Innovative Technologies in Metallurgy and Materials Science

BOOK OF ABSTRACTS

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კონფერენცია ეძღვნება პროფესორ სერგო (სეირან) მაზმიშვილის 80 წლის იუბილეს

CONFERENCE IS DEDICATED TO PROFESSOR SERGO (SEIRAN) MAZMISHVILI'S 80th ANNIVERSARY

Wellcome!

Dear Colleagues,

Organizing Committee invites you to the International Conference “Innovative Technologies in Metallurgy and Materials Science”. Conference is dedicated to Sergo (Seiran) Mazmishvili's 80th anniversary and is organized by the Faculty of Chemical Technology and Metallurgy of the Georgian Technical University and Georgian Foundrymen and Materials Scientists Society. The Meeting is taking place in Tbilisi, Georgia on July 16-18, 2015.

The meeting will create an environment for in-depth, informed discussions highlighting the importance of metallurgy and material engineering in the industry and academia.

There is also wide space for oral and poster contributions to allow established colleagues to discuss their latest results and achievements.

Besides the scientific aspects of the program, you will have a chance to appreciate the scenes of Georgia and visit historic regions of our country.

We will work hard to ensure a rewarding event, both scientifically and socially.

We look forward to seeing you in Tbilisi.

Organizing committee

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Table of Contents

Plenary Lecture

PL 1. OPTIMIZATION OF GRADES, HIGH QUALITY OF PRODUCTS, ENERGY EFFICIENCY AND ENVIRONMENTAL FRIENDLINESS BEING THE MAIN DIRECTIONS FOR DEVELOPMENT OF GLOBAL FERROALLOYS INDUSTRY

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In June 2015 upon an initiative of UkrFA International Ferroalloys Congress - INFACON 14 - took place in Kiev. Over the last 40 years since the first Congress that took place in RSA in 1974 INFACON Congresses have became major forums for the industry where such questions as theoretical and practical developments of ferroalloys industry, new technologies and equipment, energy efficiency and efficient use of resources, application of ferroalloys in steel production etc. are discussed.

Basing on papers and presentations contributed by speakers at INFACON 14 we may come to following conclusions. ***First,*** the prospects of international ferroalloys industry development are determined by corresponding trends in "big" metallurgy, especially in high-quality (special) steel grades production, consuming major quantity of produced ferroalloys. ***Second***, ferroalloy producer's success or weakness in certain companies, as well as different regions, is closely connected with energy factor (due to high energy consumption of ferroalloys production process). And ***third,*** during last years logistics (especially port and railway infrastructure) together with the level of expenses on salaries, equipment and supporting materials have significant impact on competitive performance of ferroalloys and mining (raw material) production all over the world. Let us have a closer look at these factors.

According to WSA global steel production in 2013 reached of 1,622 billion tones among which 779 million tones (48%) were produced in China. Basing on the recent forecasts in 2014 steel production should increase to 1.662 bln. tons, in 2015 to 1.635 bln. tons and by 2020 will reach 1.814 bln. tons out of which 794 mln tones will be produced in China. So, compared to the current level steel production will increase by 12%.

Steel production growth, including special high-alloyed steels leads to increase in requirement for ferroalloys i.e. Chromium, Manganese, Silicon, Nickel and others including noble ferroalloys.

Relationship between ferroalloys and steel production became even more apparent in recent years together with development of technologies of steel production at mini-metallurgical plants where electrometallurgical mode is applied as well as due to rapid development of high-alloyed steel grades manufacturing especially in China.

For the time being to produce 1 ton of steel about 20 kg of various alloys are used in average, of which about 20% account for FeCr, 18% for FeSi, 22% for SiMn, 12% for HC FeMn, 5% for refined FeMn, 4% for FeNi and 19% for other alloys in total. Thus, for production of 170 mln. tons of special steel grades (10% of global production) about 35% of all the produced ferroalloys were used and for production of 1440 mln. tons of ordinary steel grades (that is relevant to 90% of global production) 65% of all the consumed ferroalloys were used.

According to information presented at the conferences about 62.3 mln. tons of different alloys were produced globally in 2013 compared to 58,5 mln. tons in 2012; production growth during 5 previous years amounted to 8,1%. These figures obviously include production of Si Metal, various deoxidizers (Al alloys) and Si Carbide.

Substantial quantity of produced ferroalloys accounts for ***Cr alloys***, particularly ***High-Carbon Ferrochromium***. Global production capacities allow to produce 13,7 mln. tons of FeCr (2013 data) which are distributed as follows: 5,1 mln. tons may be produced in Africa, 6,8 mln. tons in Asia including China, 1,8 mln. tons in Kazakhstan and Russian Federation. In 2013 with capacity utilization rate at 76 % production of FeCr of various grades reached 10,4 mln. tons. In particular in China 39,4% of global production were smelted, 30% in RSA, 11% in Kazakhstan, 9% in India.

China has become a leader in global production and consumption of FeCr: in 2013 there were produced 4.5 mlt tons of the alloys (mainly from imported ore) while consumption of Chinese steel industry averages 7,6 mln tones of FeCr. At the same year import of chromite ore to China amounted to 10 mln tons out of which 60 % accounted for South African ore. Besides, China imported about 2.2 mln tones of FeCr in 2013, out of which about 66% were of South African origin.

Meanwhile Kazakhstan provokes competition to South Africa in supply of chromite ore as well as ferroalloys by offering ore of higher quality with Cr/Fe ratio being 3,2 while in South African ore Cr/Fe ratio is 1,3. Due to the fact that South African producers started mining relatively poor chromite ores UG2 (41 % Cr_2O_3) the quality of South African FeCr has decreased , i.e. while in 2000 Cr content in the alloys averaged 65 %, in 2013 it changed to 60 %.

Manganese alloys take leading place in the overall volume of produced ferroalloys, and the analysis of perspectives of its production is of particular interest for domestic ferroalloys industry and its raw material base.

In 2012 global Manganese raw material production totaled 49,2 mln tones and basing on the recent forecasts it will reach 58,8 mln tones by 2020, that will be induced by predicted steel production growth that in its turn will affect Mn ferroalloys smelting. (See diagram 1). About 57 % of global Mn ore output were smelted within 2013 to produce ferroalloys in China.

Global Mn alloys production in 2013 totaled 19,6 mln tones (7% reduction compared to 2012), including 12 mln toned produced in China (61,2% of global production). Currently China accounts for 67% of global SiMn production, 53% of refined Mn alloys production and 48% of HC FeMn production. China is an undisputed world leader of EMM production with 1,1 mln tones in 2013 or 97% of global production.

Regarding production of ***Silicon ferroalloys*** in 2013 global production totaled 7,27 mln tones, out of which 4,8 mln tones were smelted in China (66% of global production). Specifics of Si metal production go beyond the scope of questions discussed in this article. It should be noticed though, that China accounts for 64% of global output of Si metal and in recent years smelting continued increasing by 10,9% per annum on an average. 17% of Si metal produced undergoes further refining to polysilicone etc. used in solar power generation; there is an obvious growth in demand for Si in aluminum alloys production used in automotive industry.

Expansion of grades of ferroalloys consumed in steel industry is connected basically with ***noble ferroalloys*** smelting i.e. ***Ni, Ti, Nb, Mo, V, FeV, W and other ferroalloys***.

Global FeNb production and consumption in 2013 amounted to 80 thousand tons. In 2014 FeNb production increased to 83 thousand tones and according to forecasts within next 5 years will increase by 4,9% per annum.

About 80 thousand tones of tungsten-containing products were sold on the global market in 2013, out of which 20% (16 000 tones) accounts for ***ferrotungsten***.

Tungsten is mainly used in production of tool steels, especially high-speed steels, high-resistance steels. Such steels along with W also contain Mo and Cr.

Demand for ***nickel*** to produce special primarily stainless steels is satisfied mostly at the cost of electrolytic nickel. At the same time as new technologies in steel production develop (i.e. different combinations of AC-oxygen converters) a new nickel containing product is emerging emerged on the market named ***NPI*** (Nickel Pig Iron). NPI is most effective when used to produce stainless steel by means of AOD- process.

Global manufacturing and consumption of vanadium in the form of ***ferrovanadium*** amounted to 86 thousand tones in 2013. It is forecasted that by 2020 this figure will increase to 140 thousand tones. The major producers of FeV being China – 49,7% of global production, South Africa – 13,9%, Russia – 7,8%, Europe – 6,7%. North America – 4,5.

In the conclusion of our survey on bulk and noble alloys we would like once again to mention the tendency of using ***complex*** alloying and microalloying of special as well as HSLA low-alloyed steels. New steel grades are emerging where in line with traditional elements – Mn, Si and Cr up to 0,5% Ni, 0,5% Mo, 0,3% Nb and 0,3% V is included.

Energy factor seriously affects production of bulk as well as minor and noble alloys. For example it is a crucial factor in RSA where ferroalloy companies receive high tariffs from energy company (as well as in Ukraine). Comparative power price data were shown during the conferences (USD/kWh): 0,08 – in South Africa, 0,061 – in China, 0,046 – in Malaysia. Several ideas were offered to solve the power issue in RSA namely to use alternative sources of energy, solar in particular, as well as to build new private power generating facilities.

Moreover, the speakers at the conferences paid attention to power saving and power efficiency, including co-generating technologies. Depending on the furnace type and ferroalloys produced, co-generation capital pay-off will amount to 4-6 years. It is worth mentioning that issues of energy efficiency as well as environmental friendliness of global ferroalloys industry took center stage at the International Ferroalloys Manufacturers Congress INFACON-14. The motto of our Congress been "Energy efficiency and environmental friendliness are the future of global ferroalloys industry! ".

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Invited Lectures

IL 1. OBTAINING MULTICOMPONENT LIGATURES DURING METALLURGICAL PROCESSING OF INDUSTRIAL WASTE FOR SECONDARY TREATMENT OF LIQUID STEEL

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Currently the waste of metallurgical, chemical, and mining-concentrator processing industries is accumulated in fairly large quantities in Georgia. It is partially stored in the existing and stopped plants, partially simply scattered on the territory of the industrial region. Practically all wastes are characterized by maintenance of very expensive useful components in one or another amount.

The metallurgical development of such wastes can solve several problems:

- The raw material base, expanding complex alloy and ligature production;
- The establishment of multicomponent alloy and ligature production;
- A perceptible improvement of the ecological situation in the industrial regions;
- Utilization of the practically worthless industrial wastes allows getting scarce complex ligatures with a subzero prime price that in turn allows stimulating development of small business.

The aims of this work can be set forth as follows:

1. Identification of the wastes of metallurgical, chemical and mining industries.
2. Development of technology for obtaining multicomponent ligatures, with freely varying composition, from these wastes.
3. Study of thermo-physical parameters of the obtained ligatures.
4. Using ligatures for deoxidizing, alloying and modifying of liquid steel.

For arriving at decision the set of problems were studied by us:

- Production slime of manganese electrolytic dioxide at Rustavi industrial association AZOT;
- Residues of the Kazreti barite ore mining and processing works;
- Slimes of production of rare metals;
- As a reducing agent, it was decided to use aluminum shavings dropping out of secondary non-ferrous metal production.

In the presented work authentication of foregoing wastes was conducted with exact determination of their chemical and fractional composition, vibrations of maintenance valuable components in them depending on a place and time of storage and their actual supply.

Rational compositions of charges were expected for an aluminothermic process. Heating engineering descriptions of charges are certain and thermal balances of melting are expected in different furnaces.

The multicomponent ligatures contained a whole range of highly valuable elements - Mn-Si-Al-Ba- Ca-Mg-Ce-Fe.

In this paper was discussed the deoxidizing ability of obtained ligature, the possibility of using it for refining and modifying steel.

Experiments were conducted in the high temperature resistance Tamman-furnace. Steel was melted in alundum crucible with the open mirror of metal. After the achievement of temperature 1893 K a liquid metal was maintained some time, a sample was taken and then the ligature was introduced in an amount of 0,1- 0,3 % by insufflation into the lower layers of the molten metal.

The melt was kept within 10 minutes to separate the layers of metal and slag, and then their samples were taken.

Highly were taken the samples for the determination of nonmetallic inclusions of steel before and after processing the ligature.

The comparative melting was conducted by treatment of the same steel mixture of components that was identical to composition of ligature.

It was set by the analysis of results of the conducted experiments, that at the use of multicomponent ligature the high degree of deoxidation was attained - 30-85%.

Special mention should be made of the high degree of desulphurization - 30-75%.

On the comparative melting these indexes were made according to 55 and 45%.

Compared to using a mixture of components, amount of non-metallic inclusions have been reduced by 20-40%.

Thus, high efficiency of multicomponent ligature was confirmed at the secondary treatment of liquid steel.

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IL 2. TECHNOLOGY OF OBTAINING NI, NB AND TA COATINGS ON ALUMINUM SUBSTRATE

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In the present work, by means of analysis of state diagrams of corresponding systems and crystalline structures of used elements is revealed the opportunity of obtaining Ni, Nb and Ta coatings on aluminum substrate using the method of electron-beam technology. It is shown that activity of aluminum substrate and its low melting temperature hinder achievement of desirable adhesion of condensates of abovementioned metals with aluminum. Therefore, the directions of experimental researches for achievement of positive results were scheduled. Optimum ranges of condensation temperatures securing satisfactory adhesion of condensates with aluminum substrate were determined. In case of nickel application it equals to 250-320°C, for niobium – 200-340°C, tantalum – 200-320°C. The rates of vaporization and condensation are not limited. When substrate temperature is lower than bottom limit, adhesion of condensates with the substrate worsens, while in case of upper limit the reactive diffusion develops. As a result of reactive diffusion the intermediate compounds of $NiAl_3$ and NiAl develop in the form of powder in transitional sublayer that causes complete delamination of condensates from substrates. When applying niobium and tantalum the products of reactive diffusion create warping, embrittlement and cracking of aluminum substrate.

Samples received by means of developed technology are tested on alternate bending at an angle of ±180° (radius of curvature r = 5mm). In nickel condensate of 30-35 mkm in thickness a crack formation begins after 5-6 bends, for niobium and tantalum of 5-10 mkm in thickness – in case of 15-time bends. Delamination of condensate from substrate is not observed in any case, even after destroying the sample integrity.

Microstructure and hardness distribution in cross-section of samples are studied. In nickel condensate of 30-35 mkm in thickness are revealed two structural zones, which differ from each other in hardness and coloring. When increasing thickness of condensate up to 60-65 mkm, transition zone disappears possibly related to leveling of condensate composition and structure in time.

The influence of original surface of aluminum (it is covered with thin layer of Al_2O_3) on adhesion of coating with substrate is studied. It is established that with the purpose of elimination of Al_2O_3 influence on structuring of coatings, condensed sublayer of pure aluminum applied in the same technological cycle worsens properties of nickel coating adhesion with substrate that is related to formation of brittle intermetallic compound of Ni-Al system on activated surface. Sublayer of pure aluminum improves the degree of niobium coating adhesion with aluminum substrate, while in case of tantalum application it doesn't play significant role.

Coatings on aluminum technological samples of complicated geometric form, sprayed all-round with nickel, niobium and tantalum are obtained according to elaborated technology. Coatings satisfy all basic requirements foreseen by technical conditions.

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Keynote Presentations

K 1. OBTAINING METAL POWDERS IN HYDROVACUUM MELT SUCTION PLANT

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In the production of metal powders a relatively simple and inexpensive process is spray (dispersion) of metal melts acting on them by the stream of gas or liquids [1-4]. High spraying allows producing powders, particles of which have a structure that gives them specific properties suitable for SHS. But there are also essential shortcomings: high energy consumption, potential of explosion, need of application of inert atmosphere. At high dispersion speeds great aerodynamic forces appear promoting formation of significant amount of oxides. Therefore, powders obtained by spraying are subjected to recovery annealing, which is intended not only for recovering oxides, but also for improving technological properties of the powder (compressibility, sinterability, etc.).

According to the source [5], a spaying of inert gas in combination with vacuum induction melting (ALD Vacuum Technologies) is a leading technology to produce high quality metal powders with the following specific requirements: 1 - spherical shape, 2 – purity, 3 - rapid crystallization, and 4 - homogeneous microstructure. This method has the ability to combine different melting technologies with spraying inert gas, which makes possible production of powders of almost any metal alloys. Yet, the need for high-tech control systems, use of high vacuum and inert gas and discrete (cyclical) production process are significant disturbing factors for widespread use of this technology.

Based on the above analysis, for reducing the cost of powder production, ensuring continuity of the process and enhancing the functionality of the process equipment, we created an experimental plant of hydrovacuum absorption and granulation (dispersion) of fusions, which are based on E. Godetsky's (Ukraine) engineering developments [6]. At this plant a working body is water, which moves in the closed channels of the closed contour, creates vacuum, captures melts, granulates and carries away a granulation product from the working zone to a place of its warehousing. The plant excludes a contact of the melt drops with the atmosphere that prevents their oxidation. The plant and technology are environmentally friendly as dust, gases, noise, light, heat, water are not discharged to working zone and environment. A schematic hydraulic diagram of the plant is provided in Fig.1.

The plant is produced and tested at former Rustavi metallurgy factory, which now is “Rustavi Steel” Ltd. Aluminum powders, aluminum-magnesium alloys, bronze and cast iron were made. Technical characteristics of the powder are given in Table 1.

Table 1. Technical characteristics of the powders

Material	Granulometriccomposition, %							
	2.5>	2.5>1.6	1.6>0.63	0.63>0.4	0.4>0.35	0.35>0.16	0.16>0.063	0.063>0.05
Aluminum	0.30	0.82	43.79	27.16	12.12	12.42	3.15	0.24
Magnesium-aluminumalloy (70% Mg)	0.04	0.05	18.21	37.71	19.63	18.98	4.75	0.64
Bronze	0.7	0.43	12.06	25.18	18.10	31.47	10.49	1.57
Iron	0.87	4.85	47.66	23.40	10.23	11.27	1.74	-

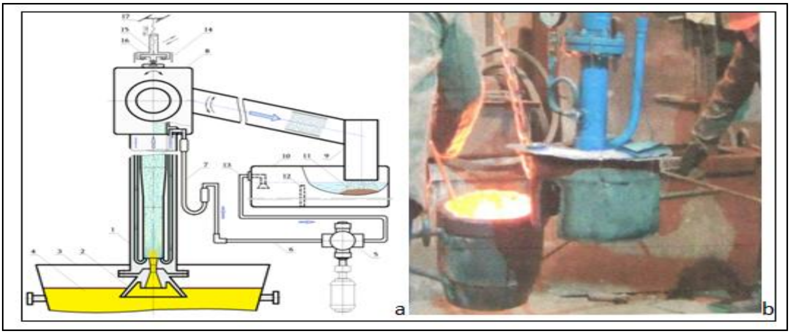

Figure. 1. The experimental plant of hydrovacuum suction and melt granulation;

a - functional diagram; b - experimental plant during operation.

1 - cylindrical body with toroidal channel; 2 –plunging in melt head with suction convergent and spray diffuser channel; 3 - ladle with melt; 4 - melt metal; 5 - water pump; 6, 7 - injection pipeline with flexible knee; 8, 9 - drainage system; 10 - retention tank of water-powder suspension; 11 - granular metal (powder); 12 - siphon accumulator; 13 - pipeline for water circulation; 14-17 - supporting suspended travel mechanism of the plant.

Unlike the technology ALD [5], functionality of developed method and the plant is not limited by processing molten metals, also it can produce non-metallic powders, for example - from slag melts. It is known that the production of powdered slag and slag pumice is mainly performed by so-called wet granulation of industrial wastes. Production of highly granular materials is topical for the construction industry [7, 8]. These man-made materials are good substitutes for natural inert filler materials. And we can say that by cost, thermal insulation properties and lightness they even surpass natural materials. There is no doubt that the production of granulated slag and slag pumice by traditional ways is accompanied by formation and accumulation of sulfur compounds in the gas mixture. Over the source of toxic emissions as part of the gas mixture sulfur dioxide and hydrogen sulfide are detected [9]. Because of large amount of gas-vapor emissions, on the basis of environmental considerations, a number of metallurgical enterprises, including ferroalloy plants in Georgia, have ceased production of granulated slag. However, this escalates the problem of recycling metallurgical slags and excludes the possibility of their use in the building industry, etc.

We have developed the plant, which unlike the relatively progressive and compact melt separating and granulating devices [10-12], completely eliminates the release of toxic vapor into the atmosphere, and this fact deserves special attention. Plant capacity depends on geometry parameters of technological units of the construction and on the pressure of supplied water that can vary within 5-9.5 atm. It is noteworthy that by adjusting the water pressures in the circulation system the suction force of vacuum can be regulated, i.e. carrying melt force; the effect of differential suction of melting products could be achieved by this. For example, the developing suction force at a lower pressure can capture only a portion of molten slag, and metal remains unaffected, this significantly reduces metal losses with slag.

Based on the above mentioned technical results, in conclusion we can say that we have created the plant for hydrovacuum suction and granulating melts, which is effective for producing metallic powders suitable for the powder metallurgy and melt cleaning from surface slags, and production of non-metallic powders and slag pumice for the construction industry.

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K 2. DEVELOPMENT OF METHODS FOR OBTAINING ANTI-CORROSION COMPOSITION COATING CONTAINING MICROCAPSULES

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One of the modern methods of increasing corrosion resistance, heat resistance, wear resistance and microhardness is the formation of composite electrochemical coatings (CEC). In this case, with the main metal from the electrolyte codeposited finely dispersed particles of various natures, which provide improved of physical and chemical properties of the surface [1]. The use of inorganic particles in the CEC practiced since the 70s years of the XX century, and the injection of organic matter, especially in capsule form - a new phenomenon, and began to develop only recently [2, 3]. At the same time, it opens up new possibilities for the needs of anti-corrosion protection, tribology, where capsules injected in the coating may work as self-healing.

The aim is to obtain anti-corrosion nickel CEC with organic microcapsules, establishing the optimal parameters of electrodeposition, study the effect of concentration of the microcapsules on the microhardness of coatings and corrosion behavior of the CEC.

For the deposition of coatings an electrolyte of brushed nickel is used. As the composition additive was used the organic microcapsules with corrosion inhibitor obtained by liquid emulsifying. The volume ratio of the additives of suspended microcapsules and electrolyte changed from 1/80 to 1/10. Deposition current density was varied from 5 to 15 mA/cm^2.

Elemental and fractional composition, appearance of the obtained coatings was evaluated using the method of electron microscopy.

Corrosion resistance of the coatings was determined by an electrochemical method with a record of voltammetric curves of anodic dissolution. Also corrosion resistance was evaluated by Korodkot method which is related with covering of coating surface by the chemically aggressive paste and subsequent keeping of coatings in a water vapor atmosphere at a temperature of 38±2 °C during 16 hours. The microhardness of the coatings was determined using Qness Q10M.

The procedure for the obtaining of gelatin microcapsules with the inclusion of a corrosion inhibitor was developed and received a patent of the Republic of Kazakhstan. By varying the conditions one can obtain microcapsules of less than 1 to 100 microns (Figure 1) [4].

