4. NANOTECHNOLOGY

4.1. Materials and Structures

3.4.1.1. Research of the possibility of nanostructuring functional materials by pre-recrystallization heat treatment. /O. Dubovyy, A. Karpechenko, T. Makryha, M. Bobrov, A. Labartkava, A. Labartkava/. Bulletin of the Georgian National Academy of Sciences. – 2021. – v. 15. – #1. – pp. 45-51. – eng.; abs.: eng., geo.

The paper is devoted to the research of the possibility of nanostructuring of functional materials, steels and ceramic sprayed coatings by pre-recrystallization heat treatment. The effect of the size of coherent X-ray scattering regions, the number of nanostructured elements and the subgrains misorientation angle on the physical and mechanical properties of technically pure iron and steel were experimentally studied. The possibility of thermal stabilization of a 62% polygonization nanoscale substructure during pre-recrystallization heat treatment at 500°C after combined plastic deformation is shown. A combination of 30% dynamic and 30% static deformations makes it possible to use such treatment in industry. Fig. 2, Tab. 3, Ref. 16.

Keywords: physical and mechanical properties, thermal sprayed coatings, deformation of steels, pre-recrystallization heat treatment

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3.4.1.2. 6th International Conference - Nanotechnology. Book of Abstracts. – Tbilisi. – 4-7 October. – 2021. – pp. 116.
Book of Abstracts contains more than 100 abstracts of papers submitted to the 6th International Conference “Nanotechnology”, 4–7 October 2021, Tbilisi, Georgia (GTUnano2021) organized by the Georgian Technical University (GTU). The GTUnano2021 is held in memory of Prof. Alex Gerasimov, the initiator of GTU’s regular series of nanoconferences in Georgia. The 6th conference participants represent universities, institutes, research centers, etc. leading in the field of nanotechnology and nanosciences from 20 countries (Armenia, Azerbaijan, Belarus, China, Czech Republic, Georgia, Germany, Hungary, India, Iraq, Japan, Kazakhstan, Mexico, Poland, Russia, Serbia, Spain, Turkey, Ukraine, and United States of America). Fig. 43. Tab. 3, Ref. 197.

Keywords: 6th International Conference “Nanotechnology”, abstracts of papers, GTU, nanotechnology and nanosciences, conference participants

4.2. Obtaining Technologies

3.4.2.1. Receipt and technology of aloe floating tablets. /M. Bakuradze, L. Bakuridze, E. Mosidze, D. Berashvili, I. Tsurtsumia/. Collection of Scientific Works of TSMU. – 2020. – v. 54. – pp. 29-31. – geo.; abs.: geo., eng.
In regenerative medicine, plants may be used as an alternative transplantation source. There is plenty of structural similarity between the vegetative and animal tissues and similarly to the human blood vessels, the plant fibers may be used as nutrient carriers. In tissue engineering, a decellularized plant may become a unique, multifunctional medical device, a plant matrix, the so-called scaffold. The performed studies resulted in the optimal composition of plant decellularization agents. It was determined that the duration of the process significantly depends on the morphological, anatomic and histological peculiarities of the plant. The biopharmaceutical studies proved that the absorption method is the most appropriate for plant decellularization for it shortens the process and is easier to perform than the perfusion. Employment of the 0.1% methylene blue made it evident that the decellularization technology does not affect the integrity and conductivity of the matrix fibers. On the grounds of the biopharmaceutical studies, we provided the plant matrix made up of the silver bionanoparticles. The properties of the silver bionanoparticles in the matrix were studied by the transmission electron microscope. The size of silver bionanoparticles is 1000 nm. and those are distributed across the matrix. We studied the silver separation dynamics from the nanodesigned

plant matrix and determined that 70% of silver was separated after 12h exposition of the matrix. Tab. 1, Fig. 4, Ref. 5.

Keywords: regenerative medicine, alternative transplantation source, decellularization agents, plant matrix, silver, bionanoparticles, aloe tablets, morphological, anatomic and histological peculiarities

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3.4.2.2. Microwave synthesis, characterization and testing of acute toxicity of boron nitride nanoparticles by monitoring of behavioral and physiological parameters. /A. Chirakadze, N. Mitagvaria, D. Jishiashvili, G. Petriashvili, N. Dvali, Z. Shiolashvili, K. Chubinidze, N. Makhatadze, A. Jishiashvili, Z. Buachidze, I. Khomeriki/. Bulletin of the Georgian National Academy of Sciences. - 2021. – v. 15. – #2. – pp. 120-126. – eng.; abs.: eng., geo.

