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Preparation and Characterization of Gold Thin Film Electrode Modified by Microbe

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Abstract: A novel method based on microbe modification has been employed to prepare gold thin film electrode. The preparation method is simple and the electrode obtained is stable and very sensitive in determining heavy metal ions. The quantitation limit of Cu^{2+} is 0.05 ng/mL.

Keywords: Gold thin film electrode, microbe modification, trace analysis.

Gold electrode is in common use in electro-analysis because of its stability and corrosion resisting. Here we report a novel method for preparation of gold thin film electrode modified by microbe. Previous works on the use of microbe to adsorb the compounds of gold and other metals were mainly focused on recovery of noble metals and treatment of wasted water[1,2]. The bacteria modified electrodes have been reported in detection of enzyme[3] and BOD[4]. Now we report the method of applying microbe to prepare the gold thin film electrode. The preparation method is simple and the gold thin film electrode obtained is stable and sensitive in determining heavy metal ions.

Preparation of the gold thin film electrode

The bacterial strain D01 was isolated from the soil of mining areas. It is gram-positive and is able to reduce Au^{3+} to gold particles[5]. Some of the strain D01 was added to a mixture of 1.4 g graphite and 0.2 g paraffin wax. They were ground thoroughly in a mortar. The carbon paste obtained was pressed into a Teflon film tube. A copper stick was insert into the carbon paste and then the electrode was polished. The obtained carbon paste electrode was used as the working electrode, with saturated calomel electrode (SCE) as reference electrode and platinum electrode as counter electrode. The three electrodes were placed into a solution of 60 ug/mL $AuCl_3$ for pre-adsorption at 625 mV for 5 min. Voltage scan was conducted at a speed of 100 mV/s to –100 mV with 8511A potentiostat. There is a peak appeared at 350 mV, corresponding to reduction of Au^{3+}. The electrode obtained has the metallic lustre, indicating the surface of the electrode was covered with gold film. The presence of the microbe has been proved to be helpful for adsorption and reduction of Au^{3+} on the electrode surface.

Characterization of the Gold Thin Film Electrode

The gold electrode is usually used as working electrode in detection of Cu(II). In our work, we have used the prepared gold film electrode to examine its character and stability in detection of Cu(II). 15mL 0.1 ng/mL $CuSO_4$ solution was added in an

electrolysis cell. A solution of 0.1 mol/L HCl was used to adjust the pH to 1.15 followed by addition of 60 μL saturated KCl solution as supporting electrolyte. The gold film electrode was placed in the cell, with saturated calomel electrode as reference electrode and platinum electrode as counter electrode, composing the three electrodes system. N_2 gas was passed in order to remove the oxygen for 10 min, and the system was then remained at –350 mV for 5 min. Voltage scan was conducted at a speed of 100 mV/s to 650 mV. The result is shown in **Figure**. **1**, indicating the anode stripping wave of Cu(II) at 375 mV. The quantitation limit is at least 0.05 ng/mL, indicating that the gold film electrode is very sensitive in Cu(II) determination. In the same conditions,

Figure 1. Anode stripping voltammetric curve of gold thin film electrode in a solution of 0.1 ng/mL Cu^{2+}.

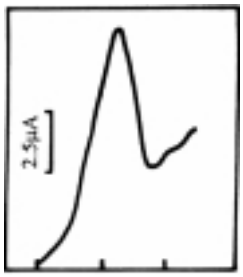
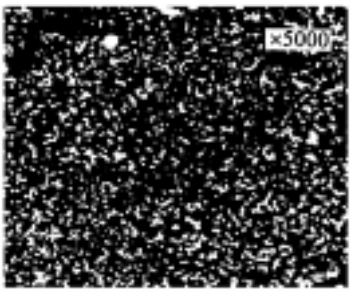


Figure 2. SEM photograph of the surface of the gold thin film electrode.



the gold plate electrode can only determine the Cu(II) with concentration up to 64 ng/mL. The carbon paste electrode without modification by microbe can determine Cu(II) to 10 ng/mL. The quantitation limit of the gold thin film electrode for Au^{3+} is 1 ng/mL. Furthermore, the prepared electrode has been proved to be stable and can be used for many times. The high determination sensitivity of the gold thin film electrode can be ascribed to that the surface of the electrode was covered with nanometer sized gold particles. This results in the increase of the surface area thus increase the redox active sites on the surface of the electrode. The SEM photograph of the gold thin film electrode is shown in **Figure 2**. The result indicates that the surface of the electrode was covered with gold particles with diameter of *ca*.80 nm.

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