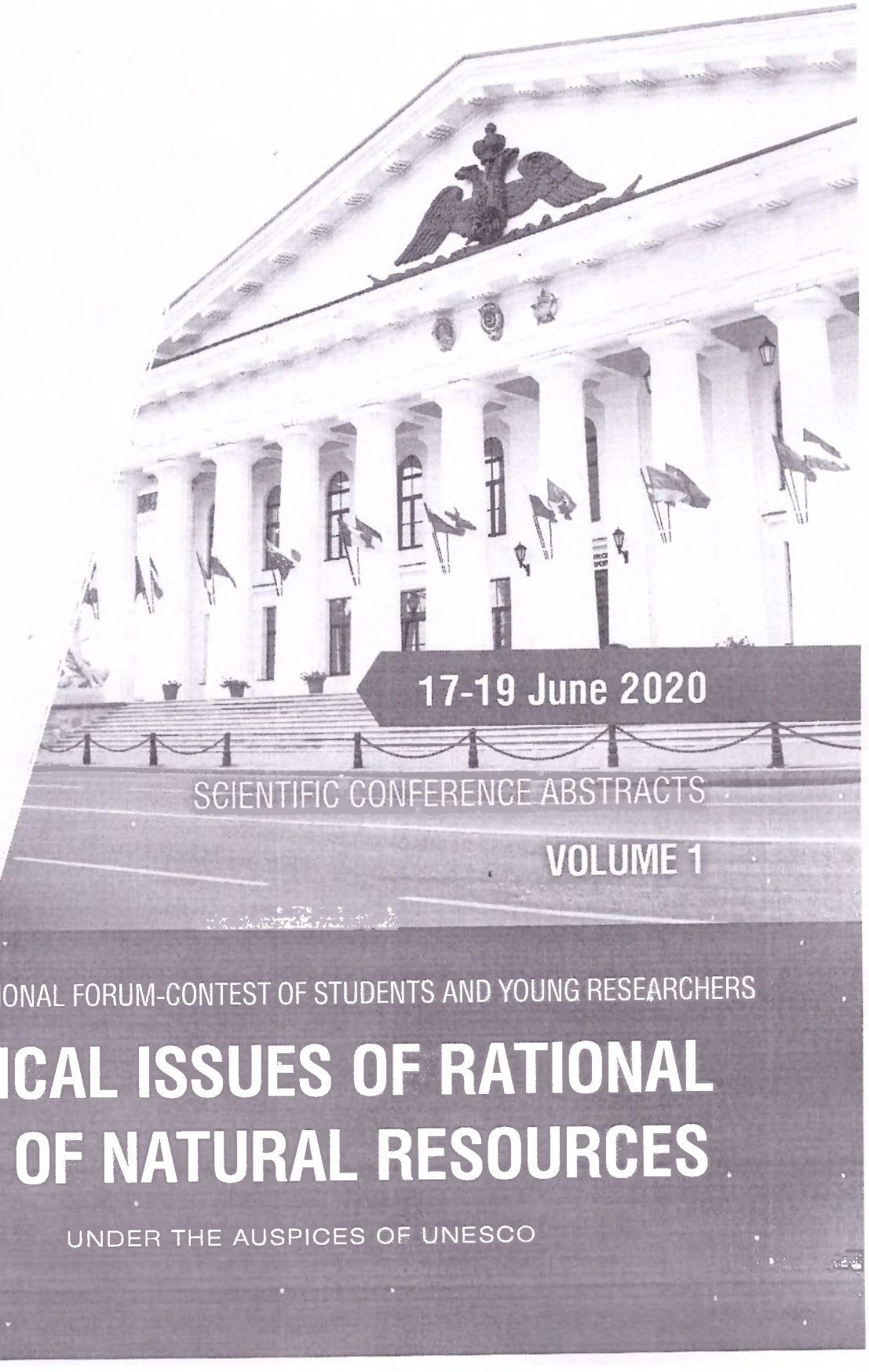
TOPICAL ISSUES
2020 OF RATIONAL USE OF NATURAL RESOURCES
June 17 - 19

United Nations Educational, Scientific and Cultural Organization

International Competence Centre for Mining-Engineering Education under the auspices of UNESCO

SAINT-PETERSBURG MINING UNIVERSITY



17-19 June 2020

SCIENTIFIC CONFERENCE ABSTRACTS

VOLUME 1

XVI INTERNATIONAL FORUM-CONTEST OF STUDENTS AND YOUNG RESEARCHERS

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The Volume contains works of young researchers - participants of the XVI International Forum-Contest of Students and Young Researchers "Topical Issues of Rational Use of Natural Resources", which was held at St. Petersburg Mining University on June 17-19, 2020. The Volume can be of great interest for a wide range of researchers, scientists, university lecturers, specialists and managers of industrial enterprises and organisations as well as for businesspeople involved in exploration, prospecting, development and processing of minerals.

