Aqueous mercuric ions detection using electrochemical surface plasmon resonance in capped gold nanowire arrays

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1. Introduction

Mercuric ion, inorganic metal ion, found in three oxidation state in nature, including elemental mercury (Hg^0), mercurous ion (Hg^+), and mercuric ion ($Hg2^+$). These three forms possess hazardous environmental contaminant and are extremely toxic metal materials to damage mammalian organs.[1] This work demonstrates a label-free technique for Hg^{2+} ions detection using capped gold nanowire arrays based sensors[2] combined with the electrochemical surface plasmon resonance method. The three-electrode electrochemical analysis (Fig. 1) and optical transmission measurement were employed to characterize the potential-current responses and the resonant peak signals were for the investigation of metal ion electrodeposition (Fig. 2). The nanostructured EC-SPR sensors were used to characterize the eletrochemical behaviors of $K3Fe(CN)_6/K2Fe(CN)_6$ redox couple and evaluate the wavelength sensitivity (480.3 nm RIU^{-1}) with a FOM of 40.0 RIU^{-1} and the intensity sensitivity (1819.9 %) in the glycerol-water solutions. Fig. shows the detection limit of 1 μM Hg^{2+} can be obtained by the chronoamperometric-spectrum analysis. The developed capped gold nanowire arrays based sensors present Hg2+ ion selectivity over the wavelength shifts of the interfering ions including Ca^{2+}, Co^{2+}, Ni^{2+}, Na^+, Cu^{2+}, Pb^{2+}, and Mn^{2+} ions. The developed capped gold nanoslit arrays based sensors present Hg^{2+} ion selectivity over the wavelength shifts of the interfering ions including Ca^{2+}, Co^{2+}, Ni^{2+}, Na^+, Cu^{2+}, Pb^{2+}, and Mn^{2+} ions. The proposed flexible capped gold nanowire arrays based sensor is applicable to be an EC-SPR label-free platform and enabled a rapid, sensitive and selective sensing method for aqueous Hg^{2+} detection. The application of biomolecule analysis can be further evaluation in the future. applicable to be an EC-SPR label-free platform and enabled a rapid, sensitive and selective sensing method for aqueous Hg2+ detection. The application of biomolecule analysis can be further evaluation in the future.

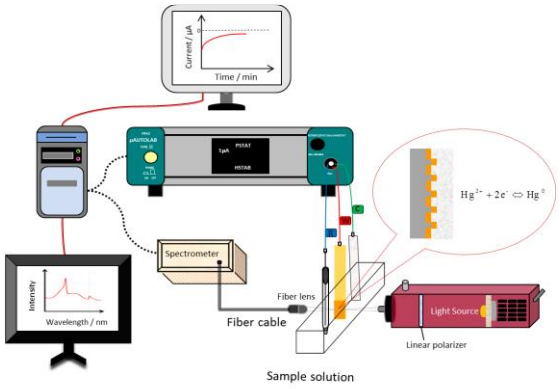

Fig.1.Schematic representation of electrochemical surface plasmon resonance configuration set-up for mercury ions detection.

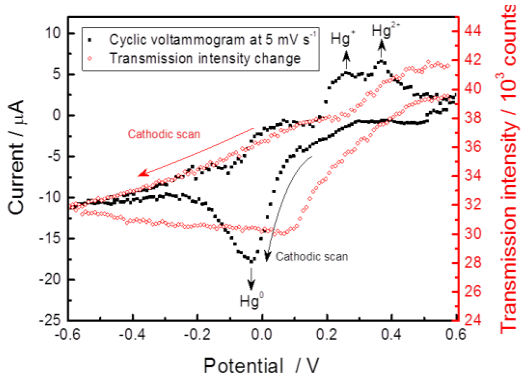

Fig. 2 Redox current curves during the first cyclic voltammetry scan and the simultaneously measured surface plasmon resonance intensity.

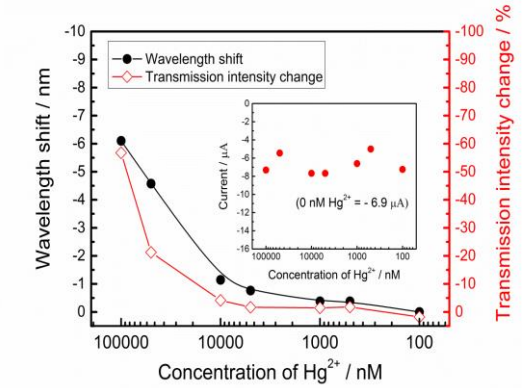

Fig. 3. The wavelength shifts and the intensity changes of gold nanowire arrays against Hg^{2+}concentrations between 100μM and 100nM. The inset shows the reduction reaction currents of amperometric responses at various Hg^{2+} concentrations.

References

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[2] Lee K-L, Huang J-B, Chang J-W, Wu S-H, Wei P-K. Sci Rep **5** (2015).