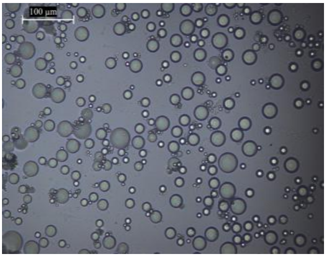

Figure 1. Optical micrograph of the microcapsules

A method for obtaining a nickel-based CEC with embedded organic microcapsules was developed. Optimal conditions for the electro deposition are: temperature ~ 30 °C; the current density ~ 10 mA/cm^2; volume ratio microcapsules ~ 1/80.

Carrying out of settlement of fractional composition shows that the most common faction represented in the electrolyte and deposited coatings are a fraction with diameter of the microcapsules 0.6 and 0.9 nm.

The coatings showed acceptable corrosion resistance and microhardness. With increasing concentration of the microcapsules in the electrolyte from volume ratio 1/40 to 1/10 the microhardness of CEC increases from 300 kgf/mm^2 to 1000 kgf/mm^2.

Coatings obtained with the average value of the current density (10 mA/cm^2) show good protection properties at low concentrations of the microcapsules in the electrolyte solution. Protective effect Z of coating deposited at volume ratio of capsules 1/80 and 1/40 is 85% and 64% which corresponds to a protection coefficient γ 6,8 and 2,8 respectively.

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K 3. DETERMINATION OF SILICOMANGANESE OPTIMAL COMPOSITION FOR INCREASING EFFECTIVE USE OF MANGANESE

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It is well-known that quality indices of technology of ferroalloys (silicomanganese) smelting process are mainly characterized by extracting value in leading element alloy and its oxide content in final dross. Manganese ferroalloys are mainly produced with carbon thermal continuous process meaning reduction of oxides existing in raw material with coke carbon.

Modern practice of commercial silicomanganese shows that main source of manganese loss (18-20%) represents so called "waste" (final) dross. In recent years analysis of ferroalloy factory work showed that either in powerful or low power furnaces, during silicomanganese smelting losses are continually increased, main reason of which is the deficit (expensiveness) of high quality manganese ore and hence worsening its quality. All of these cause decrease in foundry aggregate productivity, increase in dross sequence and losses of manganese. That is why decrease in manganese loss in its electrometallurgic refining process is very urgent problem and requires instant solving.

It is determined that manganese content in final dross of silicomanganese is determined by equation [1,2]

$$(MnO)^2 = \frac{[Mn]^2 \cdot (SiO_2)}{K_{Si-Mn} \cdot [Si]}$$

Where (MnO), (SiO_2), $[Si]$, $[Mn]$ is content of leading components in dross and metal and K_{Si-Mn} - equilibrium constant of silicomanganese production.

As it is seen from given equation content of manganese in final dross mainly depends on silicon and manganese concentration in metal that was proved in conducted surveys.

Testing smelts, aiming to receive silicomanganese containing different manganese and silicon, was done in 5 Mva power ore reduction electric furnace. The furnace is equipped with 400 mm diameter graphitized three electrodes. Power on electrodes was 110 volts and current intensity – 18-20 kilo ampere.

Tchiatura manganese concentrate (Mn–38%) was used as charge material, Bolnisi quartzite (SiO_2–94%), so called dross crust remnants (Mn–15–16%), limestone and iron scale (Fe–70%). Dross basisity in all series of smelting ($CaO / SiO_2 = 0,5$) was continuous.

Silicomanganese was smelted with the content of 65–66, 68–70, 72–74% manganese and 14–15, 16–17, 19–20% silicon.

By processing of smelting results relationship between content of manganese and silicon in metal and effective use of manganese was determined. Increase of silicon amount in metal and decrease in manganese concentration cause decrease in final dross sequence and manganese content in it.

For instance, when smelting silicomanganese containing 72-74% manganese and 14-15% silicon, dross sequence was 1.4, manganese content in it was 13-14%, effective use in manganese – 74%. When smelting silicomanganese containing 65-66% manganese and 19-20% silicon, dross sequence was 1.2, manganese content in it 9-10% and manganese effective use reached 80%.

Thus, in conditions of worsening manganese concentrate quality and hence continuously increasing its price in order to increase effective manganese use, agreed with customer, it is purposeful to smelt silicomanganese with content of 65-66 % manganese and 19-20% silicon.

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K 4. ON THE KINETICS OF HIGH-TEMPERATURE OXIDATION FOR ALUMINA FORMING HEAT-RESISTANT ALLOYS

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Nearly equiatomic Fe-Cr solid solutions containing about 4.0 wt% of Al and 0,25 wt% of La or Y are high-temperature heat and corrosion resistant in addition to the convenient production technology. The specific weight gain of the best alloys of this system is extremely low - up to 1300^0C [1].

Growth of a continuous protective layer on the surface of rare-earth-metal, containing alumina forming heat resistant alloys, is caused by a substance transports through the initial oxide layer where grain boundary diffusion is blocked by the dispersed particles of thermodynamically stable perovskite phases. This is equivalent to reduction of the effective diffusion area and leads to transformation of the oxidation law from parabolic to logarithmic one [2].

A theory, advanced by Evans, has proved most suitable for the description of the mechanism and kinetics of such scale growth, according to which

$$W = \frac{1}{K} \ell n(K \cdot \sqrt{K_P \tau} + 1),$$

Where $\boldsymbol{W}$ is a specific weight gain of oxidized object over the time τ, $\boldsymbol{K}$ is a constant of reduction of the diffusive stream, and $\boldsymbol{K_P}$ is a constant of parabolic oxidation rate. This kinetic equation is obtained on the grounds that on the places, which are free of diffusion barriers the scale growth is described by a simple parabolic law.

A closer mathematical treatment of the oxidation kinetics on the base of complex parabolic law permits to obtain a new parametrical equation of oxidation [3]:

$$\tau = \frac{2}{K^2 K_P} [e^{KW} (KW - 1) + 1] +, \frac{1}{KK_r} (e^{KW} - 1)$$

Where $\boldsymbol{K_r}$ is a linear constant of oxidation rate.

So, comparative testing of experimental alloys with decreasing effective area can be carried out within the scope of these two models.

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Oral Presentations

OP 1. INDUSTRIAL UPDATES AT "GEORGIAN MANGANESE" ZESTAFONI FERROALLOYS PLANT

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Currently, at the LLC "Georgian Manganese" Zestafoni Ferroalloys Plant a lot of things are being done to stand firmly in the world market, in terms of reducing self-costs and upgrading the technical processes, as well as providing the stable energy, environmental sustainability and safety.

For the purpose of approbation furnace No 2 has been successfully installed, the control process of an automaton system, and as for furnace No 26, it is still being installed; that system includes the electrical parameters of furnace and right manner of controlling the technology and the synchronous control in providing the mixture of materials.

Using the All Mineral Technology – German company, it was decided to extract the Manganese from the innate slag. The shaking tables and jigs are giving possibility to solve this problem effectively.

In order to increase the stable power supply and to decrease the self-cost the electrical substation " New Ferro" has been built using the "ABB" equipment. Also for the stable power supply of the country the reactive power compensators with 40x2 MVAr have been installed, that gives an opportunity at the expence of compensated power from the network to increase the power factor within the cosφ 0,92-0,98.

For the purpose of the environmental protection at the shops No 4 and No 1 the works of gas cleaning equipment are completely updated and are still being worked on. There are also installed new filters, additional fans, feeders, valves and the automation system control. The online monitoring system for all four directions of the plant area has also been puchased and installed.

OP 2. PREPARATION AND CHARACTERIZATION OF MULTI-WALLED CARBON NANOTUBES/SNO_2-CU_2O COMPOSITE AS AN ANODE MATERIAL FOR LI-ION BATTERIES

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Abstract

An aqueous sol-gel rout was applied to synthesis multi-walled nanotubes/SnO_2-Cu_2O composite as an anode material. For this purpose, MWCNT buckypapers were prepared and SnO_2-Cu_2O precursor sols were synthesized through removing nitrate ions. Spin coating technique was then used to make nano-composite electrodes onto MWCNT substrate. Some analysis techniques such as SEM, AFM and XRD as well as electrochemical tests were employed to evaluate the quality of the sol-gel thin film on to MWCNT surfaces. The results clearly revealed that the MWCNT/SnO_2-Cu_2O nano-composites are appropriate materials for using as an anode electrode for Li-ion batteries especially due to increase electrochemical energy storage property.

Introduction

Rechargeable Li-ion batteries are the novel suitable materials for electrochemical energy storage. However, to cover the demands of future high power and high energy density Li-ion batteries, it is critical point to obtain novel anode materials with high reversible capacity, long cycle life, the environmental friendship and high safety at lower cost [1-2]. In order to covering the requirements of energy storage electrode i.e. Li-ion batteries, composite of tin oxide (SnO_2) and copper oxide (Cu_2O) was considered as one of the most appropriate candidates. There have also been some researches of using carbon nanotube composites as high capacity anodes for Li-ion batteries [3]. The role of carbon nanotubes is making a three dimensional matrix with suitable electronic conductivity. Although various chemical methods can be applied for synthesis of SnO_2/Cu_2O composite, the sol-gel spin coating technique was selected in the current research to synthesize MWCNT/SnO_2-Cu_2O nano-composite films due to having many advantages such as better homogeneity, higher level purity, lower stoichiometric losses and lower cost.

Experiment and Results

The SnO_2/Cu_2O precursor sols were prepared through sol-gel rout after eliminating chloride ions of tin chloride dehydrate ($SnCl_2.2H_2O$) and copper chloride dehydrates ($CuCl_2.2H_2O$) precursor solutions. For this purpose, 2 g $SnCl_2.2H_2O$ and 0.5 g $CuCl_2.2H_2O$ were dissolved in deionized water to form SnO_2/Cu_2O oxide composite according to 80 mass % SnO_2. Stoichiometric ratios of NH_3 solution were then added to the system for removing of chloride ions from the solution. The mixed tin and copper hydroxides were precipitated in to system and filtering as well as washing them with diluted NH3 solution was performed at the next step. The formed sediment was dissolved in glacial acetic acid and finally ethylene glycol added to system to make a complex with tin and copper complexes while stirring was performed at 70 °C until the acetic acid to be completely eliminated from the resulted sol.

MWCNT substrates were coated via prepared sol by means of spin coater. The coated films were dried at 80 °C and the nano-composite films were calcined in N_2 atmosphere at 500 °C for 2 h with a heating rate of 5 °C/min.

The surface condition was analyzed by SEM equipment and its attached EDS. Phase analysis was also investigated by X-ray diffraction pattern (XRD).

In order to measure electrochemical properties of SnO_2-Cu_2O/MWCNT, electrochemical impedance spectroscopy (EIS)were performed assisting the Gamry equipment using a sine wave of 10 mV amplitude over a frequency range of 1000 kHz-0.01 Hz.

Figs. 1(a) and 1(b) show the SEM micrographs of SnO_2-Cu_2O/MWCNT composite films coated with synthesized sols on MWCNT. Fig. 1(a) shows the sample which was prepared according to 8 cycles spin coating whereas Fig. 2(b) is a sample was made via 15 cycles spin coating. It can be seen that the first sample was composed of very thin layer of SnO_2/Cu_2O on the MWCNT with no any agglomerated structure. It seems that this specimen have a homogeneous distribution of pores which can be suitable as an anode in lithium-ion batteries.

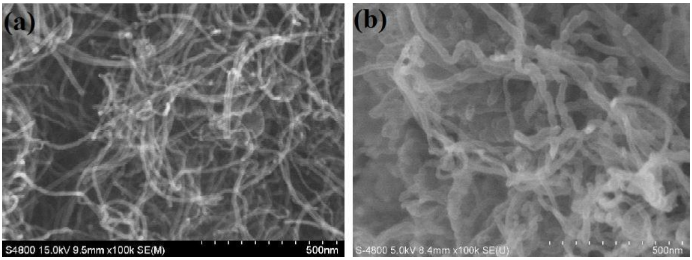

Figure 1. SEM micrographs of the samples coated via (a) 8 and (b) 15 cycles spin coating.

The charge capacity retentions of the samples prepared via 8 and 15 cycle spin coating are listed in Table 1. The Table clearly reveals that the sample a (sample prepared via 8 cycle spin coating) have higher capacity retention in compare with the other specimen. With reaching capacity of sample a to 291mAhg^{-1} after charging and discharging 0f 100 cycles, sample b shows the capacity about 204 mAhg^{-1}. For the both samples especially after 80th cycle capacity became stable as well as no capacity fading was observed. So, it can be concluded that the sample (a) have better response as an anode material for lithium-ion battery. However, fine layer coating of the sample (a) leads to obtain proper response. In addition, the capacity retention of SnO_2-Cu_2O/MWCNT nano-composite films is dominant in compare to any other commercial graphite electrode.

Table 1. Electrochemical discharge property of the samples at a current rate of 65 mAg^{-1}

Cycle number	15	30	45	60	80	100
Specific Capacity (mAhg^{-1}) (sample a)	787	698	612	461	421	391
Specific Capacity (mAhg^{-1}) (sample b)	788	657	569	405	230	204

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OP 3. CEMENT FOR MASSIVE HYDROTECHNICAL STRUCTURE AND NONEXPLOSIVE DESTRUCTIVE MATERIALS

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The present work is dedicated to cement for current and planned hydrotechnical structures in Georgia. The cement necessary for construction works, under this project is to satisfy strict standards to meet the set requirements: sulfate resistant cement, low alkali, low C3A in clinker, requirements for activity index, low heat of hydration, and requirements of alkali - silica reaction parameter. Analyzing the properties of chemically active aggregates (mainly in west Georgia and Adjara region) and cement additives for specific project we offer for mass concreting CEM III/A type of cement with 35-64 % specially selected Granulated blast Furnace Slag. CEM III cement is the product produced by simultaneous grinding GBFS and clinker with various proportions. General advantage of Using granulated slag cement in concrete are: resistance to aggressive chemicals, better concrete workability and higher finish compressive and flexural strength, lower permeability [1].

Based on local requirements proved by laboratory research, we focused our attention on four main points: 1. Alkali-Silica reaction; 2. Sulfate resistance; 3. Low heat of hydration; 4.Higher compressive strength. Alkali-silica reaction (ASR) is most common form, caused by a reaction between the hydroxyl ions in the alkaline cement pore solution in the concrete and reactive forms of silica in the aggregate. ASR can cause serious expansion and cracking in concrete [2]. High quality laboratory control is a guarantee of permanent high quality product. HeidelbergCement can support customers from raw material selection till concrete mix design composition, this company is only clinker producer in Georgia, therefore, has possibility to adjust cement composition from both driver clinker and additive.

At Georgian technical university Nonexplosive destructive materials (IDM) are received, for destruction of hard rocks and for preventive measure to cause artificial, regular slide of landslide, without explosion, with performance of ecological safety. IDM Material expansion energy formation time is 1-2 hours after mixing with water; its free expansion is equal to 20-100 % and more, expansion energy 100-300 atmosphere under material limitation condition.

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OP 4. PRODUCTION OF HOT ROLLED WELDABLE UNIFIED REBAR B500W WITHOUT HEAT TREATMENT

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Studying the influence of thermomechanical factors (t^0C, Plastic Deformation Degree %, $V^m/_s$, etc.) on structure, mechanical properties and steel corrosion resistance (30HGSA, 30HGSNA, 1H17N2, H18N10T, etc.) showed, that on the High Temperature Mechanical treatment at optimal modes strength indicators increase with preservation of plastic properties at rather high level. Contrary to expected, improvement of corrosion resistance was also observed. More detailed researches of these processes showed that Hot Plastic Deformation provides more uniform distribution of the alloying elements, than General Heat Treatment [1-3]. Lately this task was considered in other aspect; influence of thermomechanical factors on steel crack resistance at High Temperature Mechanical treatment was studied. Austenite fragmentation, increase of dispersion of secondary phases, uniform distribution of alloying elements in matrix, bases of the alloying elements and the phases introduced in matrix caused crack resistance increase [4]. Today the cancelled factor added influence, so-called, the "New phenomenon". Chemical composition of alloy + "loop" <(Ti+ N + V)> + treatment (technological process) provide so-called "New phenomenon" influence: strength indicators grow and plasticity remains at rather high level. Today “New phenomenon” is experimentally recorded and used at technological processes:

1. Thermocycling 20^0C ↔ 650^0C stressed steel 10HN3MFT, for example, work of mandrels on piercing stands (80-s of the XX century);
2. Production of high-strength tubing strings $\sigma_t \geq 760$ N/mm^2 from steel 40GFT; “New phenomenon” and normalization as rolled provide high-strength condition (2002-2004yy);
3. During rolling of selected steel 3sp on bar-rolling mill + loop< (Ti+N+ V)> provide weldable unified rebar (C≤0,22%; Ceq≤ 0,43%) B500W without heat treatment. Careful works to expand the sphere of the "New phenomenon" are conducted; it will be promoted by technical identification of a substructure and structure at the nuclear level.

Today mandrels of the piercing stands are produced from steel 08HN4DSMFT. Globular Bainite provides high resistance of the tool (Recorded indicators of 1000, 1500, 1700 pcs pipes). Technology is embedded in LLC Rustavi Steel. According to the Oxford University, globular, so-called “Superbainite” can be used for other purposes.

Production of high-strength ($\sigma_y \geq 760$ N/mm2) tubing strings is competitive, waits for embedding. Industrial approbation of B500W production took place successfully (NN25^{X}; 18^{XII}; 16^{XIV}; 12^{XVI}mm). Work is ready for widespread embedding.

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OP 5. TWO-PHASE SEGREGATION OF IRREGULAR SOLID AL-TI-FE SOLUTION

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The study and definition of phase segregation processes allow us to speak about the advisability of application of a given alloy for different purposes. The segregation processes have the negative influence on structural alloys, but at the same time these processes contribute to the elaboration of composite materials. For experimental study of such processes traditional methods of X-ray diffraction (XRD) are used. However, application of this method for measuring the parameters of crystal lattice is rendered difficult in multicomponent systems.

Our theoretical approach to the problem is mainly based on the idea that the theory of phase transformation (PT) is closely related to a new branch of instabilities in the mathematics, known as Catastrophe theory (CT) [1].

It was found out [2], that thermodynamic potential, describing PT, can be deduced from one of these catastrophes: A_3 (Cusp), A_4 (Swallowtail), A_5 (Butterfly) and A_6 (Wigwam). This procedure solves the problem of calculating critical parameters of PT in multicomponent systems.

Based on the A_6 (Wigwam) catastrophe, the new form of Gibbs potential is worked out, that is suitable for thermodynamic analysis of irregular ternary systems. By minimization of this potential and using the Lagrange transformation the numerical values of critical point are calculated for solid Al-Ti-Fe solution. Aluminum alloys of this system are attractive materials for automobile and aircraft technology and in the defense industry. As a result, the obtained values determine the process of two-phase segregation of given solution with the formation of a miscibility gap. The diagrams of two-phase segregation of irregular solid Al-Ti-Fe solution are built by the use of CALPHAD approach [3].

Key words: Catastrophe theory, Gibbs potential, Lagrange transformation, Phase segregation, CALPHAD approach

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OP 6. EFFECT OF TEMPERATURE AND WATER VAPOR PRESSURE ON SURFACE QUALITY OF THE CUTTING DURING WATER VAPOR PLASMA CUTTING

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Power and technological parameters of plasma cutting process depend on the type of plasma-forming medium. Studies have proved the advantages of application of the superheated water vapor [1]. The temperature and pressure of water vapor at the inlet of the plasma torch exert significant influence on the power parameters of the plasma arc and the quality of the cut surface. Rising temperatures and pressures contribute to the reduction of the diameter and elongation of the arc, increasing the speed of steam at the exit of the plasma torch and intensity of the vortex. Consequently, it causes the increase in voltage, the impact of the arc on metal, arc power and the decrease in cutting width, etc. [2, 3].

The surface quality of the cut is determined by the width of cut, burr size, deviation from perpendicularity of the cut surface, the roughness, the deviation in size of the cut pieces from their nominal size.

During researches plasma cutting of low carbon steel was performed, the pressure was varied from 2 to 9 atm. Temperature of water vapor varied from 120^0Cto 500^0Cfor every fixed point of pressure.

The results showed that:

- When plasma cutting in water vapor, compared to air plasma cutting, the cutting width is reduced by 0.35-0.5 mm depending on the pressure and temperature of water vapor;

- Deviation from the perpendicularity of the cut surface is reduced by 2-2.5 times;

- Burr amount and surface roughness are reduced;

- Deviations in the sizes of the cut pieces from their nominal sizes are insignificant.

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OP 7. ENHANCEMENT OF STRUCTURAL STRENGTH OF BAINITIC CAST IRON BY OBTAINING SPHEROIDAL GRAPHITE, DEVELOPING CHEMICAL COMPOSITION OF ALLOY AND HEAT TREATMENT CONDITIONS

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In the end of the 20th century the bainitic cast iron has become widespread. For its production was necessary to have cast iron with spheroidal graphite (DI-Ductile Iron), while the necessary structure of the base was obtained using isothermal bainitic hardening. As another option, cast irons of bainitic class were used (frequently bainitic structure was obtained through air cooling). In both cases after phase transformation were received (except the graphite) bainite ($B \cong$ 90-80 %), retained austenite ($\gamma_z \cong$ 10- 20%). Bainite determines the level of strength properties, while the amount of retained austenite (under optimal processing conditions) promotes development of TRIP-effects (Transformation-Induced Plasticity), i.e. plasticity indices were created "artificially" – unconventionally. Despite the high level of strategic direction, a lot of tactical issues remained unsolved. Structural strength of bainitic cast irons has always been a challenging issue. If this material has such plasticity, crack resistance and other parameters, which improve stability and durability of the end product, then sphere of bainitic cast iron application will be significantly expanded. It is a very notable fact that production of the end product is simplified but elimination of casting structure is practically impossible. Structural component of graphite attaches many desirable properties to the end product, but the obtaining of spheroidal graphite not always fits in engineering casting processes. “The gap” of thermal processing is a moment, when γ->B transformation comes to an end, but centers of new phase (martensite) in retained austenites (γ_z) are not yet formed. Neglection of this moment significantly reduces transformation induced plasticity.

On the basis of the results of carried out researches (laboratory and factory tests), for enhancement of structural strength of bainitic cast iron implementation of following steps are recommended:

1) For obtaining DI is necessary to have overheated ($t \geq 1550$°C) synthesized cast iron ($S \leq 0,01\%$; $P \leq 0,01\%$; $Mn \leq 0,30\%$), after holding for $T \geq 30$ min at this temperature metal is tapped into the ladle and poured into metal molds. This technology makes possible stable implementation of fullerene model of obtaining spheroidal graphite.

2) As far as bainite along with retained austenite has developed a new constructional material, the need of making adjustments in graphitization process arises. On the basis of analysis of already available data it is advisable to replace 50% of silicon with other graphite-forming elements, e.g $Al=1,0-1,5\%+Ca=0,05-0,10\%$. As factory tests show, this approach (350C2-> 350C1Ю1) significantly improves both, graphitization processes ($\Delta\,\alpha_{Fe-Si}=0,13$Å; $\Delta\alpha_{Al-Fe}=0,38$Å; $\Delta\,\alpha_{Ca}=3,95$Å) and mechanical properties of iron (when Si=2,3%., $KCU_{Fe} \cong 0$; and when Si=1%., $KCU_{Fe} \cong 150$ Joule/cm^2).

