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2nd International Young Scientists School

"NANOSTRUCTURED MATERIALS"

PROGRAM

of the school

May 10-12, 2016

Tomsk, Russian Federation

2nd International Young Scientists School
"NANOSTRUCTURED MATERIALS"

AIM

The 2nd International Young Scientists School "NANOSTRUCTURED MATERIALS" provides a high quality of professional presentations to young scientists and students and fosters an environment conducive to present advancements in the field of nanomaterials research.

The School gathers young researchers, post-doc and students, and experienced researchers dealing with elaboration, diagnostics and application of nanostructured materials in order to facilitate aggregation and sharing interests and results for a better collaboration and activity visibility.

The main objective of the School is to identify, systematize and solve current scientific problems in the sphere of nanotechnologies in order to join forces to determine prospective areas and compose working groups of interested co-workers for carrying out interdisciplinary research projects.

LOCATION

Tomsk Polytechnic University

www.tpu.ru

30 Lenina avenue, Tomsk, Russia

tel.: +7 (3822) 70-16-10

Website: http://nano2016.tpu.ru/

COORDINATOR

Dr. Anna Godymchuk

Dept. of Nanomaterials and Nanotechnologies

Tomsk Polytechnic University

e-mail: godymchuk@tpu.ru

cell: +7 906 947-50-27

ACKNOWLEDGEMENTS

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SCIENTIFIC COMMITTEE MEMBERS

Prof. Gleb Sukhorukov, Queen Mary University of London, Great Britain, Saratov State University, Russia
Prof. Victor Erokhin, CNR - Institute of Materials for Electronics and Magnetism, Parma, Italy
Dr. Elena Atochina-Vasserman, RASA Center, Tomsk Polytechnic University, Russia
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Mrs. Elena Yunda, Tomsk Polytechnic University, Russia

2nd International Young Scientists School
"NANOSTRUCTURED MATERIALS"

JOINT PROGRAM

May, 09, Monday

Arrival of participants	

May, 10, Tuesday

Venue: room 323, 7 Usova Street, Tomsk, Russia

Registration of participants	8^{30}-9^{00}
Opening	9^{00}-9^{20}
Lecture session	9^{30}-11^{30}
Coffee-break Poster session #1	11^{30}-12^{00}
Lecture session	12^{00}-14^{00}
Lunch time	14^{00}-15^{00}
Lecture session	15^{00}-17^{00}
Coffee-break Poster session #2	17^{00}-17^{30}
Lecture session	17^{30}-19^{00}
Coffee-break Poster session #3	19^{00}-19^{30}

May, 11, Wednesday

Venue: room 323, 7 Usova Street, Tomsk, Russia

City Tour	9^{00}-11^{00}
Registration of participants	11^{00}-11^{30}
Coffee-break Poster session #4	11^{30}-12^{00}

JOINT PROGRAM

May, 11, Wednesday

Lecture session	12^{00} - 14^{00}
Lunch time	14^{00} - 15^{00}
Lecture session	15^{00} - 17^{00}
Coffee-break Poster session #5	17^{00} - 17^{30}
Lecture session	17^{30} - 19^{00}
Coffee-break Poster session #6	19^{00} - 19^{30}

May, 12, Thursday

Venue: 13 Usova Street, Tomsk, Russia

Closing Best Poster Avarding	9^{00} - 10^{00}
Welcome Party	19^{00}

PROGRAM

May, 10, Tuesday

Registration of participants — 8:00 - 9:00

Opening Speech — 9:00
Prof. Alexander Dyachenko, Tomsk Polytechnic University, Russia

Welcome from Organizing Committee — 9:15
Prof. Gleb Sukhorukov, Queen Mary University of London, Great Britain, Saratov State University, Russia

Lecture Session #1 — 9:20 - 11:30

Chair: Dr. Elena Atochina-Vasserman
RASA Center, Tomsk Polytechnic University, Russia

Lecture "Polymeric micelles for drug delivery" — 9:20
Prof. Alexander Kabanov, Moscow State University, Russia, University of Northern Carolina Chapel Hill, USA

Lecture "Remote controlling of micro- and nanosystem delivery. The area of research where physics, chemistry and biology contribute" — 10:00
Prof. Gleb Sukhorukov, Queen Mary University of London, Great Britain, Saratov State University, Russia

Lecture "Nanoparticles in targeted drug delivery and nanotoxicity" — 10:40
Prof. Radostina Georgieva, Institute of Transfusion Medicine, University Hospital Charité, Germany

Coffee-break
Poster session #1 — 11:30 - 12:00

Lecture Session #2 — 12:00 - 14:00

Chair: Prof. Dmitry Gorin
Saratov State University, Russia

Lecture "Basic principles of red blood cell aggregation - bridging versus depletion models" — 12:00
Prof. Hans Bäumler, Institute of Transfusion Medicine, UniversityHospital Charité, Germany

Lecture "The biological chemistry of lung lining fluid: A unique target for nanoparticle delivery" — 12:40
Prof. Andrew Gow, Rutgers University, USA

