СПИСЪК НА НАУЧНИТЕ ПУБЛИКАЦИИ С ОРИГИНАЛНИТЕ РЕЗЮМЕТА,
Предоставени за участие в конкурс, за заемане на академична длъжност „доцент”

от

д-р Анна Петрова Петрова,

обявен в Държавен вестник брой 100/24.11.2020 г. от Института за космически изследвания и технологии-БАН в област на висше образование **5. Технически науки**, професионално направление **5.2. Електротехника, електроника и автоматика,** научна специалност **„Автоматизирани системи за обработка на информация и управление (охарактеризиране на материали за космически приложения)”**, за нуждите на секция „Космическо материалознание” при ИКИТ-БАН.

А 1. Дисертационен труд за присъждане на образователна и научна степен „доктор” на тема: „Структура, свойства и приложения на детонационни нанодиаманти”

BULGARIAN ACADEMY OF SCIENCE
SPACE RESEARCH AND TEHNOLOGY INSTITUTE
Department “Space material science”

Anna Petrova Petrova

STRUCTURE, PROPERTIES AND APPLICATIONS OF DETONATION NANODIAMONDS

ABSTRACT of Ph. D. THESIS

The subject of the current Ph. D. thesis is related to detonation nanodiamond particles obtained in a phase transition of the free carbon contained in explosives with negative oxygen balance (S. Stavrev et al., 1991). The processing conditions are the following: pressure - 22 GPa; temperature - 4500 K; time-frame of the process - a few milliseconds.

The parameters of the detonation wave and phase diagram of carbon shows that diamond crystallizes from microscopic drops of carbon. Nanodiamonds synthesized by detonation (DND) with monocrystalline structure and a particle size around 4 ÷ 6 nm, are particularly important for the nanotechnology application. DND has high specific area 300 ÷ 400 m2/g and in the same time DND has a high surface activity. Nanodiamond crystals, which are obtained at the front of a detonation wave in an extremely varying regime and in a very short period of time, have many surface defects. Therefore, the carbon atoms on the surface of the nanodiamond crystals cannot stabilize their electron shell. DND has a three-layer structure. The third layer consists of different functional goups (oxygenic, carboxylic, carbonylic and others) around the diamond nucleus. They determine the hydrophilic properties of the nanodiamond surface.

The conditions of the nanodiamond synthesis determine the distinguishing characteristics of the nanodiamond produced, which differ considerably from these of the natural diamond and the nanodiamond obtained by static or dynamic synthesis. These characteristics determine the specific properties of the detonation nanodiamond, which make it suitable for biological and industrial applications.

1.1. A. Petrova, S. Stavrev, Survey of carbon nanostructures synthesized by detonation method in Bulgaria, Nanoscience & Nanotechnology, 14, eds. E. Balabanova, E. Mileva, Printed by „BPS" Ltd., Sofia, 115-116 (2014)

Nanoscience & Nanotechnology, **14**
eds. E. Balabanova, E. Mileva, Sofia, 2014

SURVEY OF CARBON NANOSTRUCTURES SYNTHESIZED BY DETONATION METHOD IN BULGARIA

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Abstract: The past two decades were characterized by a huge development of explosives technology as a way to synthesize and modify nanomaterials. The creation of new powerful explosive mixtures, technologies for their preparation and methods to implement explosive processes lead to deeper understanding of the phenomena that accompany these processes (shock waves, detonation, impact velocity, accumulation, phase transitions, etc.). The rapid development of computer technology enabled accurate modeling of the complex explosive processes. Dynamic methods for synthesis of nanoparticles represent one of the most interesting changes of the energy of the shock-wave. For development of nanotechnologies detonation nanodiamonds are of special interest. Applications of detonation nanodiamonds in industry and science are diverse. They have the thermal stability typical of a natural diamond. They are suitable for various industrial applications both in the form of powder and as mechanically stable compacts. Detonation nanodiamonds are used to create high-quality materials with nanocrystalline structure (with particle size up to 100 nm). In some applications it is permissible to use chemically untreated detonation nanodiamonds – initial suspension, which is almost two times cheaper. It is necessary to make preliminary studies of powder to determine the size, particle shape and surface conditions.

Keywords: detonation nanodiamonds, aqueous suspension, electron microscopy.

quantities. The base is formed by knowledge developed over the past 30 years, which is a guarantee for technical superiority on the European market. The complete set of features of the nanodiamonds has been studied. Goals are achieved by combining nanotechnology and intellectual production in the synthesis of detonation nanodiamonds, by creating new applicable knowledge and radical innovations in advanced materials and multifunctional products.

The object of the present study are nanodiamond samples in the form of an aqueous suspension (sample 1) and dry powder (samples 2 and 3). Samples were prepared by the shock-wave method. Output explosives are TNT+hexogen in suitable proportions. The weight of the charge is 0,580 kg. The cooling environment is water. The samples were analyzed in TISNUM, Troitsk, Russia.

The interaction of X-rays with matter can be reduced to two processes: absorption, that is, transformation of the energy of the X-rays into other types of energy, and scattering, that is, change of the initial propagation direction of the X-rays.

The composition and the structure of the samples were determined by X-ray diffraction using a TETA ARL X'TRA diffractometer. Particle size was measured on a JEM-2010 electron microscope with acceleration voltage

1.2. A. Petrova, S. Simeonova, R. Valov, V. Petkov, Physico-mechanical and physico-chemical properties of bio-inert composite ceramics, Artcast 2010, 200-205 (2010)

THE ANNALS OF "DUNAREA DE JOS" UNIVERSITY OF GALATI.
FASCICLE IX. METALLURGY AND MATERIALS SCIENCE
N^0. 4 – 2010, ISSN 1453 – 083X

PHYSICO-MECHANICAL AND PHYSICO-CHEMICAL PROPERTIES OF BIO-INERT COMPOSITE CERAMICS

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ABSTRACT

Bio-inert ceramics are non-toxic, non-allergenic and non-carcinogenic materials which explain why these are frequently used as orthopedic and dental implants. Unfortunately, these are chemically inert and do not naturally form a direct link with the bone. The research carried studies micro/nanostructure properties and the porosity of the TiO_2-Nb_2O_5 ceramics, used as biocompatible polymer matrix, prepared by different technological regimes. The morphology of the composite samples of TiO_2-Nb_2O_5 was studied using scanning microscopy. The phase identification of the composites was carried by metallographic microscopy. Results obtained show the chemical composition, the technological parameters and the porosity determined, favors formation of sufficiently strong bond between the studied materials and vitreous carbon layers.

KEYWORDS: bio-inert ceramics, physico-mechanical, physico-chemical properties

1.3. A. Petrova, Z. Karaguiozova, S. Vasseva, S. Stavrev, Project I-Stone from FP6 – Re-engineering of natural stone production chain through knowledge based processes, eco-innovation and new organizational paradigms, Nanoscience & Nanotechnology, 9, eds. E. Balabanova, I. Dragieva, Printed by „BPS" Ltd, Sofia, 255-258 (2009)

Nanoscience & Nanotechnology, **9**
eds. E. Balabanova, I. Dragieva, Sofia, 2009

PROJECT I-STONE FROM FP6
„RE-ENGINEERING OF NATURAL STONE PRODUCTION CHAIN THROUGH KNOWLEDGE BASED PROCESSES, ECO-INNOVATION AND NEW ORGANIZATIONAL PARADIGMS"

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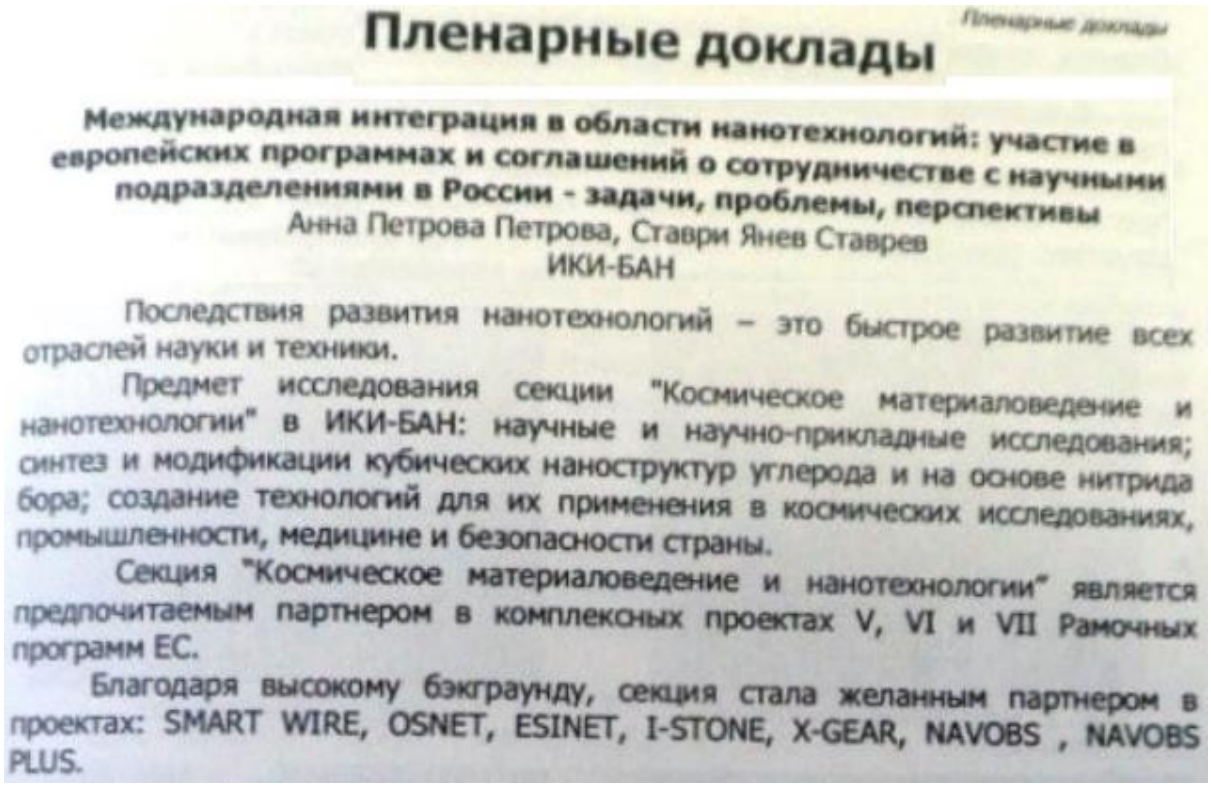
PRIORITY 3 - Nanotechnologies and nano-sciences, knowledge-based multifunctional materials and new production processes and devices
Project Coordinator: Giuseppe Gandolfi, Dr. Ing., Pedrini SPA ad unico socio, Italy
Coordinator for Bulgaria: Prof. d-r Sc. Stavri Stavrev – Space Research Institute, Bulgarian Academy of Sciences, Sofia, Bulgaria, tel: +359/2/753443, e-mail: sstavrev@phys.bas.bg
Duration: 45 months (2005-2008)
Participants: 42 from 17 Countries: Italy (7), Spain (5), Sweden (4), Netherlands (2), Belgium (1), Portugal (1), Germany (3), Greece (6), Romania (3), Bulgaria (1), Austria (1), Ukraine (1), Russia (2), Argentina(2), Denmark (1), Czech Republic (1), Poland (1).