3) Based on the results of factory tests and application of available new kinetic diagrams of austenite decomposition (iso-, aniso-) of

intermediate-carbon bainitic steels is recommended to use bainitic cast iron 350C1Ю2ДН5МФТ, intended for manufacturing of mandrels for reeling mills.

4) With the purpose of increasing operational temperature of instrument up to 400-450°C it is necessary to work on upper bainite not excluding metal heating in the area of A_1-A_3. Temperature, which secures necessary phase composition (e.g. 20% of ferrite a+ 80% of austenite) is established experimentally, and it is shown that ferrite will increase alloy plasticity, while bainite will secure the appropriate level of strength indices. All abovementioned measures will allow us to enhance structural strength of bainitic cast iron.

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OP 8. SOLUTION TO INCREASE THE EFFICIENCY OF MAJOR INFRASTRUCTURE PROJECTS

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Corrosion is a phenomenon of deterioration of the pipelines; it poses risks to rupture of steel pipes, leak and explode of hydrocarbons, thereby causing economic and environmental problems. Great care and planning goes into designing preventive measures to limit or eliminate failures and environmental impact.The creative options step leads to effective solutions of problems and increases the efficiency of major infrastructure projects [1, 2].

The present work focuses on promotion of best practices. To overcome the problem of corrosion the functional corrosion-resistant glass enamel coatings, which make it possible to protect oil and gas pipeline surfaces in extreme operating conditions, have been developed. To prepare coatings modern "Direct"low-temperature enameling technology was used.Advanced groundless technology proceeds in one stage and two times reduces energy, raw materials consumptionand number of operations. The effect of special copper-containing complex adherence promoter on the coating's ability to be in intimate contact with steel substrate is demonstrated.The best result of flexural strength according to EN 10209 (1-2 grades) is observed for frits containingpromoter componentsin an amount 1,8 - 2,0 mass % and increasing the melt action on steel[2].

Innovative glass-enamel-based materials have attracted much interest because they possess a unique combination of properties including high thermo-mechanical parameters, resistant to corrosion destruction (NACE Standard TM0177-2005), abrasionand the absence of entrapped organic growth on the pipe inner surfaces. The advantages of main pipelines with smooth, glossy surfacesare the constancy of their hydrodynamic characteristics, flow rate and pump pressure desired for energy infrastructure projects. Thanks to thehigh electrical resistivity of obtainedenamel coatings ($\rho_{293} \geq 10^{10}\Omega\cdot m$) such pipeline systems will be fully isolated from the induced current effects emitted by high-voltage power lines.

An algorithm for safety assessment of single-fired pipeline coatings has been created and numerical modeling for evaluating thelimit state design in accordance with the pipeline construction has been performed.

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OP 9. THE USE OF THE HANDHELD XRF SPECTROMETER FOR THE DIAGNOSTICS OF THE OLD GEORGIAN REPOUSSÉ METAL COVERED MANUSCRIPTS: RESULTS, PROBLEMS AND PERSPECTIVES

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Among the unique manuscripts preserved at the National Center of Manuscripts, Georgian codices bound in repoussé metal covers should be noted. Of special note are the 11th-13th cc. (considered the "Golden Age" of Georgia) manuscripts bound in repoussé metal covers and lavishly decorated with gemstones. Among them are the covers of Tskarostavi and Berta Four Gospels, masterpieces of Beka and Beshken Opizari.

Thanks to the financing from the Embassy of United States in Georgia, a project "Diagnostics of the Old Georgian Engraved Heritage (Georgian Manuscripts of the 11th-13th cc.)" was conducted at the National Center of Manuscripts. The goal of the project was to carry out detailed study of the repoussé metal covers of about 60 Georgian manuscripts, and to diagnose damages with the purpose of their subsequent restoration and conservation.

Necessity for a study of the precise composition of alloys used for repoussé metal covers of manuscripts arose in a process of the project. Chemical analysis was carried out by means of a noninvasive method – X-ray fluorescence analysis, with use of a portable XRF analyzer (XRF Gun) (accuracy - ±10% and higher, test area – 3 x 2 cm^2, penetration depth – 10-20 µm).

Research results:

1. Taking in consideration the cultural heritage specifics 33 covers were chosen, 60 points were tested by handheld XRF spectrometer.
2. For every tested point, alloy composition (main components, ligatures) and percentage of precious metals (silver, gold) in the metric system was defined through the recalculation of the chemical analysis.
3. Four covers among the analyzed ones are of gold (Manuscripts Q-928, A- 482, H-1693, H-1678). Alloy composition and gold percentage was defined. It turned out that the covers of A-482 and H-1693 manuscripts are of gold and silver alloy; gold content is 950 in the metric system (“pure” gold). The same alloy is used for the Q-928 manuscript cover, though with a bit lower gold content. H-1678 manuscript cover is of gold, silver and copper alloy; gold content is 750 in the metric system
4. Cover of the Alaverdi Four Gospels (A- 484) stands detached from the other covers: details of its cover are made of different metals. Silver gilded with gold is used as the main background. The consideration existed that the lower portion of the cover (with the inscription) had undergone restoration. However, results of the analysis contradict to this consideration. The difference is only in thickness of gold layer on upper and lower portions of the cover. This had resulted in different shades of surfaces. Gem settings of the cover are made of gold. Christ’s nimbus and cloisonné enamel icon of St. George are also made of gold. Gold content in them is comparatively low: 600-700 in the metric system. Reliquary boxes are made of silver.

5. The majority of repoussé metal covers of medieval manuscripts were made of gilded silver. The variation of coating thickness from one cover to another, and also within the bounds of the same cover was of great interest. Two types of alloys were identified: almost pure silver alloys with minimum admixture; the silver-copper alloys.
6. Differentiation of alloys assists in establishing chronology of manuscript covers. For instance, repoussé metal covers of Berta (Q-906), Tskarostavi (Q-907) and partially of Tbeti (Q-929) Four Gospels (all date to the XII century) are made of silver with thick gold plating. Manuscript covers of the XVI-XVII centuries are made both of pure silver and silver-copper alloys. In the XIX century covers were mainly made of silver-copper alloys. The ratio of silver to copper became more standardized. Repoussé metal cover of Gelati Four Gospels (O-908) is a good example of this.
7. Of special note is a silver case (cover) of manuscript Q-921. Three sections which underwent restoration were identified. Type of alloy of the case was established by means of X-ray fluorescence analysis. Based on the obtained results we could define the age of different constituent parts of the case.

Chemical analysis of the repoussé metal covers of Georgian manuscripts provides significant information about composition of alloys used in different historical epochs. This information is of importance for technological analysis of covers, as well as for development of restoration and conservation techniques and for dating purposes.

OP 10. COMPRESSION APPLICATION TO CUBIC LIKE BORON CARBIDE NANORODS: MOLECULAR DYNAMICS SIMULATION

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Boron carbide is one of the hardest materials among the ceramic materials after diamond and boron nitride. In addition to its hardness, it has high thermal stability (m.p. 2500 ^{o}C), low density (2.5 gr/cm^3), and chemical inertness and neutron capture properties. Thus, it is a crucial material for high technology applications such as abrasive for polishing and grinding media, ceramic armour applications for military protection and blasting nozzles.

Boron carbide has many structural forms [1]. We simulated icosahedral and hexagonal structures. During simulation studies, cubic structures have been observed. Therefore, we prepared boron carbides structures in cubic geometry similar to NaCl structures. Boron-Carbon distance is set to 1.8 Å. Their structural properties under compression have been studied by performing classical molecular dynamics simulations using Stillinger-Weber potential energy function parameters modified for boron-carbide systems. Simulations were repeated at 1 K, 300 K, 600 K and 900 K. Simulation time-step is 1x10^{-17}s and compression rate is 5%. Simulations revealed that cubic form of boron carbide shows very stable structures even at high temperatures.

At 1 K, first, compression caused shrinking in bond length and thickening in nanorod structure. During further compression, excess forces on atoms caused to relocation and therefore crushing has been observed. In addition, some hexagonal geometries along the nanorod have been observed at 1 K only. Simulations at 300 K showed different behaviour of structure under compression. First compression caused slipping over a diagonal plane and thickness of nanorod increased without losing cubic geometries. The next compression produced slipping normal to the plane of previous slipping. Further compressions lead to similar diagonal slipping on the structure and nanorod structure was deformed. Last compressions caused to crushing on the structure. Similar structural deformation mechanisms have been observed at 600 K and 900 K. Slippings started from the initial compression but crushing has been observed in earlier compression steps as the temperature was increased. Additionally, hexagonal geometries have been detected along the slipping plane.

As a result, cubic form of boron carbides is very stable under compression. Generally compression causes slipping in diagonal plane. Crushing is observed when slipping is stopped. Hexagonal transformation is more common along the slipping plane as the temperature is increased. Additionally, crushing is delayed when the temperature is decreased.

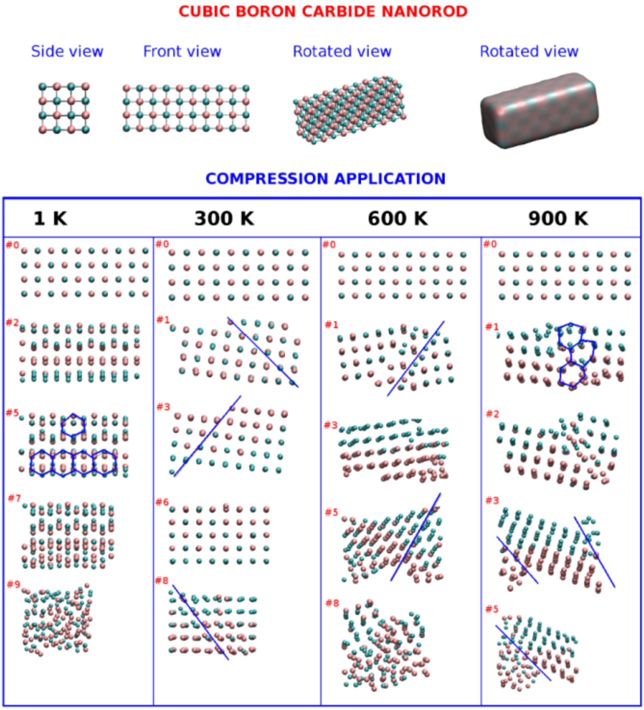

Figure 1. Snapshots of molecular dynamics simulations of cubic boron carbide nanorod under compression

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OP 11. NEW QUICK TIGHTENING MATERIAL FOR THE METALLURGICAL BLENDS AND BRIQUETTING SILICOMANGANESE

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In the Zestafoni Ferroalloy Plant there are following technological problems:

Shaft type briquette equipment is not working effectively, because the production facility is not supplied with the high quality blend materials and astringents which have good technological properties, specifically:

-Grain size of manganese containing materials which are coming from Chiatura is bigger than desired;

-In Tkibuli coal content of 0-13mm fraction is approximately 60%;

-Produced blends and Silicomanganese briquettes need several hours to reach planned and necessary mechanical strength.

All these above mentioned problems complicate process and make them expensive.

At Georgian Technical University, there is going to develop blends of Zestafoni Ferroalloy Plant which contains Tkibuli coal. There are positive results.

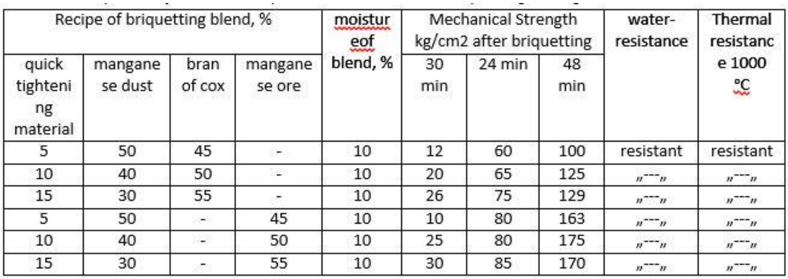
On the basis of scientific researches and developed technologies (”Know how’’) in the Georgian Technical University’s Scientific

Center, ”Nanodughabi’’ and also with the Clinker produced by Kaspi Cement Plant (Heidelberg Cement) there was created a new material for the Zestafoni Ferroalloy Plant of Metallurgical Blend and Briquetting of Silicomanganese.

Technological tests of Briquetting of Silicomanganese with the quick tightening material were done only on laboratory level in the Scientific center, ”Nanodughabi’’. It is necessary to check it on the Industrial level.

In the Zestafoni Ferroalloy Plant, industrial experiment using quick tightening material for briquetting of metallurgical blends gave us good results; these results are given in the Table 1.

Table 1. Properties of the blend briquettes, done with the new quick tightening material



Recipe of briquetting blend, %				moistur eof blend, %	Mechanical Strength kg/cm2 after briquetting			water-resistance	Thermal resistance 1000 °C
quick tightening material	manganese dust	bran of cox	manganese ore		30 min	24 min	48 min		
5	50	45	-	10	12	60	100	resistant	resistant
10	40	50	-	10	20	65	125	„---„	„---„
15	30	55	-	10	26	75	129	„---„	„---„
5	50	-	45	10	10	80	163	„---„	„---„
10	40	-	50	10	25	80	175	„---„	„---„
15	30	-	55	10	30	85	170	„---„	„---„

In the work, grain sizes of blend materials were 0-5mm, pressure force of briquettes on the crushing machine was 150kg/cm2. Hardening of briquettes started in 5-10 minutes after production without any additional thermal processing – on the basis of internal chemical energy of quick tightening material. For more and deep researches we are waiting for interest from the Plant.

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Poster Session

PP 1. CERAMIC PRODUCTION FROM POLY (SILYNE-CO-HYDRIDOCARBYNE)

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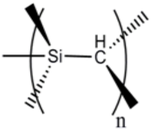
Pre-ceramic polymers are an important class of polymers which can be converted to ceramic materials upon heating. Generally, these types of polymers can form tough, hard-wearing ceramic materials with high thermal stabilities. Polycarbynes and polysilynes are examples of such polymers that form diamond, diamond-like carbon [1] and silicon carbide [2] upon pyrolysis. Polycarbynes [1] are polymeric precursors to diamond and diamond-like carbon. Polycarbynes and polysilynes are simply produced via electropolymerization. The method simply requires trihalo organo compounds for polycarbynes and trihalo silane compounds for polysilynes as monomer, electricity, a solvent and an electrolyte [2,4]. Due to ceramics’ physical and chemical properties, scientists are interested in using the material in a variety of devices and applications, ranging from electrical to biomedical applications [1-6]. However, ceramics are inherently difficult materials to work with, especially if a particular shape or film is required. Chemical vapour deposition (CVD) is a partial solution to this problem, and there are many examples of diamond films being produced in this manner. The process, however, is relatively expensive and the films do not exhibit the desired smoothness and continuity [1-4] for many of the envisioned applications, including micro-electromechanical systems (MEMS). All problems seem to be overcome if a move is made to a polymeric system where upon moderate heating are produced diamond, diamond-like material, silicon carbide (SiC) and SiO_2. Also, since these polymers are soluble, the production of ceramics of any shape is feasible. Poly (methyl silyne) (PMSi) [2-4] and polyhydridocarbyne (PHC) [1] are the most known pre-ceramic polymers. PHC forms diamond and DLC, while PMSi can be easily converted to SiC upon pyrolysis. Poly (silyne-co-carbyne) (PSC) (Sch. 1), considered as a copolymer of polysilyne and polyhydridocarbyne, simply forms silicon carbide without requiring the addition of more carbon species and a catalyst since it already contains silicon and organic carbon on its backbone [2]. Here, we report a simple method for producing silicon carbide using PSC. Poly (silyne-co-hydridocarbyne) has a unique network structure of tetrahedral bounded carbon and silicon atoms (Sch. 1). PSC was simply synthesized using trichloro (dichloro methyl) silane (TCS), electricity, a solvent and an electrolyte then converted to SiC/SiO_2 upon moderate heating.



poly(silyne-*co*-hydridocarbyne)¶

Scheme 1. Schematic representation of PSC.

Heat treatment of PSC produces a hard crystalline substance in high yield; typically in the range of 30-50%, depending on pyrolysis temperature and atmosphere. Pyrolysis at 1000 (SiC1) and 750°C (SiC2) under Ar atmosphere, respectively, resulted in about mx.40%

yield, while the materials at 1000 (SiC4) and 750°C (SiC5) obtained under CO_2 were resulted in about 50% yield. Transparent particles of SiC1 (Fig. 1a) and SiC2 (Fig. 1b) are clearly seen under an optical microscope while SiC3 and SiC6 formed at 500°C (Fig. 1c) is mostly amorphous.

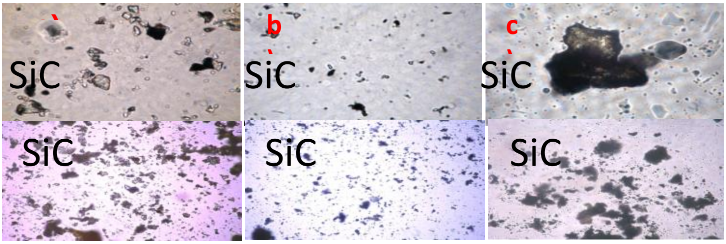


Figure 1. Optical microscope pictures of ceramic obtained under CO_2 gas. a)SiC1 & SiC4 (magnification 100x) b) SiC2 & SiC5 (magnification 100×), and c) SiC3 & SiC6 (magnification 100×).

The X-ray diffraction pattern of the ceramic specimens is shown in Figure 2. XRD patterns showed that various and polycrystalline silicon carbides were successfully produced from PSC polymeric precursor under Ar and CO_2 and ambient atmosphere.

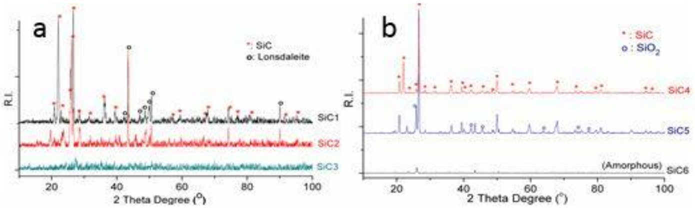


Figure 2. X-ray patterns of ceramics synthesized under Ar (a) and CO_2 (b) atmosphere.

While SiC3 and SiC6 are X-ray amorphous, SiC1, SiC2, SiC4 and SiC5 that were produced at higher temperatures are crystalline. Reflections of SiC1 and SiC2 are consistent with the mixture of 3H-SiC, 4H-SiC, 5H-, 6H- and 24R-SiC, reflections of which were assigned according to "The International Centre for Diffraction Data (ICDD))" (PDF- 19-0268, 42-1360, 72-1625 and 79-0445). Reflections of SiC4 and SiC5 are consistent with the mixture of Moissanite-5H, Moissanite-8H and Moissanite-84R, reflections of which were assigned according to "The International Centre for Diffraction Data (ICDD))" (PDF-42-1360, 72-1625, 73-2082 and 73-2086). Coesite and Moganite, which are SiO_2, were seen in the spectrum, reflections of which were assigned according to "The International Centre for Diffraction Data (ICDD))" (PDF-14-0654, 38-0360 and 42-1360). There are also some small reflections in Figure 2 that cannot be assigned to any other SiC or SiO_2 phase. *This study was supported by TUBITAK with project number 211T108.*

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PP 2. ABOUT TENSIONS IN MULTI COMPONENT ENAMEL RESULTED FROM MERGING WITH COPPER

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The goal of our research was the study of constant tensions originated in multicomponent enamel received with the use of silt deposits of Chiatura manganese ore dressing as a result of merging with copper.

With the purpose of determination of these tensions we have turned to the method, which is widely used during soldering different kinds of materials [1] and for determination of tensions in some kinds of enameled products [2]. It is indicated that in these equations we tried to get rid of complications linked with Poisson coefficients.

As indicated in [3], for characterization of constant tensions emerged in enamel, the enameled product except enameled copper is considered as three-layer composite.

Negation of existence of intermediate layer at “enamel-copper” separation surface is a reason of enameled copper emergence as two-layer composite. In our opinion, this thought is partially wrong that is confirmed by thermodynamic assessment of possible processes at separating surface, carried out by us. That is why during calculation of constant tensions it was decided to take into account both, two-layer and three-layer models. For determination of constant tensions the basic equation is [2]:

$$\sigma = \frac{E_e^{*} \cdot \Delta T[(\alpha_s^{**} - \alpha_e)E_s \cdot h_s + (\alpha_m^{***}-\alpha_e) E_m h_m]}{(1-\mu) (E_e h_e + E_s h_s + E_m h_m)}$$

(Where e – Enamel; s - separating surface; $_m$ – metal)

We used this expression both for three-layer and for two-layer composites with the difference that we entered Poisson coefficient division into all layers:

For two-layer composites:

$$\sigma = \frac{E_e \cdot \Delta T[(\alpha_m - \alpha_e)E_m \cdot h_m]}{(1-\mu_e)E_e h_e +(1-\mu_m)E_m h_m}$$

For three-layer composites:

$$\sigma = \frac{E_e \cdot \Delta T[(\alpha_s - \alpha_e)E_s \cdot h_s + (\alpha_m-\alpha_e) E_m h_m]}{(1-\mu_s)E_s h_s +(1-\mu_e) E_e h_e + (1-\mu_m)E_m h_m}$$

Only the temperature coefficient of linear thermal expansion of enamel was experimentally determined among the values entered into expressions. The rest of values were received with the use of various calculation methods, which are widely used for determination of elastic properties of amorphous solid body [4].

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PP 3. APPLICATION OF ALUM-THERMAL AND NITROGEN METHODS FOR OBTAINING NANO-COMPOSITES IN THE SYSTEMS OF SIC-SIALON AND AL_2O_3-SIALON

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By the reactive baking method at 1450^0C on the base of kaolin, aluminum nano-powder, silicium, aluminum oxide, silicon carbide with little admixes of yttrium oxide, magnesium oxide and glass perlite (Aragac, Armenia), was obtained SiALON-containing nano-composite through alum-thermal and nitrogen process in the nitrogen medium. The advantage of this method is that compounds, which are newly formed thanks to interaction going on at thermal treatment: Si_3N_4, Si, AlN reactive, contribute to SiALON formation at relatively low temperature, at $1300\text{-}1350^0$C. It is evident that inculcation of α - Al_2O_3 and ALN in crystal skeleton of ß-Si_3N_4 is easier since at this temperature interval crystal skeleton of Si_3N_4 is still in the process of formation.

It should also be stated that strength and wear resistance of SiALONs increase in their presence in silicium carbamide- and corundum -containing composites.

The paper offers processes of formation of SiC-SiAlON and Al_2O_3-SiAlON and ß-SiALON composites and describes their physical and technical properties.

Open porosity of the obtained materials equaled to 15-16 %. Materials consisted of only SiALONs. To receive compact materials the composites were grinded in planetary mill for eight hours, then they were cleaned from admixtures and the obtained powder was hotly pressed at 1750^0C under 25 MPa. Standing time at final temperature equaled to seven min.

The results of testing the samples: Density, $g/cm^3=3.24$; Thermal expansion coefficient, 1/degree $10^{-6}(800) =2.7-3.0$; Hardness, HRA=94, HV=18 GPa; Flexural Strength, 500-550 MPa.

