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A NEW SYSTEM FOR ELECTROCHEMICAL INVESTIGATIONS BASED ON PC AND LABVIEW PACKAGE

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ABSTRACT
The paper presents a new system for electrochemical researches based on PC and LabVIEW software package. An overview of well known electrochemical methods, such as potential measurements, chronopotentiometry, chronoamperometry, cyclic voltammetry and EIS is given. Electrochemical impedance spectroscopy has been adapted for systems containing large capacitances. For signal generation and recording of the response of investigated electrochemical cell, a measurement and control system was developed, based on a PC P4. The rest of the hardware consists of a commercially available AD-DA converter and an external interface for analog signal processing. The interface is a result of authors own research. The software platform for desired measurement methods is LabVIEW 8.1 package, which is regarded as a high standard in the area of modern virtual instruments. The developed system was adjusted, tested and compared with other commercially available systems.
Key words: Electrochemical Measurements, Measurement system, Electrochemical Impedance Spectroscopy, Cyclic Voltammetry

1. INTRODUCTION

Electrochemical investigation methods are widely used for characterization of different kinds of materials, as well as of the processes in systems where the electrochemical reactions take part [1, 2]. There is a series of well known methods, but some new methods from electrotechnic area have been introduced. So, first of all it was given an overview of the standard electrochemical methods and parameters, beginning with potential measurement and simple methods such as chronopotentiometry and chronoampermetry, till electrochemical impendance spectroscopy. The last named method is adapted for systems containing large capacitancies, that became actual with appearance of electrochemical supercapacitors. New methods are Dirack voltage excitation and Dirack current excitation. Measurement system described here is a new, updated version of previously developed one by the same authors at Technical faculty in Bor [3]. The system is assigned for electrochemical laboratories at faculties and institutes where it could replace expensive and/or old measurement equipment, rising work comfort and quality of obtained results at a higher level.

2. HARDWARE

For signal generation and data acquisition it was developed a measuring and control system based on PC Pentium 4. Beside PC, hardware consists of ADDA converter and external interface for analog signals conditioning [4-6]. ADDA conversion is performed using commercially available converter NI 6251 from National Instruments. National Instruments M series high-speed multifunction data acquisition (DAQ) devices are optimized for superior accuracy at fast sampling rates. They have an onboard NI-PGIA2 amplifier designed for fast settling times and high scanning rates, ensuring 16-bit accuracy even when measuring all channels at maximum speeds. All high speed devices have a minimum of 16 analog inputs, 24 digital I/O lines, seven programmable input ranges, analog and digital triggering, and two counter/timers [7].

Measurement interface designed for the needs of the electrochemical investigations by controlled current or voltage excitation have the next characteristics:
- two control voltage inputs ±10 V,
- one measuring current input ± 100 mA.
- one voltage output ±10 V for input current of ± 100 mA,
- one voltage input for the reference potential recording,
- the reference electrode input resistance higher then 10^{12} Ω,
- one the three-electrode output for electrochemical cell with the next possibilities:
    - voltage range ± 5 V with the possibility of superimposing the small signal in the range of ± 10 mV,
    - current range ± 100 mA.

Characteristics mentioned above have been realized by the block scheme given in Fig. 1.

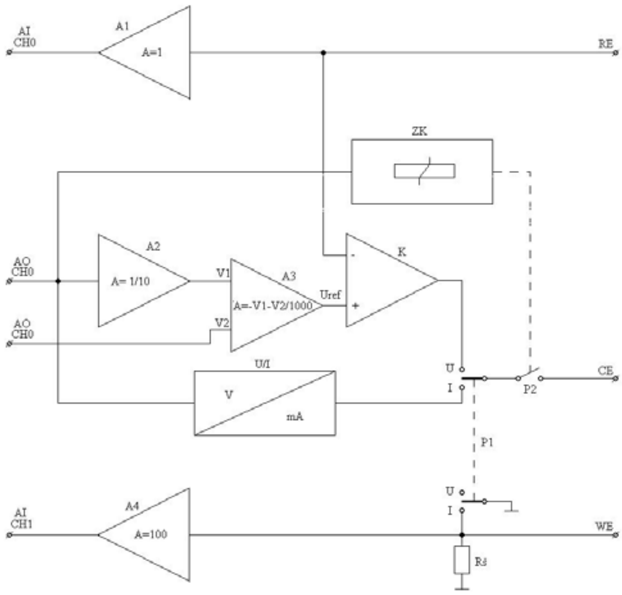

Figure 1. Block scheme of the interface

3. SOFTWARE

The software platform for predicted measurement methods was National Instruments LabVIEW 8.1 package, which is regarded as a high standard in the area of modern virtual instruments [8]. LabVIEW is based on the principles of virtual instruments with the graphical user interface. Graphical user interface has two windows:
- control panel for process control and monitoring,
- application diagram which presents used virtual instruments, relations between them, the course of signals and error detection.

