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Possibilities of implementation of elimination voltammetry in electrochemical analyzers

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Abstract

The study is focused on the implementation of elimination voltammetry with linear scan (EVLS) in electrochemical analyzers. This implementation consists in both hardware and software development. First, the hardware, involving the good potentiostat, must enable us to measure voltammetric curves at many different scan rates and with a suitable potential step. Second, the software should be able to provide a program not only for a voltammetric experiment, but also for the elimination procedure. The EVLS procedure needs the smoothing of voltammetric curves, the calculation of coefficients of chosen elimination functions and the presentation of elimination function in both numerical and graphical forms.

Keywords: voltammetry, electrochemical analyzers, potentiostat

Introduction

Thirteen years ago the theory of elimination voltammetry with linear scan (EVLS) was published and experimentally verified for selected electrode systems (Dracka, 1996; Trnkova and Dracka, 1996). To this date this method has found applications not only in electroanalysis, but also in the study of electrode processes of inorganic and organic electroactive substances at mercury, silver or graphite electrodes (Orinakova et al. 2004; Rozik and Trnkova 2006; Trnkova 2002; Trnkova et al. 2000). The EVLS can be considered as a mathematical model of the transformation of current–potential curves capable of eliminating some selected current components, while conserving others by means of elimination functions. For the calculation of the elimination functions three voltammetric curves at different scan rates should be recorded under identical experimental conditions. The attention was devoted to fundamentals of elimination voltammetry and to the transformation of irreversible current–potential curves of an adsorbed electroactive substance. The function, eliminating charging and kinetic current components and conserving the diffusion current component, yields specific, sensitive and well developed peak–counterpeak (p–cp) signal (Adam et al. 2005; Jelen et al. 2009; Mikelova et al. 2007a; Mikelova et al. 2007b; Trnkova 2002; Trnkova and Dracka 1996; Trnkova et al., 2006, 2003; Trnkova et al. 2000; Trnkova et al. 2004; Trnkova et al. 2008).

Materials and Methods

The home–made potentiostat was designed and constructed (Fig 1). New potentiostat has eight inputs for eight voltammetric experiments at the same time. The instrument can measure at five current ranges from 100 pA to 10 mA with smallest measurable value app. 5 pA. Internal battery increase noise immunity of the measurement and enable to provide measurement *in situ*. First voltammetric measurements were carried out with the VA–stand 663 (Metrohm, Switzerland). The standard cell consisted of three electrodes, a Hanging Mercury Drop Electrodes (HMDE) with an area of 0.4 mm^2 were employed as working electrode, an Ag/AgCl/3M KCl electrode served as the reference electrode and platinum wire electrode was used as the auxiliary electrode.

Results and Discussion

The potentiostat was primarily designed for detecting of various ions and molecules. Using the standard three electrode cell and cyclic voltammetry the first test was devoted to the redox processes of lead (Pb^{2+} in acetate buffer) and the second to the redox system of cadmium (Cd^{2+} in 0.1M KCl).

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Figure 1: The eight–channel potentiostat. (See page number S22-S25)

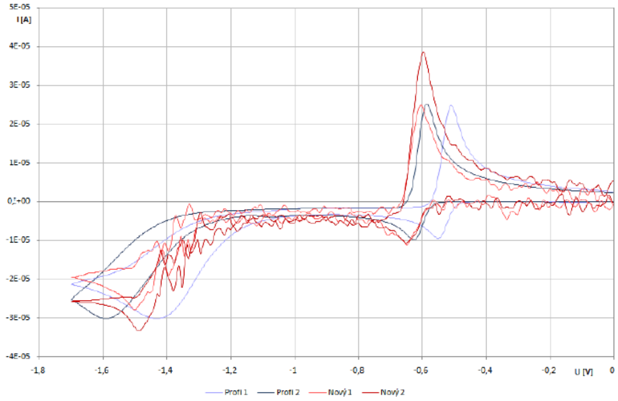

Figure 2: Cyclic voltammograms of redox couple Cd^{2+}/Cd in 0.1M KCl measured with (Autolab – blue lines) and home–made potentiostat (red lines). Scan rate 100 mV/s.

In addition to the measurements of chemical system tests with well–suited instrument inputs were carried out. The results (Fig 2) were discussed and the creation of the suitable filter circuit for suppressing noise in the measurement of real solutions was suggested. Moreover, the curves were successfully treated with elimination voltammetry implemented in the software package.

Conclusion

The small review about the possibilities of the implementation of elimination (EVLS) procedure in electrochemical analyzers was presented. The successful implementation of EVLS will need further the debugging software package and the depression of noise. The smoothing of voltammetric curves, the calculation of coefficients of chosen elimination functions and the graphic presentation of elimination function were designed.

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References

Adam V, Petrlova J, Potesil D, Zehnalek J, Sures B, et al. (2005) Study of metallothionein modified electrode surface behavior in the presence of heavy metal ions-biosensor. Electroanalysis 17(18):1649-1657

Dracka O (1996) Theory of current elimination in linear scan voltammetry. Journal of Electroanalytical Chemistry 402(1-2):19-28

Jelen F, Kourilova A, Hason S, Kizek R, Trnkova L (2009) Voltammetric Study of Adenine Complex with Copper on Mercury Electrode. Electroanalysis 21(3-5):439-444

Mikelova R, Trnkova L, Jelen F (2007a) Double elimination voltammetry of short oligonucleotides. Electroanalysis 19(17):1807-1814

Mikelova R, Trnkova L, Jelen F, Adam V, Kizek R (2007b) Resolution of overlapped reduction signals in short hetero-oligonucleotides by elimination voltammetry. Electroanalysis 19(2-3):348-355

Orinakova R, Trnkova L, Galova M, Supicova M (2004) Application of elimination voltammetry in the study of electroplating processes on the graphite electrode. Electrochimica Acta 49(21):3587-3594

Rozik R, Trnkova L (2006) Cadmium reduction process on paraffin impregnated graphite electrode studied by elimination voltammetry with linear scan. Journal of Electroanalytical Chemistry 593(1-2):247-257

Trnkova L (2002) Electrochemical behavior of DNA at a silver electrode studied by cyclic and elimination voltammetry. Talanta 56(5):887-894

Trnkova L, Dracka O (1996) Elimination voltammetry. Experimental verification and extension of theoretical results. Journal of Electroanalytical Chemistry 413(1-2):123-129

Trnkova L, Jelen F, Postbieglova I (2006) Application of elimination voltammetry to the resolution of adenine and cytosine signals in oligonucleotides II. Hetero-oligodeoxynucleotides with different sequences of adenine and cytosine nucleotides. Electroanalysis 18(7):662-669

Trnkova L, Jelen F, Postbieglova I (2003) Application of elimination voltammetry to the resolution of adenine and cytosine signals in oligonucleotides. I. Homooligodeoxynucleotides dA(9) and dC(9). Electroanalysis 15(19):1529-1535

Trnkova L, Kizek R, Dracka O (2000) Application of elimination voltammetry to adsorptive stripping of DNA. Electroanalysis 12(12):905-911

Trnkova L, Postbieglova I, Holik M (2004) Electroanalytical determination of d(GCGAAGC) hairpin. Bioelectrochemistry 63(1-2):25-30

Trnkova L, Zerzankova L, Dycka F, Mikelova R, Jelen F (2008) Study of copper and purine-copper complexes on modified carbon electrodes by cyclic and elimination voltammetry. Sensors 8(1):429-444