Hexagonal boron nitride nanoparticles, nanosheets and nanotubes (BNNPs) are even more promising materials for biomedical application than carbon nanotubes (CNTs) and nanoparticles (CNPs) due to their negligible cytotoxicity. The reported research yielded in development and testing of two distinctive microwaves enhanced comparatively low-temperature methods of synthesis of the hexagonal boron nitride nanoparticles and nanosheets with reduced distortion of the crystal lattice, and an improved method of general toxicity testing of the developed nanomaterials utilizing continuous observation of behavioral effects in white rats in combination with blood oxygen saturation, systolic blood pressure and body temperature measurements in full agreement with the 4R principles of animal welfare in scientific research. The obtained results allow us to expect that the developed materials can be a good basis for developing highly effective modalities for anticancer (in combination with chemotherapy, hyperthermia and radiotherapy) and antiviral (in combination with chemotherapy and hyperthermia) treatment. Fig. 2, Ref. 14.

Keywords: cancer, low-temperature synthesis, microwave radiation, boron nitride, nanoparticles, turbostratic effect, behavioral testing

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3.4.2.3. Obtaining of β-SiAlON nanocomposite with alumothermal and nitrogen processes. /Z. Kovziridze, N. Darakhvelidze, N. Nijaradze, G. Tabatadze, M. Mshvildadze, Z. Mestvirishvili, M. Balakhashvili, V. Kinkladze/. Ceramics and Advanced Technologies. – 2020. – vol. 22. – #2(44). pp. 21-36. – geo..; abs.: geo., eng.

To obtain a composite in SiAlON-Al_2O_3 system and to study its properties. Obtaining the composite by metallothermic and nitrogenation methods. In the present work, the composite containing SiALON is obtained through alum-thermal process, by the reactive sintering method in nitrogen medium, from the mixture of aluminosilicate raw material (Prosyanaya kaolin and Polog refractory clay - Ukraine), nanopowder of aluminum oxide (German company “ALCOA”), and metallic silicium with small additives of glass perlite Aragac (Armenia). The advantage of this method is that the aluminosilicate raw material decomposes during the heat treatment process and the alum-thermal-nitration process takes place at the same time, making it easier to open AlN and AL_2O_3 in the newly formed β-$S_{i3}N_4$ crystal lattice, which provides β-SiALON generation at a relatively low temperature, 1250-13000^{o}C. Corundum-SiALON composite material is obtained by reactive sintering process at a temperature of 14500C.The corundum and sialon phases in the composite are confirmed by X-ray phase, spectral and electronmicroscopic analyzes. To obtain consolidated samples, the material obtained by reactive sintering was grounded in the attritor and hot pressed at 30 MPa and 1620^0 C and was kept at the final temperature - 7 min. The phase composition of the obtained samples remained unchanged after hot pressing, the density increased and the porosity dropped below 1%, accordingly the numerical values of the mechanical properties were increased: $\sigma_{press.}$ - 1600 MPa; σbend. - 460 MPa; HV - 19.7 GPa. Obtained corundum-SiALON composite with its physical-technical properties: porosity – 0-1%; density - 3.21 g/cm3; σpress. - 1923 MPa; σbend. - 470

MPa; HV - 19.7 GPa, elasticity modulus - 22 GPa; dynamic hardness - 3214 N/mm2; chemical stability to sulfuric acid (density - 1.84 g/cm3) - 99.3%, to water - 99.8%.The obtained materials may be recommended in armor engineering, when measuring temperature in metals molten as protective coatings for the thermocouple, as well as in high-temperature furnace linings, as well as in clean processing operations as a metalworking cutting material. Fig. 5, Tab. 6, Ref. 29.

Keywords: β-SiAlON, corundum, reactive sintering, composite, properties, metalworking cutting material

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3.4.2.4. Synthesis, characteristic and activity of nanosized Cu–Me (Me–Co, Zn, Ni) oxide systems in co oxidation in the presence of H_2. /S.T. Jafarova/. Azerbaijan Chemical Journal. – 2021. – #1. – pp. 48-54. – eng.; abs.: eng., az., rus.

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Nanooxides of Cu–Me composition (Me–Co, Zn, Ni) were synthesized by hydrothermal reduction of metal salts with subsequent calcination and the influence of their properties (size, morphology, structure) on catalytic activity of deep CO oxidation reaction in the presence of H_2 was considered. The nanooxides have been characterized by XRD and SEM methods. It was revealed that particles of Cu–Co–O are nanoplates (30–35 nm), and Cu–Zn–O (12.5–20 nm) are nanorods. The SEM method revealed a higher structural organization of the Cu–Co–O particles than Cu–Zn–O; the growth of nanocrystals is shown by varying the magnification of the scale grid of images. The highest activity of the Cu–Co–O system was found among the mentioned and corresponding individual oxides. The effect of metal (Cu/Co) ratio on the dispersibility and morphology of nanoparticles and their activity has been studied. The non-additive increase in activity is explained by the redox properties of cobalt oxides and the contribution of copper to electronic state of this element. The variation of composition, as well as high dispersibility (30–35 nm) make it possible to reduce the temperature of oxidation beginning (T50%) of CO to less than 115^0 C. Fig. 7, Ref. 17.

