

Thermodynamics of interactions between lead(II) and cadmium(II) ions and azulene-based complexing polymer films

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Abstract In order to understand the essential processes/interactions between the metal ions and modified electrodes which are based on complexing polymeric films, access to thermodynamic characteristics is compulsory. The paper enlarges the information concerning the sorption of metal ions within complexing polymer films, particularly based on azulene, which can be involved in metal detection sensors. Interactions between lead(II) or cadmium(II) ions and complexing polymer films have been studied using chemical preconcentration–anodic stripping method. The films have been obtained by controlled potential electrolysis in millimolar solutions of 4-azulen-1-yl-2,6-bis(2-thienyl)pyridine (**L**) in acetonitrile. Poly**L** films affinities towards these metal ions have been quantified at different temperatures by means of sorption isotherms. Parameters for sorption of lead(II) and cadmium(II) ions within poly**L** films have been calculated for Freundlich, Langmuir and Redlich–Peterson isotherms. The best fit was obtained when using Langmuir isotherm. The results evidence that lead ions are better sorbed than cadmium within poly**L** film. Thermodynamic parameters for the chemical sorption of lead(II) and cadmium(II) ions within poly**L** films have been calculated.

Keywords Poly(4-azulen-1-yl-2,6-bis(2-thienyl)pyridine) complexing modified electrodes · Chemical preconcentration–anodic stripping · Lead and cadmium ions · Sorption isotherms · Thermodynamic parameters

Introduction

Among heavy metals, cadmium and lead are some of the most life-threatening species whose toxicity mostly depend on their chemical structure and levels of exposure as Shukla a.o. 1984 [1] showed. Thus, the World Health Organization has recommended that the limits for Pb(II) and Cd(II) in drinking water should be less than 0.010 and 0.003 mg L⁻¹ [2], respectively. Therefore, it is important to detect the excess of lead and cadmium in the aquatic environments.

Anodic stripping voltammetry (ASV) is a powerful tool for determining the trace metal contaminants in environmental and biological samples. This method is based on a previous sorption of metal ions originated from the solution sample onto the electrode surface. Then, a negative potential is applied, and the metal ion is reduced to metal during an electrolysis, after which the electrode potential is scanned to anodic values, and the metal is thus anew dissolved (stripping). The recorded stripping currents are proportional to the amount of immobilized ions. ASV has applications related to the characterization of metal ions interactions with simple and macromolecular ligands [3–5] and for determination of apparent metal complex stability constants [6–11]. Moreover, by combining ASV with a preconcentration based on complexing polymers, it is possible to enhance both sensitivity and selectivity of the metal ion analysis [12–16].

In order to obtain complexing polymers attached to electrodes, the most efficient approach is the direct electropolymerization of complexing monomers, leading to

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