One-pot synthesis of fluorescent copper nanoclusters for label-free glutathione sensing

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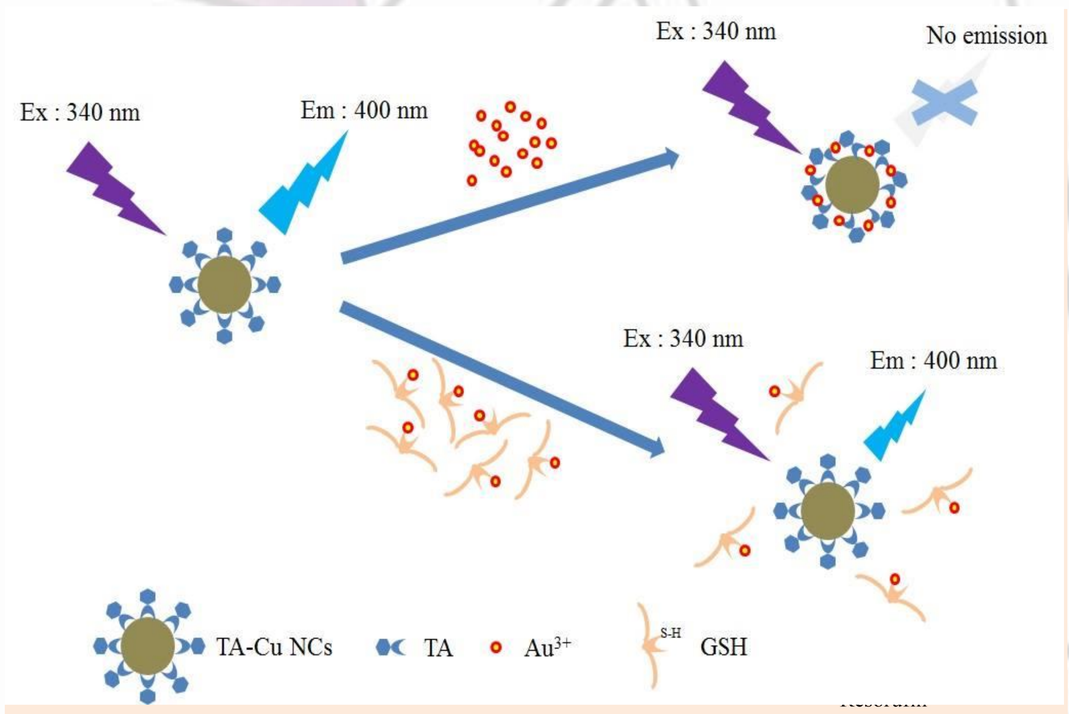
Abstract：

A new label-free probe using copper nanoclusters (Cu NCs) for sensitive and selective glutathione (GSH) has been demonstrated. The highly stable Cu NCs synthesized from copper nitrate and thiosalicylic acid (TA) displays strong blue fluorescence at 400 nm when excited at 340 nm. The fluorescence quenching of TA-Cu NCs induced by Au^{3+} is minimized in the presence of GSH through the formation of Au-GSH complexes. The fluorescence intensity of TA-Cu NCs in the presence of 0.5 mM Au^{3+} increased upon increasing the concentration of GSH from 10 nM to 4 μM. The limit of detection (signal-to-noise ratio 3) of this assay for GSH is 3 nM.



