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SPR-based assay kit for rapid determination of Pb^{2+}

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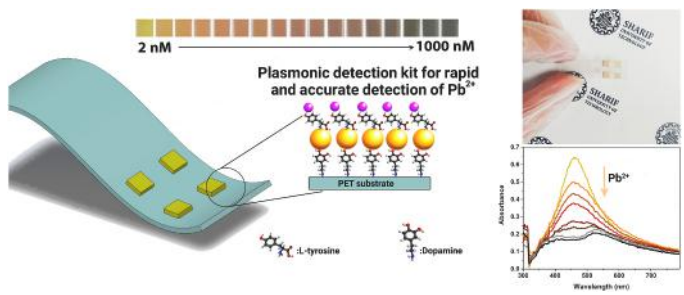
HIGHLIGHTS

- First effort to develop a Pb^{2+} recyclable optical nanosensor by immobilizing L-tyrosine functionalized AgNPs.
- The developed sensor detected Pb^{2+} ions on-site in the dynamic range of 1 nM–1000 nM.
- The limit of detection for detecting Pb^{2+} was as low as 1 nM even in the complex solutions.
- The developed colorimetric kit was able to respond accurately for three consecutive runs.

GRAPHICAL ABSTRACT



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ABSTRACT

A recyclable optical nanosensor was developed by immobilizing L-tyrosine functionalized silver nanoparticles (AgNPs) on the polyethylene terephthalate (PET) substrate for rapid determination of Pb^{2+} ions. At first, the L-tyrosine functionalized AgNPs were assessed in the solution phase; the response time was lower than 15 s, and a limit of detection lower than 9 nM was obtained in the dynamic range of 1–1000 nM. For fabrication of the optical assay kit, the design of experiment (DOE) was used to optimize the immobilization efficiency of the nanoparticles on PET films by studying $AgNO_3$ concentration and pH as two crucial parameters. The assay kit in optimal conditions showed a sharp localized surface plasmon resonance band suitable for sensitive determination of Pb^{2+}. The fabricated sensor showed promising results for rapid determination of lead ions with the limit of detection value as low as 1 nM (S/N = 3). The sensor reproduced the obtained results even after three consecutive runs, which proved the recyclability of the optical assay kit. The recoveries of the spiked concentration in real samples were in the range of 95%–103%, which confirmed the applicability of the sensor in practical applications.

1. Introduction

Water is the most precious resource for human beings, animals, and the environment, continuously under threat by mining and metallurgical processes, electronic and municipal wastes, and extreme usage of pesticides in industrial agriculture. Heavy metals are the primary hazardous substance for water bodies, soil, and air [1,2]. Even though some of the heavy metals are considered essential (such as Zn,

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