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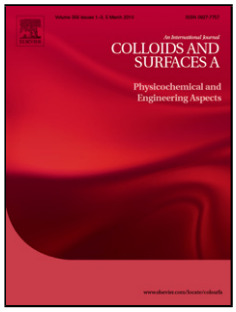

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Authors: Rupasree Choudhury, Tarun Kumar Misra

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Gluconate Stabilized Silver Nanoparticles as a Colorimetric Sensor for Pb^{2+}

Rupasree Choudhury and Tarun Kumar Misra*

Department of Chemistry, National Institute of Technology, Agartala, Tripura799046, India

***Corresponding Author:** E-mail: tkmisra70@yahoo.com or tkmisra.chem@nita.ac.in

Tel.: +91-381-2346630; Fax: +91-381-2346360

Abstract

Synthesis and functionalization of silver nanoparticles (Ag-NPs) were simultaneously accomplished with highly water soluble gluconate anions ($Gluc^-$). The gluconate functionalized silver nanoparticles (Gluc-Ag-NPs) were found to be anionic in nature with zeta potential (ζ) value of -55±2 mV at pH 7.92 and were made apply for a chemo-sensor probe for Pb^{2+}. The particles belong to face-centered-cube (FCC) crystal system and have pseudo-spherical shape with diameter 9.57±2 nm. Although free gluconates are reputed complexing agent for various metal ions, we have found, when they are in the state of adsorption onto the Ag-NPs surface, bind selectively Pb^{2+} in aqueous solution over other metal ions including Al^{3+}, Ba^{2+}, Cu^{2+}, Cd^{2+}, Ca^{2+}, Fe^{3+}, Hg^{2+}, K^+, Mg^{2+}, Mn^{2+}, Na^+, Ni^{2+}, and Zn^{2+}. Binding onsets association followed by aggregation of particles, which is a kinetic effect and leads to quenching of surface Plasmon band intensity at 395 nm and subsequently appearing of a band at 524 nm. The phenomenon results color change of the particles. The study of aggregation kinetics at UV-vis spectroscopy tool helps to evaluate $Gluc^-$---Pb^{2+} association constant (K_{asso} = 3.42x10^5 M^{-1}) and critical coagulation concentration (CCC = 1.91 µM) values. The developed system is simple and highly sensitive to detect Pb^{2+} ions colorimetrically with limit of detection (LOD), 0.2029 µM. The system showed excellent recovery results when it was tested for determining Pb^{2+} from tap-water samples spiked with the same.

Keywords: Gluconate; Silver nanoparticles; Aggregation kinetics; Association constant; Sensing

1. Introduction

Gluconate ($Gluc^-$) salts are highly water soluble, nontoxic and not metabolized in the animal body [1]. They are therefore extensively used in the formulation of food, pharmaceutical and hygienic products [2]. People take its salts of Ca^{2+}, Zn^{2+}, Fe^{2+}, etc., directly by oral or intravenous administration to meet required essential minerals against their deficiencies [2,3]. Ramachandran et al. [2] illustrated the purpose of uses of these elaborately in their reported review article. Gluconate ($Gluc^-$), being an