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Abstract

The Use of Voltammetry for Sorption Studies of Arsenic (III) Ions by Magnetic Beads Functionalized with Nucleobase Hydrazide Derivatives †

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Abstract: Arsenic is amongst the most hazardous heavy metals released into the environment by natural or human-induced sources. A known carcinogen and irritant, its trivalent and pentavalent forms are the most common in aqueous media rendering their onsite monitoring and removal crucial. In this work, different adsorbents based on iron oxide nanoparticles (Fe_3O_4 NPs) coated with (3-aminopropyl)triethoxysilane (APTES) were prepared. The nanoparticles were then functionalized with one of the three nucleobase derivatives: adenine hydrazide (AH), guanine hydrazide (GH) or uracil hydrazide (UH). The successful functionalization of the nanoparticles was confirmed using Fourier transform infrared spectroscopy. Boron-doped diamond electrodes were modified using the different functionalized nanoparticles, and the interaction of the nucleobases with trivalent arsenic ions was assessed using square wave voltammetry, the adsorption efficiency being extracted from the decrease of the nucleobase peak maximum intensity. The electrochemical evaluation of adsorption isotherms showed that the Langmuir model was a better fit compared to Freundlich, and that the adsorption capacity increased in the following order: AH < UH < GH. Furthermore, it was shown that the adsorption follows a pseudo-second order kinetic model implying the involvement of chemisorption in the process. The electrochemical detection of arsenic utilizing the magnetic nanoparticles functionalized with guanine hydrazide showed a better analytical performance compared to adenine and uracil hydrazide, with a sensitivity of 1.92 $\mu A.\mu g^{-1}.L$ and limit of detection of 1.6 μg/L.

Keywords: adsorption isotherm; arsenic; Fe_3O_4 nanoparticles; nucleobase-heavy metal interaction; nucleobase hydrazides

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