In LabVIEW, one builds a user interface by using a set of tools and objects. The user interface is known as the front panel. One then add code using graphical representations of functions to control the front panel objects. The block diagram contains this code.

3.1. Control panels

At all control panels there are fields for input parameters, for actual values display as well as for graphical presentation of obtained results. In Fig. 2 it is presented a control panel for galvanostatic method. There are fields for current value, I [mA], pulse duration, t_p [s], open circuit potential, E_o [V], total time, t_t [s], as well as for actual current, overvoltage and time indication. On the panel is also a graphical presentation of an example of galvanostatic curve, E = f(t).

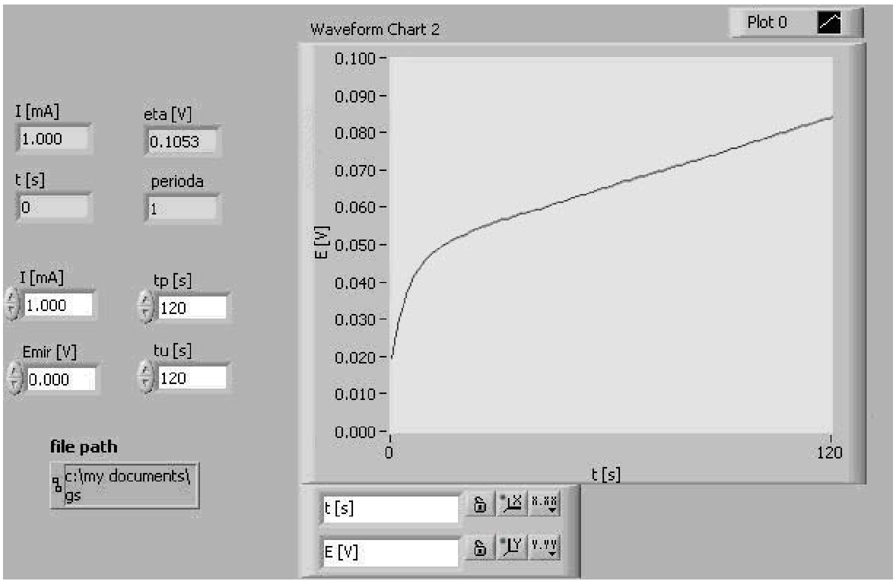

Figure 2. Control panel for galvanostatic method

4. SYSTEM REALIZATION AND TESTING

A photograph of the realized described system for electrochemical measurements is given in Fig. 3. In the figure galvanic cell is replaced by its physical model that is used for testing the measurement system itself, but the measurement methods, too.

