

Colorimetric sensor for phosphate ions detection using 2-mercaptoethanesulfonate modified silver nanoplates

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Abstract:

A new, distinctive, and inexpensive colorimetric sensor for the detection of phosphate ions (Pi) performed on paper-based analytical device (PAD) based on anti-aggregation of 2-mercaptoethanesulfonate (MS) modified silver nanoplates is proposed. An aggregation of MS-AgNPIs due to the electrostatic interaction between the negatively charged sulfonate group on MS-AgNPIs and europium ions (Eu³⁺) causes color change. Whereas, the color of MS-AgNPIs remains unchanged in the presence of premixed Eu³⁺ with Pi because the higher binding affinity of Eu³⁺ has towards Pi leaving the AgNPIs dispersed. An apparent color changing from dark violet to pink with the increasing amount of Pi can be observed by naked eyes on PAD and can be used for quantification by the measurement of color intensity using ImageJ software. The aggregation and anti-aggregation of MS-AgNPIs were characterized by TEM and UV-visible spectroscopy to confirm the mechanism. This method can detect Pi in the range of 5 - 150 ppm with a detection limit of 1.67 ppm (3 SD/Slope) and a limit of quantification equals to 5.07 ppm (10 SD/Slope). The optimum parameters including pH, concentration of MS and Eu³⁺, reaction time, and effects of interferences were studied. This method can be applied with the detection of Pi in real samples collecting from soils and in agree with the standard method (UV-visible spectrophotometry).

Key words: phosphate ions, silver nanoplates, paper-based analytical device, colorimetric method.