Abstract: The need for an IP (I-STONE) to address the current problems and the future requirements of the European Stone Sector originates from the ever increasing need of the EU *Construction industry* for more and higher quality stone products and the fact that despite its economic importance, the Stone Sector has not made any significant technological progress the last decades. The aim of the proposed IP is the re-engineering of the stone production chain, in order to considerably increase its efficiency and productivity, minimize the amount of stone wastes disposed in the environment, produce a new generation of multifunctional products based on stone wastes and safeguard the quality in stone application and use. The ultimate target of the project is to transform the rather traditional Stone Sector into a modern, competitive and knowledge-based industry and ensure a lasting technological superiority of EU over its competitors.

Keywords diamond, metallization, composites, coating, tools

Figure 1. I-Stone logo

1.4. А. Петрова, С. Ставри, Международная интеграция в области нанотехнологий: участие в Европейских программах и соглашений о сотрудничестве с научными подразделениями в России - задачи, проблемы, перспективы, „Новейшие разработки российских и болгарских организаций в области нанотехнологии и наноматериалов", Федеральное агенство по науке и инновациям, Москва, 7-12 (2009)



Пленарные доклады

Пленарные доклады

Международная интеграция в области нанотехнологий: участие в европейских программах и соглашений о сотрудничестве с научными подразделениями в России - задачи, проблемы, перспективы

Анна Петрова Петрова, Ставри Янев Ставрев
ИКИ-БАН

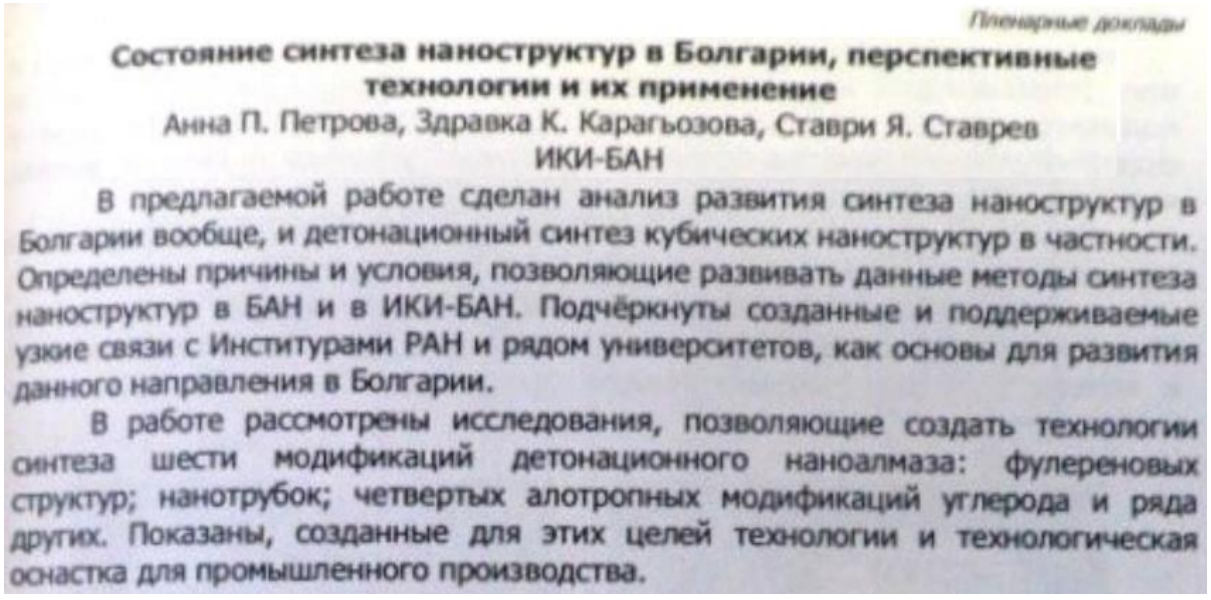
Последствия развития нанотехнологий – это быстрое развитие всех отраслей науки и техники.

Предмет исследования секции "Космическое материаловедение и нанотехнологии" в ИКИ-БАН: научные и научно-прикладные исследования; синтез и модификации кубических наноструктур углерода и на основе нитрида бора; создание технологий для их применения в космических исследованиях, промышленности, медицине и безопасности страны.

Секция "Космическое материаловедение и нанотехнологии" является предпочитаемым партнером в комплексных проектах V, VI и VII Рамочных программ ЕС.

Благодаря высокому бэкграунду, секция стала желанным партнером в проектах: SMART WIRE, OSNET, ESINET, I-STONE, X-GEAR, NAVOBS , NAVOBS PLUS.

1.5. А. Петрова, С. Ставрев, З. Карагьозова, Состояние синтеза в Болгарии, перспективные технологии и их применение, „Новейшие разработки российских и болгарских организаций в области нанотехнологии и наноматериалов", Федеральное агенство по науке и инновациям, Москва, 17-23 (2009)



Пленарные доклады

Состояние синтеза наноструктур в Болгарии, перспективные технологии и их применение

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ИКИ-БАН

В предлагаемой работе сделан анализ развития синтеза наноструктур в Болгарии вообще, и детонационный синтез кубических наноструктур в частности. Определены причины и условия, позволяющие развивать данные методы синтеза наноструктур в БАН и в ИКИ-БАН. Подчёркнуты созданные и поддерживаемые узкие связи с Институрами РАН и рядом университетов, как основы для развития данного направления в Болгарии.

В работе рассмотрены исследования, позволяющие создать технологии синтеза шести модификаций детонационного наноалмаза: фулереновых структур; нанотрубок; четвертых алотропных модификаций углерода и ряда других. Показаны, созданные для этих целей технологии и технологическая оснастка для промышленного производства.

1.6. Z. Karaguiozova, S. Stavrev, A. Petrova, Metallization of diamond powder, Nanoscience & Nanotechnology, 4, eds. E. Balabanova, I. Dragieva, Heron Press, Sofia, 204-205 (2004)

Nanoscience & Nanotechnology, 4
eds. E. Balabanova, I. Dragieva, Heron Press, Sofia, 2004

METALLIZATION OF DIAMOND POWDER

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Abstract. The paper has studied the wear resistance and the microhardness of composite diamond coatings, made in a solution "EFTTOM NICKEL" with a metallized Ultra Dispersed Diamond Powder – UDDP. The obtained coatings are with a good adhesion with the base of the samples. The best wear resistance is obtained in the case with the electroless grasping of a metalized UDDP.

Keywords: diamond, metallization, coating, superabrasives, tools

the use of diamonds with coatings, particularly titanium or chromium [4].

In electroplated bonds a single layer of diamond crystals is attached to a grinding wheel by means of a layer of metal, typically nickel that is electroplated on top of the diamonds [5]. Usually pill-out ratio of coated grits can be reduced by 20–40% compared to that of uncoated ones. Moreover, most of crystals can be used to their full potential [6].

В 4. Хабилитационен труд - научни публикации (не по-малко от 10) в издания, които са реферирани и индексирани в световноизвестни бази данни с научна информация

4.1. A. Petrova, A. Miteva Influence of additive on structural and physicomechanical properties of nano-microcrystalline aluminum alloys, JBTA, Vol. 26, №2, 314-318 (2020)

Journal of the Balkan Tribological Association *Vol. 26, No 2, 314–318 (2020)*

Nano- and microtribology

INFLUENCE OF ADDITIVES ON STRUCTURAL AND PHYSICO-MECHANICAL PROPERTIES OF NANO-MICROCRYSTAL ALUMINIUM ALLOYS

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ABSTRACT

Al-Fe-V-Si alloys are promising materials for the space and automotive industries. The ribbons are obtained by a plurality of planer flow casting technique. The purpose of this work is to analyze the influence of additional particles on the microstructure of aluminium ribbons. Two types of microstructure are observed. Microhardness (Vickers) is measured with a hardness tester and a NanoScan microscope.

Keywords: Nano-microcrystalline Al-Si alloys, nanostructure, microhardness.

4.2. T. Ivanova, A. Harizanova, A. Petrova, Morphological and optical investigation of Sol-Gel ZnO films, Journal of Physics, Conference Series Vol. 700, №1, IOP Publ., 012047-012054 (2016)

19th International Summer School on Vacuum, Electron and Ion Technologies (VEIT2015) IOP Publishing
Journal of Physics: Conference Series **700** (2016) 012047 doi:10.1088/1742-6596/700/1/012047

Morphological and optical investigation of Sol-Gel ZnO films

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Abstract. This paper presents morphological and optical studies of the properties of spin-coated ZnO films depending on the annealing temperatures. The films microstructure was explored using a scanning nano-hardness measuring device of the NanoScan family, based on the principles of atomic force microscopy, in a constant frequency mode. The surface study revealed that the root-mean-square (RMS) surface roughness of 985.64×985.64 nm ZnO films becomes greater with the increase of the annealing temperature, but the film surface remains uniform and smooth. The results were confirmed by XRD analysis, which demonstrated that the crystallite size grew from 25 to 36 nm with the thermal treatments. The ZnO films possessed high transmittance in the visible spectral range and the optical band gaps in ZnO films varied from 3.25 eV to 3.52 eV. The optical and morphological properties of the ZnO films formed on Si and quartz substrates are very good. The sol-gel approach proposed for deposition of nanostructured ZnO films is promising for applications in optoelectronic devices or solar cells.

4.3. B. Pejova, D. Nesheva, Z. Aneva, A, Petrova, Photoconductivity and Relaxation Dynamics in Sonochemically Synthesized Assemblies of AgBiS2 Quantum Dots, J. Phys. Chem. C, 115 (1), 37-46 (2011)

J. Phys. Chem. C **2011**, *115*, 37–46

Photoconductivity and Relaxation Dynamics in Sonochemically Synthesized Assemblies of $AgBiS_2$ Quantum Dots

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The transport properties of nonequilibrium (photoexcited) charge carriers in sonochemically synthesized three-dimensional (3D) assemblies of $AgBiS_2$ quantum dots (QDs) deposited as thin films were studied. To characterize the photoconduction of quantum-confined nanocrystals close packed in thin film form, both stationary and time-resolved experiments were performed. Besides by interband electronic transitions in the bulklike part of the nanocrystals, the photoresponse of nanocrystalline films was found to be also affected to a greater extent by the crystal boundary barrier height modulation upon illumination. The surface and bulk recombination velocities were found to be comparable. Good agreement was obtained between the band gap energy determined by analysis of the photoconductivity data measured by the constant field and the constant photocurrent method (~1.18 eV). This value is in agreement with the optical spectroscopy data. It is higher than the optical band gap of a bulk specimen of this semiconductor, due to 3D confinement effects on the charge carrier motions within individual QDs. The nonequilibrium conductivity was found to relax exponentially with a time constant of 1.67 ms, which corresponds to average lifetime of minority charge carriers (holes).