Keywords: nanooxides, nanoplates, nanorods, modification, morphology, structure, CO oxidation, electron microscopy

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The newest achievement in the synthesis of cobalt oxide nanoparticles are considered. Cobalt oxide nanoparticles have attracted a great attention due to their uncommon properties and application in a supercapacitor, optoelectronic device, Li-ion battery gas sensor and electrochromic devices. Recently, nanostructured transition metal oxides with valuable properties have become a new class of materials for many technological fields. Cobalt oxide nanoparticles obtained from various precursors show different size distribution as well as different optical, electrical, magnetic, and electrochemical properties. A reduction in particle size to nanometer-scale leads to changes in properties compared to bulk ones due to quantum size effects. Depending on the application area, the choice of an appropriate synthesis method for nanoparticles with desirable properties is a crucial factor. This work aims to provide additional information on the synthesis methods and properties of cobalt oxide nanoparticles. Fig. 4, Tab. 1, Ref. 96.

Keywords: cobalt oxide, crystallite size, supercapacitor, synthesis method

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4.3. Processing Technologies

3.4.3.1. Anionic zeolite nanomaterial – environmentally safe complex fertilizer with prolonged action. /G. Tsintskaladze, T. Sharashenidze, M. Zautashvili, M. Burdjanadze, G. Antia, N. Mumladze/. Bulletin of the Georgian National Academy of Sciences. – 2021. – v. 15. – #3. – pp. 59-64. – eng.; abs.: eng., geo.

The development and implementation of effective and cost-effective environmental technologies is one of the priority problems in Georgia for the rehabilitation of soil fertility and natural vegetation cover. The paper proposes a new method for nanomodification of natural zeolite - clinoptilolite, based on the introduction of the appropriate salt into the structure of the zeolite so that the resulting material does not lose its zeolite structure and acquires both cation-exchange and anionexchange properties. Some amount of ammonium dihydrogen phosphate ($NH_4H_2PO_4$), potassium nitrate (KNO_3) and cations mixed with them (Fe, Ca, Mn, Zn, Mg, Cu, Mo, Co, Sn) were introduced by fusion method into the clinoptilolite structure. Only the amount of ammonium dihydrogen phosphate changed, while the amount of potassium nitrate (KNO_3) and cations remained unchanged. Accordingly, zeolite nanomaterials of various composition, structure and properties were obtained, which were studied by the methods of chemical, IR spectroscopic and X-ray diffractometric analyses. The obtained zeolite nanomaterials as fertilizers of complex composition and long-term action were used to study their effect on wheat productivity both in the open field and in laboratory conditions. Zeolite nanomaterials of three different compositions were studied. Tab. 3, Ref. 14.

Keywords: natural zeolite, zeolite-anionic form, nanomodified, I.R. spectroscopic, agriculture

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4.4. Nanobiotechnology

3.4.4.1. Growing technology for soybeans with nanoherbicides. /A. Korakhashvili, T. Kacharava, L. Korakhashvili/. Annals of Agrarian Science. – 2021. – v. 19. - #3. – pp. 199-203. – eng.; abs.: eng.

Modern herbicide market in agriculture is about 2 billion tons and about 73 billion dollars industry with sophisticated multi-impact problems with food safety and human health, with increasing of weed resistance with every passing year at the topmost. Nanoherbicides under development in the current decade of our century could be a new strategy to address all the issues caused by the con-ventional non-nanoherbicides. From the beginning of 21 century group of Georgian scientists with farmers associations have begun development nanoherbicides (experimental name “Nanocooper 076”, which is under registration) in soybean experimental pilot plots and farmer’s fields, which will allow farmers to clear their soybean plantings from weeds without using toxic chemicals, like Glyphosate. As the potential use of nanostructured nanomaterials enables the use of nanoherbicides effectively and rules out the emergence of various weed-resistant population at an early stage of growing agricultural crops (first weeks after sowing), these very desirable nano technological methods and practices in general agriculture are reviewed by this article. Fig. 2, Tab. 1, Ref. 18.

Keywords: soya seed pilling, Nanocooper 076, soil contamination, friendly nanotechnologies, nanoherbicides, agriculture

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