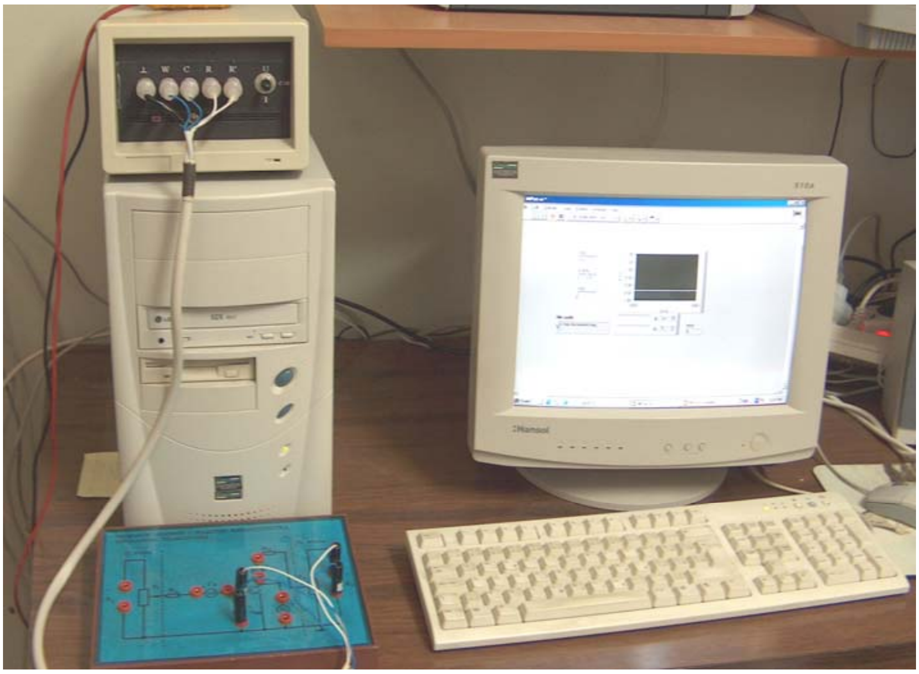

Figure 3. Photograph of the electrochemical measurement system

The system is calibrated using high accurate measurement instruments predicted for laboratory instruments adjusting (PRIMA B7-21A, PRIMA B7-38 and PHILIPS 5712). Measurement error less than 0.5 % in all ranges is achieved. The results are compared with those obtained in the same conditions using commercial galvanostat-potentiostat AMEL 551, and also with the results obtained by simulation in ORCADE software package. Excellent agreement of compared data can be seen in Figs 4 and 5.

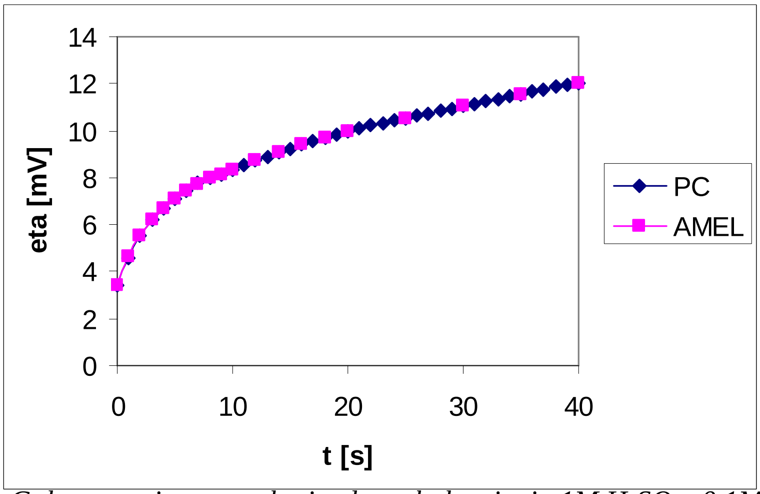

Figure 4. Galvanostatic curve obtained on chalcocite in 1M H_2SO_4+0,1M $CuSO_4$ using current intensity of 0,5 mA: PC – result obtained on the system described in the paper, AMEL – results obtained using commercial system

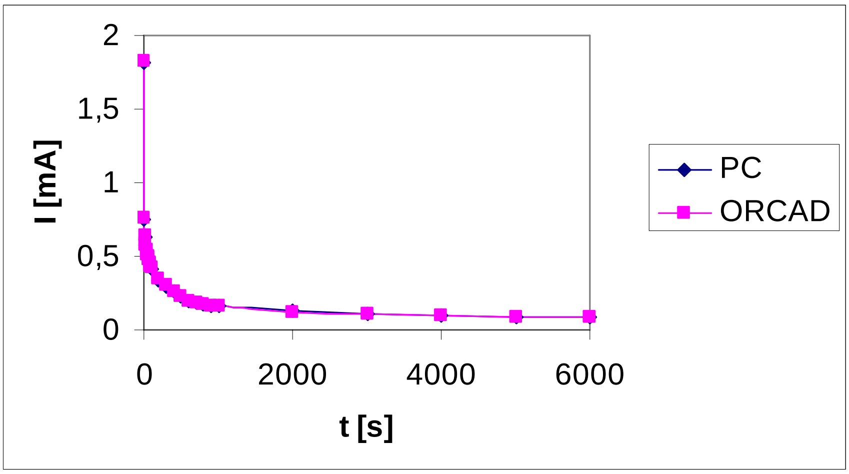

Figure5. Potentiostatic curve for chalcocite in 1M H_2SO_4+0,1M $CuSO_4$ obtained using an excitation voltage of 20 mV: PC – result obtained on the system described in the paper, ORCAD – results obtained by simulation

5. REFERENCES

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