Phase composition of the composites was studied by X-ray diffraction method, while the structure was studied by the use of optic and electron microscope. Obtained materials are used in protecting jackets of thermo couples used for melted metal temperature measuring (18-20 measuring) and for constructions used for placing objects in factory furnaces, and for cutting ceramics.

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PP 4. CONTROLLED LOCAL HYPERTHERMIA AND MAGNETIC HYPERTHERMIA OF SURFACE (SKIN) CANCER DISEASES

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Average size hematite and magnetite micro and nanopowders and polydispersity index, zeta potential and distribution of particles were studied. Analysis showed that average size of the obtained particles for magnetite is 740.9 nm, for hematite particles – 30-80 nm. Alternate current feed source was created for hyperthermia. Proceeding from the requirements of the objectives the U type MnZn material magneto conductors were selected, in which 10.0 and 8.0 mm width gaps were cut and glass test tubes with magnetite or hematite suspensions were placed in them. Series of experiments at various field intensity and frequencies showed that for efficient magnetic hyperthermia therapy more powerful device was needed with frequency of up to 10 Mega Hertz to achieve the temperature -42-44°C necessary for full activation of Neel and Brown mechanisms in particles.

At the next stage, on the basis of experimental material the anticancer mono-therapeutic effect of hyperthermia and its adjuvant action in poly chemotherapeutic treatment was presented by the use of a device created by us – "Lezi". As a result of the experiment it was shown that in all animals (outbred albino mice, 3 months old, 12 groups) inhibition of cancer growth was fixed and intratumoral necrosis developed, while after 7 and 10 sessions tumors were ulcerated, which refers to positive effect of the experiment (National Center of Intellectual property of Georgia "Georgian Patent", Certificate of Deposition # 5054 "Controlled local hyperthermia for treatment of cancer diseases"). On the basis of results of morphological study it was proved that liver and lungs (main target bodies) are intact; cancer cells are not fixed in preparation, secondary tumor injuries are not fixed. There is a positive conclusion of laboratory of Morbid Anatomy "PathGeo", Form # IV-200 -6/A about macro-morphologic and micro-morphologic description.

Figure 1. Clinical therapeutic device "Lezi 1"

Clinical therapeutic device "Lezi 1" is created at the Bionanoceramic and Nanocomposite Materials Science Center (manager Prof. Z. Kovziridze) of Georgian Technical University for Treatment of skin and subcutaneous cancer diseases by controlled local hyperthermia (National Center of Intellectual property of Georgia "Georgian Patent", Certificate of Deposition 6193. Clinical device for

Treatment of skin and subcutaneous cancer diseases by controlled local hyperthermia).

Our group has constructed new clinical device "Lezi 1" at the application of which at the Clinical Oncology Institute, in Tbilisi, Lublyana str. #5 volunteer patients will be subjected to treatment of skin cancer diseases by the method of hyperthermia developed by us. Now we are developing a new device for treatment of proctologic cancer diseases.

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PP 5. DEVELOPMENT OF METHODS FOR DETERMINATION OF VANADIUM (V) IN VARIOUS ALLOYS

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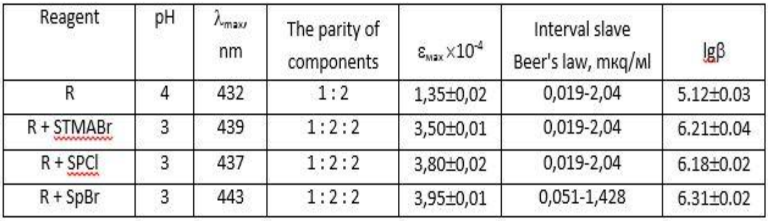
Determination of vanadium (V) in various objects including alloys still provides an analytical interest. For determination the microgram amounts of vanadium photometric method is considered as express and most economical. In the references a lot of information is available about many organic reagents with various functional groups. But bearing in mind that the vanadium(V) relates to a number of metals which tend to form stronger bonds with oxygen to form a very strong chelate complexes can be predicted that azoderivatives of pyrogallol-2,3,4-trihydroxy-4`-sulfoazobenzol (R) can be proposed as a promising reagent for photometric determination of vanadium(V) in analytical chemistry [1, 2, 3]. It was studied the complex formation of vanadium (V) with R. It has been found that at pH 4, λ_{max}=432nm it was formed an intensively colored binary complex. It was also studied the effect of a third component, cationic surfactants – cetylpyridinium chloride SPCl, cetylpyridinium bromide SPBr, cetyltrimethylammonium bromide STMABr on complex-formation. It was found that the maximum yielding of mixed-ligand complexes observed at pH 3, λ_{max}=439, 437, 443 nm accordingly SPSl, SPBr, STMABr. For studying the effect of cationic surfactants on the complex-formation V (V) R on pH_{opt} were filmed the absorption spectra of R (λ_{max}= 365 nm), V(V)R-CAS and specified in the table. From the data can be seen that the binary and mixed-ligand complexes of vanadium (V) have absorption maximum which bathochromic shift than the maximum absorption of the reagent.

Other basic photometric characteristics of vanadium (V) complexes were studied and indicated in the Table 1.

Table 1. Basic photometric characteristics of vanadium (V) complexes



Reagent	pH	λ_{max}, nm	The parity of components	$\varepsilon_{max} \times 10^{-4}$	Interval slave Beer's law, мкq/мl	lgβ
R	4	432	1 : 2	1,35±0,02	0,019-2,04	5.12±0.03
R + STMABr	3	439	1 : 2 : 2	3,50±0,01	0,019-2,04	6.21±0.04
R + SPCl	3	437	1 : 2 : 2	3,80±0,02	0,019-2,04	6.18±0.02
R + SpBr	3	443	1 : 2 : 2	3,95±0,01	0,051-1,428	6.31±0.02

It was found that with the influencing of cationic surfactants mixed-ligand complexes yield was observed at acidic medium and the stability constants of their complexes were increased. The influence of foreign ions and masking substances on the complex-formation was studied. The developed method has been used in photometric determination of vanadium (V) in standard alloys УГ3$_{Д,}$ УГ5$_{Д,}$ and УГ6Д.

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PP 6. AUTOCLAVE METHOD FOR OBTAINING COMPOSITE POWDERS

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Autoclave technology for obtaining composite powders covered with copper and nickel was developed [1-3].

Graphite can be covered with copper in sulphate, as well as in ammonia sulphate solution in the conditions of 413 K and PH_2=2.5 MPa with 7-12 mkm thick covering.

When covering aluminum and tungsten carbide with nickel, 100% recovery of composite powder is reached when the solution contains ammonia sulphate 115-120, ammonia 30, antraquinon 0,2 gr/dm^3 in the conditions of 423 K and PH_2 = 1.5 MPa. Nickel cladding is smooth and even, thickness of which is changing from 1-2 to 10-15 mkm.

The covering, obtained as a result of plasma dispersion of Ni/Al and Ni/WC composite powders, is characterized by high solidity and adhesion stability.

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PP 7. OBTAINING NICKEL-FREE STEELS WITH NITROGEN

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Austenitic, ferritic, martensitic and duplex stainless steels containing a large amount of alloying elements which include nickel are widely used in the world today [1]. The price of nickel is steadily growing. Besides, nickel is proved to be allergen and therefore, there is an interest in the medical practice on use of alloys with improved properties and a low content of nickel or without it [2]. In recent years particular attention has been paid to obtaining of high nitrogen steels which exhibit a set of good properties; for example, a significant increase in strength without ductility loss, improvement of corrosion resistance, heat resistance, increase of austenite stability, independence on temperature, as well as stresses and plastic deformation. Nitrogen prevents formation of intermetallic phases.

The area of application of high nitrogen steels is large. It involves medicine, oil and chemical industry, electronics, etc. There are different technologies for high nitrogen steels. Despite significant advances in the production of high nitrogen steels by means of electro-slag remelting under nitrogen pressure [3], in comparison with vacuum-induction and plasma technology, it all still preserves actuality. Usage as a consumable electrode made of steel of the desired chemical composition during electro-slag remelting is not economically efficient. However, a combination of melting and alloying process is problematic primarily because of the limited size of the pool of liquid metal and electro-slag remelting time. The work is devoted to finding the possibilities to realize combining the processes of melting and alloying in electro-slag unit (A-550, 300 amp.), receiving manganese, chromium and chromium-manganese nitrogen steels and to their research.

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PP 8. IMPROVEMENT OF PLASMA SPRAYING EFFECTIVENESS

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One of the methods of materials generation is an application of special coatings on constructional material with the use of low-temperature plasma spraying. Plasma flow is characterized by relatively simple adjustment of energy and gas dynamic parameters.

Receipt of plasma coatings from powdered materials becomes more and more topical. Such coatings are used in machine building, aviation, power engineering, metallurgy etc.

In modern plasmatrons, during turbulent delivery of plasma flow, as soon as plasma flow leaves the nozzle, the powder particles melt and accelerate not only in axial direction but also in radial direction; they mix with surrounding cold atmosphere. As a result takes place reduction of velocity of particles of sprayed material, oxidation and respectively non-heated particles originate in the zone of coating formation and quality of coating layer is worsened.

Use of low-enthalpy laminar flows enables us to change the quality of spraying and to improve characteristics of coatings [1-3].

The effectiveness of application of coatings can be assessed through the powder utilization ratio.

The losses of powder are mainly caused by splashing and small vaporization of coating material in plasma. The powder utilization ratio decreases with incomplete melting of sprayed particles [1].

If the solid or fritted powder particles appear in the jet, they strike and rebound from coated surface.

The velocity of particles increases in laminar flow. The difference between the velocities of laminar and turbulent flows is small when the distance is up to 100 mm. With the increase in a distance from the nozzle tip this difference increases and particles are heated during dwell time in laminar jet up to the temperature above melting point. Laminar plasma jet has small angle of divergence 1-3°, which leads to an increase in powder deposition ratio.

In laminar plasma flow at the same thermal arc power the powder particles are heated and accelerated in comparatively long plasma jets with comparatively low temperature and corresponding vaporization. The dissociation of material becomes slower, while the powder utilization ratio increases.

It is established, that the maximal coating quality is achieved at the spray distances L=100-120 mm when using turbulent plasma. In this range the powder utilization ratio is slightly varied, however at the distance L>120 both the powder utilization ratio and coating quality drastically worsen.

Absolutely another pattern takes place when using laminar plasma flow. The powder utilization ratio does not worsen with increasing the spray distance from small diameter of plasma burner nozzle to substrate, when L=140-150 mm. Application of high enthalpy laminar plasma flows provides: increase of particles’ velocity; minimal angle of divergence 1-3°; heated particles move in longitudinal direction that makes impossible their mixing in surrounding air; increase in temperature of sprayed particles.

All abovementioned factors promote increase of powder application ratio by 1,4 times in case of the same mode (arc power, quantity of delivered powder etc.).

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PP 9. INVESTIGATION OF THE POSSIBILITY OF EXTRACTING ARSENIK AND GOLD FROM ARSENIC CONTAINING SULFIDE RAW MATERIALS

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Research relates to the production of elemental arsenic and gold, which is used in metallurgy for alloying and impart specific properties in electronics - for the manufacture of semiconductors with special properties.

For the purpose of extracting arsenic and gold the process of preliminary alkali leaching (pH 10-11) arsenopyrite ore and its residues, firing additional oxidizer to recover gold bound to arsenate iron (II) and iron (III), was studied [1].

$$2FeAsS + 10NaOH + 7O_2 = 2Fe(OH)_3 \downarrow + 2Na_2SO_4 + 2Na_3AsO_4 + 2H_2$$

$$2Fe_3(AsO_4)_2 + 12NaOH + 3H_2O_2 = 6Fe(OH)_3 + 4Na_3AsO_4$$

Recovery processes of sodium arsenates and sodium arsenite from aqueous solutions (55-60 ^{0}C), obtained after following leaching from arsenic containing raw materials, have been studied [1,2].

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PP 10. SYNTHESIS OF SCHIFF BASE DERIVATIVES AND THEIR METAL COMPLEXES OF NANOSTRUCTURED POLYHEDRAL OLIGOMERIC SILSESQUIOXANES (POSS)

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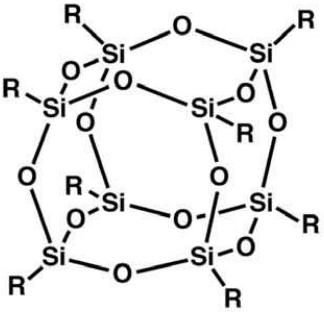
Polyhedral oligomeric silsesquioxanes (POSS), also known as polyhedral oligo-silsesequioxanes, or simply silsesquioxanes, is the general IUPAC name for a family of polycyclic compounds consisting of silicon and oxygen. POSS materials have drawn great interest because of their rigid framework and the unique opportunity which they offer for preparing truly molecularly dispersed nanocomposites [1]. The formula for the completely condensed silsesquioxanes $R_n(SiO_{1.5})_n$ reflects the ratio of silicon and oxygen, where *R* may be any organofunctional groups (either hydrogen or an alkyl, alkene, aryl, arylene etc.), while *n* is an even integer ≥4 (Scheme 1). This kind of POSS molecules has a nano-sized cage structure with sizes of 1-3 nm, and can be considered as the smallest particles of silica. The variety of R groups makes POSS molecules amenable to be compatible with different monomers or polymers. Silsesquioxanes exist in a variety of structures from random polymers to more ordered arrangements [2].

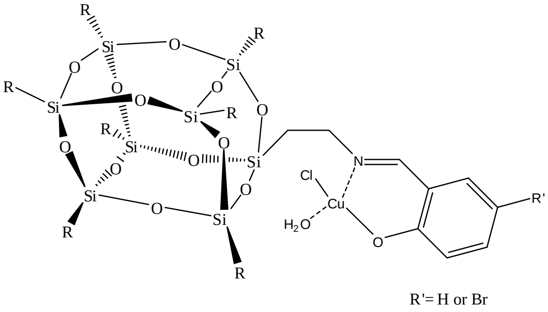


Scheme 1.The Structural representation of POSS.

POSS molecules are equivalent in size to random polymer coils. When bonded to the polymer chain, they can limit molecular motion, improving glass transition temperature and mechanical properties [3].

More recently a diverse and entirely new chemical technology of polyhedral oligomeric silsesquioxane (POSS) nanocomposites has been developed. This technology affords the possibility of preparing plastics that contain nanoscale reinforcement (POSS segments) directly bound to the polymer chains. Unlike previous hybrid systems, the POSS technology materials have the additional advantage of being employable in the same manner as organic monomers or in the form of blendable resins [4].

In this study a POSS derivative compound (OAPS) was prepared by using 3-aminopropyltriethoxysilane (APTES) with hydrolytic condensation procedure in alkaline medium. Schiff base derivatives of OAPS were synthesized by condensation of OAPS with salicylaldehyde and 5-bromosalicyladehyde. Transition metal complexes of these nanostructured POSS derivatives of Schiff bases were isolated by refluxing metal salt solutions (Scheme 2).



Scheme 2. The structural representation of Schiff base Cu (II) complex of POSS derivative.

The characterization of the synthesized compounds was carried out by elemental (C, H, N, Si and Metal) analysis, FT-IR, ^{1}H &^{29}Si NMR, TG-DTA and magnetic susceptibility techniques. CP/MAS ^{29}Si NMR showed only one pek at -79.6 ppm assignable to cage structure of Schiff base derivative of POSS (Figure 1).

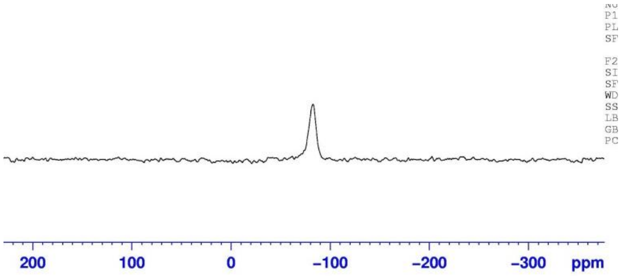


Figure 1.29Si CP/MAS NMR spectrum of Schiff Base derivative of OAPS.

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PP 11. CATALYTIC ACTIVITY OF POLYMER-METALICCOMPLEXES OF CU (II) AND CO (II) IN THE OXYDATION PROCESS OF TOLUENE

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The nature of the solvent has a strong influence on the rate and order of homogeneous chemical reactions. The addition of the neutral solvents that do not participate in the reaction may interfere with the course of the process and reduce its speed. By choosing, the appropriate solvent can significantly accelerate or slow down the chemical reaction. In this context, becomes clear the importance of selection of the most suitable solvent for the reaction or the use of initiators that are involved in the intermediate interactions and increase the reactivity [1,2].

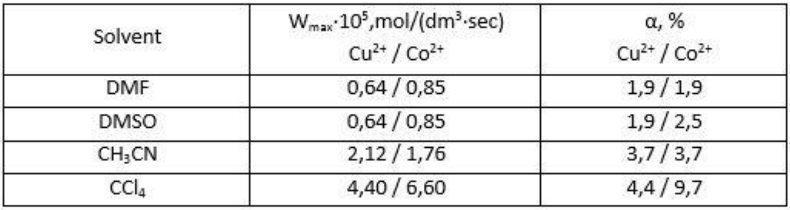
The kinetics of liquid-phase oxidation of toluene by oxygen was studied using volumetric, potentiometric, spectral and chromatographic methods. Complexes of copper (II) and cobalt (II) with polymeric matrix of polyethyleneimine - polyacrylic acid $(PEI/PAA)_n$ fixed on the glass beads were used as the catalysts. The processes were carried out at 348 K, atmospheric pressure, acetonitrile media and *n* –number of layers. It was established, that the main products of toluene oxidation are benzaldehyde and hydroperoxide of toluene with a conversion of toluene 3.3 – 4.2%. By infrared spectral analysis of the catalyst established that $(PEI/PAA)_n$ are not oxidized and do not undergo degradation. The activity of catalysts [M^{2+}-$(PEI/PAA)_n$-glass] gradually decreases with repeated use [3].

To find the optimal thickness of polymer matrix for oxygenation of toluene the number of layers are from 1 to 40 in the system [M^{2+}-$(PEI/PAA)_n$-glass]–$C_6H_5CH_3$–CH_3CN. It was established that the highest yield is observed for systems [Cu^{2+}-$(PEI/PAA)_{30}$-glass] and [Co^{2+}-$(PEI/PAA)_{40}$-glass].

To determine the concentration of metal ions in the catalyst by atomic adsorption spectroscopy the polymer-metallic complexes of cobalt and copper were washed out from the glass beads. It was established that with increasing thickness of multilayer the concentration of metal ions are increased too. This is related to the increasing of active sites of the copolymer on the glass surface. Due to swelling of the PEI-PAK copolymer in the oxidation process reached the highest availability of the internal active centers that cause prolongation of the activity.

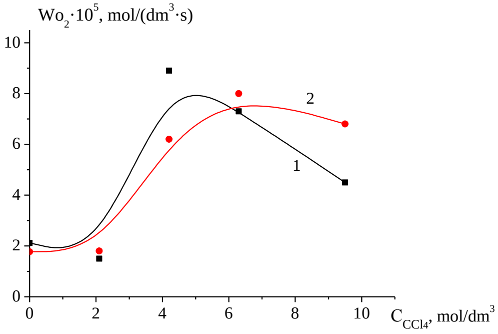
Dimethyl sulfoxide (DMSO), dimethylformamide (DMF), acetonitrile (CH_3CN) and carbon tetrachloride (CCl_4) were used as solvents (Table 1).

Table 1. Effect of the solvent nature on the oxidation of toluene by oxygen in the presence of[M^{2+}-$(PEI/PAA)_n$-glass]at P_{atm}=94.1kPa, T = 348 K, τ = 1 hour



Solvent	$W_{max}\cdot10^5$,mol/($dm^3\cdot$sec) Cu^{2+} / Co^{2+}	α, % Cu^{2+} / Co^{2+}
DMF	0,64 / 0,85	1,9 / 1,9
DMSO	0,64 / 0,85	1,9 / 2,5
CH_3CN	2,12 / 1,76	3,7 / 3,7
CCl_4	4,40 / 6,60	4,4 / 9,7

As seen from the experimental data, the oxygenation of toluene in the presence of [M^{2+}-(PEI/PAA)$_n$-glass]in DMSO or DMF medium are observed very little absorption rate of oxygen and the degree of conversion of toluene does not exceed 2%, where as in the CCl_4 medium, the conversion of toluene reaches 9.7% (Fig. 1).



T = 348K, P = 92,6 kPa, C_{tol} *= 0.95 M,* m_{kat}*= 0.5 g, 1 – [*Cu^{2+}*-(PEI/PAA)*$_{30}$*-glass]; 2 – [*Co^{2+}*-(PEI/PAA)*$_{40}$*-glass]*

Figure 1. Effect of the concentration of carbon tetrachloride on the oxidation of toluene by oxygen inthe system [M^{2+}*-(PEI/PAA)*$_n$*-glass]–* CH_3CN *–* CCl_4*.*

Changing the speed of the reaction at the transition from one solvent to another is related to the change in the chemical potential of reacting particles and activated complex (change in their activity coefficients).

When changing the system from carbon tetrachloride to dimethyl sulfoxide and dimethylformamide the stoichiometry of oxidation of toluene is not changed. At the same time, the rate of oxidation of toluene decreases in the row of CCl_4> CH_3CN >DMSO >DMF.

Apparently, the injection of CCl_4 causes a change in the mechanism of oxidation process, from coordination to radical chain. The result is formation of 3-chloromethylradical which activates the oxidation of toluene.

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PP 12. INORGANIC POLYMERS DOUBLE CONDENSED PHOSPHATES OF MONO- AND POLYVALENT METALS-GENERAL OVERVIEW

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During last 40 years the intensification of research in the field of condensed crystal chemistry was due to a very rapid development of progressive methods of analysis, as well as to the evolution and achievements in this field of chemistry. Numerous cyclophosphates with diverse formula were obtained and described in chemical literature last two decades [1-4]. Actually phosphorous anions are known for n=3, 4, 5, 6, 8, 9, 10 and 12 [1-2, 5-8]. Double condensed phosphates of poly- and monovalent metals enjoy a number of rather interesting and appreciable properties, which explicate various areas of their use in diverse fields. Thermal stability of above mentioned condensed phosphates, elevated content of phosphorus – these properties have caused their application as raw components for manufacture of phosphates glasses; The crystalline and non-crystalline ultra-phosphates are used in quantum electronics, which are predetermined by their specific properties.

In fact it is necessary to underline, that some compounds of cyclophosphates primarily synthesized, were firstly examined and determined by us, sometimes in collaboration with Dr. N. Chudinova and academician I. Tananaev [3-6, 1, 8-10]. In this point of view the achievements obtained by methods and direction of researches named "Scientific School of Tananaev", in the vast and extensive field of condensed phosphates, is very remarkable.

Sufficient stability of polymeric phosphates in this respect makes it possible to identify and categorize them by the method of paper chromatography, this circumstance permitted scientists to examine the process of formation and the composition of many normal, basic and/or acid of both simple and double di—, tri—, tetra-, octa- and dodecaphosphates or ultra-phosphates of polyvalent metals. This method together with the chemical analysis, IR—spectroscopy, thermogravimetry, X-Ray diffraction, structural analysis was used by us.

