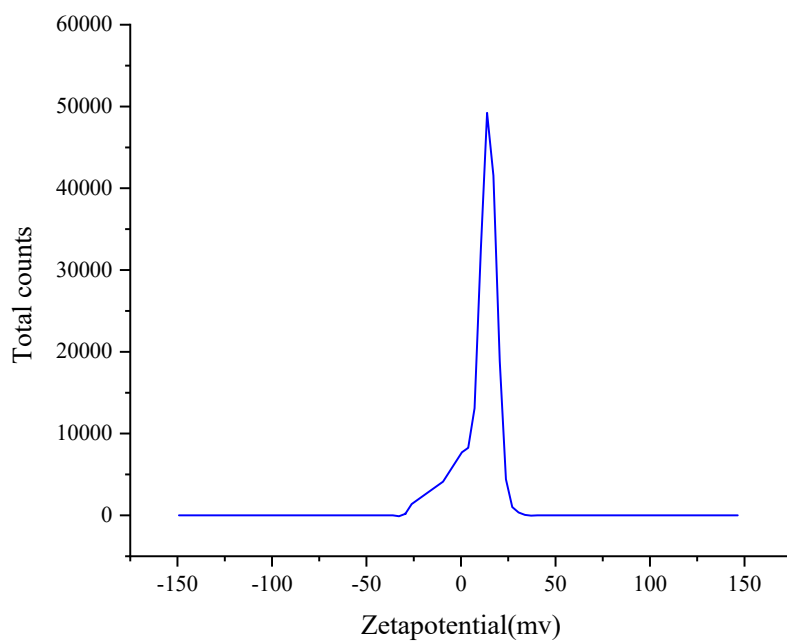


Fig.S4 The zeta potential of AuAgNCs.

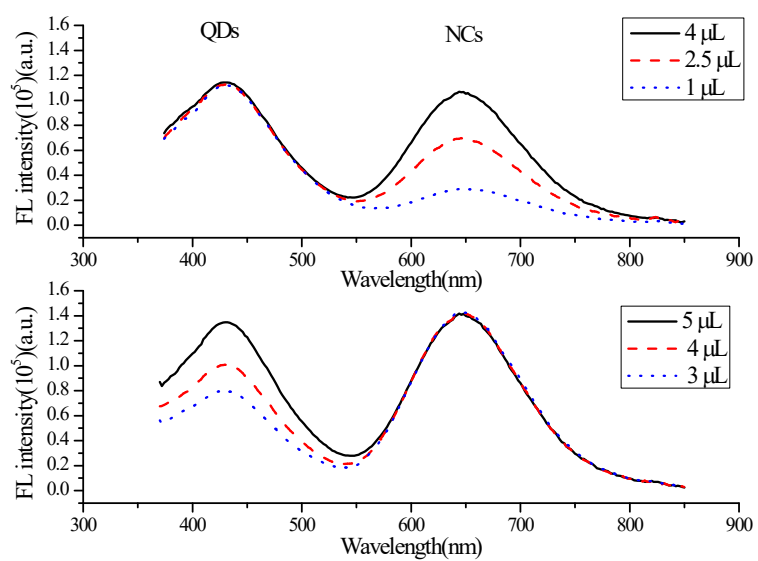


Fig.S5 Fluorescence spectra of fixing the concentration of WS₂-QDs and changing the concentration of MUA-AuAgNCs (A) and of fixing the concentration of MUA-AuAgNCs and changing the concentration of WS₂-QDs (B).