PROGRAM

May, 10, Tuesday

Lecture "Drug delivery for protection against stroke" ***Prof. Dmitriy Atochin,*** Massachusetts General Hospital, USA	13[20]
Lunch time	14[00]-15[00]
Lecture Session #2	15[00]-16[30]
Chair: Dr. Roman Surmenev *Tomsk Polytechnic University, Russia*	
Lecture "Templates, materials & sizes: Tuning of thelayer-by-layer formed encapsulating carriers for applications in humans. A multidisciplinary research" ***Dr. Maria Antipina,*** Institute of Materials Research and Engineering, A*STAR Singapore	15[00]
Lecture "Nano-dimension, nano-structures and their applications in modern and future accelerators" ***Prof. Pavel Karataev,*** John Adams Institute at Royal Holloway, Department of Physics, University of London, GB	15[40]
Lecture "Bioactive thin films for functionalization of dental and orthopaedic implants" ***Prof. Alina Vladescu,*** National Institute for Optoelectronics, Romania	16[20]
Coffee-break Poster session #2	17[00]-17[30]
Lecture Session #3	17[30]-19[00]
Chair: Prof. Alina Vladescu *National Institute for Optoelectronics, Romania*	
Lecture "Catalysis and Complexity in Nanoscience: From Molecular Control to Applications" ***Prof. Valery Fokin,*** University of Southern California, USA	17[30]
Lecture "Personalized and Precision Therapy in Cancer" ***Prof. Lyuba Varticovski,*** National Cancer Institute, Maryland, USA	18[10]
Coffee-break Poster session #3	19[00]-19[30]

PROGRAM

May, 11, Wednesay

City Tour — 9^{00} - 11^{00}

Registration of participants — 11^{00} - 11^{30}

Coffee-break
Poster session #4 — 11^{30} - 12^{00}

Lecture Session #4 — 12^{00} - 14^{00}

Chair: Dr. Maria Antipina
*Institute of Materials Research and Engineering, A*STAR*

Lecture "Chromophore- and luminophore-containing polymers for optoelectronics" — 12^{00}
Prof. Alexander Yakymansky, Institute of Macromolecular Compounds of the Russian Academy of Sciences, Russia

Lecture "Structure and morphology of matrix-free Ge quantum dots" — 12^{40}
Dr. Andrei Sapelkin, Queen Mary University of London, Great Britain

Lecture "Patterned Arrays of Polyelectrolyte Multilayer Microchambers: Fabrication, Properties and Applications" — 13^{20}
Dr. Maxim V. Kiryukhin, Institute of Materials Research and Engineering, A*STAR Singapore

Lunch time — 14^{00} - 15^{00}

Lecture Session #5 — 15^{00} - 16^{30}

Chair: Dr. Andrei Sapelkin
Queen Mary University of London, Great Britain

Lecture "Lipids and Biomolecules confined in two-dimensional layers at the liquid/air interface" — 15^{00}
Prof. Gerald Brezesinski, Max Planck Institute of Colloids and Interfaces, Potsdam, Germany

PROGRAM

May, 11, Wednesay

Lecture "Electrostatic characteristics of bacterial cells and implications in biotechnology"
Prof. Ales Lapanje, Saratov State University, Russia — 15⁴⁰

Lecture "Image-guided therapy: the advent of theranostic agents"
Dr. Enzo Terreno, Molecular & Preclinical Imaging Centers Department of Molecular Biotechnology and Health Sciences, University of Torino (Italy) — 16²⁰

Coffee-break
Poster session #5 — 17⁰⁰ - 17³⁰

Lecture Session #6 — 17³⁰ - 19⁰⁰

Chair: Dr. Gerald Brezesinski
Max Planck Institute of Colloids and Interfaces, Potsdam, Germany

Lecture "Nanoparticle enhanced optical biomedical imaging, sensing and therapy"
Prof. Valery Tuchin, Saratov National Research State University, Russia — 17³⁰

Lecture "Electrically pumped Er-Si nanoparticle core shell probes for near infrared bio-imaging"
Prof. Munir H. Nayfeh, University of Illinois at Urbana-Champaign, USA — 18¹⁰

Coffee-break
Poster session #6 — 19⁰⁰ - 19³⁰

LECTORS

PROF. GLEB SUKHORUKOV

School of Engineering and Materials Science
Queen Mary University of London, GB
http://www.sems.qmul.ac.uk/
staff ?g.sukhorukov

Saratov State University, Russia
http://www.sgu.ru/en/person/
suhorukov-gleb-borisovich

e-mail: g.sukhorukov@qmul.ac.uk

Remote controlling of micro- and nanosystem delivery

One of the challenges in the bionanotechnology field is development of nano-sized delivery systems comprising different functionalities. These systems should enable to ship and to carry bioactive substances to pre-defined site and unload it in designed time and place. Layer-by-layer assembled technology provides an unique tool to make delivery systems multifunctional, but tailoring polymers and nanoparticles in capsule wall while the cargo is placed in capsule lumen.

