Electrodeposition of poly(1,8-diaminonaphthalene) films for toxic chromate extraction from bathing solutions

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Investigations on analytical applications of polymer-modified electrodes have been tremendously developed for the recent decade. One possibility is to use a conducting polymer as a sensor to heavy metal ions. The mechanism of metal ions trapping depends on the structure as well as electrochemical properties of the polymer. Poly(1,8-diaminonaphthalene), p(1,8-DAN), due to the presence of free amino groups in the polymer structure, is able to extract the heavy metal ions via complexation reaction [1-4]. Another way of withdrawing of heavy-metal ions from the solution is spontaneous redox reaction between the reduced polymer and metal cations [5]. In effect, the metal ions are reduced to the ions of the lower oxidation level or to the metal precipitated on the polymer surface, whereas the polymer oxidizes.

In order to pursue these interesting and useful characteristics of p(1,8-DAN), it is necessary to acquire understanding and control of the film deposition process. Therefore the main aim of this work was optimization of the methods of electrochemical synthesis leading to obtaining the porous polymer films of high capacity to metal ions (NH_2 groups in the bulk of compact polymer film are not accessible for the metal ions). We studied the electrodeposition process in different solvents, aceto-nitrile, acetone and propylene carbonate, in the presence of organic and inorganic acids ($HClO_4$, HCl, CH_3COOH and CCl_3COOH) as well as at different monomer concentration, from the range 0.001 M to 0.05M). The cyclic voltammograms recorded during polymerization and IR spectra of resultant polymer films were used to discover the mechanism of electropolymerization.

Finally, we investigated the obtained polymer films to extraction of chromium (VI) ions from bathing solution. The mechanism of the process was determined on the base of the changes of open circuit potential of the system: Au/p(1,8-DAN)/0.1M $HClO_4$/SCE, upon addition of $Cr_2O_7^{2-}$ ions (Fig. 1). The application of the polymer films to removal of hexavalent chromium meets the environmental requirements, due to toxic properties of these ions.

In spite of harmful effects, Cr (VI) is used in many applications, including electrodeposition, steel production, dye manufacturing and metal finishing.

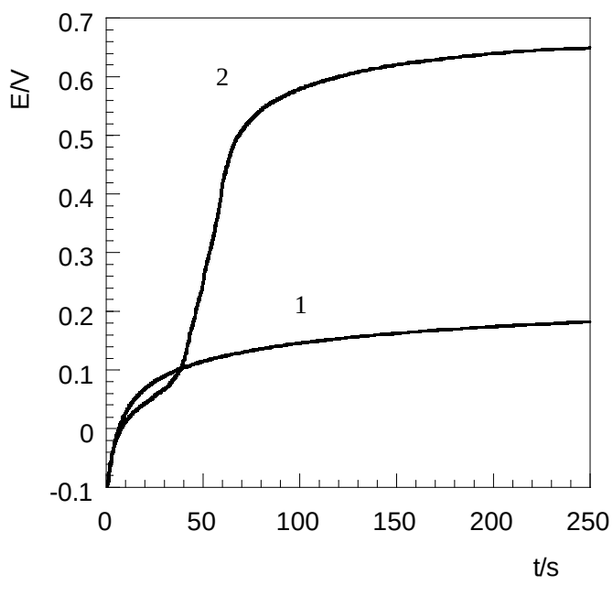

Fig. 2. Open circuit potential responses of p(1,8-DAN)-modified Au electrode after polymer reduction (at –0.3 V) in 0.1 M $HClO_4$ (1) and in 0.1 M $HClO_4$ after addition of $Cr_2O_7^{2-}$ (2).

References

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