4.4. D. Nesheva, M. Šćepanović, Z. Levi, S. Aškrabić, Z. Aneva, A. Petrova, Z. Popovic, Structural characterization and photoluminescence of ZnSe nanolayers, J. of optoelectronics and advanced materials, Vol. 11, №9, 1351-1354 (2009)

JOURNAL OF OPTOELECTRONICS AND ADVANCED MATERIALS, Vol. 11, No. 9, September 2009, p. 1351 - 1354

Structural characterization and photoluminescence of ZnSe nanolayers♣

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Single layers of ZnSe (30, 40, 50, 70, 100 nm and 1 μm thick) are deposited at room substrate temperature by thermal evaporation of ZnSe powder in vacuum. The film surface morphology and structure are investigated by Atomic Force Microscopy (AFM). The as-deposited films are smooth and homogeneous while the relaxed ones show pits on the surface and a root mean square roughness of 2 - 4 nm. It is assumed that as-deposited films are highly strained and the strain relaxation with time creates pits and increases the surface roughness. Optical transmission measurements on relaxed films (≤ 100 nm thick) show an energy dependence of the absorption coefficient typical of amorphous materials, but the AFM data indicate the presence of nanocrystals (apparent grain size 25 - 30 nm). Therefore, it is assumed that the layers contain two phases, amorphous and crystalline, and the portion of the crystalline phase decreases with decreasing thickness. Photoluminescence (PL) measurements carried out at various temperatures in the range 20 – 300 K reveal two bands in the spectra of all films, centred at ~ 500 and ~ 550 nm. The bands are related to radiative recombination in the crystal phase, via two kinds of deep acceptors which are not discrete but have certain energy distributions in the forbidden gap.

(Received November 5, 2008; accepted December 15, 2008)
Keywords: Thin films, ZnSe, Thermal vacuum evaporation, Atomic force microscopy, Photoluminescence

4.5. M. Dimitrova, L. Pramatarova, E. Pecheva, P. Laquerriere P. Montgomrey, A. Petrova, G. Altankov, Osteoblast cell activity on calcium phosphate layers grown on glass by a laser-liquid-solid interaction, J. of optoelectronics and advanced materials, Vol. 9, №1, 240-243 (2007)

JOURNAL OF OPTOELECTRONICS AND ADVANCED MATERIALS Vol. 9, No. 1, January 2007, p. 240 - 243

Osteoblast cell activity on calcium phosphate layers grown on glass by a laser-liquid-solid interaction

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A calcium phosphate layer was grown on glass by a laser-liquid-solid interaction (LLSI) process in simulated body fluid (SBF). Glass samples with a layer grown by simple soaking in the SBF (i.e. without laser irradiation) were prepared for comparison. Formation of an inhomogeneous calcium phosphate (CaP) layer on both laser-treated and non-treated samples was observed. The results showed that the laser irradiation did not change the layer structure and morphology but yielded the growth of a thicker CaP layer. With increasing load the elasticity and the hardness increased for both laser-treated and non-treated samples. Furthermore, we tested the osteoblast cell activity of the CaP layers grown on the laser-treated and non-treated samples. Toxicity test showed that the viability of the cells on the layer grown by the LLSI process was over 95%. A permanent increase in the cell number was observed for both groups of samples, and it was more stable on the laser-treated surfaces. The latter showed a higher cell number after 7 days of cell culturing. A slower increase, resulting in a lower cell numbers was observed for the samples untreated with laser irradiation.

(Received November 28, 2006; accepted December 21, 2006)
Keywords: Calcium phosphate, Simulated body fluid, Laser-liquid-solid interaction, Osteoblast cells

4.6. L. Pramatarova, E. Pecheva, M. Dimitrova, P. Laquerriere, A. Petrova, P. Montgomrey, T. Petrov, Mechanical properties of extracellular matrix/hydroxyapatite composites, J. of optoelectronics and advanced materials, Vol. 9, №1, 229-232 (2007)

JOURNAL OF OPTOELECTRONICS AND ADVANCED MATERIALS Vol. 9, No. 1, January 2007, p. 229 - 232

Mechanical properties of extracellular matrix/hydroxyapatite composites

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An increasing interest in biomimetics – design of materials based on natural biological structures - has led to the nanomechanical characterization of biomaterials. In this regard, nanoindentation has been used in conjunction with the determination of the mechanical properties of the extracellular matrix (ECM) proteins that are known as ligands in reactions with cell surface receptors involved in bone physiology. The aim of the presented work is to investigate the - and nano-scale mechanical properties of laser designed extracellular matrix/hydroxyapatite composites. The osteoblast-like cell line SAOS-2 synthesised and assembled its own ECM on the solid substrates under standard cell culture conditions. After selective removal of cells, thin films of ECM on substrates of stainless steel (SS), silicon (S) and silica glass (SG) were obtained. One group of samples was soaked in simulated body fluid (SBF) and another was obtained by simultaneous immersion in the SBF and treatment by laser irradiation. As a result, a hydroxyapatite (HA) crystal layer was grown on the surfaces. The mechanical properties of the obtained composites, such as elastic modulus (E) and indentation hardness (H), were analysed. It was observed that by applying a typical working force in the range 200 μN to 600 μN and a displacement range of 0-60 μm, E increased for all composites obtained by the laser process (for samples immediately removed from the SBF). Surface scanning along the direction centre of the sample to the laser treated area showed a decrease in the Young's modulus, to values similar to those in the human bone.

(Received November 28, 2006; accepted December 21, 2006)
Keywords: Extracellular matrix, Mechanical properties, Hydroxyapatite, Laser-liquid-solid-interaction process

4.7. D. Nesheva, Z. Aneva, B. Pejova, I. Grozdanov, A. Petrova, Photoelectrical characterization of nanocrystalline $AgBiS_2$ thin films, J. of optoelectronics and advanced materials, Vol. 11, №9, 1347-1350 (2009)

JOURNAL OF OPTOELECTRONICS AND ADVANCED MATERIALS, Vol. 11, No. 9, September 2009, p. 1347 - 1350

Photoelectrical characterization of nanocrystalline $AgBiS_2$ thin films

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The photoelectric properties of chemically produced nanostructured $AgBiS_2$ thin films are investigated. Atomic force microscopy is used to prove the nanocrystalline structure of the films, and a value of ~ 10 nm is obtained as an upper limit for the average grain size. The temperature dependences of the photocurrent measured in the range 77 – 390 K do not display high photosensitivity at low temperatures. This observation is related to a high density of fast recombination centers created at the interfaces between the nanocrystals. Persistent photoconductivity is measured at low-temperatures after turning off the light, and a high voltage polarization is observed on light illumination of the films. Both effects are related to trapping of photoexcited carriers in deep defect states, and are considered as responsible for the rather low value (< 0.5) of the exponent in the photocurrent intensity dependence. Constant photocurrent method measurements, carried out at energies higher than the optical band gap, reveal fine structure in the absorption spectra of the films, which could be assigned to higher excitons in $AgBiS_2$ quantum dots, and be considered as an indication of a narrow size distribution of the nanocrystals in the layers.

(Received November 5, 2008; accepted December 15, 2008)
Keywords: $AgBiS_2$ thin films, Nanocrystals, Photocurrent

4.8. B. Pejova, I. Grozdanov, D. Nesheva, A. Petrova, Size-dependent properties of sonochemically synthesized three-dimensional arrays of close-packed semiconducting $AgBiS_2$ quantum dots, Chemistry of Materials, Vol. 20, Issue 7, 2551-2565 (2008)

Chem. Mater. **2008,** *20,* 2551–2565

Size-Dependent Properties of Sonochemically Synthesized Three-Dimensional Arrays of Close-Packed Semiconducting $AgBiS_2$ Quantum Dots

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3D arrays of close-packed $AgBiS_2$ quantum dots (QDs) in thin film form were synthesized for the first time using novel, convenient sonochemical approach. Structural, optical, and photoelectrical properties of the synthesized material were investigated with an emphasis on their dependence on crystal size. The sonochemically synthesized $AgBiS_2$ colloidal crystals have an average QD radius of 4.2 nm, twice as small compared to the QD solid obtained without ultrasonic irradiation. The optical band gap energy of sonochemically synthesized $AgBiS_2$ QD thin films of 1.40 eV is strongly blue-shifted in comparison to that of the macrocrystal (0.90 eV) and that of nanostructured films synthesized by conventional chemical route (1.10 eV). Upon annealing, E_g exhibits a red shift to 1.00 eV. Spectral dependence of stationary nonequilibrium conductivity of the 3D QD assemblies suggests that the thin films' photoconductivity is modulated by the intercrystalline barrier height decrease. E_g of the films calculated on the basis of photoconduction spectral response in the low-absorption region is 1.18 eV. Thermal band gap energy of the films is 1.10 eV, whereas both the variable range hopping conduction and thermionic emission mechanisms are predominant in the overall intercrystalline charge carrier transport through 3D QD assemblies.

4.9. D. Nesheva, A. Petrova, S. Stavrev, Z. Levi, Z. Aneva, Thin film semiconductor nanomaterials and nanostructures prepared by physical vapour deposition: An atomic force microscopy study, J. of Physics and Chemistry of Solids, Vol. 68, Issue 5-6, 675-680 (2007)

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Thin film semiconductor nanomaterials and nanostructures prepared by physical vapour deposition: An atomic force microscopy study

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Abstract

Amorphous/nanocrystalline SiO_x/CdSe, GeS_2/CdSe, SiO_x/ZnSe and Se/CdSe amorphous multilayers (MLs) were grown by consecutive physical vapour deposition of the constituent materials at room substrate temperature. A step-by-step manner of deposition was applied for the preparation of each layer (2−10 nm thick) of MLs. Surface morphology has been investigated by atomic force microscopy (AFM) in order to get information about ML interfaces. For a scanned area of $3.4 \times 4\,\mu m^2$ SiO_x/CdSe and GeS_2/CdSe MLs showed surface roughness which is around three times greater than the roughness of SiO_x/ZnSe MLs. This observation has been connected with effects of both film composition and deposition rate. For a scanned area of $250 \times 250\,nm^2$ the roughness determined in all MLs displayed close values and a similar increase with the ML period. The latter has been related to the flexible structure of amorphous materials. The AFM results, in good agreement with previous X-ray diffraction and high resolution electron microscopy data, indicate that the application of step-by-step physical vapour deposition makes possible fabrication of various amorphous/nanocrystalline MLs with smooth interfaces and good artificial periodicity at low substrate temperatures.

