ARSENIC DETECTION BY GOLD COBALT/COPPER ELECTRODE IN AQUEOUS MEDIA

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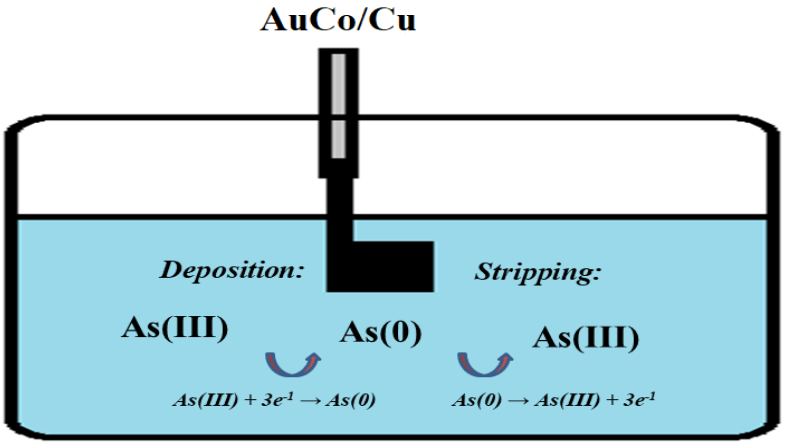
Arsenic has five different oxidation states −3, 0, +3, and +5. In the natural water As usually exists in arsenite (As(III)), and arsenate (As(V)) as inorganic forms. Arsenic can also exist as organic dimethylarsinic and monomethylarsonic acids. Drinking arsenic-polluted water can cause serious health problems like irregular heartbeat, atherosclerosis and skin cancers [1]. It is very important to note that arsenite is more toxic than arsenate, the same as inorganic arsenic is more toxic than the organic arsenic forms [2]. Arsenic can be determined by several analytical methods including atomic absorptions spectroscopy (AAS), inductively coupled plasma – atomic emission spectrometry (ICP-AES), inductively coupled plasma – mass spectrometry (ICP-MS), etc. [3]. Analysis using these methods takes a lot of time and it is expensive, therefore electrochemical methods could be a good replacement as cheap, fast and easy methods for arsenic detection.

Herein, three different gold cobalt/copper (AuCo/Cu) electrodes were prepared by electroless deposition of Co on Cu surface, followed by Au nanoparticles deposition on the prepared Co/Cu electrodes by galvanic displacement using three different deposition times (30, 60 and 300 s).

Au loading was determined by energy-dispersive X-ray spectroscopy (EDX) analysis for all three electrodes and it was found to be 5.8, 7.1 and 15.3 μg cm^{-2} for AuCo/Cu(30s), AuCo/Cu(60s) and AuCo/Cu(300s), respectively.

Next, these electrodes were tested in 1 mM $NaAsO_2$ in $NaHCO_3$ + Na_2CO_3 buffer by anodic stripping voltammetry (ASV) in potential range from -0.7 V to -0.2 V vs. SCE at a scan rate of 50 mV s^{-1}. Arsenic determination by ASV method proceeds in two steps where As(III) is reduced to As(0) as the adsorbed form on the electrode surface and then oxidized to As(III) form that diffuses into the solution, scheme 1.



Scheme 1. Schematic representation of arsenic ions sensing at AuCo/Cu electrodes by anodic stripping voltammetry.

Cyclic voltammogram (CVs) of AuCo/Cu(30s) electrode reveals activity for detection of As(III) in 1 mM $NaAsO_2$ solution. Namely, AuCo/Cu gave a well-defined peak corresposning to As electrooxidation. The peak current density amounted to1.73 mA cm^{-2} at -0.4 V , while it was only 0.15 mA cm^{-2} at the same potential in the absence of As ions in the solution. The influence of experimental conditions on arsenic detection was tested by recording CVs at different deposition potential (E_d) and different deposition time (t_d).

The real water sample was diluted with $NaHCO_3$ + Na_2CO_3 buffer (sample: buffer 75:25 vol.% ratio) and used for arsenic determination. AuCo/Cu(30s) electrode shows a well-defined arsenic oxidation peak in the real sample.

Within this work, AuCo/Cu(30s) electrode with only 5.8 μg cm^{-2} of Au showed good activity for arsenic detection in the real sample and in 1 mM $NaAsO_2$ with $NaHCO_3$ + Na_2CO_3 buffer. This electrode is prepared by the simple and fast method, and it could be a potentially good sensor for arsenic detection in aqueous media.

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