Development of a Rapid, Reusable Sensing Mechanism for the Selective Identification of Heavy Metal Contaminants in Water: An Implementation of Functionalized Isotropic Silver Nanoparticles for Toxic Ion Detection

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Toxic heavy metal contamination has become an impending global threat due to rapidly increasing diffusion by water from mining settlements and industrial factories. Current sensing methods are either too expensive or inconvenient for widespread use in these locations. In response to this growing issue, my objective was to develop an innovative yet simple mechanism that would accurately and selectively identify the presence of the toxic ions mercury (Hg2+), lead (Pb2+), and thallium (Tl2+) in water. Silver nanoparticles were first synthesized through a UV exposure box in conjunction with the chitosan stabilizing agent in a 1:1 ratio, providing isotropic configuration. The nanoparticles were then developed with varying functionalizations in composition, from which initial molecular absorbance enhancements were determined. I then streamlined the sensing capabilities of the nanoparticles with increasing dilutions of the heavy metal ion solutions, identifying the specific functionalization of 1.0 mM Ag NPs with 4 pH 4.0 mM chitosan as producing the optimal spectra enhancement. R66 dyes were then integrated within the sensing mechanism, responsive and selective only to mercury, lead, and thallium, in addition to reinforcing reusability through the incorporation of EDTA. Further tests using the UV-Visible Spectrophotometer and Fluorescence Spectrometer allowed for the observation of enhanced absorbance peaks for mercury, lead, and thallium, with immediate and visible detection at minimal concentrations of each respective ion. Such developments suggest the immediate viability of the mechanism for effective heavy metal sensing in locations threatened by the expanding dangers of toxic ion contamination.

Awards Won:
King Abdulaziz &amp
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