Keywords: A. Nanostructures; A. Chalcogenides; B. Vapour deposition; D. Surface properties

4.10. S. Kaschieva, K. Christova, I. Boradjiev, A. Petrova, J. Koprinarova, S. Dmitriev, The role of high-energy electron irradiation induced defects in some mechanical properties of Si-SiO_2 structures, J. of optoelectronics and advanced materials, Vol. 9, №2, 394-397 (2007)

JOURNAL OF OPTOELECTRONICS AND ADVANCED MATERIALS Vol. 9, No. 2, February 2007, p. 394 - 397

The role of high-energy electron irradiation induced defects in some mechanical properties of Si-SiO_2 structures

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The mechanical stress produced by 23 MeV energy electron radiation in both n- and p-type Si-SiO_2 structures is studied as a function of the dose. Low dose electron irradiation (2,4 – 4,8x10^{14} cm^{-2}) increases significantly the yield stress for n-type Si-SiO_2 samples, but to a much lesser extent for p-type ones. The nanohardness of irradiated structures is measured using the sclerometry method. Our results show that the nanohardness increases with the dose in the same manner for both groups studied. The values are very close, but for p-type samples are consistently higher. The variations of both the stress and nanohardness are remarkable at low doses. These mechanical properties of the irradiated samples are discussed on the basis of radiation induced defects.

(Received November 1, 2006; accepted December 21, 2006)

Keywords: Thin films, Electron irradiation, Mechanical stress, Nanohardness

Г 8. Научна публикация в нереферирани списания с научно рецензиране или в редактирани колективни томове

8.1. A. Petrova, Types of Aluminum alloys and their applications, Сборник доклади от годишна университетска научна конференция, В. Търново, Издателски комплекс на НВУ „Васил Левски”, Научно направление „Технически науки”, 1968-1974 (2020)

TYPES OF ALUMINUM ALLOYS AND THEIR APPLICATIONS

Anna Petrova

Abstract *The aluminum parts are made of alloys resistant to weathering, corrosion and UV rays. This makes it possible to use them in extreme conditions. Most applications of aluminum alloys are explained by their physical and mechanical properties. This article discusses the types of aluminum alloys, their properties and applications.*

Key words: *aluminum alloys, structure, microhardness*

8.2. A. Petrova, Properties of detonation nanodiamonds, Сборник доклади от годишна университетска научна конференция, В. Търново, Издателски комплекс на НВУ „Васил Левски”, Научно направление „Технически науки”, 1975-1980 (2020)

PROPERTIES OF DETONATION NANODIAMONDS

Anna Petrova

Abstract *Carbon nanoparticles, which include nanodiamonds, are used in a number of technological applications. There is a special class of nanodiamonds called detonation nanodiamonds (DND), with the particle sizes several nm. The DND were produced by detonation of carbon-containing explosives. They are nanoparticles which has great interest in recent years due to its properites.*

Key words: *detonation nanodiamonds, aqueous suspension, electron microscopy*

8.3. **A. Petrova, Aluminum in the automotive industry, Сборник доклади от годишна университетска научна конференция, В. Търново, Издателски комплекс на НВУ „Васил Левски”, Научно направление „Технически науки”, 1981-1989 (2020)**

ALUMINUM IN THE AUTOMOTIVE INDUSTRY

Anna Petrova

Abstract *Today, aluminum is widely used in our lives. All types of vehicles on the earth, from bicycles to space rockets, are made of aluminum. The car is the most common form of transport in the world. Aluminum alloys, due to their special inherent properties, are leaders among structural materials used in the automotive industry. The transport sector already accounts for the largest share of global aluminum consumption - 27%. And in the coming years, this figure will only increase. This article examines the applications of aluminum alloys in the automotive industry.*

Key words: *aluminum, aluminum alloys, automotive industry, automotive applications, light metals and alloys, automotive, automobile*

8.4. A. Petrova, A. Miteva, The abrasive properties of detonation nanodiamonds, 13th International Conference on Tribology BULTRIB, Printing House of the Technical University Sofia, 93-97 (2018)

Tribological Journal BULTRIB Vol. 7, 2018
Papers from the 13th International Conference **BULTRIB '18**
25-27 October 2018, Sofia, Bulgaria
Society of Bulgarian Tribologists
FIT – Technical University of Sofia

THE ABRASIVE PROPERTIES OF DETONATION NANODIAMONDS

Anna PETROVA, Adelina MITEVA

Abstract*: A large area in the application of detonation nanodiamonds is surface polishing. Mills, diamond cutting blades, drill bits and blades with embedded diamond particles are used in the various industries, with new metal-diamond connections, resistant to high temperatures and mechanical stress, ensuring a high cutting speed. An important process in the production of details is the finishing of high-precision polishing for the needs of: radio engineering, electronics, optics and mechanical engineering*

Keywords: *detonation nanodiamonds, abrasive properties, carbon nanostructures, coatings, poloshing*

8.5. A. Miteva, A. Petrova, Detonation nanodiamonds – some biomedical applications, 13th International Conference on Tribology BULTRIB, Printing House of the Technical University Sofia, 98-103 (2018)

Tribological Journal BULTRIB Vol. 7, 2018
Papers from the 13th International Conference **BULTRIB '18**
25-27 October 2018, Sofia, Bulgaria
Society of Bulgarian Tribologists
FIT – Technical University of Sofia

DETONATION NANODIAMONDS - SOME BIOMEDICAL APPLICATIONS

Adelina MITEVA, Anna PETROVA

Abstract: *Nowadays investigations of detonation nanodiamonds are the subject of great interest. This is mainly due to their unique properties and consequently to their actual and potential applications in various fields of industry and everyday life. In this paper we briefly review some of the main existing medical and biological applications of detonation nanodiamonds. Possible future extensions of these biomedical applications are considered.*

Keywords: *detonation nanodiamonds, biomedical applications, carbon nanostructures, drug delivery system, nanomedicine*

8.6. B. Barbov, A. Petrova, Oxidation of Aluminum Alloys in the Processing Condition, SES 2018, 447-450 (2018)

S E S 2 0 1 8
Fourteenth International Scientific Conference
SPACE, ECOLOGY, SAFETY
7 – 9 November 2018, Sofia, Bulgaria

OXIDATION OF ALUMINUM ALLOYS IN THE PROCESSING CONDITION

Boris Barbov[1], Anna Petrova[2]

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Keywords: *Nano-microcrystalline Al-Si alloys, hot extrusion, Nikitin formal kinetics*

Abstract: *An important characteristic of the nano-microcrystalline ribbons based on Al-Si alloys, that we have studied, is their propensity for oxidation at high temperatures. The amount of oxides formed during the preparation or consolidation of rapidly solidified alloys, are protected the melts from the air. The oxide layer hinders contact between the microcrystalline ribbons during hot extrusion and deteriorates the mechanical properties of the obtained blanks. The hot extrusion process is carried out at temperatures above T = 400 °C. The heating of the ribbons during extrusion creates preconditions for further oxidation of the metal and increase of the oxide layer over time. Knowledge of the oxidation process allows to minimize the impact of the oxide layer on the structure and properties of the extruded blanks. The high wear and tear strength of Al-Si alloys makes them an important material for use in the automotive and aerospace industries for making various details such as pistons, cylinder blocks, bushings, bearings.*

The study of the oxide layer formation and its properties have been made on the basis of the formal Nikitine kinetics.

8.7. B. Barbov, A. Petrova, Microstructure and Mechanical Properties of Nano-Microcrystalline Aluminum Alloys, SES 2018, 451-456 (2018)

S E S 2 0 1 8
Fourteenth International Scientific Conference
SPACE, ECOLOGY, SAFETY
7 – 9 November 2018, Sofia, Bulgaria

MICROSTRUCTURE AND MECHANICAL PROPERTIES OF NANO-MICROCRYSTALLINE ALUMINUM ALLOYS

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Keywords: *Nano-microcrystalline Al-Si alloys, X-ray diffraction, TEM, NanoScan*

Abstract: *In past decades a new direction has developed in the production of aluminum products, applicable in automobive and aerospace industries. Composite alloys by adding inert nano- and microparticles are obtained. The influence of these particles on the structure of alloys at elevated temperatures is relatively poorly studied.*

Composite extrudates from powders of low Si content are prepared. Addition of 2 wt. % TiC particles are used as a new phase in nano-microcrystalline aluminum alloys from the Al-Fe-V-Si system. We assume that the additive particles are inert and homogeneously distributed in the sample volume. Bulk samples have a high experimentally measured density of 2.9 g/cm^3 comparable to a calculated density value of 3.13 g/cm^3. This indicates that the hot extrusion process provides good contact between the aluminum matrix and the TiC particles.

8.8. A. Petrova, Methods for analysis of surface modified metal alloys, SES 2017, 341-347 (2017)

S E S 2 0 1 7
Thirteenth International Scientific Conference
SPACE, ECOLOGY, SAFETY
2 – 4 November 2017, Sofia, Bulgaria

METHODS FOR ANALYSIS OF SURFACE MODIFIED METAL ALLOYS

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Keywords: *Microstructure, morphology, roughness, electroless Ni coatings, aluminum alloy, stainless steel*

Abstract: *In the last decades, there is interest in the fabrication of nanostructures suitable for different applications. Physical and mechanical properties of the nanoscale particles are novel, different from those in the bulk materials.*

This review deals with the latest techniques developed to perform the analysis of coatings on alluminium alloys or steel, classical and novel measurements for complementary characterization of the surfaces.

The topography of the surfaces of the metals and applied coatings are tested using atomic force microscopy (AFM), scanning electron microscope (SEM) and optical microscopy (OM) analysis. Coating defects and pores are demonstrated on 2D and 3D images.

8.9. А. Петрова, Анализ на наноструктури чрез сканираща микроскопия, SES 2017, 348-353 (2017)

S E S 2 0 1 7
Thirteenth International Scientific Conference
SPACE, ECOLOGY, SAFETY
2 – 4 November 2017, Sofia, Bulgaria

АНАЛИЗ НА НАНОСТРУКТУРИ ЧРЕЗ СКАНИРАЩА МИКРОСКОПИЯ

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Ключови думи: *Микроструктура, морфология, грапавост*

Резюме: *Текущите изображения предоставят допълнителна информация за свойствата на повърхността. Техниките за изследване при сканираща сондова микроскопия (SPM) са безразрушителни и осигуряват измерване на механичните свойства на изследваните образци. Микроскопът позволява измерване на грапавостта на повърхността. Трудно е да се сканира, когато има пори, големи образования и драскотини върху повърхността на пробата.*

Морфологията на повърхността се наблюдава с микроскоп NanoScan.

8.10. Z. Karaguiozova, A. Petrova, A. Ciski, G. Cieślak, Displacement (immersion) tin plating, SES 2015, 383-388 (2016)

S E S 2 0 1 5
Eleventh Scientific Conference with International Participation
SPACE, ECOLOGY, SAFETY
4 – 6 November 2015, Sofia, Bulgaria

DISPLACEMENT (IMMERSION) TIN PLATING

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Keywords: *Electroless immersion coatings, tin coatings, printed circuit boards, etching, wet angle*

Abstract: *The metal layering on the metal surface flowing without the presence of the reducing agents or an external source of electricity is called immersion plating. The salt solution of the noble metal and less noble metal substrate are needed the process to take place. The deposition of the noble metal on the plated surface is observed due to displacement process.*

The immersion plating of Tin on Copper is too popular in the production of printed circuit boards. The displacement of copper with tin in the solution of tin salt becomes. The achieved layer is characterized with better solder wettability, corrosion and oxidation protection of the surface.

