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Surface-enhanced Raman scattering enhancement due to localized surface plasmon resonance coupling between metallic nanoparticles and substrate

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ABSTRACT

In this study, gold nanostructures (AuNSs) and silver nanoparticles (AgNPs) were integrated with a silver micro-flower-like structure deposited on a screen-printed carbon electrode (AgMF-SPCE) for enhancing surface-enhanced Raman scattering (SERS) by using 4-mercaptobenzoic acid (4-MBA) as a Raman reporter. SERS was enhanced by approximately 3.6–52.1-fold, depending on the frequency of the incident laser, the localized surface plasmon resonance frequency of metallic NPs, and particle–particle aggregation effects. Compared with AgNP/SPCE and AgMF-SPCE substrates, the AgNP/AgMF-SPCE substrate showed high temperature tolerance and long-term durability. Furthermore, the proposed substrates easily obtained hot spots for other Raman reporters such as 4-aminothiophenol, 5,5'-dithiobis-2-nitrobenzoic acid, and 4-chlorothiophenol. A linear relationship was found between the Raman signal and the concentration of Raman reporters in the range 10 nM–100 μ M, with the limit of detection in the range of 6.19–77.2 nM at a signal-to-noise ratio of 3.0. These results suggest that the AgNP/AgMF-SPCE substrate will be well suited for quantitative analysis.

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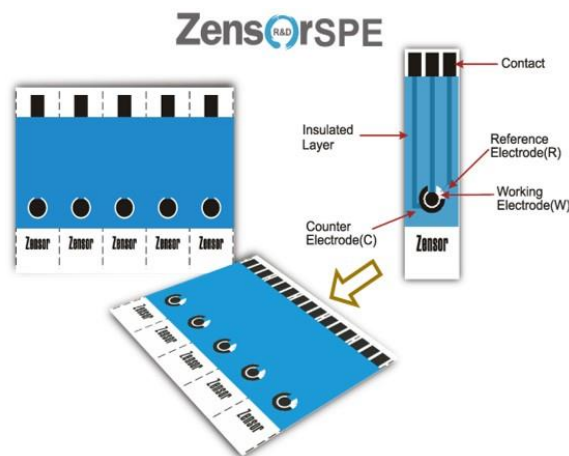
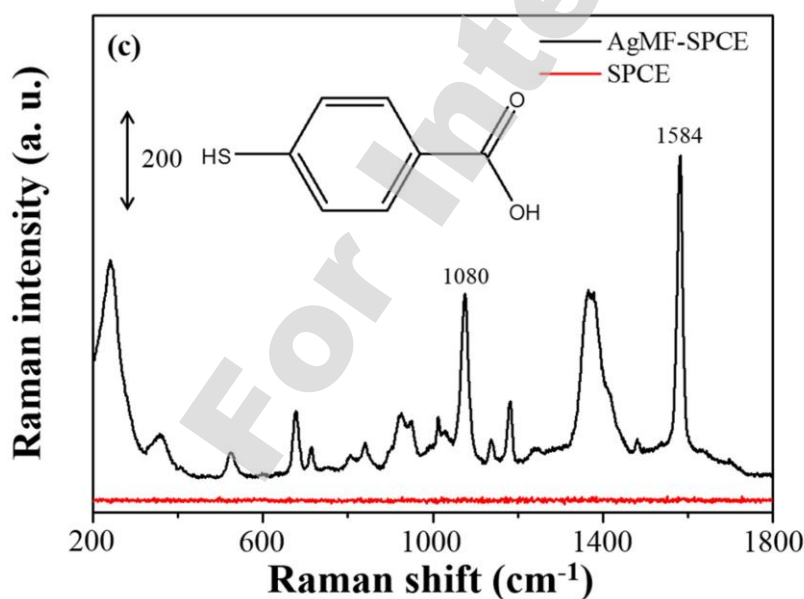


Fig. 1. SEM images of SPCE substrate in the (a) presence and (b) absence of AgMFs. (c) SERS spectra of 10 μ M 4-MBA molecules on the SPCE substrate in the presence and absence of AgMFs.

A simple and versatile paper-based electrochemiluminescence biosensing platform for hepatitis B virus surface antigen detection

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ABSTRACT

Electrochemiluminescence (ECL) has been considered to have better performance in rapid detection. A novel paper-based ECL biosensing platform for hepatitis B surface antigen (HBsAg) detection was developed based on a simple paper discs, the flexible design of a machine and a circuit of the custom-made ECL device. Through the modified magnetic suspension sandwich immunoassay protocol, rapid and sensitive clinical HBsAg detection was realized on the developed platform. The platform was characterized using cyclic voltammetry (CV) and ECL methods and obtained a linear range of 34.2 pg/mL–34.2 ng/mL with a 34.2 pg/mL (3 σ) detection limit. This paper-based ECL sandwich immunoassay showed high sensitivity and selectivity, acceptable reproducibility, fast analysis time and better performance than chemiluminescent immunoassay (CLIA) and enzyme-linked immunosorbent assay (ELISA) for detecting HBsAg in real clinical serum samples.

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Fig. 1. Schematic illustrations of fabrication of paper-based SPEs.

