Impedimetric biosensor of heavy metals based on self-assembled HRP/gold nanoparticles/ ferrocenylurea DAB dendrimer monolayers

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Heavy metal ions have entered into the environmental life cycle through the pollution of soil and water as a consequence of industrial development [1], been lead and copper related causes of many heavy metal-related diseases [2]. Lead can cause gastrointestinal, neuromuscular and neuropathological symptoms [3]. Concurrently, copper has been connected with neurodegenerative disorders such as Parkinson's, Alzheimer's, and Prion disease [4]. The biosensor is based on the direct electrochemistry of horseradish peroxidase (HRP) immobilized on the self-assembled monolayers (SAMs) of gold nanoparticles, a DAB dendrimer of first generation functionalized with thiolated and ferrocenylurea groups, and colloidal gold nanoparticles of 5 nm. This modified electrode was very effective to the direct electrochemistry of HRP and showed high sensibility and operational range in the hydrogen peroxide determination. These properties make possible the development of a biosensor based on the selective inhibition of the immobilized enzyme caused by the metal ions, which results in a decrease in the response to hydrogen peroxide proportional to the quantity of ion present in the test solution [5] and an increase in the resistance of electrode surface. Usually, most of the inhibition-based biosensors are amperometric, although some, based on electrochemical impedance spectroscopy (EIS), have been developed [6, 7]. In this work, a new inhibition-based biosensor for the indirect determination of toxic lead and copper ions is reported. EIS has been successfully used as a detection signal for the determination of Pb^{2+} and Cu^{2+} ions. Complemented by amperometric analysis, a linear response between 0.05 and 1.5 mg L^{-1} was obtained for both ions, with detection limits of 0.27 µg L^{-1} and 0.77 µg L^{-1} for Pb^{2+} and Cu^{2+}.

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FIGURES

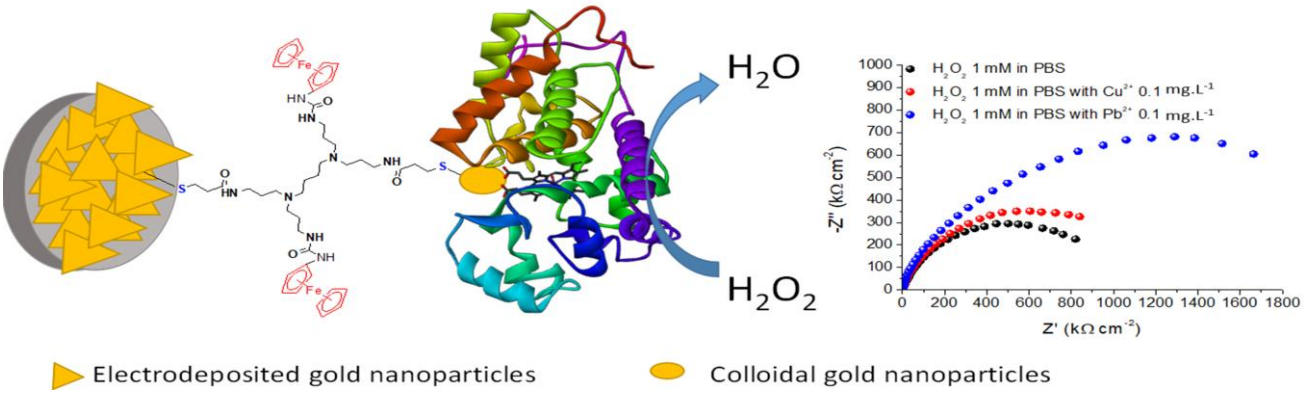

Figure 1: Scheme of the biosensor operation and its impedance response in the absence and presence of Cu^{2+} and Pb^{2+}.