The morphology observation, hardness and elasticity measurements are carried out of the Tin and Tin-DND coatings.

8.11. T. Stoikova, A. Petrova, T. Grozdanova, Innovative nanostructured composite coatings, International Conference, Vol. 1, Varna, 332-339 (2015)

INNOVATIVE NANOSTRUCTURED COMPOSITE COATINGS

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The past two decades were characterized by a huge development of nanotechnologies as a way to synthesize and modify nanomaterials. Dynamic methods for synthesis of nanoparticles represent one of the most interesting changes of energy. Nanodiamonds (ND) are of special interest for the development of various technologies. They are used to create high-quality materials with nanocrystal structure and particle size up to 100 nm. The nanostructured composite coatings are usable in the production of new generation of multifunctional products based on innovative materials, which safeguard the quality in application and use.

The gear industry has to implement major changes in gear design, mechanical transmission systems and fabrication techniques. The production of new gears, using new materials steel-coated with innovative surface treatments, based on nanodiamonds, has been analysed.

8.12. Т. Грозданова, А. Петрова, Перспективни материали за работа в екстремни условия, SES 2014, 497-500 (2015)

S E S 2 0 1 4
Tenth Anniversary Scientific Conference with International Participation
SPACE, ECOLOGY, SAFETY
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ПЕРСПЕКТИВНИ МАТЕРИАЛИ ЗА РАБОТА В ЕКСТРЕМНИ УСЛОВИЯ

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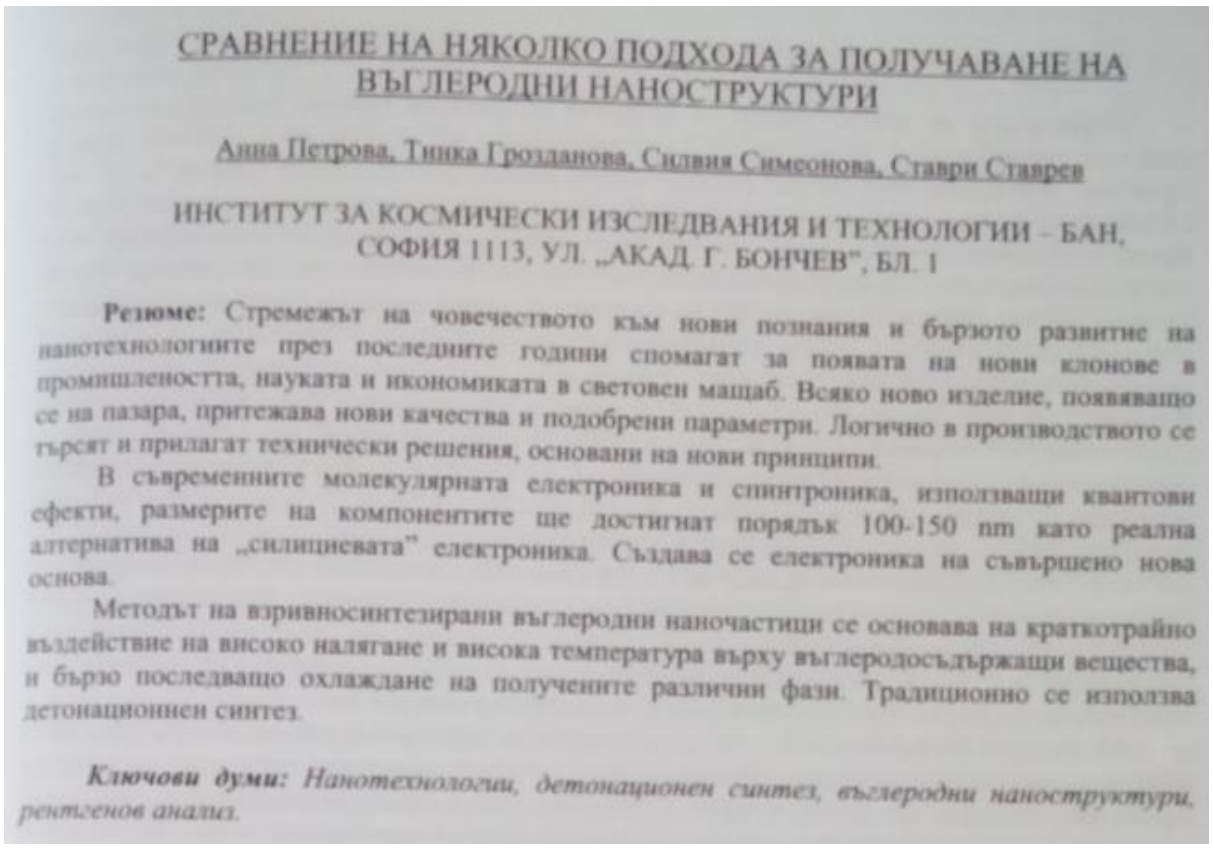
Ключови думи: *Трибология, нанотехнологии.*

Резюме: *В статията са представени самосмазващ се композиционен антифрикционен материал, съдържащ молибденов дисулфид, предназначен за работа във вакуум и космически условия, и материали с повишена твърдост и износоустойчивост от стомана и лят чугун, с нанесени композитни, наноструктурирани, никелови покрития.*

8.13. А. Петрова, Т. Грозданова, С. Симеонова, С. Ставрев, Сравнение на няколко подхода за получаване на въглеродни наноструктури, Международна конференция „Металознание, хидро- и аеродинамика, национална сигурност”, София, 55-60 (2014)



СРАВНЕНИЕ НА НЯКОЛКО ПОДХОДА ЗА ПОЛУЧАВАНЕ НА ВЪГЛЕРОДНИ НАНОСТРУКТУРИ

Анна Петрова, Тинка Грозданова, Силвия Симеонова, Ставри Ставрев

ИНСТИТУТ ЗА КОСМИЧЕСКИ ИЗСЛЕДВАНИЯ И ТЕХНОЛОГИИ – БАН, СОФИЯ 1113, УЛ. „АКАД. Г. БОНЧЕВ", БЛ. 1

Резюме: Стремежът на човечеството към нови познания и бързото развитие на нанотехнологиите през последните години спомагат за появата на нови клонове в промишлеността, науката и икономиката в световен мащаб. Всяко ново изделие, появяващо се на пазара, притежава нови качества и подобрени параметри. Логично в производството се търсят и прилагат технически решения, основани на нови принципи.

В съвременните молекулярната електроника и спинтроника, използващи квантови ефекти, размерите на компонентите ще достигнат порядък 100-150 nm като реална алтернатива на „силициевата" електроника. Създава се електроника на съвършено нова основа.

Методът на взривносинтезирани въглеродни наночастици се основава на краткотрайно въздействие на високо налягане и висока температура върху въглеродосъдържащи вещества, и бързо последващо охлаждане на получените различни фази. Традиционно се използва детонационнен синтез.

Ключови думи: *Нанотехнологии, детонационен синтез, въглеродни наноструктури, рентгенов анализ.*

8.14. Т. Грозданова, А. Петрова, С. Симеонова, Трибологични характеристики на самозмазващ се композиционен антифрикционен материал, съдържащ молибденов дисулфид, Межд. конференция „Металознание, хидро- и аеродинамика, национална сигурност", София, 61-64 (2014)

ТРИБОЛОГИЧНИ ХАРАКТЕРИСТИКИ НА САМОСМАЗВАЩ СЕ КОМПОЗИЦИОНЕН АНТИФРИКЦИОНЕН МАТЕРИАЛ, СЪДЪРЖАЩ МОЛИБДЕНОВ ДИСУЛФИД

Тинка Грозданова, Анна Петрова, Силвия Симеонова

ИНСТИТУТ ЗА КОСМИЧЕСКИ ИЗСЛЕДВАНИЯ И ТЕХНОЛОГИИ – БАН, СОФИЯ 1113, УЛ. „АКАД. Г. БОНЧЕВ", БЛ. 1

Резюме: Твърдотелните смазващи материали (твърдотелни смазки) са високоефективни антифрикционни материали, осигуряващи нисък коефициент на триене на трибосистемите. Нанасят се върху работните повърхности, подложени на триене в екстремни условия – висока температура, лъчения, отсъствие на окисляваща атмосфера, сухо триене (без смазка) и др. В статията е разгледан антифрикционен самозмазващ се материал, съдържащ молибденов дисулфид.

Ключови думи: *Самосмазващ композитен материал, вакуум, молибденов дисулфид.*

8.15. А. Петрова, Т. Грозданова, С. Ставрев, Нанотехнологиите – реалното бъдеще, Трета международна конференция „Наука, образование, иновации", Шумен, 174-181 (2014)

THIRD INTERNATIONAL SCIENTIFIC CONFERENCE
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35TH ANNIVERSARY OF GEORGI IVANOV'S FLIGHT

Original Contribution

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НАНОТЕХНОЛОГИИТЕ – РЕАЛНОТО БЪДЕЩЕ

Анна Петрова, Тинка Грозданова, Ставри Ставрев

ИНСТИТУТ ЗА КОСМИЧЕСКИ ИЗСЛЕДВАНИЯ И ТЕХНОЛОГИИ – БАН, СОФИЯ 1113, УЛ. „АКАД. Г. БОНЧЕВ", БЛ. 1

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NANOTECHNOLOGIES – THE REALISTIC FUTURE

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ABSTRACT: *Nanotechnology is one of the key technologies of the 21st Century. Nanotechnological products and processes hold an enormous economic potential for the markets of the future. The production of ever smaller, faster and more efficient products with acceptable price-to-performance ratio has become for many industrial branches an increasingly important success factor. Due to its interdisciplinary cross-sectional character, nanotechnology will affect broad application fields of chemistry, materials, electronics, medicine, information technology, environmental and energy engineering. Also in space technology a high potential for nanotechnological applications is postulated. The increasing commercialisation of manned and unmanned space travel as well as ever more ambitious missions for the scientific investigation of the solar system and far space, require the development of more efficient, more economical and more resistant space technologies and systems in the future. Nanotechnology could contribute significantly to solutions and technological breakthroughs in this area (nano-spin-on).*

8.16. Т. Грозданова, А. Петрова, Трибология и екология, Трета международна конференция „Наука, образование, иновации", Шумен, 167-173 (2014)

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ТРИБОЛОГИЯ И ЕКОЛОГИЯ

Тинка Грозданова, Анна Петрова

ИНСТИТУТ ЗА КОСМИЧЕСКИ ИЗСЛЕДВАНИЯ И ТЕХНОЛОГИИ – БАН, СОФИЯ 1113, УЛ. „АКАД. Г. БОНЧЕВ", БЛ. 1
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TRIBOLOGY AND ECOLOGY