The present data are the result of our studies – synthesis, analysis, and examination of the experimental records and their comparison in correlation with the achievements in the field of inorganic polymer's chemistry [1-6,8]. We synthesized numerous new double condensed oligo- and cyclophosphates, general properties of which we have examined [3-6,8]: systematic investigation of M^I_2O-$M^{III}_2O_3$-P_2O_5-H_2O at 100^0C-600 ^{0}C, where M^I = alkali metals and M^{III} – Ga, In, Sc at the molar ratio of $M^I_2O/M^{III}_2O_3$ = 2,5:1; 5:1, 7,5:1; 10:1 was executed. In addition, investigation of systems Ag_2O-$M^{III}_2O_3$-P_2O_5-H_2O at 100^0C -400^0C and analysis of the results are on the stage of detailed examination. Many compounds were thoroughly observed and the structures are determined by X-ray structural techniques [4-6, 15]; Duration of the synthesis is variable: from 2 days to two months.

Therefore, presented data are the outcome of synthesis, analysis, examination of the experimental records, their analysis, determination and evaluation of their properties and correspondence with accomplishments and advances in the area of inorganic polymer’s chemistry [2-7]. More of 65 a new formerly unknown double condensed phosphates have been obtained, including the first representatives of double cyclooctaphosphate classs – $K_2Ga_2P_8O_{24}$ and $Rb_2Ga_2P_8O_{24}$ (were obtained by M. Avaliani&N. Chudinova [5,8]), crystal structure was examined and described [1,5,6]. One of primary synthesized cyclododecaphosphates, e.g $Cs_3Ga_3P_{12}0_{36}$, $Cs_3Sc_3P_{12}0_{36}$, $Cs_3In_3P_{12}0_{36}$ have been obtained by us during investigation of systems Cs_2O-$M^{III}_2O_3$-P_2O_5-H_2O at the molar ratio P : Cs : M^{III} = 15:5:1, 15:7,5:1 [10-12], (see also detailed and interesting publication [7]). These achievements, including the successful synthesis of the first representatives of already highlighted double cyclophosphate classes – $K_2Ga_2P_8O_{24}$ and $Rb_2Ga_2P_8O_{24}$ are noted and distinguished by many scientists/authors in the important publications [1,2,6,9], numerous compounds were thoroughly examined, also are observed by X-ray structural techniques and are described in works [3,4,8-10,13-15]. Main compounds are presented below: $M^IM^{III}HP_3O_{10}$, (forms I, II, III), $M^IM^{III}HP_3O_{10}\cdot H_2O$, $M^I_2M^{III}H_3(P_2O_7)_2$, $M^I_2M^{III}P_3O_{10}$, $M^IM^{III}(H_2P_2O_7)_2$, $M^IM^{III}(H_2P_2O_7)_2\cdot 2H_2O$, $M^IM^{III}P_2O_7$, $M^IM^{III}(PO_3)_4$, $[M^IM^{III}(PO_3)_4]_x$, ultra phosphate $M^I_3M^{III}P_8O_{23}$, cyclooctaphosphates $M^I_2M_2^{III}P_80_{24}$, cyclododecaphosphates $M^I_3M^{III}_3P_{12}0_{36}$, polyphosphates $M^{III}(P0_3)_3$ etc.

Nowadays we examine and do research on systems at the another molar ratio P: $M^{I:}$ M^{III} = 15:3:1,5; 15:6:1,5; 15:8:1,5 at the temperature range 100-400°C (M^I=Cs and/or Ag). Discussing the range of $M^IM^{III}(PO_3)_4$ compound structures, where M^I is constantly alkali or any other monovalent metal and where M^{III} is any of trivalent metals such as Gallium, Indium, Scandium and others, even rare earth elements, it can be concluded: while the radius of M^{3+} decreases, the polyphosphate chain identity period increases, due to complication of its form-factors; the cycles slowly appear, the number of structural types increases caused by correlation of average distances between (M^{III}-O) and (M^{I}-O).

The less the correlation / ratio, the more is the probability of big cycle formation.

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PP 13. SORPTION OF CADMIUM IONS BY SAXAUL ACTIVATED COAL

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Chemical pollution is among the most dangerous types of contamination, which is primarily exposed to water and air. Heavy metals in the aqueous medium react with other components to form hydrated ions, complex organic and inorganic compounds. Most absorbing metals (Hg, Cd, Pb, Ni, Zn) are among the toxic poisons of cumulative effects. Best mode for maintaining clean water is to prevent their contamination.

The most common "reagent" cleaning methods do not allow purifying the water on a high level. For additional cleaning of sewage and drinking water sorption methods should be used. The efficiency of the adsorption purification reaches 80-95% and depending on the chemical nature of the sorbents, the adsorption surface and its accessibility, the chemical structure of substances and its condition in the solution.

This work aims to develop innovative technologies for the remediation of water from toxic metals and their compounds, combining biotechnological method of their adsorption by living organisms and chemical methods for their subsequent immobilization in sediments using activated absorbents or transformation them into water-insoluble complexes of heavy metals.

Promising is the use of microorganisms [1, 2] living in the water bodies in combination with natural sorbents which have high sorption properties. The developing of new sorbents, modification of existing ones and their introduction to purify water is always actual [3].

The objectives of the study were the selection of the optimal conditions for producing the activated coal and study of sorption characteristics using model solutions containing heavy metals.

The activated coal (sorbent SAC) was produced by carbonization of saxaul (haloxylon) wood chips at temperature 800 ^{0}C in an inert atmosphere of argon. The obtained coal exposed further activation by sharp steam (sorbent SAC SSA). For increasing an active surface of sorbents it was briquetting with preliminary grinding to fraction 71 μm (sorbent SAC B).

Sorption capacity of sorbents of cadmium ions (II) was studied in static conditions at pH 6.3 (Figure 1).

The sorption capacity of the saxaul AC for three types is quite high. The sorbents with different surface preparation characterized different equilibrium time of cadmium ions in solution and on surface.

Studies have shown that the degree of sorption of cadmium by obtained activated coals differs slightly in the range of cadmium concentration in solution 5 to 50 mg/cm^3. And for SAC sorbent the degree of sorption is directly depended on the concentration.

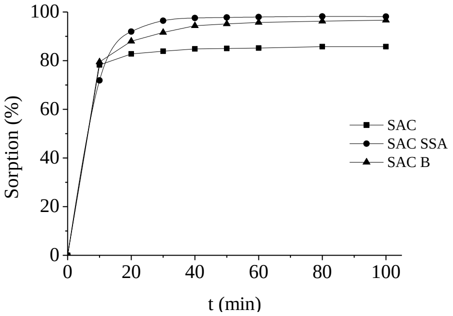

Figure 1. Sorption of cadmium in the static mode: $C_{Cd} = 5$ *mg/cm*^{3}*; T =295K; S:L = 1:100;* $\upsilon_{mix} = 100$ *rpm; pH = 6.3*

The rate of adsorption process is generally characterized by a rate of change of concentration of the adsorbent in solution over time.

Using Van't Hoff differential method of determination order of reaction built a logarithmic dependence of the reaction rate of the initial concentration of Cd^{2+} (Figure 2). The value of the reaction rate constant *K* was $1.28*10^{-2}$ and the reaction order $n \approx 1$.

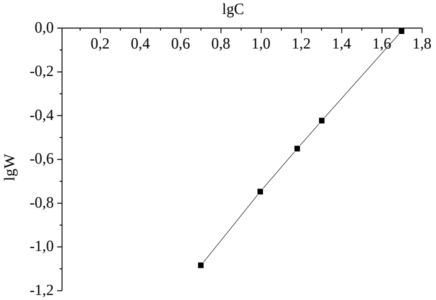

Figure 2. The dependence of the reaction rate on the concentration of cadmium

The adsorption of cadmium (II) ions on SAC in dynamic mode was also studied. The initial concentration of cadmium was 5 mg/cm^3 and pH of solution was 6 and 3.5. The flow rate of 5 liter of the solution was 10 cm^3/min.; weight of sorbent was 10 g.

Under these conditions the sorbent SAC B absorbed cadmium with the greatest speed and sorption capacity of greater than 2.5 mg/g.

It was determined that saxaul activated coal has high sorption characteristics. Thus its using in combination with biological and sorption methods for cleaning water is a perspective.

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PP 14. OBTAINING GE(IV) COORDINATIVE COMPOUNDS CONTAINING BIOACTIVE LIGANDS AND STUDYING THEIR BIOLOGICAL PROPERTIES

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Germanium (IV) halogenides, thiocyanates and mixed halogenide-thiocyanate coordinative compounds are synthesized with pyridinecarboxylicacidhydrazides (Isonicotinic acid hydrazide (IAH), nicotinic acid hydrazide (NAH), picolinic acid hydrazide (PAH)), isonicotinoilhydrazonepurpuralacetone (lar) and other bioactive ligands. Their physical-chemical and biological propertieshave been studied.

It has been defined that Ge(IV) coordinative compounds: $GeCl_4 \cdot 4lar$, $GeBr_2 \cdot 2lar$, $GeI_4 \cdot 4lar$,$GeCl_2(NCS)_2 \cdot 4lar$and $GeBr_2(NCS)_2 \cdot 2lar$have much higher antitubercular properties than free ligand larusan (lar).

During the therapeutic study of Ge(IV) coordinative compounds: $GeI_4 \cdot 4PAH$, $Ge(NCS)_4 \cdot 4NAH$, $GeCl_4 \cdot 6NAH$, $GeI_4 \cdot 4NAH$, $GeBr_2(NCS)_2 \cdot 4PAH$,$Ge(NCS)_4 \cdot 2PAH$, it has been found out that the ligand PAH-containing compounds reveal hypotensive and hypoglycemic activity, and the ligand NAH-containing compounds have hypertensive and hyperglycemic activity.

It is especially important to carry out intensive scientific studies in the direction of determining anticancer properties of Ge (IV) coordinative compounds. We will increase the number of the compounds synthesized by us with involving medicinal drugs of new generation – new ligands.

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PP 15. EFFECT OF GRAPHITE NANOPOWDER ON THE PROPERTIES OF DOLOMITE-SERPENTINITE COMPOSITE

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We pursued application of carbon-containing admix to obtain high refractory carbon-containing composite on the base of dolomite-serpentinite clinker. We have studied dolomite-serpentinite composite obtained by the use of carbon-containing admix and binder. TIMREX KS 6 mark graphite nanopowder was selected as carbon-containing admix, by adding 10% of 20% $MgSO_4$ solution as a binder. We studied their influence on physical-technical properties of the composite together with the effect of quantity of admix and changes in forming pressure. To avoid oxidation of carbon in the composite, silica was introduced into the charge as antioxidant and the regime of sintering was selected. Besides, complex action plasticizer was added to the charge.

Research was carried out by the use of differential thermal and electron microscope analyses.

We consider compression pressure - 100 mPa, added graphite nanopowder -15% and 20% magnesium sulfate solution as a binder - are optimal, since even at the application of this latter the satisfactory results were obtained.

Phase analysis of optimal composition DN8 specimens (Table 1) by x-ray diffraction and electron microscope methods was performed.

The results show that the main constituents of the composite are MgO in the form of periclaseandtricalcium silicate – alit.

Electron microscope figures of the composite DN8 specimens show well sintered specimen surface, with clearly expressed formed crystals of the main phases of the clinker, in particular, those of periclase and alit, but we can observe traces of belite inclusions too.

Simultaneously plasticizer of complex impact was added to the charge. Researches proved that it is possible to obtain carbon-containing highrefractory composite of high physical-chemical characteristics on the base of dolomite –serpentinite clinker. Technological scheme for composite production has been develoZed.

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PP 16. MICROBIOLOGICAL LEACHING OF GOLD FROM BASE GOLD-BEARING QUARTZ ORES

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Gold-bearing deposits are generally divided into base (ore) and sand deposits. Most ore deposits belong to the hydrothermal type, where gold is being formed (deposited) on minerals – quartz and different sulfides (common pyrite, chalcopyrite and arsenopyrite).

Today most of the world's gold is recovered with cyanide playing a large part in the beneficiation of the yellow precious metal. However the use of cyanide, given its toxicity, requires decontamination of toxic waste in drainage waters [1].

Mixed technologies are the reserve capable of competing with the currently used cyanidation technology. In this respect, of significance is the application of environmentally friendly microbiological methods. Of particular importance is the role of autotrophic (silicate) bacteria, given their ability of rapid growth on different substrates and change pH, redox potential, form organic acids, amino acids, absorb oxygen, etc. [2].

According to the available data, known today synthesis of nanoparticles, which is generally carried out through chemical and physical methods, is characterized of a whole number of unfavorable aspects and, besides, is rather costly. In addition, the traditional applicable technologies are associated with the use of toxic substances and as a result, of accumulation of toxic waste.

During the last decade, attention has been directed to the application of biological methods for nanoparticles production, for, as is commonly accepted, the biological systems are the very determinants of the synthesis of inorganic nano- and macro-sized materials in the environment.

The bacterial gold leaching from gold-bearing ores undergoes two phases: the latent phase and the gold dissolution phase. Dissolubility of gold depends on its content in the ore.

Initially a strain of gold-adapted bacteria was prepared and a strain of silicate gold-adapted bacteria elected. Also prepared were the fermentation nutrient media. For the purpose of improving the technological processes of leaching gold from ores, the microflora and nutrient areas of the experimental objects were studies.

Since base quartzite ore is the experimental object, the silicate bacteria spread area was determined therein, also the bacteria nutrient media were selected. The commercial strain deposited in the catalog of microbes was used in the experiments.

The ore reduction ratio makes 0.074 mm in thickness. The first study was carried out by the accumulation leaching method: 2 kg of the averaged specimen is added with 1 liter of bacterial culture and 1 liter of nutrient medium. The process runs under pH=8 aeration conditions.

In 30 days, the produced mass is separated from the liquid phase. The conducted analytical research demonstrated that the recovery or leaching of gold took place from the whole solution, making 84% of the theoretical value/recovery. The sorption of gold from liquid took place on the activated carbon [3].

The circumstance that after gold cementation the solution still contained an insignificant amount of gold should be mentioned, which indicates that the cementation process needs to be further improved or a combined sorbent is to be selected. Studies in this direction are under way.The produced gold solution and the solid sorbate were subjected to atomic absorptive analysis for gold content. Below are given the gold leaching results in the form of table.

The second experiment on gold-bearing quartzite ore was carried out in a percolator, which implies circulation of the culture solution under aeration conditions. Initially the zinc dump was used, pH=8; gold leaching process being run for 35 days. [4,5]

Analytical calculations indicated gold cementation on the zinc dump, but in very small quantities (0.032 g/t), or 4.57% of the theoretical value, whereas the gold content in the enriched solution made 0.65 g/t, or 92.8% of the theoretical value. Activated carbon was found best for cementation.

The figure below illustrates a liquid gold concentrate in the isoamyl layer.

Figure 1. Gold concentrate in isoamyl layer

Thus, the research carried out by us demonstrated the possibility of leaching liquid gold from base quartzite ores with the deposited strain of silicate bacteria, with the subsequent cementation on an active carbon layer.

Gold (Au) metal particles (sized 30-40 nm) have been produced, whereas in the isoamyl layer gold is being formed as octahedral thin plates (sized 5 μm–8 nm), with the manipulation of the parameters, which determine the growth and metabolic activity of microorganisms.

The sizes of gold nanoparticles are rather variable. In our case, the production of gold nanoparticles of high dispersion degree has been achieved, this being conditioned by the proper selected silicate bacteria and nutrient media.

The studies in this direction are intensively carried out.

We have studied the processed gold-bearing base quartzite ore (0,7-0,8) of the Madneuli deposit.

The microbiological synthesis of nanoparticles has the great potential for a simple, cost-effective and environmentally friendly production of nanoparticles with the unique properties of such metals as Au, Ag, Mn, Cu, As, etc..

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PP 17. DETERMINATION OF DEGREE OF SEPARATION OF METAL CONTAINING MATERIAL FROM METALLURGICAL SLAG DUMP OF LTD RUSTAVI-STEEL

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The problem of processing dump slags and extracting metal components from them with the subsequent application as secondary raw materials has some aspects. First of all, the metal extracted from metallurgical slag is much cheaper than the metal extracted from ore as a result of a number of technological processes. Secondly, after extraction of metals from slags the slag can be usefully utilized; and finally, useful processing of slag dumps gives the chance to vacate the territory occupied from dumps or at least not to expand it to uncertain limits, i.e. improves also an ecological situation in a dump zone and around it.

The choice of the direction to use the slags is defined by the three main indicators:

– The metallurgical value of slag which is defined by its chemical composition;

– Degree of preparation of slag for sprcific processes;

– Requirements imposed on metallurgical conversion in which the reverse product is used.

Proceeding from the main goal of this project, profitable use of screenings of metal from processing of dump slags of Rustavi Metallurgical Factory with compensation of deficiency of the preparation of steel, smelting charge, and also implementation of the ecological doctrine of the enterprise.

Importance of this subject stipulated on a junction of two contradictions connected to metallurgical production in Georgia:

On the one hand:

– In Georgia there are no reserves of the coked coals, their prices constantly grow on the international market;

– There is no production of natural iron ore raw materials in Georgia and cost of production permanently increases at international market;

– Practically there is no development of new fields of natural resources;

– Constant increase of tariffs on energy resources both, on railway and sea transportations.

On the other hand:

– The wastes of metallurgical, machine-building, mining and chemical productions, fuel and energy complex, accumulated for decades, are waiting for the qualified applications today;

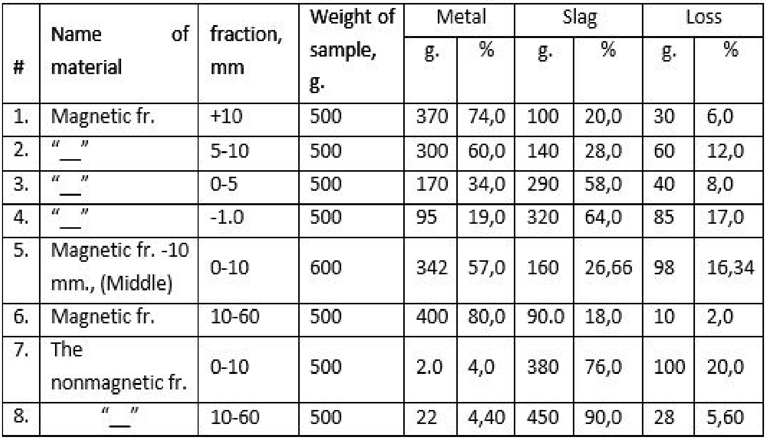
– The location of wastes is near metallurgical and chemical productions;

– It does not require huge costs of exploration and development.

Processing and recycling, useage of them as relatively cheap raw materials for metallurgical production will give considerable decrease in costs of charging materials, improvement of quality and competitiveness, and, above all, decreases cost of final product. At the same time will be solved an environmental problem of cleaning the regions where the huge technogenic fields of waste are accumulated [1,2].

The existing technology of processing slags (the AMCOM LLC company (USA)) consists in preliminary division of slag into fractions. Metal and a magnetic product are extracted from each fraction separately, the received scrap passes cleaning in a tumbling drum. The complex composition of the final product contain fractional trade slag gravel, sand, oversized lump slag, scrap metal, iron-magnetic products. Scrap goes to furnace as chasm of steel-smelting units, and for iron containing magnetic product with high content of iron, it is necessary to develop and calculate the rational resurse and energy saving scheme for conditions of electricsteel-smelting processing. For this purpose, at the first stage for the presented batch of product has been carried out complex investigations in order to study distribution of iron in magnetic and nonmagnetic particles (see Table. 1).

Table 1. Distribution of metal in enriched products



#	Name of material	fraction, mm	Weight of sample, g.	Metal		Slag		Loss	
				g.	%	g.	%	g.	%
1.	Magnetic fr.	+10	500	370	74,0	100	20,0	30	6,0
2.	"__"	5-10	500	300	60,0	140	28,0	60	12,0
3.	"__"	0-5	500	170	34,0	290	58,0	40	8,0
4.	"__"	-1.0	500	95	19,0	320	64,0	85	17,0
5.	Magnetic fr. -10 mm., (Middle)	0-10	600	342	57,0	160	26,66	98	16,34
6.	Magnetic fr.	10-60	500	400	80,0	90.0	18,0	10	2,0
7.	The nonmagnetic fr.	0-10	500	2.0	4,0	380	76,0	100	20,0
8.	"__"	10-60	500	22	4,40	450	90,0	28	5,60

On the basis of these data it is planned to develop and calculate the rational resurse and energy saving scheme for electric steel-smelting processing. In general, it is possible to claim that the realized actions for processing of slag dumps will give chance to weaken the crisis situation at local market of scrap metal in a short term and at the same time it will lead to improvements of ecological situation in industrial regions. But after that it is necessary to find fundamentally new solution to the problem of deficiency of scrap metal.

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PP 18. ELABARATION OF ECOLOGICALLY SAVE TECHNOLOGY FOR OBTAINING HIGH PURITY METALLIC ANTIMONY AND GOLD FROM GOLD-BEARING ANTIMONY ORES

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A new technology for integrated processing of gold-bearing antimony ores has been developed in order to solve certain problems in the gold-mining industry. The technology based on vacuum thermal processes allows not only extraction of gold but also production of associated materials – antimony sulfide (Sb_2S_3) and metallic antimony (Sb).

The kinetics of the extraction process of antimony sulfide from the Zopkhito ore deposit (mountainous Racha, Georgia) was studied for various fraction ores. Commercially pure (~95 mas. %) antimony was prepared via iron reduction of Sb under vacuum with subsequent sublimation and condensation. Elimination of arsenic and sulfur from the metallic antimony was realized by vacuum heat treatment ($P \cong 10^{-5}$ MPa). The resulting product was a high-purity metallic Sb (~ 99.2 mas. %) [1].

As is known from international best practice, the main method of recovery of gold from ores and concentrates is the cyanide method, which is characterized by high toxicity and furthermore, does not produce economically acceptable results in the case of gold-bearing antimony ores.

An alternative path to solve this problem is proposed by the authors: the process of gold recovery was carried out using chemical (thiourea leaching) and electrochemical (electro chlorination) methods.

The possibility of using thiocarbamide method of gold extraction from residues of vacuum-thermal processing of gold containing antimony ore is established.

Experimentally is studied the influence of the main technological factors on the thiourea leaching process of residues and optimum leaching conditions are established: composition of the solution – ThiO-0,5%; $Fe_2(SO_4)_3$-0,8%; H_2SO_4-0,8%. Mode of Leaching: duration – 4 hours; solid to liquid 1:3; rotation speed of mixer 200 rev/min; temperature – 18-25^{0}C. In these conditions, the degree of the gold extraction is 82-87% [2].

Also the method for gold extraction from the residues of vacuum-thermal treatment of the concentrate of gold-containing antimony ore has been established by eco-friendly electrochemical method.

The effect of main technological parameters on the process of electrochemical leaching of the residues has been studied in the presence of a selective ligand, thiourea, in chloride system and optimal conditions of leaching have been established providing for the gold extraction from gold-containing residues by 82-90% in the conditions of so-called “soft” oxidation without release of molecular chlorine at the anode and eco-contamination [3].

