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Recyclable colorimetric sensor of Cr³⁺ and Pb²⁺ ions simultaneously using a zwitterionic amino acid modified gold nanoparticles

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Abstract: In this work, a rapid, simple and sensitive colorimetric sensor for simultaneous (or respective) detection of Cr³⁺ and Pb²⁺ using tyrosine functionalized gold nanoparticles (AuNPs^{Tyr}) has been developed. Tyrosine, a natural and zwitterionic amino acid, could be as a reducing and capping agent to synthesise AuNPs and allow for the simultaneous and selective detection of Cr³⁺ and Pb²⁺. Upon the addition of Cr³⁺ or Pb²⁺ (a combination of them), the color of AuNPs^{Tyr} solution changes from red to blue grey and the characteristic surface plasmon resonance (SPR) band is red-shifted to 580 nm due to the aggregation of AuNPs. Interestingly, the aggregated AuNPs^{Tyr} can be regenerated and recycled by removing Pb²⁺ and Cr³⁺. Even after 3 rounds, AuNPs^{Tyr} show almost the same $A_{580\text{ nm}} / A_{520\text{ nm}}$ value for the assays of Pb²⁺ and Cr³⁺, indicating the good recyclability of the colorimetric sensor. The responding time (within 1 min) and sensitivity of the colorimetric sensor are largely improved after the addition of 0.1 M NaCl. Moreover, the AuNPs^{Tyr} aggregated by Cr³⁺ or Pb²⁺ (a combination of them) show excellent selectivity compared to other metal ions (Cr³⁺, Pb²⁺, Fe²⁺, Cu²⁺, Zn²⁺, Cr⁶⁺, Ni²⁺, Co²⁺, Hg²⁺, Mn²⁺, Mg²⁺, Ca²⁺, Cd²⁺). More importantly, the developed sensor manifests good stability at room temperature for 3 months, which has been successfully used to determine Cr³⁺ and Pb²⁺ in the real water samples with a high sensitivity.

Keywords: Colorimetric detection; chromium ions; lead ions; AuNPs^{Tyr}

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