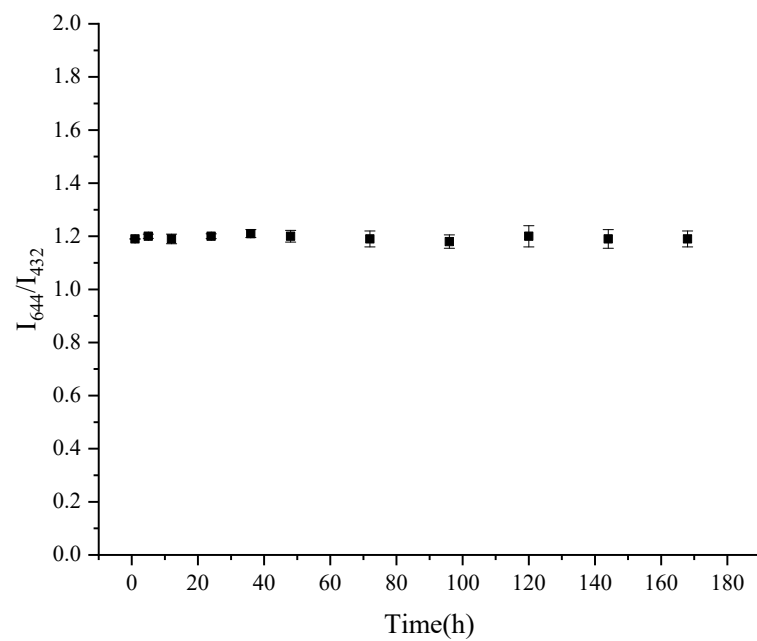


Fig.S6 The stability of this ratiometric probes of NCs/QDs.

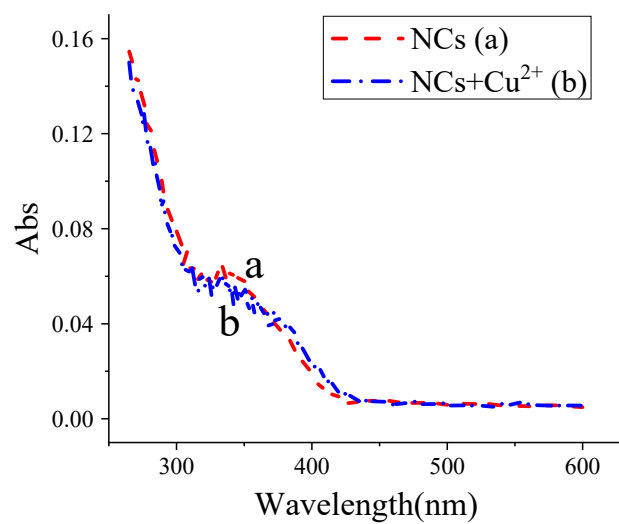


Fig.S7 UV-vis of NCs without Cu²⁺ (curve a) and with the addition of 10 μ M Cu²⁺(curve b).

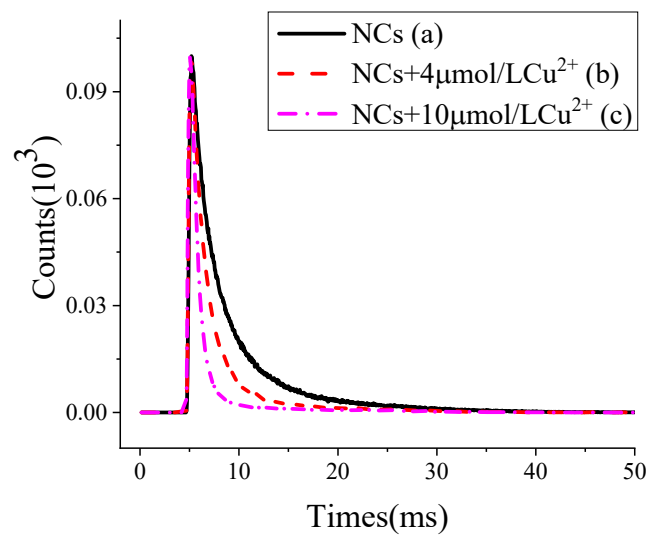


Fig.S8 Fluorescence intensity decay curves of NCs without Cu²⁺, adding 4 and 10 μM Cu²⁺.

Table.S1 The fluorescence decay lifetime of NCs in different concentration of Cu²⁺.