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PP 19. SCAFFOLDS FOR TISSUE ENGINEERING

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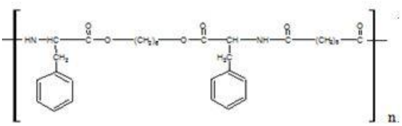
We have obtained the biodegradable, bio-compatible scaffolds (base-film for cell growing) possessing well developed porous surface made of polyester amide 8-Phe-6 (polymer composed of sebacic acid, L-phenylalanine and 1,6-hexanediol) [1,2].



Polyester amide 8-Phe-6

8 – Phe – 6			
Tg °C	Mw	Mw/Mn	Elongation%
35	61600	2,64	7,5 ± 2,5

Characteristics of Polyester amide 8-Phe-6

Figure 1. biodegradable, bio-compatible scaffolds

Porous films were obtained by ultrasonic or mechanical dispersion of two-phase system (water/biodegradable polyester amide solution in chloroform), followed by freezing of the obtained emulsion and subsequent freezing-drying [2].

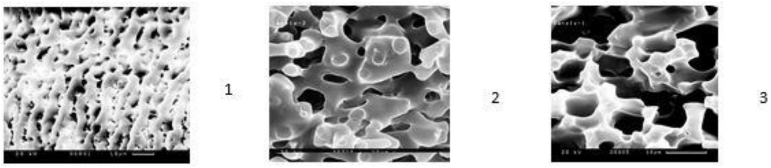


Figure 2. Electronic photographs: 1. Monolithic film; 2. Scaffold (porous film) obtained by mechanical dispersion; 3. Scaffold (porous film) obtained by ultrasonic dispersion

The obtained porous films (pore size 10-30 μm) were compared with monolith films and were characterized by means of electron and optic microscopy. Since pore size determines adhesion capacity of cells and porosity increases the bio-compatibility of the material, these types of scaffolds are promising in tissue engineering.

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PP 20. STUDY AND PROSPECTS OF APPLICATION OF MANGANESE AND COPPER-CONTAINING AMORPHOUS-CRYSTALLINE MATRIX MATERIALS

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During obtainiing materials used for electrotechnical purposes it is necessary to take into account basic properties and, in particular, electric properties of materials, including temperature coefficient of electrical resistance (α_T). This coefficient has a positive value for most metals, while for pure semiconductors it manifests negative values. The value of α_T for alloys and doped semiconductors, as well as for glass and ceramics, is hard-to-predict and requires experimental determination for material of each composition. Namely, some well-known alloys (constantan and manganin) have very low value of α_T, i.e. temperature has minimal effect on their resistance. With the purpose of obtaining materials with necessary α_T baking (agglomeration) of mixtures of oxides of the chemical elements, such as manganese, nickel, copper etc. is frequently used. The end product is a solid ceramic mass, from which termistors, variators, rectifiers and other wares are made [1,2]. The manganese and copper-containing composition in the system Cu_2O-MnO-B_2O_3 has been studied by us with the purpose of expanding the assortment of such materials. This choice was caused by the interest in copper-containing manganese-borate glasses, proceeding from the opportunity of implementation of electron-type electric conductivity [3]. The opportunity of glass formation (synthesis at 1273-1373K) in Cu_2O-MnO-B_2O_3 system selected for research has been established for up to 60% content of oxides of polymetallic elements. By means of single-stage thermal processing of obtained glasses amorphous-crystalline matrix material has been obtained, amorphisation degree of which doesn't exceed 50%. The composite obtained through thermal processing of glasses manifests electric and thermal properties, which are extraordinary for borate glasses and famous glassy-crystalline materials. In particular, fluxing is registered at temperatures more than 1100 K, and values of α_T are within the range $(0,5\text{-}1,0)°10^{-3}$ K^{-1}, when specific electrical resistance (lgρ, Ω·m) at room temperatures is equal to 5-8 units. Represented characteristics make possible the application of obtained materials in production of high-temperature thermistors, variators and other wares.

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PP 21. OBTAINING AND STUDYING POROUS HEAT INSULATING MATERIALS WITH THE USE OF LOCAL NATURAL ROCKS

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Porous inorganic materials hold a special place in important branches of industry, such as metallurgy, construction materials, agroindustry etc. With their use is possible to receive light weight materials and wares distinguished by high-temperature stability. Such kinds of materials are rare in nature and they are usually artificially obtained with the use of natural rocks liable to swelling, such as perlites and obsidians. Through their special thermal processing are received filling materials and wares with low thermal conductivity and bulk weight, and at the same time with wide temperature range of use (-200°C to +900°C) [1,2]. In this regard over the last years a special attention was paid to technogenic (manmade) raw materials available in Georgia, such as Kvareli slate. Studying these raw materials the prospects of obtaining some kinds of silicate materials were established [3,4].

The goal of our researches was the study of Kvareli slate with the purpose of determination of possibility of receipt of porous heat-insulating materials from it. The work was divided into two stages, first of which was devoted to the possibility of expansion of raw material under study, while from the ensuing researches was established the effect of some factors on the expansion process, such as granulometry of raw materials. Assessment of research results was made through analysis of structural change of material under investigation caused by thermal processing and via determination of two characteristic parameters – bulk volume weight (V, kg/m^3) and water absorption (W, %). Optimum temperature of thermal processing was determined through DTA-method and it was established that expansion process can be conducted during thermal processing of slate at temperatures more than 700°C. There was more precisely defined that the maximum of slate expansion intensity falls in 900-1000°C range. According to X-ray phase analysis at this point of time deep structural transformation of material occurs: disintegration and transformation of initial crystalline phases with concurrent formation of new amorphous component take place. Through the study of properties of expanded slate obtained by thermal processing it was established that drastic change of properties happens, amount of which can be determined by expansion degree (K) and granulometry of materials (q, mm). Change of properties (provided that $1 \leq q \leq 5$) obtained as a result of thermal processing (800-1000°C) of Kvareli slate is as follows: $1<k<3$; $450<V<1000$; $5<W<40$. According to the results of carried out researches the slate is liable to expansion and is prospective for receipt of porous materials.

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PP 22. CONSTRUCTION AND CONSIDERATION OF CURRENT-VOLTAGE CHARACTERISTIC

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As is known, current increase according to ordinary current-voltage characteristic of classical alternating current machine almost does not cause the variability of voltage loss. Experiment confirms that such current-voltage characteristic does not give desired result, i.e. the parts either do not weld to each other or get pierced. In our opinion, the latter should be caused by temperature perturbation of the spot with unlimited sinusoidal current [1, 2].

With the purpose of studying alternating current block there was elaborated and assembled the bench of current-voltage characteristic both with unlimited and limited current supply.

The bench of current-voltage characteristic with current limiting differs from the bench without current limiting by the reason that the bank of capacitors with maximum capacity of 23 microfarad and control step of 1 microfarad was switched in the primary circuit of power supply unit of microwelding machine. Three values (8, 12, and 16 microfarad) of capacity of condenser bank were arbitrarily selected. In the beginning the length of ribbon resistor was equal to 2 meters, and then it was gradually reduced. On the basis of studying current dependence on voltage in case of different capacities the group of current-voltage characteristics for microwelding machine according to resistance was constructed by us, and this group consists of constant and dropping characterictics.

The welding spot is located at the dropping characteristic that promotes stabilization of engineering process.

The received group of characteristics was described mathematically by us, in particular with the seventh order polynomial and with minimum error (1,5%) it coincides with experimentally obtained current-voltage characteristic.

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PP 23. DISPOSAL OF SCRAP TIRES BY LOW-TEMPERATURE PYROLYSIS AND PHYSICAL-CHEMICAL EXAMINATION OF OBTAINED LIQUID PRODUCTS

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Disposal and preservation of scrap tires is a significant problem nowadays in the whole world. The scrap tires reserve amounts up to ~25 million tons worldwide and this number is increasing by ~7 million tons per year. Only 23% from the reserve of the worn-out tires is utilized in various ways e.g. the export in other countries, obtaining energy from their combustion - grinded vehicle rubber generates 10-16% more heat than coal, to cover road sand sport fields surfaces upon their mechanical grinding, highway roads are surrounded by the voice-resistant walls which contains cement and grinded vehicle rubber. Remaining 77% of the worn-out vehicle tires are not properly disposed due to the absence of the relevant cost-effective method [1, 2].

Disposal of used vehicle tires by means of low-temperature (250-300^{0}C) pyrolysis is a technology generating pyrolysis gases, char, metal cord and pyrolysis liquid products, which according to its characteristics resembles to the crude oil and upon the typical oil-refining processing it is possible to obtain valuable fuel for vehicles and boilers [3].

The advantage of the low-temperature pyrolysis process is that it does not require high energetic expenses, pyrolysis decomposition products do not pollute the environment and technological process is ecologically safe and secure with no residues and its recycled products have wide consumption and demand on the market.

It is estimated that upon the completion of the low-temperature pyrolysis process (temperature, pressure, used raw materials, etc.) various liquid products are obtained with different chemical composition and characteristics [4, 5].

Physical and chemical characteristics of liquid products obtained by means of low-temperature pyrolysis process of scrap tires are investigated: density at 20^0C, pour point, flash point in PM cap, distillation range, kinematic viscosity at 20^0C, water and contaminants content, water soluble acids and bases, ash, carbon residue of 10% remains, acidity, corrosiveness to copper, sulfur content.

Hydro-carbonic composition of the above mentioned liquid is examined by 2 dimensional gas chromatograph with time of flight MS-detector (PEGASUS 4D GC×GC -TOFMS).

As a result of the research it is estimated that liquid product obtained by means of low-temperature pyrolysis process of worn-out tires represents complex mix of 5159 compounds, which mainly consists of hydrocarbons with the number of carbon atoms C_4-C_{40} (alkanes, cycloalkanes, aromatics) and heteroatom organic compounds (oxygen, sulfur, nitrogen, bromine, chlorine).

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PP. 24. ELECTROCHEMICAL SYNTHESIS AND CHARACTERIZATION OF POLY (2-AMİNO-BENZYLALCOHOL) AND POLY (O-ANİSİDİNE-CO-2-AMİNO-BENZYL ALCOHOL)

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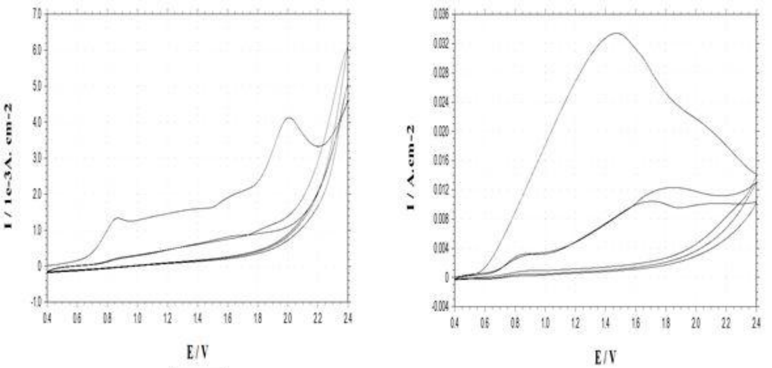
The conjugated double bond system present in conducting polymers and their ability to switch between various oxidation states constitute the unique property [1]. Therefore, these polymers have found wide application area; electrochromic devices and photoelectrochemical devices, rechargeable batteries, sensors and corrosion protection [2-5].The synthesis of conducting polymers could be realized either by chemical or electrochemical techniques. The electrochemical synthesis is a simple, relatively not expensive and most convenient method for preparation of a thin film. Also, electrochemical synthesis takes place directly on the metal surface [5]. Polyaniline and their derivatives have been the most studied substances among this area. They produce more stable and homogenous films on the metal surface than the other conducting polymers [6].In recent years numerous studies appeared in the references aiming to improve their film quality. One way of obtaining better quality films on the metal is to produce composites and copolymers [7].



(a)

(b)

Figure 1.The voltammograms recorded during the poly (2-amino-benzyl alcohol)(a) and poly (o-anisidine-co-2-amino-benzyl alcohol) (b) film growth on Pt electrode; scan rate; 50 mV/s.

İn this study the electrochemical synthesis of poly (2-amino-benzyl-alcohol) and poly (o-anisidine-co-2-amino-benzyl alcohol) have been investigated on the Platinum electrode. The electrochemical polymerization of homopolymer and the copolymer has been examined in oxalic acid solution as aqueous medium and TBAP/MeCN as unaqueous medium. Polymer film has been obtained in TBAP/MeCN medium. The copolymer films have been synthesized from unaqueous TBAP solutions containing different ratios of monomer concentrations: o-anisidine: 2-amino benzyl alcohol: 8:2, 5:5, 2:8. The characterization of polymer films were achieved with FTIR, UV-visible spectroscopy, SEM and cyclic voltammetry techniques.

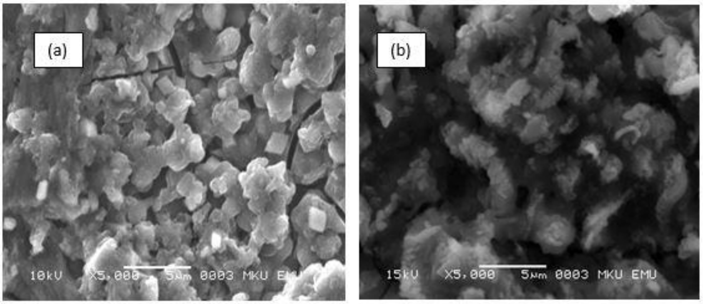


Figure 2. The SEM micrographs of poly (o-anisidine) (a), and poly (o-anisidine-co-2-amino benzyl alcohol) (b).

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PP 25. ENHANCED LADLE-FURNACE FOR SMELTING AND CASTING STEEL

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Proposed device and method comprises loading the burden made up of metal scrap and fluxes, forcing natural gas and air or oxygen from below to smelt the burden by gas-air or gas-oxygen flame, equalizing temperature and chemical composition of melt volume, adding slag-forming constituents, shutting off feed of natural gas and air or oxygen, and blowing the melt by inert gases from below. In melting, ladle-furnace is inclined to drain primary slag. Natural gas and air or oxygen are forced via cooled gas-air or gas-oxygen nozzle made up of tubes inserted one into another and arranged in furnace slide gate pouring cup hole and dusted by dry refractory sand. Natural gas is fed via furnace outer tube, while air or oxygen is fed via inner tube. Ladle-furnace is closed by crown with electrodes to smelt additionally the burden by electric arcs and is jointed to gas cleaner through crown. After smelting primary slag is drained from ladle-furnace; later it is moved to initial position to be fed with fluxing additives for forming secondary slag. Now, blowing by inert gases is performed from below along with boiling, deoxidizing, alloying, deep sulfur removal, dephosphorization and homogenization of chemical composition and temperature of finished steel. Application of this device and method will provide higher quality of steel, higher efficiency and lower production costs of steelmaking.

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PP 26. THE USE OF RADIAL FORGING METHOD

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Radial forging method is used in the mechanical engineering to process the axisymmetric details of complex shape, processing of which is costly if done by metal cutting machines, as it results in the loss of metal in the form of shavings. This method is also used in the metallurgy, specifically in the plants of cold pipe-rolling, in order to prepare the tube for drawing. Radial forging provides a high degree of accuracy. The accuracy of the details is of the second and third class, while the cleanliness of the surface reaches the ninth or the tenth class. In addition to that, the radial forging method improves the structure of the metal and its mechanical properties. Quite a wide range of details can be obtained with the radial forging machines, including the stepped shafts and axles, a cone-like, squared and six-sided hole pipes, axisymetric details of inner surfaces of the complicated configuration: those with internal threads or with internal spiral splines of nipples and pipes. Metal processing with radial forging machines offers high accuracy, efficiency and metal-saving.

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PP 27. TECHNOLOGY OF MANUFACTURING LAYERED COMPOSITE MATERIALS BY THE METHOD OF ELECTRO-CONTACT HEATING UNDER PRESSURE

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Method of isothermal electro-contact diffusion welding of layered composites under pressure is offered. The scheme is developed and laboratory installation is created on which pre-production models of the layered composite of steel and aluminum is produced. A new method of electro-contact hot deformation is proposed for realization of diffusion welding by pressure of stratified blanks providing high-temperature isothermal process. In this case a rolling process or composite pressing is meshed with simultaneous electric current transmission in deformation center. Considering that a resistance of transient layer far exceeds the resistances of composite components, heat is intensively release just in this layer. As the surfaces are approached over a distance of inter-atomic forces, the energy of boundary atoms easily reaches the energy threshold of capture with a formation of qualitatively new metallic bond. Proposed method, providing isothermal process in deformation center, excludes the necessity of previous preparation and prevention of surfaces. In this case, strength of layer connection may approximate or exceed strength limit of cladding layer.

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PP 28. EXPERIMENTAL AND THEORETICAL INVESTIGATION OF MELT CRYSTALLIZATION KINETICS IN MULTICOMPONENT SYSTEMS

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Low temperature ionic melts such as crystalline hydrates and ionic liquids are considered as handy objects for an experimental investigation of crystallization kinetics. Nickel nitrate $Ni\ (NO_3)_2{\cdot}6H_2O$ as model object has been used. Investigation of melt crystallization kinetics makes it possible to spread obtained results on overall phase transition class. The presented mathematical model considers change of system temperature depending on conditions of heat exchange and thermal effect, and also redistribution of components at phase transition in condensed multicomponent systems.

The research of crystallization kinetics in two-dimensional systems (films) for nickel nitrate $Ni\ (NO_3)_2{\cdot}6H_2O$ was carried out by measurement of the luminous flux transmission.

Calculation of crystallization degree M is carried out based on transparencies difference for liquid and solid phases.

The crystallization in three-dimensional (T-D) systems was studied on the basis of the thermal analysis and measurement of electric properties of samples. The temperature (using miniature resistance sensor), electric resistance and capacity (using specially developed follow-up electronic device for measurement of impedance vector [1]) in experimental cell have been measured during crystallization.

While the reverse curve of electric resistance logarithm presents more qualitative reflection of crystallization kinetics, temperature data has been used for calculation of crystallization degrees *M* change in time.

An equation is used generally to describe phase transition process kinetics, which describes changes in phase conversion degree, M with time, τ:

$$M(\tau)=1-\exp(-B\tau^{k})$$

or:

$$\ln\{-\ln[1-M(\tau)]\}=\ln(B)+k\ln(\tau)$$

Equation (1) is a trivial solution of Kolmogorov-Avrami's kinetic equation [2-4], which is in general presented as convolution integral [5].

$$M(\tau)=1-\exp\{-\int_{0}^{\tau}J(t)C_{f,V}[\int_{t}^{\tau}V(\theta)d\theta]^{n}dt\}$$

J – is nucleation intensity; V – linear growth rate; $C_{F,V}$ – is shape factor of particles, when area f_c (for 2-space systems) and volume V_c (for 3-space systems) are expressed by characteristic linear size (radius) r : $f_c=C_f \cdot r^2$, $V_c=C_V \cdot r^3$ (for circle $C_f=\pi$, for sphere $C_V=4\pi/3$); $n=1,2,3$ – is system space dimension. At suppositions, that $J=const$, $V=const$ from (3) parameter $B=C_V JV^n/(n+1)$ from equation (1) is determined; $k=n+1$, however in case of simultaneous formation (or introduction) of all the N_m centers at process beginning nucleation intensity is expressed by Dirac's Delta Function: $J=N_m\delta(\tau)$, and then $B=C_V N_m V^n$; $k=n$.

The linear formula (2) when *N=const* suits for approximation of experimental data well but slopes of lines *k*=2.14 and *k*=3.09 somewhat differ from theoretical values for two-dimensional and three-dimensional systems accordingly.

Mathematical model of non-isothermal phase transition process (for three-dimensional system), taking into account changes in the system composition is presented as a differential equation system [6]:

$$\frac{dN_U}{d\tau} = J \tag{4.1}$$

$$\frac{dL_U}{d\tau} = N_U \cdot V \tag{4.2}$$

$$\frac{dF_U}{d\tau} = 2C_F L_U \cdot V \tag{4.3}$$

$$\frac{dM}{d\tau} = 3\frac{C_V}{C_F} F_U \cdot V(1-M) \tag{4.4}$$

$$\frac{dN}{d\tau} = J \cdot (1-M) \tag{4.5}$$

$$\frac{dL}{d\tau} = N \cdot V \cdot (1-M) \tag{4.6}$$

$$\frac{dF}{d\tau} = 2C_F L \cdot V \cdot (1-M) \tag{4.7}$$

$$\frac{dT}{d\tau} = -K_m(T-T_S) + \frac{q}{c}\frac{dM}{d\tau} \tag{4.8}$$

$$\frac{dX_i}{d\tau} = \frac{1-\alpha_i}{1-M} X_i \frac{dM}{d\tau} \tag{4.9}$$

FU, LU, NU – are summary surface; length and number of particles, respectively in conditions of unlimited growth; F, L, N – are actual summary surface; length and number of growing phase, respectively; T, Ts – are system and external medium temperatures; Km – is heat exchange coefficient; q – is heat of phase transformation; c – is heat capacity of the system; XI, αi – are concentration and inter-phase partition factor of the i-th component, respectively; Here surface shape factor CF is used for expression of particle surface (for 3-space systems) by characteristic linear size (radius) r: $F_c=C_F \cdot r^2$ (CF= $C_F=4\pi$ for sphere).

Application of the proposed mathematical model enables calculation of both general process kinetics, as well as parameters, characterizing the forming graininess and texture of three-space systems and films. In general the presented mathematical model can be applied for the simulation of phase transition processes in condensed systems, such as crystallisation of melts, glasses and other vitreous solids, polymers, epitaxial growth of films, decomposition of solid solution etc.

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PP 29. STUDYING ENGINEERING PROCESS OF MANUFACTURING MUZZLES FOR COMBAT WEAPON

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Selection of material with rational composition for muzzles of combat weapons of special purpose and perfection of technology of manufacturing appropriate muzzles is very topical and problematic issue. In this regard the work foresees study and analysis of special tubes manufacturing methods for elaboration of cheap, simplified and improved technology.

Materials used in available engineering processes of manufacturing weapon muzzles, such as 30XH2MFA and 50RA-type steel for carbines and guns is very expensive and requires an application of complicated processes of thermal processing. Tube blanks of special purpose, represented by metal rods, after thermal processing undergo perforation with the use of expensive perforators.

After perforation and mechanical treatment of blanks it is necessary to make spiral furrows on the interior surface of blank for giving the slug (bullet) rotational movement that provides stable and linear motion of bullet.

In current practice there are following methods of making furrows on the interior surface of muzzle: 1) forging; 2) mandrel drawing; 3) furrowing and 4) chemical erosion.

For implementation of abovementioned processes are used expensive bulky machines and devices, and this fact in whole complicates the operation conditions and makes the use of mentioned processes more expensive.

In this work on the basis of theoretical and practical researches is represented the substitute for materials used for available combat weapon, which is relatively cheaper and is characterized by reasonably good mechanical properties. The improved highly effective processes of making muzzle barrels are are determined [1]. Besides, this work foresees elaboration and assimilation of simple, cheap and reliable devices, which give the opportunity of making spiral furrows on the interior surface of muzzle.