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ABSTRACT: *Ecological and economical aspects of frictional interactions must be taken into account in product design and in the operation of machines. Tribology is the study of friction, wear and lubrication. The concept of „Green tribology" (environment-friendly tribology) as „the science and technology of the tribological aspects of ecological balance, as well as the environmental and biological impacts" was introduced by Prof. P. Jost. There are a number of problems that can be addressed by Green tribology. The specific field of tribology emphasizes on the aspects of interacting surfaces in relative motion, which are of importance for energical or environmental sustainability. It is necessary not only to expect novel development but also to create realistic solutions by conventional technologies. Ecotribology is an engineering technology that can contribute a lot to the development of the modern society.*

KEY WORDS: *Tribology, vacuum conditions, self-lubricating composite materials, molybdenum disulfide (MoS_2), nanotechnologies.*

8.17. А. Петрова, С. Симеонова, Т. Грозданова, Физико-механични свойства на образци от титанова керамика покрити със стъкловъглерод за приложение в медицината, SES 2013, 487-491 (2014)

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Ninth Scientific Conference with International Participation
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ФИЗИКО-МЕХАНИЧНИ СВОЙСТВА НА ОБРАЗЦИ ОТ ТИТАНОВА КЕРАМИКА ПОКРИТИ СЪС СТЪКЛОВЪГЛЕРОД ЗА ПРИЛОЖЕНИЕ В МЕДИЦИНАТА

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Ключови думи: *Биокерамика, ендопротези, стъкловъглерод.*

Резюме: *При имплантирането на различни стави в човешкото тяло, като най-целесъобразен е установен модулния принцип за изграждане на ставните протези, позволяващ вариации във вида на използвания материал за отделните компоненти на феморално-ацетабуларната става. Това позволява избор на оптимална комбинация от материали за артикулиращите повърхнини на импланта съобразно специфичните данни на пациента. За изработване на различни видове протези се използват както метални (стоманени и титанови) сплави, така и различни видове керамики. Биоинертните керамики са нетоксични и не предизвикват алергии. Това обеснява голямото им приложение като материали за ортодонни и ставни импланти.*

В настоящата работа са изследвани образци от титанова керамика (титанов диоксид и добавки), направени по проект 02-234/17.12.2008 с НФНИ при МОМН.

Анализирани са микро и макроструктурата - повърхност, среден размер на частиците, еластичност, микротвърдост по Викерс, Кнуп и NanoScan за образци, на основата на която са изработени ставни импланти за бъдещо медицинско приложение. Получените резултати са сравнени с характеристиките на други, известни в литературата материали, използвани за различни видове импланти в човешкия организъм.

8.18. D. Teodosiev, R. Valov, V. Petkov, S. Simeonova, A. Petrova, B. Tabakova, Microstructural and mechanical study of composite ceramic material intended for hip joint prosthesis, Scientific Proceedings of International Conference Nondestructive testing days 2012, №1(130), 104-107 (2012)

ISSN 1310-3946

НАУЧНИ ИЗВЕСТИЯ на НТСМ
SCIENTIFIC PROCEEDINGS

Year /Година XX ❐ Number/ Брой 1 (130) June/Юни 2012

MICROSTRUCTURAL AND MECHANICAL STUDY OF COMPOSITE CERAMIC MATERIAL INTENDED FOR HIP JOINT PROSTHESIS

ИЗСЛЕДВАНЕ НА МИКРОСТРУКТУРАТА И МЕХАНИЧНИТЕ СВОЙСТВА НА КОМПОЗИТЕН КЕРАМИЧЕН МАТЕРИАЛ С ПРИЛОЖЕНИЕ ЗА ПРОТЕЗА НА ТАЗОБЕДРЕНА СТАВА

ИССЛЕДОВАНИЕ МИКРОСТРУКТУРЫ И МЕХАНИЧЕСКИХ СВОЙСТВ КОМПОЗИЦИОННОГО КЕРАМИЧЕСКОГО МАТЕРИАЛА ДЛЯ ПРИМЕНЕНИЯ КАК ПРОТЕЗ ТАЗОБЕДРЕНОГО СУСТАВА

D.Teodosiev[1], R.Valov[2], V.Petkov[2], S. Simeonova[1], A. Petrova[1], B. Tabakova[3]
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Abstract *We investigated the mechanical properties of the composite material in the Al_2O_3 - ZrO_2 system with different content of the two oxides and the influence of the temperature treatment. Preliminary synthesis is made aiming partial stabilization of the ZrO_2 with Y_2O_3. The sintering of the composite material is carried out at temperature up to 1680^0C. The obtained composite ceramic possesses high hardness – 90 HRA, compressive strength - 1650 MPa and bending strength - 260 MPa. We studied four compositions with different content of the two basic oxides. The mechanical properties – compressive and bending strength of the compositions are determined.A method for coating of the described ceramic with vitreous carbon is developed. For this purpose the ceramic substrate, in our case the sintered Al_2O_3 - ZrO_2 samples, are covered with polymer organic material, with complex structure of the type (CnHm). During the heating the polymer decomposes to: carbon, which subsequently forms the desired carbide structure; hydrogen (H_2) and organic radicals (CxHy). The presence of H_2 in the furnace environment favours the reduction of the oxides at the ceramic surface by extracting and chemically bonding the labile oxygen O^{2+} ions. The obtained free chemical bonds are lately saturated by the carbon atoms from the decomposition of the polymer organic material, thus forming the desired carbide layer on the substrate surface.*

KEYWORDS: BIO COMPATIBLE CERAMIC, AL_2O_3 - ZRO_2, VITREOUS CARBON, PHYSICO-MECHANICAL, PHYSICO-CHEMICAL PROPERTIES

8.19. З. Карагьозова, К. Айлот, Л. Александрова, И. Дрангажова, А. Петрова, С. Васева, С. Ставрев, Влияние на термичната обработка на основния материал върху физико-механичните показатели на химически покрити зъбни колела, Инженерни науки, Изд. ИМ „Акад. А. Балевски”, БАН, XLVI, кн. 4, 69-73 (2009)

INFLUENCE OF THE BASIC MATERIAL THERMAL PROCESSING ON THE PHYSICAL-MECHANICAL PROPERTIES OF CHEMICALLY COATED GEARS

Z. Karaguiozova, Ch. Ailot, L. Alexandrova, I. Drangajova,
A. Petrova, S. Vaseva, S. Stavrev

Summary

Coatings layering on steel products working under hard conditions are wide spread method. The nanotechnology development discovers novel methods to improve details physical and mechanical properties, mostly wear resistance. The base material quality influences on the physical and mechanical properties of the products working under pressure, under stretch and bend. The material properties are depending on the structure. The structure is depending on the base material preliminary treatment. The thermal processing is of importance for steel products.

Постъпила на 08.05.2009

8.20. З. Карагьозова, А. Петрова, С. Васева, Ж. Калейчева, П. Шумналиев, Ставри Ставрев, Влияние на добавка от нанодиамант върху свойствата на никелово покритие, VI Международен конгрес „Машини, технологии, материали", кн. 3, София, 12-14 (2009)

ВЛИЯНИЕ НА ДОБАВКА ОТ ВЪРХУ СВОЙСТВАТА НА НИКЕЛОВО ПОКРИТИЕ

INFLUENCE OF NANODIAMOND ADDITIONS ON THE PROPERTIES OF NICKEL COATINGS

Карагьозова Здравка, Петрова Анна, Силвия Васева, Жулиета Калейчева, Петър Шумналиев, Ставрев Ставри

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Ключови думи: диамант, метализация, покритие, абразиви, NanoScan
Изследвано е влиянието на добавка от нано и микро уякчаващи частици върху някои физико-механични свойства на безтоково никелово покритие. Като наноразмерен уякчаващ материал е използван нанодиамант, получен по взривен метод. Използваните микроразмерни усилващи частици са cBN.
Получените резултати за физико-механичните и експоатационни характеристики за покритие никел-нанодиамант потвърждават уникалността на свойствата характерни за наноразмерните частици, използвани като подиславащ елемент: висока износо- и корозо-устойчивост, повишена твърдост, нисък коефициент на триене, подобрена адхезия.
Проведените експерименти са етап от тестови изследвания във връзка с работа по Проекта X-Gear по VI РП в секция «КМ и НТ» при ИКИ-БАН.

8.21. Д. Теодосиев, Й. Георгиев, Н. Петров, А. Петрова, Синтез карбид титана с применением нового донора углерода, „Новейшие разработки российских и болгарских организаций в области нанотехнологии и наноматериалов", Федеральное агенство по науке и инновациям, Москва, 41-49 (2009)

Синтез карбид титана с применением нового донора углерода

Д. Теодосиев[1], Й. Георгиев[2], Н. Петров[3], А. Петрова[1]
[1] Институт космических исследований - БАН, София, Болгария
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Потребность в расходо- и энергоэффективных материалах и технологиях, щадящих одновременно с этим окружающую среду, непрерывно возрастает. Все более широкое применение в машиностроении и медицине находит новый класс таких материалов, разработанных или на основе аморфного стеклоуглерода, или на базе карбидов бора, титана или вольфрама.

Карбид характеризуются высокими: температурой плавления, твердостью электропроводимостью, химической и тепловой устойчивостьями, а также высоким сопротивлением износу. По этим качествам они являются основой для керамики с широким спектром применения в ключевых высоких технологиях.

8.22. Z. Karaguiozova, A. Petrova, S Vasseva, S Stavrev, Project X-gear – Development of gear-drive trains based on new materials and novel gear systems, EC framework 6 collective research project, Nanoscience & Nanotechnology, 9, eds. E. Balabanova, I. Dragieva, Printed by „BPS" Ltd., Sofia, 252-254 (2009)

Nanoscience & Nanotechnology, 9
eds. E. Balabanova, I. Dragieva, Sofia, 2009

PROJECT X-GEAR
"DEVELOPMENT OF GEAR-DRIVE TRAINS BASED ON NEW MATERIALS AND NOVEL GEAR SYSTEMS" EC FRAMEWORK 6 COLLECTIVE RESEARCH PROJECT

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Space Research Institute, Bulgarian Academy of Sciences,
1000 Sofia, P.O. Box 799, Bulgaria

PRIORITY 3 - Nanotechnologies and nano-sciences, knowledge-based multifunctional materials
and new production processes and devices
• EC Framework 6 Collective Research project
COLL-CT-2006, Contract Number 030433
• Full title
–Development of Gear-Drive Trains Based on New Materials and Novel Gear Systems
• Project leader -D'Appolonia, Italy
• EC Contract signed 28 August 2006 and Consortium Agreement signed by all Members
• Coordinator for Bulgaria: Prof. D.Sc. Stavri Stavrev – Space Research Institute, Bulgarian Academy of Sciences, Sofia, Bulgaria,
tel: +359-2-9753443, e-mail: astavrev@phys.bas.bg
Duration: 42 months (2006-2010)
Total Request for the project: 2 697 094,60 Euro
EC Contribution for the project: 1 872 586,00 Euro
EU Contribution for Bulgaria (SRI-BAS): 119 498,00Euro
Participants: *22 from 9 Countries*: Italy (6), Netherlands (1), Belgium (3), Portugal (2), Bulgaria (4), Poland (2), England (1), Finland (1), Poland (2) (Figure 1).

