

## MULTISENSOR SYSTEM FOR DETERMINATION OF IRON(II), IRON(III) AND URANIUM(VI) IN COMPLEX SOLUTIONS

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The mining and processing of uranium ore has contaminated wide areas in some European countries. For example, forty-five years of uranium mining in the southern parts of the former East Germany resulted in more than 800 mine tailing piles containing 500 millions tons of rock material on the area over 1000 km<sup>2</sup>. For radiological and environmental assessment and efficient remediation actions it is necessary to control the composition of waters flooding the mines. The redox reactions play the key role in the chemical process in such a systems. The most important redox pairs coupled to each other to a certain degree are U(IV)-U(VI) and Fe(II)-Fe(III), because different oxidation states of a element are related to different solubility, and consequently, different mobility. Collecting mine water samples and analysing them in a conventional laboratory significantly disturbs the system because of essential oxidation of U(IV) and leads to false analytical results. No methods are currently available for in situ speciation of these redox pairs.

One of the possible solutions of the problem is the use of sensor arrays together with pattern recognition math methods (PARCs) for interpretation of their signals. Earlier we developed and applied such a system (the so called "electronic tongue") for determination of ionic components and related chemical forms [1]. A primary part of multisensor systems is a specially designed sensor array. Cross-sensitivity to different components and stable and reproducible responses in complex media are of primary importance for sensors of such array. However, previously there were no attempts to apply multisensor approach for development of sensor systems, capable to determine not only species recognised via ionic processes but also redox potential generating components.

The aim of the present paper is the development and analytical evaluation of a multisensor system for determination of low content of iron(II), iron(III) and uranium(VI) in complex aqueous media.

Sensor array included sensors on the basis of chalcogenide vitreous materials with redox and ionic cross-sensitivities, crystalline silver sulphide electrode, noble metal electrodes Pt, Au, Ag and redox sensor on the basis of oxide glass. Potentiometric measurements have been taken in a conventional electrochemical cell vs. a standard Ag/AgCl reference electrode. All measurements have been taken at room temperature.

Calibration solutions contained UO<sub>2</sub>(NO<sub>3</sub>)<sub>2</sub> in concentration range 10<sup>-6</sup>-1,6×10<sup>-5</sup> mol/L, K<sub>3</sub>Fe(CN)<sub>6</sub> and K<sub>4</sub>Fe(CN)<sub>6</sub> or FeSO<sub>4</sub>×(NH<sub>4</sub>)<sub>2</sub>SO<sub>4</sub> and FeCl<sub>3</sub>, with the ratio of Fe(II)/Fe(III) concentration from 100:1 to 1:100, the total concentration of Fe was 10<sup>-4</sup> and 10<sup>-5</sup> mol/L. All solutions have been made on the background electrolyte of calcium and magnesium chlorides and sulphates with the fixed content of 5-27 mmol/L of each component which is a typical one for groundwater or mining water. Sensor potentials have been processed by a back-propagation artificial neural net.

Average error of determination of Fe(II) and Fe(III) is about 20 %, of uranium(VI) - 40 %. It was found that sensitivity of the sensor array to iron and uranium is irrespective of the chemical form of these species.

### *Reference.*

Di Natale C., Davide F., Brunink J.A.J., D'Amico A., Vlasov Yu.G., Legin A.V., Rudnitskaya A.M. *Sensors and Actuators*, 1996, V.34, N1-3, p.539-542.