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PP 30. INNOVATION TECHNIQUE FOR RECEPTION OF HIGH-PERFORMANCE LUMINOPHORE

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Luminescence defectoscopy is based on the ability of a luminescent test solution – penetrant (solution of luminophor in the organic solvent) to penetrate unnoticeable surface defects (1µm) and then by lighting in the UV radiation area to display their character and location Synthetic luminophors used in luminescent defectoscopy have high luminescent properties but at the same time are expensive and toxic. The aim of the project is to improve simple technology worked out by to release high by effective non-toxic luminophor from natural raw material and reduce it to the licensing condition.

Luminophor obtained by the offered technology has high operational properties. In particular, it has an ability to detect microcracks less than 1 µm; luminescence intensity in relation to the standard – uranyl nitrate is 450-500%, colour factor is greenish-yellow; the product is cheap highly adhesive and stable which corresponds to the International Standarts.

The suggested technology is based on the use of local inexpensive raw material. In comparison with the prototype [1,2], technology is oversimplified which lowers the cost of production. Presented project could be interesting for both, local and global markets.

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PP 31. THE AVAILABILITY OF NATURAL GAS CONTENT IN SHALES OF KAZBEGI-OMALO ZONE

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From the viewpoint of the shales spreading, lithologic content and tectonic peculiarities Georgia can become a country producing significant amount of shale-gas, taking into consideration the characteristic index of natural gas content and experience of revolution recently [1] made in North America in the sphere of shale gas and oil.

From the viewpoint of gas content, the promising ones may be shales of various age and content. So called black shale (carbon-bearing) formations are known almost on all the continents and they are of various ages. They were formed in the deepwater (bathyal) of sea basin and along the continents in the shelf (shallow water) seas and lagoons where the processes of biogenic sedimentation were clearly observed. Sometimes these processes united sedimentary and volcanogenic-sedimentary rocks altered at various degrees, sometimes bituminous argillites and oil shale.

Shales are also well spread in Georgia, in various tectonic units and comprisequite vast territories [2,3]. Taking into consideration a number of significant data, at this stage of researches we chose shales of the Caucasian Folded System. Just these researches of shales of the Kazbegi-Omalo zone are financed by Shota Rustaveli National Foundation fund; on basis of data of these researches we develop criteria for prospecting works.

We have described and researched sandstones (quartz sandstones, quartzites, arkosic sandstones), siltstones (slates, siltstone-psammite) spread in the Lower and Middle Jurassic depositions. The latter of the aforementioned components occupy about 80% of the Lower and Middle Jurassic depositions.

The generation of the Lower and Middle Jurassic schistose terrigenous formation of the Caucasian Folded System took place at certain stages of development of sedimentation basin under various paleo-tectonic, paleo-volcanic and sedimentation conditions that is well reflected in the represented complexes where there are distinguished the Hettangurian-Sinemurian (transgressive), Upper-Pliensbachian-Lower Toarcian (transgressive-regressive) and Upper-Toarcian-Aalenian-Bajosian (regressive) series of different lithologic composition [4].

On the whole territory of the Kazbegi-Omalo zone (the Kazbegi region, the gorges of rivers Asa, Pirikita Alazani, Tusheti Alazani, Story and etc.) we carried out fieldworks and took samples of shales from natural exposures and sections; then we described and researched them in laboratory (microscopic, X-ray-phase, X-ray fluorescent, thermal analyses) and considering the results (tectonic conditions, mineralogic paragenesis, organic carbon content, level of the catagenesis) we distinguished, from the viewpoint of shale-gas content, promising local districts; we took into account the necessary demands for ensuring further environmental safety. Lots of specialists argue about the environmental effects in the result of shale gas production and about the regulation of these issues. Accordingly, it is necessary to control all the problems related to the environment safety in the process of prospecting shale gas in Georgia.

Noteworthy is the analysis of the probable role of catagenesis and natural fissuring of the shales. According to the available data, the metamorphism degree in some zones of Racha-Svaneti and Kazbegi-Omalo corresponds to thermogenic gas window (of high maturity close to half anthracite stage).

In terrigenous formation organic material is represented by scattered micro-inclusions of various contents. Carbon content in the rocks is conditioned by their lithologic-granulometric content and metamorphism degree. The richest in organic content are pelitic rocks – shales, considerably poor are - siltstones and sandstones. It’s obvious that the best way for establishing the regularity of accumulation and distribution of organic material in the basin of terrigenous sedimentation is to study the material content of shales [5].

The results of our researches and literary data show that in the Lower- and Middle Jurassic rocks (shales, siltstones, arkosic sandstones) there is fixed quite high content of carbon (up to 2%). Accordingly, the territory can be considered as promising from the viewpoint of natural gas content, as the organic carbon content is more than 0, 90% (shales), and the post-diagenetic alteration corresponds to the metagenesis stage [6].

Accordingly, considering a number of parameters and properties, the Lower- and Middle Jurassic sedimentary formations represent one of the most promising, non-traditional gas containing object, though for previous evaluation of the hydrocarbons resource potential it is necessary to carry out further large-scale field works and laboratory researches.

In case of establishing the productivity even of the smallest part of the researched shales, Georgia can become one of the richest contries producing shale gas.

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PP 32. HIGH-TEMPERATURE ELECTROCHEMICAL SYNTHESIS OF SOME INTERMETALLIDES

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Attractiveness of electrochemical synthesis – important part of electrochemistry is caused by the fact that it makes possible to create such conditions in the reaction site (oxidation-reduction potential, rate of electrode processes etc.) that is not possible to implement in the conditions of usual (specimen) synthesis. Two or more-component intermetallides can be received using electrochemical synthesis that is implemented:

- Naturally, in the given melt metals are reduced in equilibrium (quaziequilibrium) condition – within the range of 0,2 v potential;
- Via mutual influence of depolarizers, selection of "intercompatible" depolarizers that provides electrochemical reduction of targeted metals in quaziequilibrium condition;
- Via change in acid-alkaline balance of electrolyte – by means of cationic (anionic) additives [2].

Electrochemical behavior of depolarizers – YF_3-$AlCl_3$ (Na_3AlF_6); YF_3-AlF_3 (Na_3AlF_6)-$Ca(VO_3)_2$; $NaMoO_4$-$CoCl_2$($NiCl_2$) against the background of melts of alkaline metal halogenides was studied by us, and acid additives (Ca^{2+}, Mg^{2+}, PO_3^-) were used for this purpose. As a result becomes possible an approach in desirable limits of potentials of electroreduction of metals available in melt.

Voltammetry, potentiostatic and galvanostatic electrolysis, X-ray phase, X-ray microanalysis and chemical analyses were used as research methods. As a result of the research were determined electrolyte composition and optimum parameters of processes.

Receipt of YAl_3 using galvanostatic electrolysis:

Melt composition (mass %): KCl(85) + YF_3(12-13) + $AlCl_3$($NaAlF_2$) (3-2), T – 1073K, D_k – 0,25 A/cm^2, τ – 60 min, cathode – Ni, anode – graphite, current yield – 85-90%.

Ratio of electrolyte components for receipt of intermetallides $MoCo_3$ (Ni_3) using potentiostatic method is:

$$[MoO_4^{-2}]:[Co^{3-}(Ni^{3-})]:[Mg^{2+}\ or\ (PO_3^{-})]=5:1:2(2,5)$$

The following intermetallides: YF_3, YAlV, $MoCo_3$, $MoNi_3$ are synthesized in the form of fine (dispersed) powders.

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PP 33. SYNTHESIS OF GOLD NANOPARTICLES FROM GOLD HYDROCHLORIC ACID BY USING THE RED WINE

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Key words: gold nanoparticles, red wine, "green" chemistry, electron microscopy, ferromagnetism

Gold nanoparticles are widely used in medico-biological research, immune analyses, clinical chemistry, target delivery of medicines, oncology, etc. [1, 2]. Such widespectrum applications of the gold nanoparticles are derived from their unique optical, physicochemical and catalytic properties. It is noteworthy that the nanosized gold manifests ferromagnetic properties which are not characteristic of macrosized gold [3].

Toxic reducing agents such as sodium borohydride and hydrazine are often used for fabrication of gold nanoparticles. The reducing agents of this kind allow synthesizing nanoparticles; however, because of the adverce impact of such reducing agents on the environment and human health, they have to seek for and to develop alternative methods of the synthesis of nanoparticles. The fabrication of nanoparticles by green chemistry is among these methods.

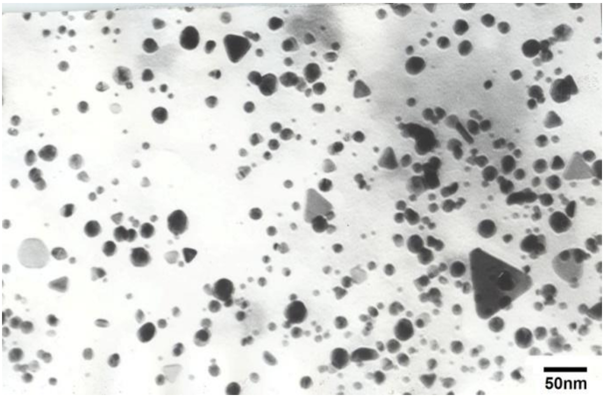

Figure 1. Microphoto of the synthesized gold nanoparticles.

The advantages of this method are environmental friendliness and harmless for the man, the synthesis goes not take much time, and the process is of low cost.

In this work the synthesis of gold nanoparticles from gold hydrochloric asid $HAuCl_4$ was investigated. Dry red wine Saperavi produced by traditional ancient Georgian technology in clay Jugs (kvevri) was used as a reducing agent. The synthesis was performed at room temperature. For preparing the working solution of concentration 10^{-3}M, the concentrated solution of $HAuCl_4$ and distilled water were used. The red wine was added in small portions to the initial reagents in a testing tube with continuous stirring of the solution. The development of an orange-red color of the solution pointed to the formation of gold nanoparticles. The solution was stable; there was no aggregation of the nanoparticles for several weeks. Hence the red wine Saperavi was simultaneously a reducing and stabilizing agent.

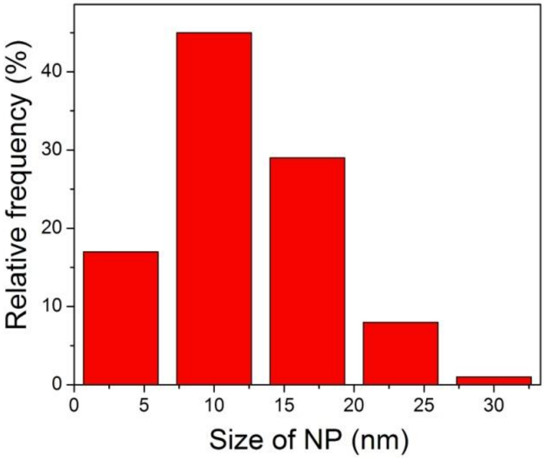

Figure 2. Distribution of gold nanoparticles by their size

The optical absorption spectra were recorded with the help of UV spectrophotometer Sintra 10e. The absorption peak was located close to the wavelength 550 nm. The peak was caused by surface plasma resonance associated with the collective excitation of conduction electrons and localized in a wide spectral range from the visible region to the UV one depending on the size, structure and shape of the nanoparticles [1].

Transmission microscope JEM-100SX was used for electron-microscopic investigation. In fig.1 it is seen that the sizes of nanoparticles varied over a wide range from 3 to 30 nm. In the mikrofotos, the nanoparticles of various shapes are seen: spherical nanoparticles, nanowires, nanotriangles, nanocubes and other.

Therefore, by using the dry red wine, we can fabricate stable gold nanoparticles at room temperature. The suggested method is simple and cheap with the use of nontoxic reagents. The obtained results are promising for application in medicobiological practice and invite further investigation.

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PP 34. NUCLEATION OF SILICON DIOXIDE NANOPARTICLES IN THE SOLUTION BASED ON TETRAETHOXYSILANE

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Key words: nucleation, tetraethoxysilane, alcohols, electron-mikroskopy, silicon-dioxide

Dielectric films have wide application in microelectronics and nanotechnology. Recently the methods of deposition of dielectric films from solutions have been developed. Based on the investigation of the properties of lower aliphatic alcohols, it was revealed that tetraethoxysilane was the most suitable for the synthesis of SiO_2 films. Tetraethoxysilane is most often used as an

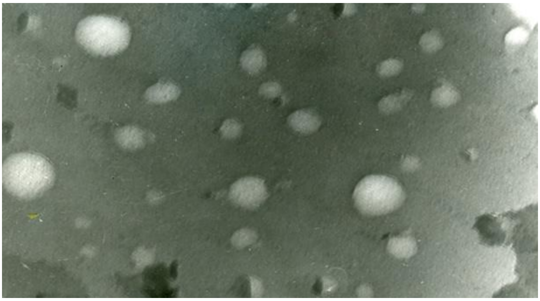

Figure 1. Microphoto of the synthesized nanoparticles.

initial reagent. Acetone and ethanol containing minor amounts of water are the most suitable solvents.

In this work, the silicon dioxide films were deposited from the solution of tetraethoxysilane and ethanol. Hydrochloric acid was used as a catalyst of hydrolysis and **as a stabilizer of the film-forming solution.** The deposition was performed by centrifugation at the rate of 2500 rev/min. The substrate was silicon of p-type conduction with crystallografic orientation (111) and 60 cm in diameter.

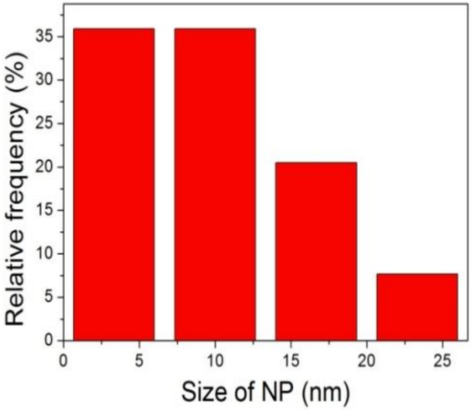

Figure2. Distribution of nanoparticles by the size

The deposited layers were placed in a thermostat and dried at 130^{0}C for 35 min. The temperature was gradually increased up to 200^{0}C, and the films were kept for 50 minutes. The final drying took place at 290^{0}C for 40 min in the thermostat. For complete removal of the solvent and organic residue, the obtained films were annealed at 450^0C for 1 hour in a diffusion furnace. Dense oxide films with good adhesion to the silicon substrate were formed.

The analysis of the IR spectra recorded by using the spectrophotometer UR-20 showed that the absorption region of the films was over the wavelength range from 1000 to 1150 cm^{-1} corresponding to the Si-O bond. Other organic residue was not observed.

The electron-microscopic examination, performed using the transmission microscope JEM-100SX, showed the presence of spherical nanoparticles in the SiO_2 films fig. 1.This can be related to the phenomenon of nucleation of nanoparticles in the film-forming solution based on TES, the nucleation representing the first-kind phase transition. The nucleation usually occurs in the oversaturated solution. The oversaturated solution is a metastable state of solution which exists for a very short time during which the excessive substance settles out. The distribution of nanoparticles by their sizes is shown in the fig. 2. The films were porous and had rough surfaces and somewhat worse electric properties than the films deposited from the solution of TES and acetone. In spite of this fact, the obtained films are promising for application in the following fields:

- Medicine, particularly dermatology;
- Synthesis of magnetic nanocomposites;
- As model objects in biophysical studies;
- Optics of speckles;
- Gas sensors;

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PP 35. LIQUID STEEL TREATMENT WITH EXOTHERMIC SLAG-PRODUCING MIXTURE

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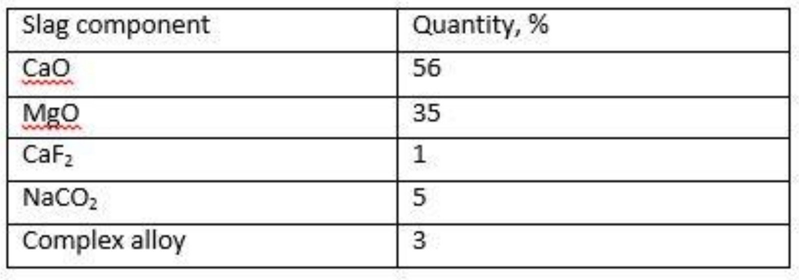
For the purpose of improving of liquid steel quality, methods of out-of-furnace treatmentof liquid steel are broadly used, including steel treatment with exothermic slag-producing mixtures.

The work aims at optimization of steel treatment process using exothermic slag-producing mixture of optimal composition.

For this purpose, we have developed a slag-producing mixture. Exothermic component of the mixture is a complex alloy obtained from industrial wastes with the following chemical composition, mas. %: 30 Al , 21% Si , 3,5 Ca , 2,5 Mg, 0,10 C, 0,01S, 0,02P , 42,87 Fe [1]. Composition of the proposed slag-producing mixture is given in Table 1.

Table 1. Composition of the proposed slag-producing mixture



Slag component	Quantity, %
CaO	56
MgO	35
CaF_2	1
$NaCO_2$	5
Complex alloy	3

Liquid steel was treated using the proposed mixture in a mixer. The steel was melted in an electric resistance furnace. The steel temperature at the moment of releasing from the furnace was 1923 K. In the mixer, 1/3 of total volume of liquid steel to be treated was added to the slag-producing mixture. The rest of the steel was added in 3 minutes. The alloy of steel and the slag-producing mixture stayed in the mixer for 7 minutes and then samples of the steel and the mixture were taken.

After processing of the obtained results, it was established that sulfur content in the treated steel was reduced to 80-92 %, and phosphorus content to 30-41 %. Total quantity of non-metals was also reduced.

Thus, liquid steel treatment using proposed slag-producing mixture ensures high quality of steel, which is a precondition of supplying competitive products to consumer market.

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PP 36. POWDERY COMPOSITES CONTAINING GRAPHENE MODIFIED ALUMOORGANIC COMPOUNDS

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Graphene (2D structure) has unique physico-chemical properties: due to its prospective potential, this century is called graphene century. Graphene appears to be the strongest material and thus invlovment of its fragments into corundum ceramics increases exploitation characteristics of the materials. Fixing graphene fragments on alumina surface by alumoorganic compounds results in new type graphene-alumina complex, in which these two components are connected by C-O-Al bonds. Alumina particles are isolated with graphene layer in ceramics (consolidated by such powders), and at the same time they increase flexural strength and fracture toughness of materials. Graphene-alumina hybride composite at the level of ceramic microstructure is resulted by powders sintering (Formal analogy: Inorganic-Organic Hybrid composite contained in a mollusk shell). Obtaining new type powdery composites based on modified graphene and alumina has been received by using the available materials (graphite, alumina, alumoorganic compounds). Synthesis of ceramics containing of graphene structure according to the following scheme: alumina→alumoorganic modified alumina→graphene oxide immobilization on modified alumina → ceramics. Ultrafine alumina powders are obtained by sonification of aluminium powders in alkaline environments (ammonium alkaline, 80^0C) and by subsequent annealing of obtained gels at 800-1200^0C temperatures (Fig.1).

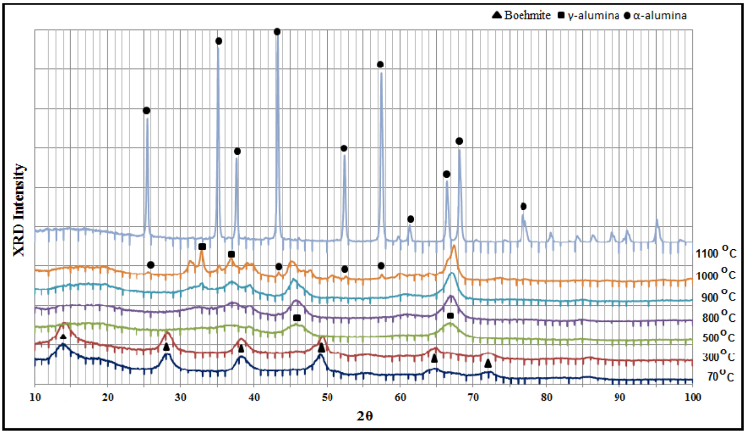

Figure 1. Transformation of metastable aluminium oxyhydroxide in α-Al_2O_3 phase

Graphene oxide (functionalized graphene), that consists of (-OH, -COOH, -O-O-) functional groups are obtained by oxidation of graphite powder ($KMnO_4$, HNO_3, H_2SO_4). Direct functionalization of graphite has been implemented by grinding in nanomill in a presence of solid oxidants. Modification of alumina and functionalized graphene has been performed with different types of alumoorganic compounds in inert atmosphere. Pressing powdery composites [graphene]–O-AlR–O-[Al_2O_3] and [Al_2O_3]-O-AlR–O-[graphene]–O-AlR–O-[Al_2O_3] have been obtained. Due to reactive

Al-C bonds, modification processes are carried out at room temperatures. Accounted for alumoorganic compounds (AlR_3, $AlXR_2$, AlX_2R), it became possibile to connect chemically graphene fragments and correspondingly grow 2D structure, or create 3D structure from multi-layers, connected with Al-O bonds. Composites containing similar types of graphene structure (single and multi-layers) create new functional materials, applicable in photovoltaics, sensors, new type catalysts, energy storage, information recording and reserving sources and etc.

During the work the following devices have been used: high temperature vacuum furnace OXY-GON Industries Inc (USA), Electronic Scanning Microscopes Nikon Eclipse LV 150, Optical Microscope NMM-800TRF, Planetary mill Pulverisette 7 *premium line*, Shimadzu Dynamic Ultra Micro Hardness Tester DUH-211S, Analysette 12 Dynasizer and others.

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PP 37. CLEANING NATURAL AND RIVER WATER USING LOW COST SORBENTS AND THEIR FURTHER USE

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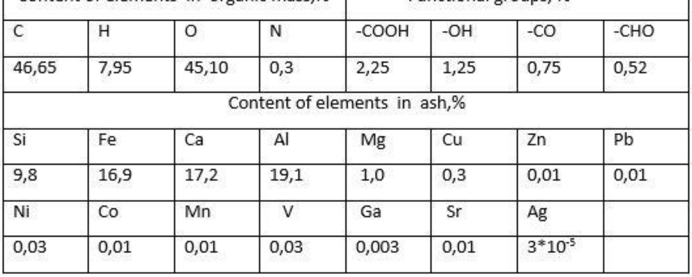
Cleaning by adsorption is a priority direction in cleaning large volume of water. Natural materials and their modified forms are used to provide effective cleaning of water. Research is being carried out to find out how industrial waste can be used as sorbent, which has features similar to expensive sorbents.

Coal slates from Tkibuli (Coal enrichment tails) is one example of such waste material. The research studies physical-chemical features of Tkibuli coal slates and their adsorption characteristics. As a result, the material can be categorized as an organic-mineral sorbent. Modern methods of research - radiographic, radio structural, micro radio spectral have revealed that coal slates contain 40%-60% of mineral and 30%-40% of organic parts [1]. The table below shows the chemical structure of Tkibuli coal slates.