Figure 1. Participants Geographyc distribution

Abstract: European mechanical transmission sector producers of gears and gearing products rely on traditional technologies and are characterised by a general conservatism. However over the years the end products in which the gears are used have become more complex and are pushing the state of the art in new technology. Thus the requirement for more sophisticated and reliable gears become extremely important. The gear industry has to implement major changes in gear design and gear fabrication techniques just to keep up with the changing needs of the end product. In line with the strategic objectives of the associations of manufacturers of gears and mechanical transmission systems, the objective of X-gear is the diffusion and the standardisation of novel technologies and new materials for a new generation of gears characterised by higher accuracy, resistance, reliability, and tribology properties. In this context X-GEAR plays a role in the competitiveness of European industry since aims to comply with the tighter and tighter requirements being put on the gear industry for lighter weight, higher torque transmissions and quieter, more efficient gear trains.

Keywords: diamond, metallization, composites, coating, tools

lect and develop new materials and novel surface treatments for high performance gears.

- **The Main Innovations:**
  - **Development of new materials** starting from the analysis of new direct hardening and air quenching steels, of advanced sintered steels and nanopowders.
  - **Development of new processes** integrating the most recent advances in material properties, tooling design and tooling materials, automation, heat treatment, hard machining, innovative post-processing and the application of different modes and grades of powder forging.
  - **Design Tool Development** for realising the full benefit of nanostructured coatings.
  - **Produce Novel Helical Gears** manufactured in new materials steels coated with innovative surface treatments for application in the

8.23. З. Карагьозова, А. Петрова, С. Васева, С. Ставрев, Влияние на добавка от нанодиамант върху свойствата на никелово покритие, SENS 2008, 192-194 (2008)

S E N S 2 0 0 8
Fourth Scientific Conference with International Participation
SPACE, ECOLOGY, NANOTECHNOLOGY, SAFETY
4–7 June 2008, Varna, Bulgaria

ВЛИЯНИЕ НА ДОБАВКА ОТ НАНОДИАМАНТ ВЪРХУ СВОЙСТВАТА НА НИКЕЛОВО ПОКРИТИЕ

Здравка Карагьозова, Анна Петрова, Силвия Васева, Ставри Ставрев

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Ключови думи: *диамант, метализация, покритие, абразиви, NanoScan*

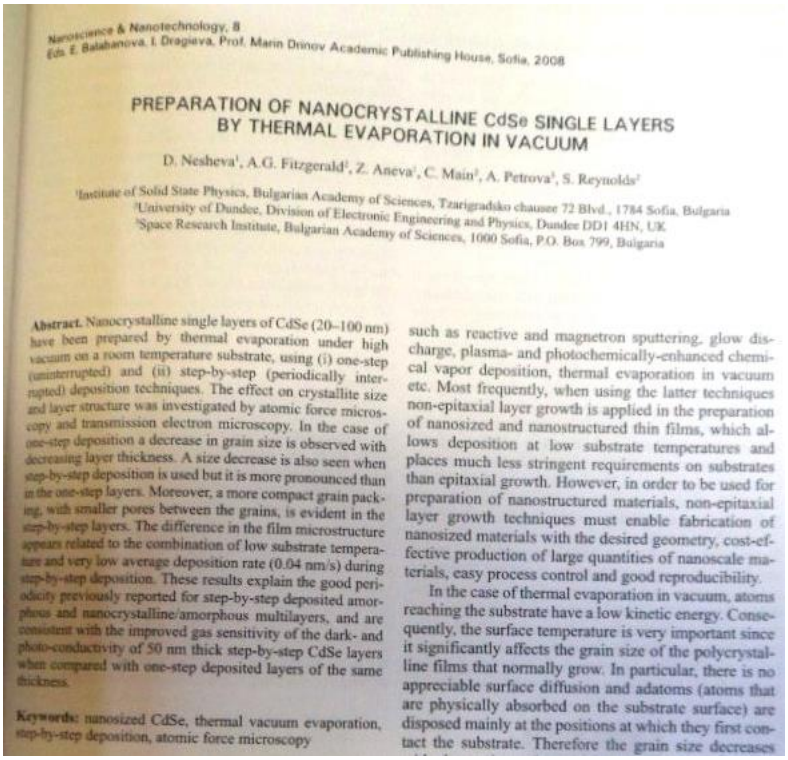
Резюме: *Изследвано е влиянието на наноразмерен уякчаващ материал (нанодиамант) върху някои свойства на безтоково никелово покритие.*

Проведени са сравнителни тестове на композиционни никелови покрития, включващи микроразмерни усилващи частици (cBN).

Получените резултати за физико-механичните и експоатационни характеристики за покритие никел-нанодиаманд потвърждават уникалността на свойствата характерни за наноразмерните частици, използвани като подисляващ елемент: висока износо- и корозо-устойчивост, повишена твърдост, нисък коефициент на триене, подобрена адхезия.

Проведените експерименти са етап от тестови изследвания във връзка с работа по Проекта X-Gear по VI РП в секция «КМ и НТ» при ИКИ-БАН.

8.24. D. Nesheva, A. Fitzgerald, Z. Aneva, C. Main, A. Petrova, S. Reynolds, Preparation of nanocrystalline CdSe single layers by thermal evaporation in vacuum, Nanoscience & Nanotechnology, eds. E. Balabanova, I. Dragieva, Prof. Marin Drinov Academic Publishing House, 8, 107-110 (2008)



Nanoscience & Nanotechnology, 8
Eds. E. Balabanova, I. Dragieva, Prof. Marin Drinov Academic Publishing House, Sofia, 2008

PREPARATION OF NANOCRYSTALLINE CdSe SINGLE LAYERS BY THERMAL EVAPORATION IN VACUUM

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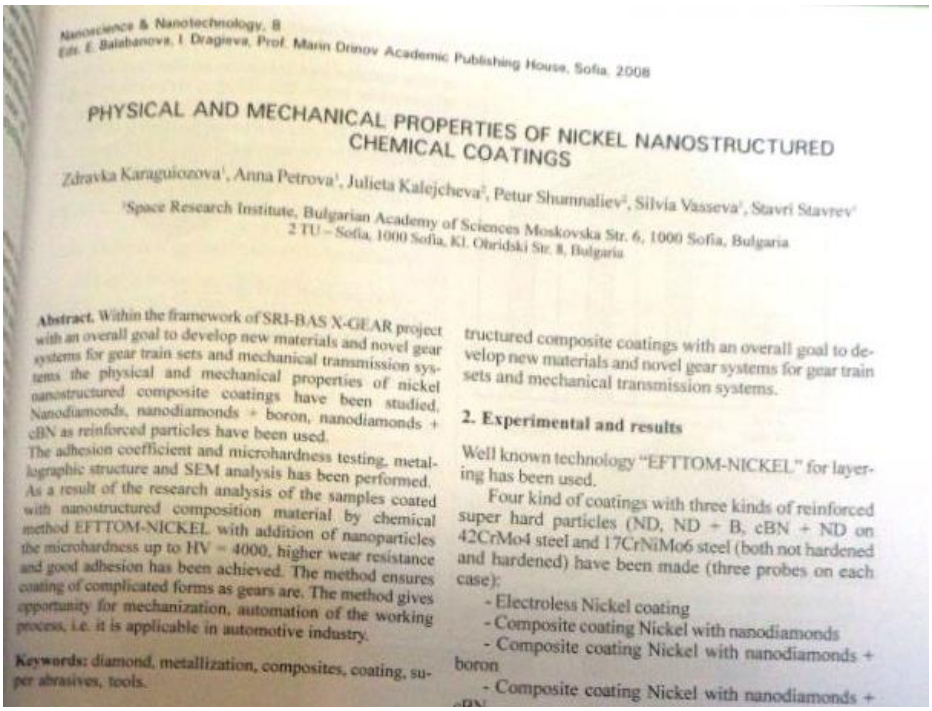
Abstract. Nanocrystalline single layers of CdSe (20–100 nm) have been prepared by thermal evaporation under high vacuum on a room temperature substrate, using (i) one-step (uninterrupted) and (ii) step-by-step (periodically interrupted) deposition techniques. The effect on crystallite size and layer structure was investigated by atomic force microscopy and transmission electron microscopy. In the case of one-step deposition a decrease in grain size is observed with decreasing layer thickness. A size decrease is also seen when step-by-step deposition is used but it is more pronounced than in the one-step layers. Moreover, a more compact grain packing, with smaller pores between the grains, is evident in the step-by-step layers. The difference in the film microstructure appears related to the combination of low substrate temperature and very low average deposition rate (0.04 nm/s) during step-by-step deposition. These results explain the good periodicity previously reported for step-by-step deposited amorphous and nanocrystalline/amorphous multilayers, and are consistent with the improved gas sensitivity of the dark- and photo-conductivity of 50 nm thick step-by-step CdSe layers when compared with one-step deposited layers of the same thickness.

Keywords: nanosized CdSe, thermal vacuum evaporation, step-by-step deposition, atomic force microscopy

such as reactive and magnetron sputtering, glow discharge, plasma- and photochemically-enhanced chemical vapor deposition, thermal evaporation in vacuum etc. Most frequently, when using the latter techniques non-epitaxial layer growth is applied in the preparation of nanosized and nanostructured thin films, which allows deposition at low substrate temperatures and places much less stringent requirements on substrates than epitaxial growth. However, in order to be used for preparation of nanostructured materials, non-epitaxial layer growth techniques must enable fabrication of nanosized materials with the desired geometry, cost-effective production of large quantities of nanoscale materials, easy process control and good reproducibility.

In the case of thermal evaporation in vacuum, atoms reaching the substrate have a low kinetic energy. Consequently, the surface temperature is very important since it significantly affects the grain size of the polycrystalline films that normally grow. In particular, there is no appreciable surface diffusion and adatoms (atoms that are physically absorbed on the substrate surface) are disposed mainly at the positions at which they first contact the substrate. Therefore the grain size decreases

8.25. Z. Karaguizova, A. Petrova, J. Kalejcheva, P. Shumnaliev, S. Vasseva, S. Stavrev, Physical and mechanical properties of nickel nanostructured chemical coatings, Nanocsience & Nanotechnology, eds. E. Balabanova, I. Dragieva, Prof. Marin Drinov Academic Publishing House, 8, Sofia, 177-180 (2008)



Nanoscience & Nanotechnology, 8
Eds. E. Balabanova, I. Dragieva, Prof. Marin Drinov Academic Publishing House, Sofia, 2008

PHYSICAL AND MECHANICAL PROPERTIES OF NICKEL NANOSTRUCTURED CHEMICAL COATINGS

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Abstract. Within the framework of SRI-BAS X-GEAR project with an overall goal to develop new materials and novel gear systems for gear train sets and mechanical transmission systems the physical and mechanical properties of nickel nanostructured composite coatings have been studied. Nanodiamonds, nanodiamonds + boron, nanodiamonds + cBN as reinforced particles have been used.
The adhesion coefficient and microhardness testing, metallographic structure and SEM analysis has been performed. As a result of the research analysis of the samples coated with nanostructured composition material by chemical method EFTTOM-NICKEL with addition of nanoparticles the microhardness up to HV = 4000, higher wear resistance and good adhesion has been achieved. The method ensures coating of complicated forms as gears are. The method gives opportunity for mechanization, automation of the working process, i.e. it is applicable in automotive industry.

