Colorimetric sensor based on L-Cysteine functionalized silver nanoparticles for cadmium (II) ion detection

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Cadmium is an element used in many industries. Overuse of agrochemicals and industrial waste have resulted in an increase in Cd^{2+} levels in soil and water systems causing serious bio-hazards. Therefore, the development of sensitive detection methods for trace cadmium are important. In this study, a facile and selective method for the detection of divalent cadmium ions using L-cysteine functionalized silver nanoparticles (AgNPs) is introduced. AgNPs were synthesized by reduction of silver nitrate using hydroxylamine hydrochloride. Synthesized AgNPs were then surface functionalized with L-cysteine which is an amino acid. L-cysteine contains a thiol group which displays high affinity for Ag surfaces and a carboxyl group which can interact with the surrounding, or in this case, to act as a sensor for Cd^{2+} ions. Alterations in morphology and size of nanoparticles due to functionalization were confirmed by UV-Vis spectral changes. The presence of Cd^{2+} induces the aggregation of L-cysteine functionalized AgNPs as they are linked together by "carboxylate-Cd^{2+}-carboxylate" coordinative couplings, resulting in a colour change from yellow to deep orange. The concentration of Cd^{2+} could be monitored by the colorimetric response obtained by UV-Vis spectroscopy or even by naked eye and the detection limit is as low as 1 ppm. This novel detection principle showed selectivity towards Mg^{2+}, Ca^{2+} and Cd^{2+} ions. Therefore, it may be successfully applied to determine Cd^{2+} in Mg^{2+} and Ca^{2+} in waters.

Keywords: cadmium, silver nanoparticles, L-cysteine, UV-Vis spectroscopy