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Recyclable colorimetric sensor of Cr^{3+} and Pb^{2+} 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 Cr^{3+} and Pb^{2+} 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 Cr^{3+} and Pb^{2+}. Upon the addition of Cr^{3+} or Pb^{2+} (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 regnerated and recycled by removing Pb^{2+} and Cr^{3+}. Even after 3 rounds, $AuNPs^{Tyr}$ show almost the same $A_{580\ nm}$ / $A_{520\ nm}$ value for the assays of Pb^{2+} and Cr^{3+}, indicating the good recyclability of the colorimetric sensor. The responding time (within 1 min) and sensitivity of the colorimetric sensor are largely impoved after the addition of 0.1 M NaCl. Moreover, the $AuNPs^{Tyr}$ aggregated by Cr^{3+} or Pb^{2+} (a combination of them) show excellent selectivity compared to other metal ions (Cr^{3+}, Pb^{2+}, Fe^{2+}, Cu^{2+}, Zn^{2+}, Cr^{6+}, Ni^{2+}, Co^{2+}, Hg^{2+}, Mn^{2+}, Mg^{2+}, Ca^{2+}, Cd^{2+}). More importantly, the developed sensor manifests good stability at room temperature for 3 months, which has been successfully used to determine Cr^{3+} and Pb^{2+} in the real water samples with a high sensitivity.

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