Cu ²⁺ (μM)	α ₁	τ ₁ (μs)	α ₂	τ ₂ (μs)	χ ²	τ _{avg} ¹ (μs)
0	94.99	1.79	5.01	6.51	0.9995	2.55
4	99.38	1.35	0.62	6.35	0.9995	1.46
10	92.21	1.08	7.79	0.18	0.9784	1.06

$$1: \tau_{avg} = \frac{\alpha_1 \tau_1^2 + \alpha_2 \tau_2^2}{\alpha_1 \tau_1 + \alpha_2 \tau_2}$$

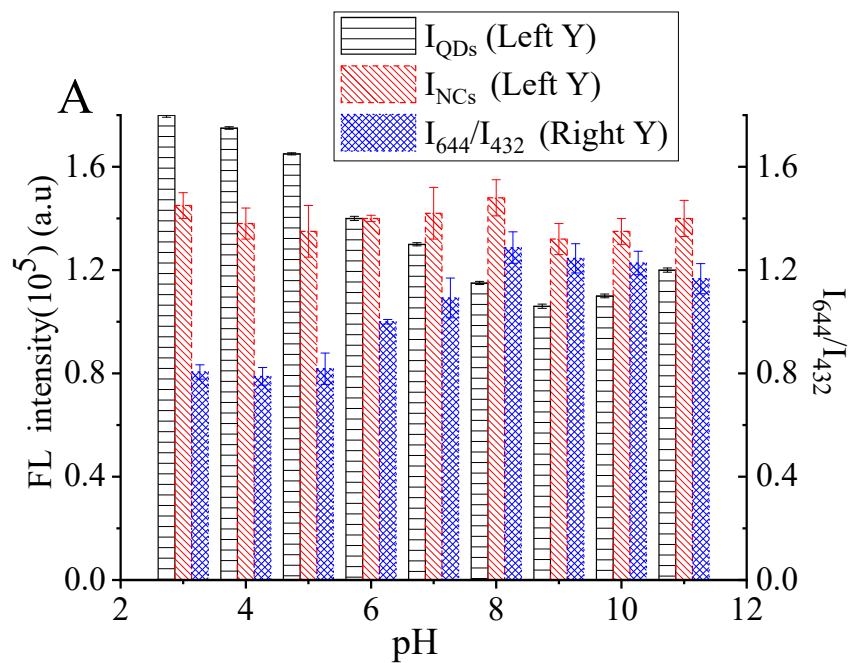


Fig.S9 I_{QDs} (horizontal bars) and I_{NCs} (diagonal bars) and the ratio of I_{NCs}/I_{QDs} (grid column) without Cu^{2+} ions.

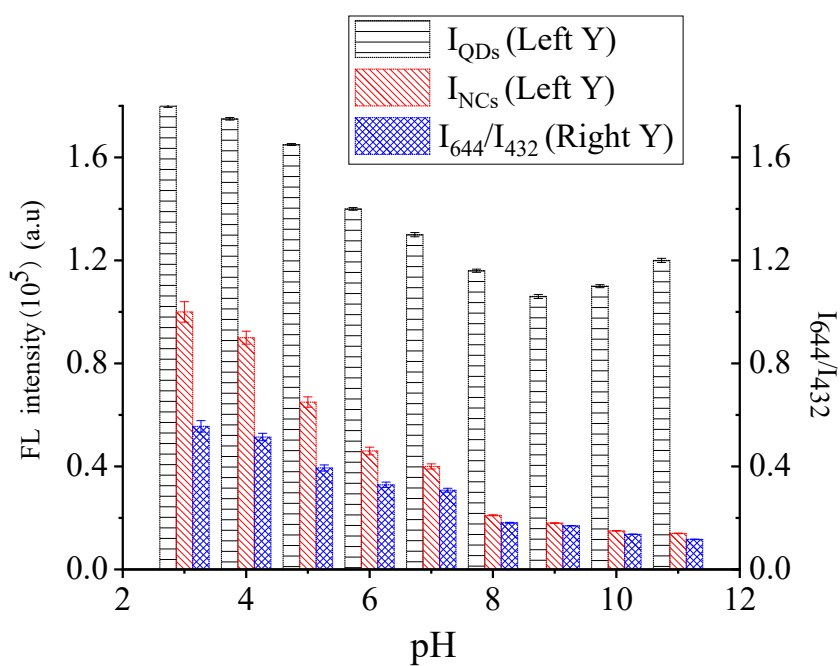


Fig.S10 I_{QDs} (horizontal bars) and I_{NCs} (diagonal bars) and the ratio of I_{NCs}/I_{QDs} (grid column) with the addition of $10 \mu M$ Cu^{2+} ions.