Scheme 1. Schematic illustration of label-free fluorescence determination of GSH

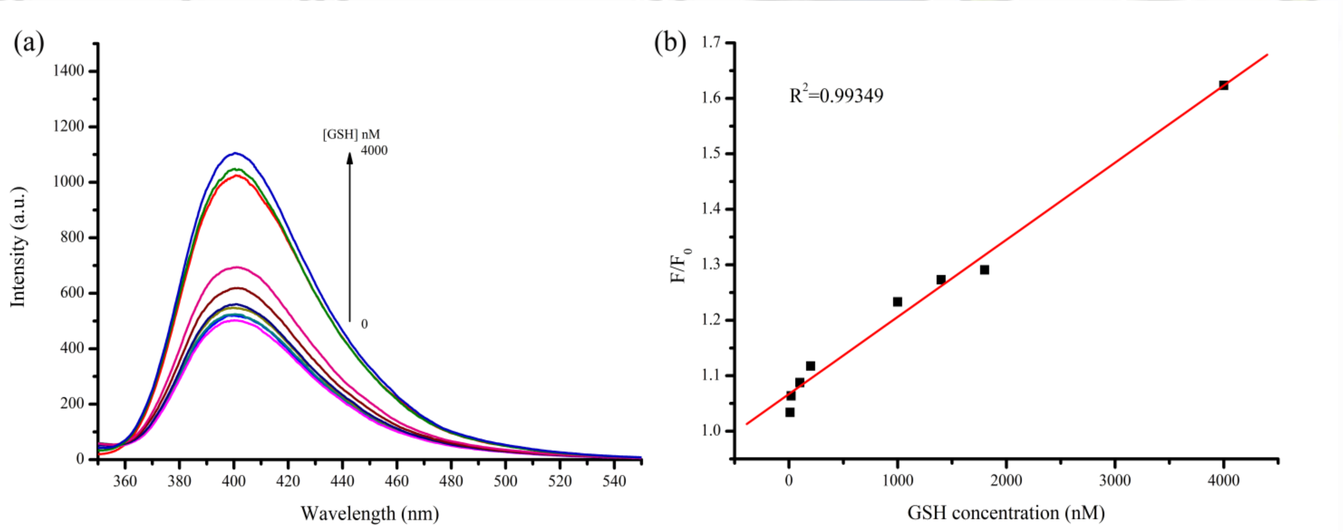


Fig. 3. (a) Detection of GSH in standard solutions using TA–Cu NCs(0.0125X)–Au^{3+}(5×10^{-4} M) system; (b) The fluorescence intensity ratio (F/F_0) vs. GSH concentration over the ranges of 10–4000 nM. PB solutions (100 mM, pH 7.0) were used to prepare the standard solutions.

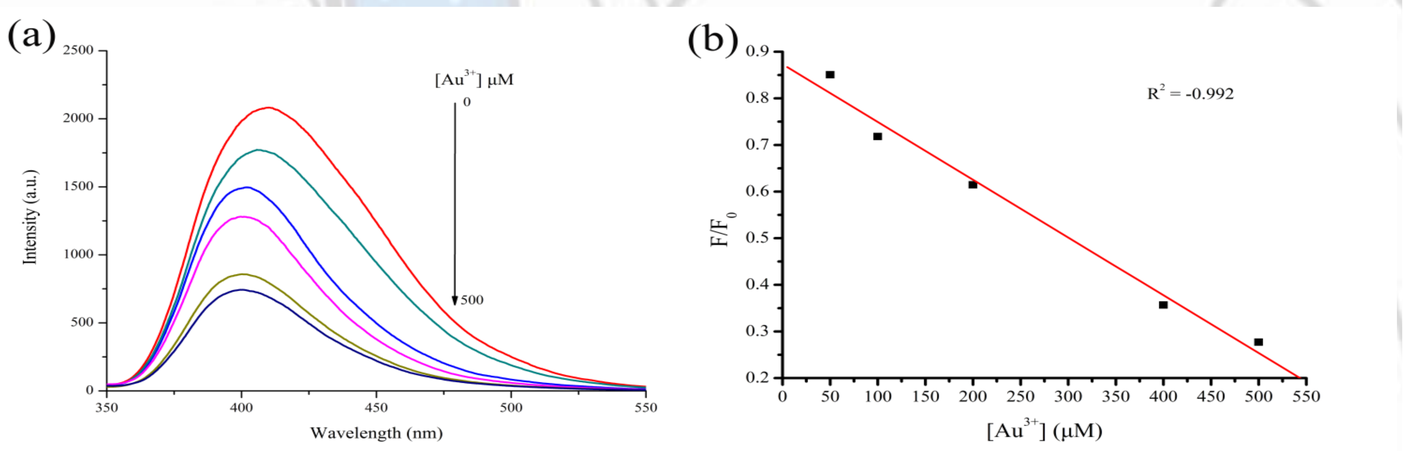


Fig. 1. Detection of Au^{3+} in standard solutions using TA–Cu NCs(0.0125X); (b) The fluorescence intensity ratio (F/F_0) vs. Au^{3+} concentration over the ranges of 50–500 μM. PB solutions (100 mM, pH 7.0) were used to prepare the standard solutions.

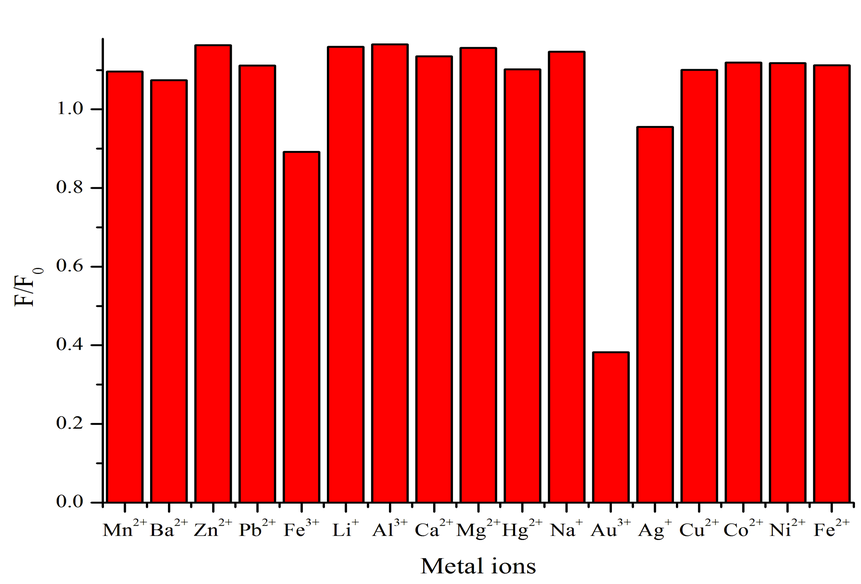


Fig. 2. Relative emission intensities (F/F_0) of as-prepared TA–Cu NCs after the addition of 10^{-4} M of different metal ions. Mixtures were prepared in phosphate buffer (0.1 M, pH 6.0). F_0 and F are the emission intensities at 400 nm of the TA–Cu NCs before and after the addition of the metal ions.