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Session 1. NEW APPROACHES TO RESOLVING OIL & GAS SECTOR - SPECIFIC ISSUES

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phases. The same applies for the sample which was heated to 1173 K in the oven. Also, superposition of the two XRD-measurement shows nearly identical results.

During heating, the DTA graph shows one sharp exothermic peak and two broad endothermic peaks. By heating up a Sample with the stoichiometry InSn and the help of a phase diagram, the exothermic peak can be explained as the melting peak of an InSn alloy. Due to the multitude of systems that contain the elements Pt, Cu, In and Sn, it is hard to find a concise explanation for the two endothermic peaks. Their shape at least indicates a reaction or phase transition which took place over an extended temperature range.

In summary, the experiments delivered results, which strongly indicate that the synthesis of the Pt_2InCu_2Sn-phase was successful. By using Rietveld refinement it was possible to find a crystal structure to sufficiently explain the measurement. The result is also backed by the chemical analysis obtained by EDX. The DTA was able to provide an insight into the processes during heating in the lower temperature range. Future investigations should initially focus on the physical properties of the new alloy. Secondly, further elements should be introduced into the system and the changes of the physical properties could be explored. Furthermore, it is necessary to establish phase diagrams, by which all resulting solid solution phases can be contextualized.

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ELECTROCHEMICAL BEHAVIOUR OF GOLD IONS ON CARBON ELECTRODES PRODUCED FROM RICE HUSK

Activated carbons (AC) have a set of unique properties: electrical conductivity, high specific surface area, resistance to many chemical reagents, due to which their practical applications are constantly expanding. High interest in gold is associated with various fields of application of this metal and its value as an asset in the financial market. Gold is the subject of numerous studies of electrochemical processes occurring at the surface of various materials. The purpose of this work is to study the anodic oxidation and cathodic reduction of gold ions using carbon-based materials, which were obtained by carbonization and activation of rice husk (RH). In the present work, gold electrodeposition process on the carbon electrode was studied by means of voltammetry, while the morphology of the electrodeposits was analyzed by scanning electron microscopy (SEM).

The cleaned and dried RH was collected from local farms of Almaty region, Kazakhstan, and subjected for carbonization at 500°C in the argon atmosphere. Carbonized RH was mixed with potassium hydroxide by use the weight proportion of 1:5 (carbonized rice husk to KOH) and activated at 850°C under argon atmosphere. The resulting mixture was subjected to washing by distilled water until the neutral pH. Specific surface area of resulting carbon materials was

investigated by use of "Sorbtometer-M". Microstructural and elemental analysis was carried out using the Quantum 3D 200i Dual System SEM, JEO JSM-6490LA scanning electron microscope and Raman spectroscopy ("NTEGRA Spectra Raman"). The electrochemical investigations were conducted by using Autolab Potentiostat/Galvanostat Model AUT83945. A working solution with the concentration of 100 $mg \cdot L^{-1}$ were prepared by diluting the standard samples of Au^{3+} ions ("IRGIREDMET") with distilled water. The basic background electrolyte was a solution of 0.1 $mol \cdot L^{-1}$ hydrochloric acid.

In order to identify the surface morphological features of synthesized samples, the SEM has been used. As it can be seen from Figure 1 a,b, the samples have a complex structure. Surface macrostructure represent typical macropores with diameter of 4-22 μm (Figure 1a,b). The typical Raman spectrum of graphene exhibit three peaks: peak D at 1351 cm^{-1}, peak G at 1580 cm^{-1}, and peak 2D at 2700 cm^{-1}. The ratio between the intensities of peak G (I_G) and peak 2D (I_{2D}), I_G / I_{2D} gives an estimate of the number of layers. Analysis of Raman spectra (Figure 1c) of carbon material obtained from RH showed the content of graphene films with three or more layers (I_G / I_{2D}= 0.63; 0.50; 0.43; 0.30). The obtained adsorbents composed of amorphous silica and carbon. Specific surface of annealed RH was determined by BET method; it was 2818 $m^2 g^{-1}$, pore specific volume was 1.59 $cm^3 g^{-1}$ and average pore size was within 1.0 ÷ 2.0 nm. The carbonized and activated rice husk (CARH) have a rather low redox potential and the stationary potential is 0.05 V (Ag/AgCl). The measured stationary (real) potential of gold in a hydrochloric acid medium is equal to 0.47 V (Ag/AgCl). The potential difference between gold (oxidizing agent) and sorbent (reducing agent) is 0.42 V relative to the reference electrode. Cyclic voltammetry curves of gold ions in 0.1 M HCl measured on carbon-capped electrodes are illustrated in Figure 1d (curve 1). This curved represents an oxidative peak (0.8 V) in the reverse scan and a reductive peak (0.55 V) in the forward scan. The background electrolyte based on 0.1 M HCl measured on a carbon electrode was also examined in this potential region (Figure 1d, curve 2). However, no clear redox processes were observed. Since activated carbon has a large surface area, large charge-discharge currents of the double electric layer (non-Faraday currents) were revealed.