Table 1. Chemical structure of Tkibuli coal slates quick tightening material



Content of elements in organic mass,%				Functional groups, %			
C	H	O	N	-COOH	-OH	-CO	-CHO
46,65	7,95	45,10	0,3	2,25	1,25	0,75	0,52
Content of elements in ash,%							
Si	Fe	Ca	Al	Mg	Cu	Zn	Pb
9,8	16,9	17,2	19,1	1,0	0,3	0,01	0,01
Ni	Co	Mn	V	Ga	Sr	Ag	
0,03	0,01	0,01	0,03	0,003	0,01	$3*10^{-5}$	

Adsorptive effectiveness of coal slates in relation to ammonium ions, phosphates and heavy metals – Fe, Cu, Pb, Zn, Ni, and Cd has been studied [2]. Optimal parameters of adsorption of heavy metals in water have been found. Possibilities of removing copper and cadmium from natural and river waters through the use of slates have been studied. Adsorption isotherm has been drawn; adsorption kinetics and the influence of various factors on the process have been researched. The results show that the presented sorbent is effective in cleaning low Fe, Cu^{2+}, Pb^{2+}, Zn^{2+}, Cd^{2+} natural and river waters. The waste can be further used in the production of construction materials.

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PP 38. SYNTHESIZE ANTI-CORROSION COVER ENAMELS – PLANNING AND OPTIMIZATION OF THE EXPERIMENT

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Development of new engineering and technology leads to a tightening of requirements for protection of surfaces of metal products and coatings on them. The most reliable protection of metal products to this day is enamel coating due to its heat resistance, high anti-adhesion and anti-corrosion properties in various aggressive environments, gloss, wide color gamma and etc.

The process of synthesizing the protective enamel coating is energy-intensive and time-consuming process, which takes a great time and a lot of high qualified scientific personnel. Therefore, the problem of planning and optimization of the process of synthesis enamel frits and coatings based on them becomes important and crucial role in the protection of surfaces of metal products for different purposes.

Searching areas adapted system Na_2O - RO_3 - B_2O_3 - TiO_2– Aragats perlite. Analysis of the references [1-3] and own data led to the conclusion that the content of individual components should be changed to following ranges: Perlite 46-56, B_2O_3 7-15, TiO_2 13-18, R_2O 12-17 and RO_3 2-6 wt. %.

To determine the optimum composition of enamels programs were drawn for [4,5] planning and optimizing experiment and predicting properties depending upon the composition based on the method of multiple linear regressions. Using the software were minimized the experiment time and flow rate of experimental materials.

To determine the optimal composition chemical resistance in the water and the thermal coefficient of linear expansion of the enamel frit were selected as the main Properties. These properties were measured by known methodologists. Program for planning of the experiment gave 22 compositions in the aforementioned range of the system under study. Research of glass formation in the pulping temperatures ranging between 1523-1573^{O}K showed that half of the compositions did not give homogeneous glasses.

Subsequently, the following properties were examined in 11 synthesized glasses: chemical resistance in water, the temperature coefficient of thermal expansion (TCTE), softening temperature of enamel, whiteness and gloss of enamel coat, fluidity enamel frit, temperature and interval of firing the enamel.

Processing experimental data using computers gave the following mathematical relationships between properties and the composition of the glass:

---**TCTE**
α=0,3[**Perlite**] + 0,534[**B_2O_3**] + 0,779[**TiO_2**] + 4,553[**Na_2O**] + 1,375[**RO_3**]
--- **Softening temperature**
Tg=7,884[**Perlite**] + 5,855[**B_2O_3**] + 9,606[**TiO_2**] + 5,643[**Na_2O**] + 5,576[**RO_3**]
--- **Chemical resistance**
ChR=1,001[**Perlite**] + 0,9956[**B_2O_3**] + 1,003[**TiO_2**] + 0,9961[**Na_2O**] + 0,99[**RO_3**]

In square brackets are shown components by weight %. These Research data are shown in the Table 1.

Table 1. Research data

#	$\alpha_{experimental}$, $10^{-7}\cdot grad^{-1}$	$\alpha_{calculated}$, $10^{-7}\cdot grad^{-1}$	Tg experimental, ^{O}K	Tg calculated, ^{O}K	ChR experimental, %	ChR calculated, %
1.	113.3	114.8	758	760	99.99	99.99
2.	119.0	119.0	763	751	99.95	99.95
4.	110.5	114.2	743	735	99.96	99.95
6.	91.1	94.4	758	755	99.99	99.97
8.	120.0	116.6	753	744	99.98	99.95
11.	114.7	113.5	724	741	99.97	99.96
13.	97.5	94.7	753	761	99.97	99.99
17.	93.5	93.9	755	750	99.98	99.97
19.	103.9	101.5	753	742	99.98	99.96
21.	95.9	95.1	733	742	99.97	99.94
22.	118.5	118.5	725	739	99.97	99.92

Table 2. Some technological properties of enamel

#	firing temperature, ^{O}K	firing range, ^{O}K	Gloss, %	Whiteness, %	Fluidity, mm
1.	993	973-1053	35	10	55
2.	993	973-1053	32	33	36
4.	1023	1013-1123	36	38	46
6.	1043	1033-1123	34	37	20
8.	1093	1073-1123	36	35	28
11.	1023	1013-1123	29	33	46
13.	1043	1023-1073	30	42	18
17.	1013	993-1053	40	37	30
19.	1003	993-1053	33	25	25
21.	1093	1083-1163	31	37	40
22.	1083	1063-1133	20	55	35

With the help of optimization program composition №21 was chosen as the base of enamel. Minimum correction of the selected enamel by method of adding to composition P_2O_5 - 1,3-3, Li_2O - 1-8,5 and increase TiO_2 up to 16 wt.% gave us a practical enamel composition with the necessary technological properties: SiO_2 39-44, B_2O_3 4-10, Al_2O_3 8-10,5, Na_2O 10-15, K_2O 0,6-1,5, TiO_2 12-18, P_2O_5 1,3-3, CaO 0,8-4, Li_2O 1-8,5, Fe_2O_3 0,05-0,2, MoO_3 or WO_3 2-6 wt.%.

Obtained Enamel coatings successfully passed test where they were held 1,5m underwater for one year in the Black Sea coast zone.

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PP 39. PHYSICAL-CHEMICAL STUDY OF MINERALOGICAL COMPOSITION OF NATURAL PELOID “PHKHOVELI”

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Minerals that are inorganic part of Pkhoveli therapeutic muds are examined in this work. The opinion is expressed that given clay consists of primary (mineral of montmorillonite-beidelite group, glaukonit, kaolinite) and secondary (quartz, feldspars, calcite, pyrite) minerals.

Peloid is the product of Pkhoveli mud volcano, it belongs to so-called “bald mountain peloids” group. It is characterized by curative properties.

Information on the nature of inorganic component of this clay is given in [1]. It is shown that the basic mineral of Pkhoveli peloid inorganic part is Montmorillonite. Though, is not specified in which form this mineral is represented and which minerals coexist with it.

Analysis of information sources [1-7] clearly shows, that individualization of Montmorillonite, namely of anhydrous sheet silicates involves some problems. For example, in case of clay minerals such effective research methods of studying crystals as diffractography, doesn’t allow us to make univocal conclusions. It is a result both of difficulty in obtaining of respective reference standards for most of minerals, and of identity of their X-ray reflection.

That is why clay analysis needs multistep, complex research. It consists of diffractography, IR spectroscopy, derivatography, crystal optics, various means of chemical analysis, respective treatment of the subject etc.

For a most part the carrying out of two stages of research – research of primary (initial) sample and study of received products by various methods of clay treatment according to the results of this research is recommended.

Just because that the results of initial samples researches have been represented in previous work, our research objective was the determination of nature of peloid's inorganic component, and that points a necessity of carrying out of subject's thermal processing, in order to remove organic components that are a part of clay and adsorbed water, the part less bonded with basic mass.

Using this content and data presented in information sources [1-6], petrochemical calculation has been carried out by us in order to determinate clay's possible mineral content.

Oxides that are the part of the composition are completely presented in the following minerals:

Montmorillonite (Mt) _ $(Ca,Na)_{0,35}\cdot(Al,Mg,Fe)_2[(Si,Al)_4O_{10}](OH)_2\cdot nH_2O$;

Beidellite (Bei) _ $(Ca,Na)_{0,3}\cdot Al_2[(Al,Si)_4O_{10}]\cdot(OH)_2\cdot 4H_2O$;

Glauconite (Gl) _ $(K, Na)(Al, Fe)_2[(Al,Si)_4O_{10}](OH)_2$;

Pyrite _ FeS_2;

Feldspars: Anortite (An) _ $CaO\cdot Al_2O_3\cdot 2SiO_2$;

Albite (Ab) _ $Na_2O\cdot Al_2O_3\cdot 6SiO_2$;

Orthoclase _ $K_2O \cdot Al_2O_3 \cdot 6SiO_2$;

Calcite (Q) _ $CaCO_3$;

Kaolinite (Kt) _ $Al_2O_3 \cdot 2SiO_2 \cdot 2H_2O$;

Two of the enumerated minerals are from Montmorillonite-Beidellite group and are inclined to mutual binding, while structural binding between them and Glauconite-Kaolinite is expectable. As to others – they can be numbered among the secondary products according to the consideration of soil mineralogy.

Mineral content of Pkhoveli clay inorganic part is testified by the diffractogram of research (Fig. 1). Reflections are clearly distinguished that are characteristic for the most of minerals **[Mt-Bei, Gl, Cc, Q, Fs P (An, Ab, Or)],** and are sufficient for giving a research gradation for the rest.

Absorption bands existing in IR spectrum point out the existence of expectable minerals (Fig. 2). In shortwave area are distinguished three groups of bands: bands existing in 3800-3400 cm^{-1} area should be caused by the oscillation of structural hydroxides in octahedral layer (sheet), 3625-3650 cm^{-1}-of **Al-OH** bond, while 3400-3410 cm^{-1} - by oscillation of adsorbed hydroxides, that gives the band of malformed oscillation at 1600 cm^{-1}.

In the long-wave area the bands existing in 1000-1100 cm^{-1} should reflect oscillations of **Si-O** bond, in 900-950 cm^{-1} – of aluminum being in tetrahedral state, in 845 cm^{-1} – of three-layer minerals, while in 500-535 cm^{-1} – by oscillations of Si-O-A l(IV) bond.

Thermography fixes clearly one "strong" (160°C) endo-effect and another one with lesser value (600°C). First among them should be linked with removal of adsorbed water, while the second one – with removal of structural water, that must be succeeded **Mt-Bei** structure's shift. This phenomenon, as it seems, should be accompanied by heat generation started at 600°C. Exothermic (heat-generation) effect with the maximum at 420°C in our opinion should be linked with the water of organic matter. Its value points out that it is the part of organic matter that is not removed from the subject during initial thermal processing. **TG** curve is in exact accordance with phenomena fixed by **GTA** (Fig. 3).

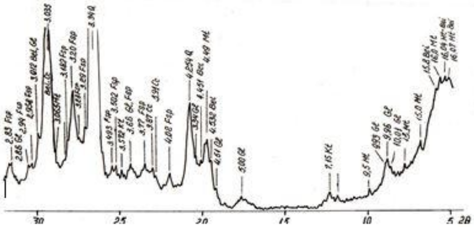

Figure 1. *Fragment of diffractogram*

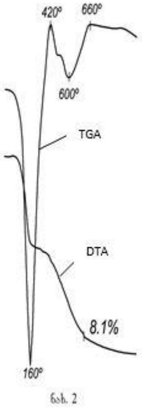

Figure 2. IR-spectrum

Figure 3

Mineral-petrographic analysis shows that basic mass of polished specimen is less crystallized (its grains are of colloidal size), in which calcite and quartz (feldspar) grains are included in the form of insertions. It is more difficult to make conclusions during analysis of polished specimen of locally taken sample, though the photography of polished specimen discovers the picture characteristic for montmorillonites.

Therefore, we can conclude that inorganic component of Pkhoveli healing clay basically represents sheet silicates of montmorillonite-beidellite group, to which minerals of glist and probably kaolinite group are merged. Quartz, Calcite, Feldspar and probably Pirite are diffused in this basic, mostly amorphous mass. As it seems inorganic part of clays from this location can be divided into primary and secondary minerals. The first includes minerals that are developed as a result of low-temperature processes or formed during attenuation in-statu. Minerals of the second group are developed under high temperatures and pressures and get into peloids in the course of sediments deposition cycle.

In the end we would like to mention that thoughts expressed by us have the nature of rather assumption, than substantiation and needs the carrying out of special new cycle of researches that is scheduled for the future.

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PP 40. RECOVERY OF SPECIAL COMPOSITION MANGANESE CONCENTRATES FROM THE CHIATURA LOW GRADE ORES

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According to the established technology at the Chiatura Mining and Concentration Complex, selective extraction of manganese ores is not carried out and mixed ore is supplied to the plants. In these enterprises concentrates are produced only by the content of manganese that is incorrect, because neglecting specific composition of the raw ore in most cases limits the capacity and efficiency of target application of obtained concentrates and products in the production of ferroalloys.

The Chiatura ore belongs to the group of poor ores and due to the low technological characteristics of concentrated ores (yield of the concentrate does not exceed 25%, and Mn reduction is 60%) a big amount of unused waste is obtained as a result of concentration (yield – 75%, Mn – 12-18%), piled on the territory adjacent to Chiatura having a huge ecological impact on the region.

For rational using of Chiatura ore, extending the mine exploitation, reducing industrial waste and improving the ecological environment it is better to produce special composition concentrates and products at the Chiatura Mining and Concentration Complex, which will be used in ferroalloy production.

The paper deals with the technology of obtaining special composition concentrates and products for producing medium-carbon ferromanganese, electrolytic manganese and silicomanganese from Chiatura carbonate ores, intermediate products and enrichment tails; basic parameters of the concentrates are also presented.

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PP 41. OBTAINING MANGANESE FERROALLOYS FROM SPECIAL COMPOSITION CONCENTRATES AND PRODUCTS

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In 2014, molten steel has reached in the total number of 821 349 tons in half a year, which is 2.5% higher than the previous year's figure.

Typically, a quantitative increase in steel leads to the increase of ferroalloy production.

According to the current data, an average of 250 thousand tons of silicomanganese is melted in Georgia each year and ferroalloy export has taken the leading place in the country's economy in recent years, (10-18% of export products).

Production of ferroalloys in our country is due to the existence of the Chiatura ore, in the mine of which nearly 200 mln tons of manganese ore is still remained.

The paper deals with the possibility of obtaining medium-carbon ferromanganese and silicomanganese, to fill the deficit of high quality concentrates, using highly basic special composition concentrates and rich silica-containing lump products, obtained from the Chiatura manganese-containing low grade ores.

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PP 42. THE MATHEMATICAL INVESTIGATION OF THE POLYPYRROLE CONSTANT-VOLTAGE OVEROXIDATION OVER ACTIVE METALS IN STRONG ACID MEDIA

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Conducting polymers (CP) are one of the most studied classes of compounds during the 5 last decades. Their study is explained by their capacity to combine the properties of plastic with metal conductivity and by ease in their modification [1].

One of the most important aspects of the use of conducting polymers is their use in corrosion-protecting coatings, cause the major part of them isn´t soluble and remains on the surface even in the overoxidized state in the acid media. [2] But in the case of soluble conducting polymer, its overoxidation will be accompanied by dissolution and depolymerization, resulting in the surface exposure to the aggressive media.

In the case of the polythiophene, the monomer polymerization potential may not differ much of the overoxidation potential, so, the process may be accompanied by the monomer repolymerization, forming the protecting coating again.

The comprehension of this process requires the detection of its most probable mechanism that may have rigid theoretical foundation only by analysis of an adequate mathematical model, the development of which will be described in this work.

It´s possible to prove that the system may be described by the set of the following equations:

$$\frac{d\Theta}{dt} = G_{\max}^{-1}(v_1 - v_2) \equiv F_1$$

$$\frac{dh}{dt} = \frac{2}{\delta}\left(\frac{D}{\delta}(h_i - h) + v_1 - v_2 - v_3\right) \equiv F_2$$

$$\frac{dq}{dt} = \frac{U}{AR} - i_F \equiv F_3$$

It´s possible to prove that the system may act as a temporal dissipative structure, and that its existence is maintained by the diffusion of protons and by the accumulation of the macromolecules of medium length.

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PP 43. NEW DESIGN OF THE SHORT NETWORK FOR ARC FURNACE

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The new scheme of a short network design for the arc furnace, according to the scheme "a triangle on electrodes" in three bifilar uses in which fuller symmetry reached by the crossing points forming a triangle directly at electrode holders, is proposed by us. In the offered scheme, current carrying pipes of different polarity are located on the same sleeve that promotes further reduction of inductance of the short network. Application of the considered scheme allows to reduce reactance by 2,5-3 times and the active resistance of short networks by 15-20%, and also to reduce melting duration, specific expense of the electric power and increase installation power factor.

On one of the 11 MV.A ferroalloy furnaces (Argveta plant, ''GiTim Group", the Republic Georgia) instead of the usual scheme of a short network ("a triangle on electrodes") we offered and realized the scheme of the above-stated design of a secondary electrode holder which was tested previously on the 5 MV.A ferroalloy furnace by us.

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PP 44. CRACKING RESISTANCE OF C0,4NMNVTI STEEL

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Cracking resistance of C0,4 NMnVTi steel is investigated by J-integral method [1]. Specimens are tested at cracks propagations to different dimensions with recording of loading diagrams.

By using metallograph and computer are obtained fractographs, on which are measured extensions of cracked areas; areas of according diagrams are measured; experimental dimensions of J_I-integral are computed. By using computer program "Microsoft XL" are built experimental data correlation functions, their respective equations and experimental values of J_{IC}-integral –energy characteristic of the cracking resistance.

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PP 45. METHOD FOR PURIFICATION OF QUARRY GROUNDWATER OF MADNEULI POLYMETALLIC DEPOSIT OF GEORGIA FROM HEAVY METAL SULFATES, WITH THEIR SUBSEQUENT SELECTIVE EXTRACTION

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To prevent ecological catastrophe in Bolnisi and Marneuli regions of Georgia, conditioned by discharge of sour quarry ground waters, containing sulfates of nonferrous heavy metals (copper, zinc, cadmium, iron and free sulfuric acid) into the river Mashavera that hundreds fold exceeds the permitted limit of concentration, we have developed a method of treatment of these effluents.

The offered method enables to thoroughly neutralize sulfates, to settle heavy metals into sediment, to filter this sediment and to discharge into river the water that will not contain any more heavy metal ions after such treatment.

Alkalinity of water discharged into river is pH = 9,5, which in its turn enables us to precipitate heavy metals existing in the river, that is, to improve ecology of rivers of this basin. Besides, reagents used at this moment are the wastes of other enterprises, which in their turn contaminate environment of other regions of Georgia (Chiatura, Kaspi, Kavtiskhevi). Filtered deposit, which contains rather high concentration of nonferrous metals, is subjected to chemical and electrochemical treatment, enabling selective extraction of copper, zinc and cadmium, each of 99.95% purity; the remaining part is burnt and gypsum of the 4 grade (alabaster, plastering material) is obtained.. This makes the enterprise not only waste-free but it also contributes to the receipt of high economic profit at the expense of realization of ready products such as copper powder (ПМС-1), zinc (Ц-0), electrolytic magnesium dioxide (ЭДМ) and others.

The method offered by us can be used not only in Georgia, but also in other countries of the world with analogous polymetallic sulfide deposits and problems of quarry ground waters [1-5].

References

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Author Index

სერგო მაზმიშვილი

(1934-2006)

სერგო მაზმიშვილი გახლდათ სტუ-ს ღვაწლმოსილი პროფესორი და პედაგოგი, რომელმაც უდიდესი წვლილი შეიტანა ჭიათურისა და საზღვარგარეთის მანგანუმის ღარიბი მადნების გამოწვა-გრავიტაციული მეთოდით გამდიდრების რაციონალური ტექნოლოგიის დამუშავებაში. როგორც თვალსაჩინო მეცნიერი, 2002 წელს ერთსულოვნად იქნა არჩეული უკრაინის უმაღლესი სკოლის მეცნიერებათა აკადემიის აკადემიკოსად.

პროფესორი ს. მაზმიშვილი დაჯილდოებულია ღირსების მედლით და ორდენით. მას გამოქვეყნებული აქვს 200-ზე მეტი სამეცნიერო ნაშრომი და ავტორია გამოგონებების. მისი ხელმძღვანელობით დაცულია მრავალი საკანდიდატო და სადოქტორო დისერტაცია.

ბ-ნ ს. მაზმიშვილის ხელმძღვანელობით განხორციელდა ზესტაფონის ფეროშენადნობთა ქარხანაში სამრეწველო ბრიკეტ-დანადგარის პროექტირებისათვის საჭირო მასალების დამუშავება-წარდგენა. მისივე ორგანიზებით აშენდა საცდელი სამრეწველო საამქრო ჭიათურის სამთო-გამამდიდრებელ კომბინატში, სადაც მის მიერ დამუშავებული მადნების გამდიდრების თერმოგრავიტაციული მეთოდით ყოველწლიურად 30 000 ტონა კარბონატული კონცენტრატის გადამუშავება ხდებოდა, ეს კი ჭიათურის საბადოს რაციონალური გამოყენებისა და მთლიანად რეგიონის განვითარებისათვის მეტად მნიშვნელოვანი იყო.

ბატონი სერგო არაერთი სამეცნიერო ჯილდოს მფლობელი გახლდათ, მათ შორის სტუ-ს უმაღლესი ჯილდოს - გამოჩენილი მეტალურგის, გიორგი ნიკოლაძის სახელობის მედლის კავალერი.

პროფ. ს. მაზმიშვილი იყო სტუდენტების საყვარელი და გამორჩეული მოძღვარი. მას გააჩნდა ახალგაზრდებთან ურთიერთობის განსაკუთრებული თვისებები, რაც პირად მომხიბვლელობაში, ლექციის წაყვანის მხოლოდ მისთვის დამახასიათებელ მანერაში, გამართულ მეტყველებაში, ბრწყინვალე დიქციასა და რაც მთავარია, გადასაცემი მასალის ღრმა ცოდნაში გამოიხატებოდა.

Professor Sergo Mazmishvili

(1934-2006)

Sergo Mazmishvili was an honored professor and teacher of Georgian Technical University, who greatly contributed to development of the rational technology of roasting and gravitational enriching Chiatura and foreign manganese low grade ores. As a prominent scientist, he was unanimously elected as an academician of Ukraine's High School Academy of Sciences in 2002. Professor S. Mazmishvili is awarded with the Medal and Order of Honor. He published more than 200 scientific papers and is the author of numerous inventions. Under his supervision many master's and doctoral theses are defended. Under his leadership were prepared and introduced materials necessary for the design of industrial equipment for production of briquettes in Zestafoni Ferroalloy Plant. He organized a trial industrial plant built in Chiatura mining-enrichment enterprise, where the annual 30 000 tons of carbonate concentrate was processed using his method of thermo-gravitational enriching the ores that was increasingly important for the rational use of Chiatura mines and the development of the region.

Mr. S. Mazmishvili owned numerous scientific awards, including the GTU highest award - Medal of Honor of an outstanding metallurgist Giorgi Nikoladze.

Prof. S. Mazmishvili was a favorite lecturer and dominating teacher for students. He had special skills of communicating with students, expressed in his personal charm, lecturing manner, the brilliant speech and most importantly, a deep knowledge of the transferred material.

Notebook