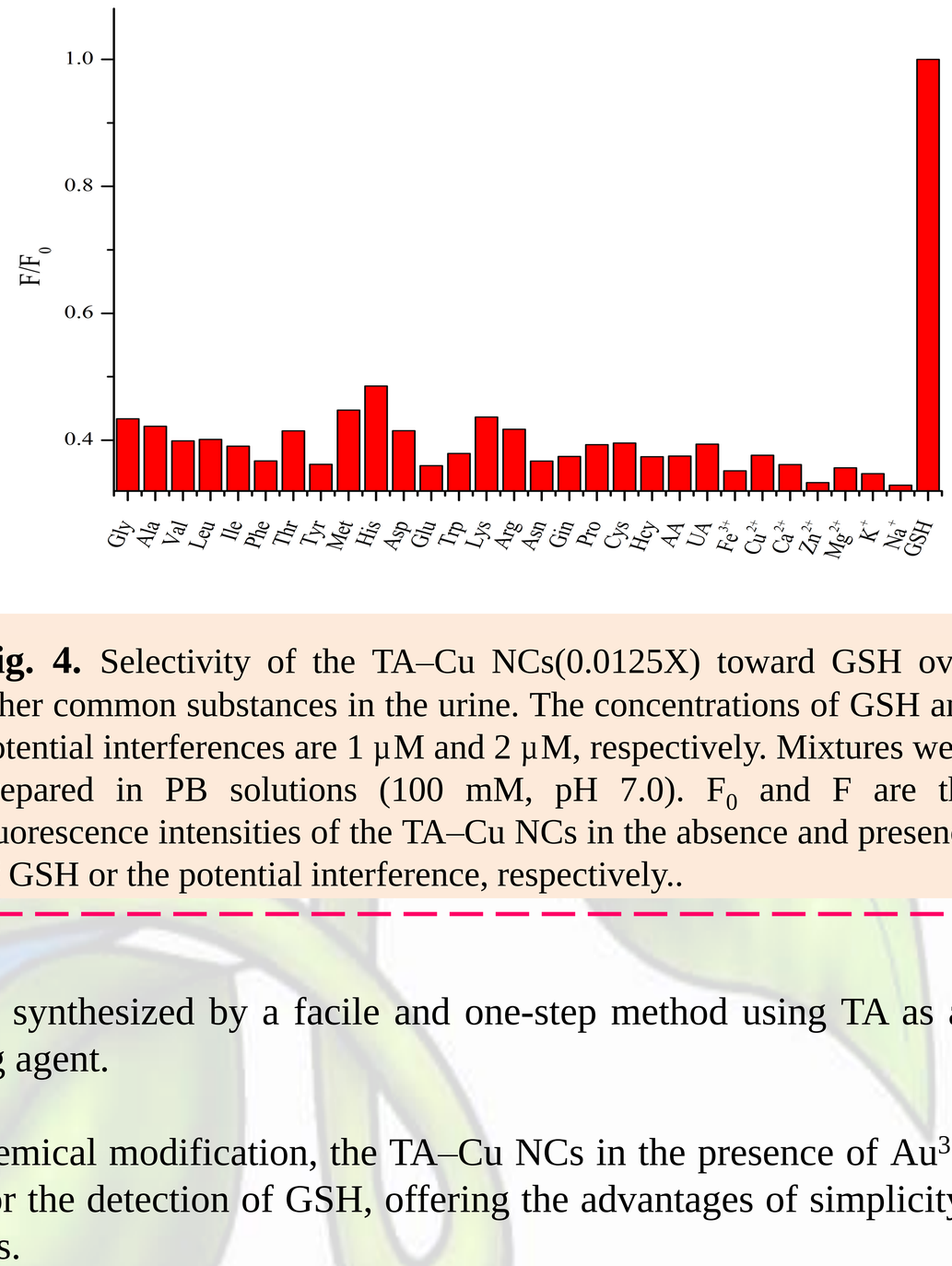


Fig. 4. Selectivity of the TA–Cu NCs(0.0125X) toward GSH over other common substances in the urine. The concentrations of GSH and potential interferences are 1 μM and 2 μM, respectively. Mixtures were prepared in PB solutions (100 mM, pH 7.0). F_0 and F are the fluorescence intensities of the TA–Cu NCs in the absence and presence of GSH or the potential interference, respectively..

Conclusions

- TA–Cu NCs were synthesized by a facile and one-step method using TA as a capping and reducing agent.
- Without further chemical modification, the TA–Cu NCs in the presence of Au^{3+} were directly used for the detection of GSH, offering the advantages of simplicity and cost effectiveness.
- The assay provided advantages of sensitivity and selectivity for quantitation of GSH, with LOD 3 nM

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