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Application of Sensors in the Detection of Heavy Metals Ions in the Environment

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Introduction

Heavy Metals (HM), with high atomic number and much higher density than water, are present in the environment naturally. Their contamination to the environment is due to artificial industrial operations and also due to other causes such asthe dissolution of metals (through metal corrosion), and heavy metals leaching etc[1].

They are considered hazardous due to their toxicity, which is related to their heaviness, and the great danger to the human and animal health and the environment.

There exist several methods characterize the presence of heavy metals in waters, qualitatively and quantitatively. Atomic Absorption Spectroscopy (AAS), Inductively Coupled Plasma-Mass Spectrometry (ICP-MS), Inductively Coupled Plasma/Atomic Emission Spectrometry (ICP-AES) are few of the methods that can be applied to detect and measure the presence of heavy metals in water samples[2]. Even though those methods have great sensitivity and selectivity, but there exist several disadvantages such as: high cost of the instruments, long sample preparations time, requirement for calibration standards, and the requirement for well-trained personnel for the operation.

Attention was directed on the use of sensors as a tool to detect contamination of heavy metals in waters. In contrast, sensors have great potential in high throughput detection of multiple heavy metals on-site.

Sensors are classified based on different signal transduction mechanisms, including electrochemical, optical, and gravimetrical sensors. In general the advantages of chemical sensors include the possibility to perform real-time continuous measurements and relatively inexpensive apparatus.

One of these gravimetrical methods that are newly applied as a sensor for HM in water is the Quartz Crystal Microbalance (QCM)[3]. QCM is a high resolution apparatus (nano-gram range) that uses a quartz crystal which resonance frequency is reversibly proportional to the mass gain or loss of the quartz sensing surface[4]. Mass gains cause frequency drops and vice versa.

The QCM system can be applied in various environments, i.e. in both gas and liquid phase's analyses. The main task is to modify the sensing quartz crystal surface by the introduction of receptor films on the surface. This procedure is called the sensing layer immobilization[5]. The appropriate immobilization approach, applying chemicals, metal oxides, polymers etc., is essential to ensure the QCM high sensitivity and stability responses.

The aims of this research topic are:

• Immobilization (Modification) of sensor surface which enables to obtain surface-modified electrodes with high heavy metal ions complexing ability. The approach will be to apply some multi-functional polymers on the sensor surfaces (QCM, QCM-I).

• The analysis, of some selected heavy metals (Zn, Pb, and Cu) in water samples, will be investigated by Atomic Absorption Spectroscopy (AAS) and Inductively Coupled Plasma Spectroscopy-Optical Emission Spectrometry (ICP-OES).

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