Keywords: diamond, metallization, composites, coating, super abrasives, tools.

tructured composite coatings with an overall goal to develop new materials and novel gear systems for gear train sets and mechanical transmission systems.

2. Experimental and results

Well known technology "EFTTOM-NICKEL" for layering has been used.

Four kind of coatings with three kinds of reinforced super hard particles (ND, ND + B, cBN + ND on 42CrMo4 steel and 17CrNiMo6 steel (both not hardened and hardened) have been made (three probes on each case):

- Electroless Nickel coating
- Composite coating Nickel with nanodiamonds
- Composite coating Nickel with nanodiamonds + boron
- Composite coating Nickel with nanodiamonds +

8.26. З. Карагьозова, Л. Марков, А. Петрова, Ж. Калейчева, П. Шумналиев, С. Ставрев, Физико-механични свойства на композиционно никелово покритие, SENS 2007, Варна, 324-328 (2008)

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ФИЗИКО-МЕХАНИЧНИ СВОЙСТВА НА КОМПОЗИЦИОННО НИКЕЛОВО ПОКРИТИЕ

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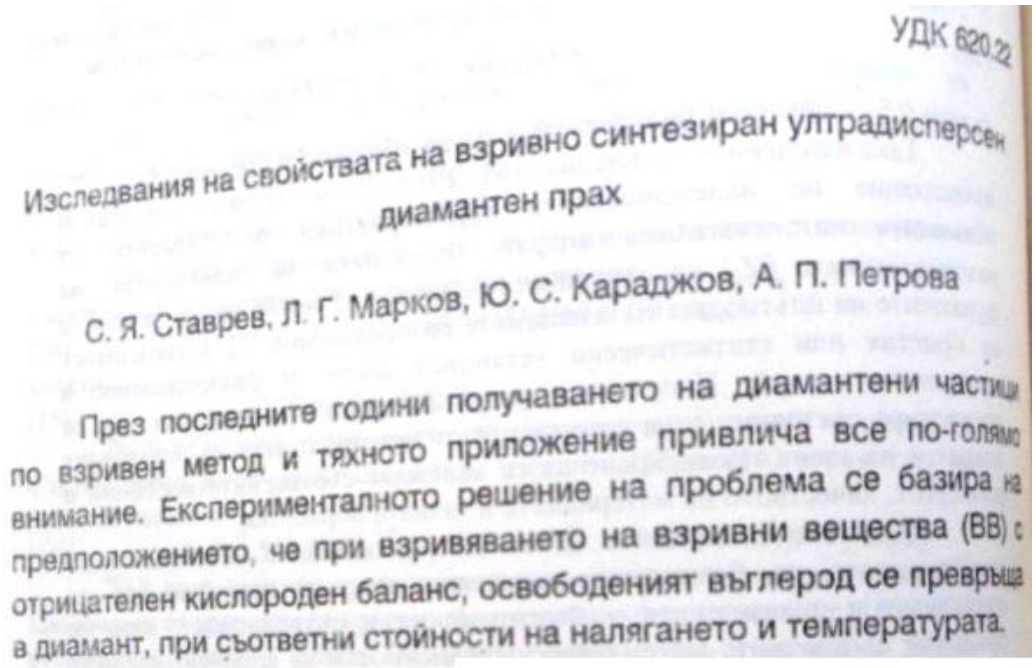
***Ключови думи**: Композиционни диамантени покрития, УДДП (нанодиамант), X-Gear.*

***Резюме:** Във връзка с изследвания по проекта "X-Gear" по VI РП в секция "КМ и НТ" при ИКИ-БАН са проведени изследвания за нанасяне на композиционно никелово покритие (КП), отложено по химически начин с УДДП (нанодиамант).*

Основните съставляващи на покритието са никелова матрица и подсилващ, уякчаващ материал - УДДП. Матрицата обгражда и поддържа подсилващия материал, осигурявайки свързването му. С използването на диамантени наночастици като подсилващи елементи, са свързани надеждите за реализиране на много добри физико-механични и експоатационни характеристики, присъщи за нанокристалното състояние като повишена износоустойчивост и микротвърдост; увеличение на корозионната устойчивост и намаляване на пористостта; рязко намаляване на коефициента на триене; повишаване на кохезията и адхезията, по-добро задържане на диамантените зърна от матрицата, което води до удължаване живота на работната повърхност на образците неколкократно.

8.27. С. Ставрев, Л. Марков, Ю. Караджов, А. Петрова, Изследвания на свойствата на взривносинтезиран ултрадисперсен диамантен прах, Юбилейна научна сесия „40 години от първия полет на човек в Космоса", ВВВУ „Георги Бенковски", т. 2, Долна Митрополия, 50-57 (2001)



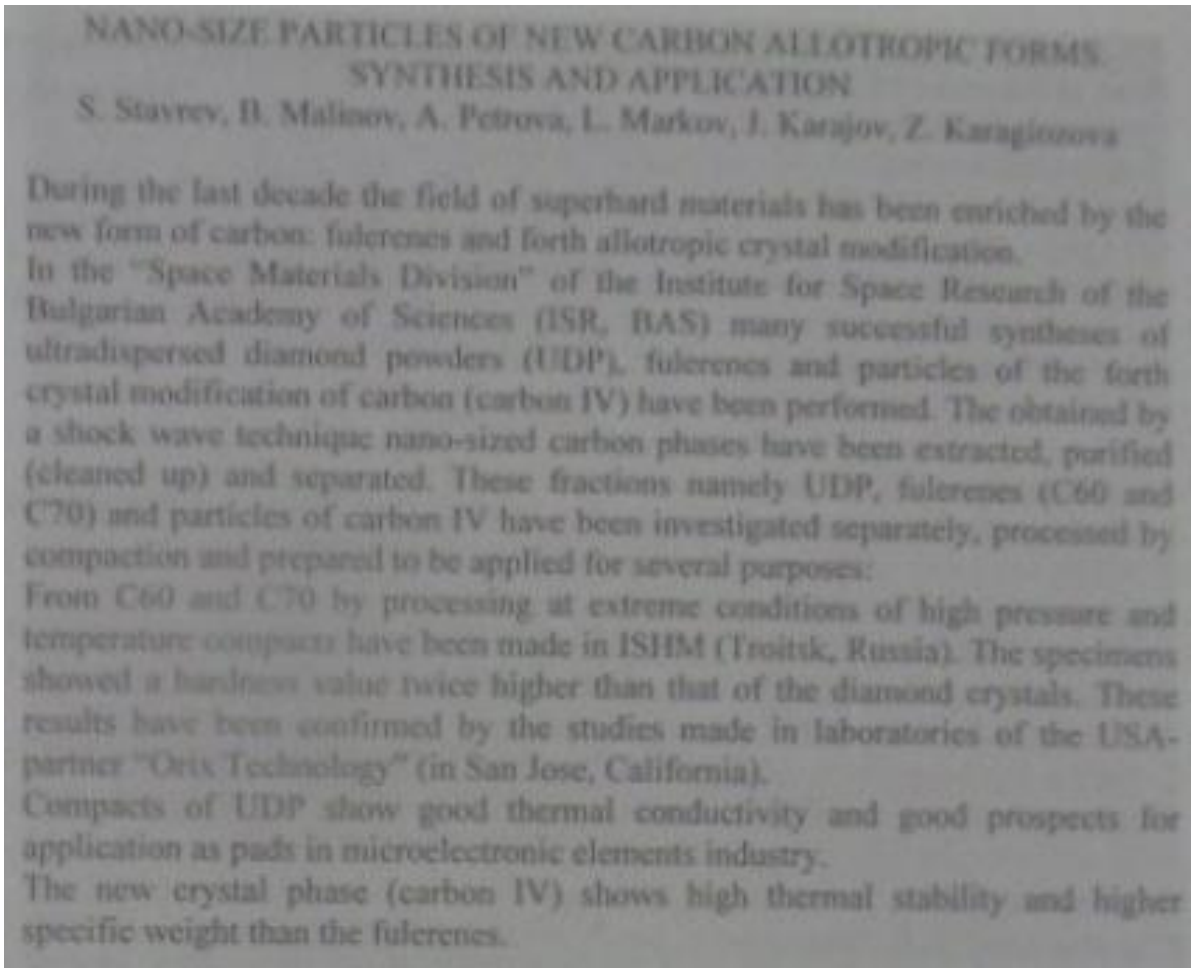
УДК 620.22

Изследвания на свойствата на взривно синтезиран ултрадисперсен диамантен прах

С. Я. Ставрев, Л. Г. Марков, Ю. С. Караджов, А. П. Петрова

През последните години получаването на диамантени частици по взривен метод и тяхното приложение привлича все по-голямо внимание. Експерименталното решение на проблема се базира на предположението, че при взривяването на взривни вещества (ВВ) с отрицателен кислороден баланс, освободеният въглерод се превръща в диамант, при съответни стойности на налягането и температурата.

8.28. S. Stavrev, B. Malinov, A. Petrova, L. Markov, J. Karadjov, Z. Karagiozova, Nano-size particles of new carbon allotropic forms. Synthesis and application, Nanoscience & Nanotechnology, 25-26 (1999)



NANO-SIZE PARTICLES OF NEW CARBON ALLOTROPIC FORMS. SYNTHESIS AND APPLICATION

S. Stavrev, B. Malinov, A. Petrova, L. Markov, J. Karajov, Z. Karagiozova

During the last decade the field of superhard materials has been enriched by the new form of carbon: fulerenes and forth allotropic crystal modification.

In the "Space Materials Division" of the Institute for Space Research of the Bulgarian Academy of Sciences (ISR, BAS) many successful syntheses of ultradispersed diamond powders (UDP), fulerenes and particles of the forth crystal modification of carbon (carbon IV) have been performed. The obtained by a shock wave technique nano-sized carbon phases have been extracted, purified (cleaned up) and separated. These fractions namely UDP, fulerenes (C60 and C70) and particles of carbon IV have been investigated separately, processed by compaction and prepared to be applied for several purposes:

From C60 and C70 by processing at extreme conditions of high pressure and temperature compacts have been made in ISHM (Troitsk, Russia). The specimens showed a hardness value twice higher than that of the diamond crystals. These results have been confirmed by the studies made in laboratories of the USA-partner "Orix Technology" (in San Jose, California).

Compacts of UDP show good thermal conductivity and good prospects for application as pads in microelectronic elements industry.

The new crystal phase (carbon IV) shows high thermal stability and higher specific weight than the fulerenes.

Благодаря за вниманието Ви!

Надявам се, да сте намерили нещо, което Ви е заинтригувало и впечатлило!

И както обикновено:

May the Force be with you!

Ани Петрова

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