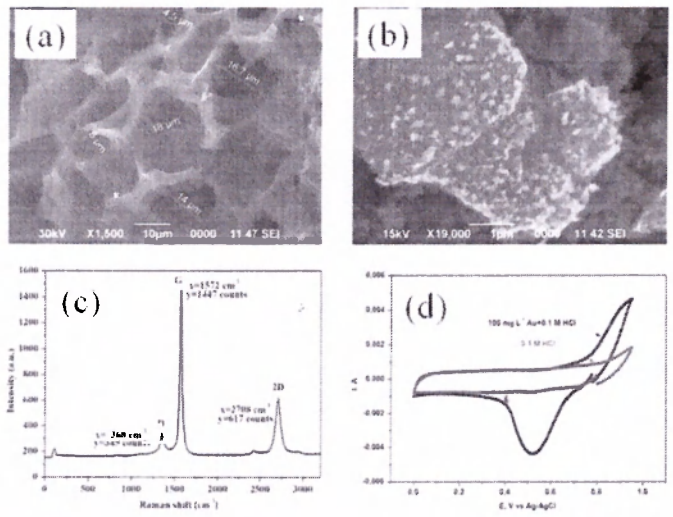

Figure 1. (a) SEM images of the surface of the carbon electrode before and (b) after adsorption of gold, (c) Raman spectra of activated carbon, (d) Cyclic voltammograms on carbon electrode in (curve 1) 0.1 M HCL + 100 $mg \cdot L^{-1}$ $HAuCl_4$ and (curve 2) 0.1 M HCl at 5 $mV \cdot s^{-1}$.

In turn, charge-discharge currents are due to the large surface area of electrode, which is reflected on the voltammograms. Thereby in order to calculate the kinetic data on the gold electroreduction reaction on this material, compensation should be made for a non-Faraday current. For this purpose, the currents of a double electric layer were taken from the value of the cathodic current peak. Finally, the resulting peak current values were used to calculate the diffusion coefficient which will be discussed during the Conference.

The resulting material obtained on the basis of RH was studied by modern and informative methods of physico-chemical analysis including scanning electron microscopy, Raman spectroscopy and BET analysis. It was demonstrated that the resulting material has a developed macroporous structure and possesses a high specific surface area. The electrodeposition of gold was studied in solutions containing $HAuCl_4$ forming $AuCl_4^-$ ions. When current density was equal to zero, the system exhibited a constant open circuit potential of about +420 mV vs. Ag/AgCl.

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RESEARCH OF THE TECHNOLOGICAL VARIABILITY OF PYRITIC POLYMETALLIC ORES OF THE ARTEMYEVSKY DEPOSIT

Polymetallic ores are the most favorable object for the development of the principles of technological typification of processed raw materials, since even in the conditions of an undeveloped system of automation of flotation operations, the plant necessarily provides shift reports for at least three controlled elements: Cu, Pb, Zn. These three elements are simultaneously reflected in each of the resulting concentrates. Taking into account the possibility of calculating the ratios between the metal contents in the ore, it is possible to form a fairly representative multidimensional information space, which can be analyzed using neural network modeling methods. The application of the ratio of metal content in the ore was successfully used in the development of the classification of technological flotation schemes of, for example, pyritic copper and copper-zinc ores [1]. The geological and mineralogical features of the pyritic polymetallic deposit are reviewed in the literature [2-4]. For specialists in the field of classical flotation, the main link in the development of the classification of processed raw materials is a set of preliminary studies, which includes mineralogical, fractional, granulometric analyses of the ore, as well as some studies of the physical properties of the minerals included in the ore. This approach to creating a system of technological classification is not acceptable, since it does not provide an online mode because of the constant variability of the type of ore mixture processed at the plant.

For the analysis, an array of results of shift work of the plant obtained during the processing was formed. The statistical array consisted of 342 observations. The classification of the array of initial observations of input parameters was carried out using the 12:12-24:1 Kohonen neural network model KSOM, 12×2 format. The initial data was divided into learning – 172, control – 85 and test – 85 samples.

To achieve higher reliability in the identification of topological Kohonen maps for diagnostic purposes a methodology is proposed. It includes the interpretation of calculated average values of studied parameters of all neurons, using the method of factor analysis, design of selected neurons on the plane of the main components $F_1 - F_j$ and applying on them the physical values of the vectors of the measured parameters and contour lines of output functions. The developed approach of technological classification of processed raw materials allows us to trace the changing trend on the topological map of Kohonen. According to the presented trend, it is hardly possible to count on adequate actions of operational personnel to manage flotation operations. This observation confirms the reason for the observed large variability of technological indicators.