Fabrication of reduced graphene oxide-magnetic nanocomposite (rGO-Fe_3O_4) as an electrochemical sensor for trace determination of As(III) in water resources

ABSTRACT

In this work, an electrochemical sensor has been developed for trace determination of As(III) in water resources using differential pulse anodic stripping voltammetry (DPASV), on the surface of screen printed electrode modified reduced graphene oxide-magnetic nanocomposite (rGO-Fe3O4/SPE). Field Emission Scanning Electron Microscopy (FESEM) and Transmission Electron Microscopy (TEM) showed a homogeneous distribution of Fe3O4 nanoparticles on GO sheets with an average size of 15.90 ± 0.84 nm. Raman spectroscopy and Electrochemical Impedance Spectroscopy (EIS) studies demonstrate that while As(III) was reduced to As0, during deposition step (− 0.5 V, 300 s), GO nanosheets were electrochemically reduced to rGO to provide more sensitive and conductive substrate. Under optimized conditions, the anodic peak current was proportional to the As(III) concentration over a wide range of 2–300 μg L- 1, with a detection limit and quantitative limit of 0.10 and 0.33 μg L- 1 (S/N = 3) respectively. The proposed As(III) electrochemical sensor also exhibited a relative standard deviation of 3.2% for six replicate analysis of 50 μg L- 1 As(III). Stability test showed the sensor retained ~ 93% of its initial signal after 30 successive measurements and ~ 90% of its initial measurement after two weeks storage at room temperature. In addition, the fabricated sensor was successfully employed for determining the As(III) residue in several water samples including lake water, reverse osmosis drink water and mineral water. The results were in agreement with inductively coupled plasma mass spectrometry (ICP-MS) when compared.

Keyword: Arsenate; Electrochemical sensor; Magnetic nanoparticles; Graphene; Water