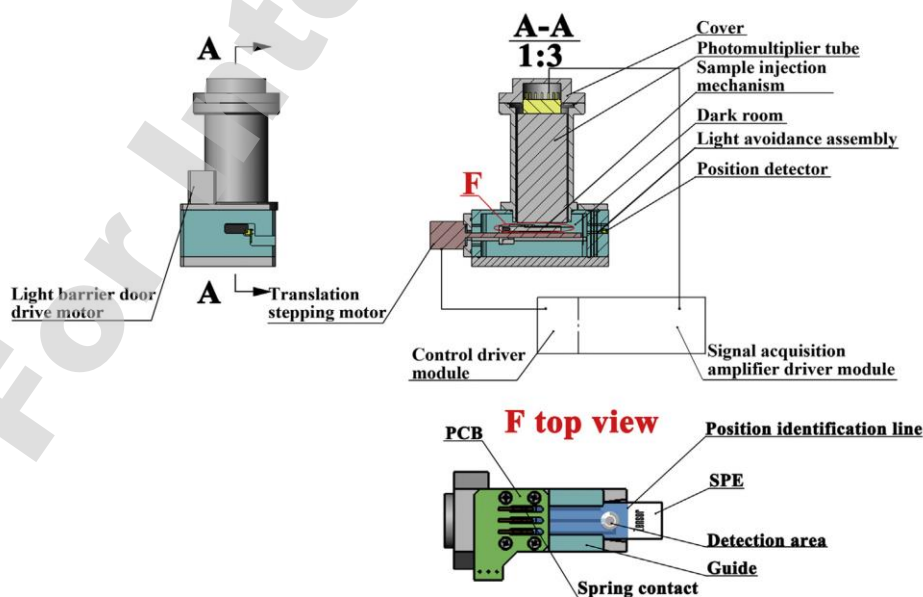


Fig. 2. Internal structure of the custom-made ECL detector.

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Determination of mercury (II) ions based on silver-nanoparticles-assisted growth of gold nanostructures: UV–Vis and surface enhanced Raman scattering approaches

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ABSTRACT

Innovative dual detection methods for mercury(II) ions ($\text{Hg}^{(II)}$) have been developed based on the formation of gold nanostructures (AuNSs) following the addition of mercury-containing solution to a mixture containing an optimized amount of $\text{Au}^{(III)}$, H_2O_2 , HCl, and silver nanoparticles (AgNPs). In the absence of $\text{Hg}^{(II)}$, the addition of $\text{Au}^{(III)}$, H_2O_2 , and HCl to the AgNP solution changes the solution's color from yellow to red, and the absorption peak shifts from 400 to 526 nm, indicating the dissolution of AgNPs and the formation of gold nanoparticles (AuNPs). Because of the spontaneous redox reaction of $\text{Hg}^{(II)}$ toward AgNPs, the change in the amount of remaining AgNP seed facilitates the generation of irregular AuNSs, resulting in changes in absorption intensity and shifting the peak within the range from 526 to 562 nm depending on the concentration of $\text{Hg}^{(II)}$. Under optimal conditions, the limit of detection (LOD) for $\text{Hg}^{(II)}$ at a signal-to-noise ratio (S/N) of 3 was 0.3 μM . We further observed that AgNP-assisted catalytic formation of Au nanomaterials deposited on a surface enhanced Raman scattering active substrate significantly reduced the Raman signal of 4-mercaptobenzoic acid, dependent on the $\text{Hg}^{(II)}$ concentration. A linear relationship was observed in the range 0.1 nM–100 μM with a LOD of 0.05 nM (S/N 3.0). As a simple, accurate and precise method, this SERS-based assay has demonstrated its success in determining levels of $\text{Hg}^{(II)}$ in real water samples.

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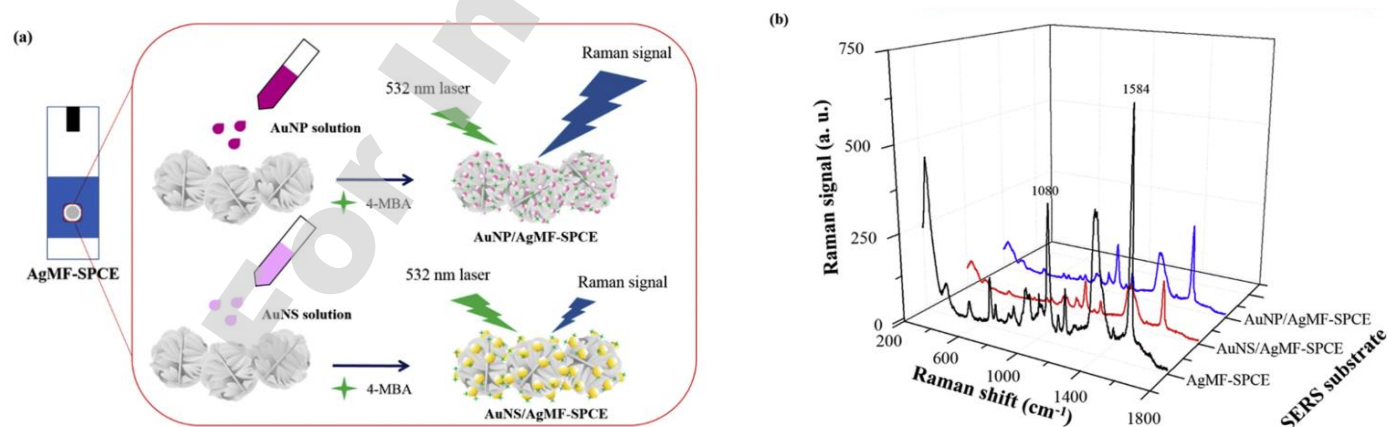


Fig. 4. (a) Schematic representation of the SERS method for measuring $\text{Hg}^{(II)}$, and (b) SERS spectra of AgMF-SPCE, AuNP/AgMF-SPCE, and AuNS/AgMF-SPCE substrates.