The talk is devoted to current research leading to the fabrication of carriers with remote guiding and activation by optical, magnetic and ultrasound addressing, what envisages unique applications as multifunctional biomaterials in-vivo when the bioactive compound is release when reach designated location upon light, magnetic field or ultrasound. The paper demonstrates application for intracellular delivery of compounds and cellular response as well as in vivo perspectives.

DR. MAXIM V. KRIYUKHIN

Institute of Materials Research and Engineering, A*STAR Singapore
http://recast.inoe.ro/

e-mail: kiryukhin-m@imre.a-star.edu.sg

Patterned Arrays of Polyelectrolyte Multilayer Microchambers: Fabrication, Properties and Applications

Active drug release systems offer an important privilege to manage the dosage, time and sometimes site of drug release after the implantation procedure has been performed. A number of existing approaches towards such systems include arrays of microreservoirs equipped with stimuli-responsive actuators or valves. A breakthrough could happen if microreservoirs themselves are made of responsive material susceptible towards remote triggers.

A combination of imprint technology and Layer-by-Layer assembly of Polyelectrolyte Multilayers has been applied to fabricate patterned arrays of microchambers of different size, shape, and aspect ratio. Nanoindentation system and tensile tests were performed to study their mechanical properties and determine stability criteria. Encapsulation of various types of cargo in microchamber arrays was achieved by infiltration of molecules of interest through the polymer network driven by concentration gradient, or template-assisted self-assembly of porous colloidal particles. Site-specific release of encapsulated cargo from the selected microchambers has been triggered by focused laser beam.

The developed technology allows loading a variety of components, almost regardless of their solubility and molecular weight. Regular patterns of microreservoirs give an option to customize release profile or perform immediate highly localized burst release. Possible applications include release-on-demand and multianalytical sensor systems.

DR.ENG. ALINA VLADESCU

National Institute for Optoelectronics (INOE2000), Department for Advanced Surface Processing and Analysis by Vacuum Technologies
http://recast.inoe.ro/

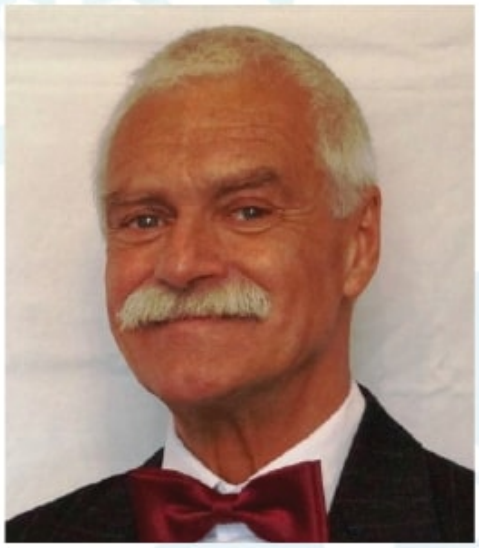
e-mail: alinava@inoe.ro

Bioactive thin films for functionalization of dental and orthopaedic implants

For improving osseointegration of the metallic implants, the bioactive coatings were frequently used. The hydroxyapatite is one of the most extensively used due to their remarkable osseointegration and bioactivity characteristics. The main drawback of hydroxypatite is its low mechanical strength which restricts its use as biomaterial.

The goal of this study was to show that the mechanical characteristics of hydroxyapatite could be enhanced by addition of small amount of different elements (Ti, Si, Mg) in its structure, without loss the bioactive compatibilities. All the coatings were prepared by RF magnetron sputtering. The pure HAP coatings were obtained by sputtering of pure HAP target in an Ar atmosphere, at 700 ЊC substrate temperature.

The nanoindentation results show that presence of small amount of all elements has a positive effect on mechanical properties of hydroxyapatite. Also, it was found that the resistance to the SBF attack and biological characteristics of hydroxyapatite were improved by addition of those elements to its structure.



PROF. HANS BÄUMLER

Institute of Transfusdion Medicine, Charité - Universitätsmedizin Berlin,10117 Berlin, Germany
www.charite.de

e-mail: hans.baeumler@charite.de

Basic principles of red blood cell aggregation - bridging versus depletion models

Interactions between cellular components of blood such as aggregation, agglutination or adhesion of cells are observed in a variety of normal and pathological conditions in human or other mammals. Rouleaux formation of red blood cells (RBCs) in static blood, platelet adhesion and aggregation in both thrombosis and hemostatic plug formation or leukocyte adhesion to the endothelium are examples of such interactions. In the case of RBC, the agglutination of cells is caused, for example, by specific binding of immunoglobulins to the surfaces of adjacent cells whilst the aggregation of RBCs or rouleaux formation is caused by fibrinogen in blood plasma. But this rouleaux formation can also be seen, if the RBCs are resuspended in electrolyte solutions containing neutral macromolecules like dextran. The aggregation of RBCs is completely reversible and the disaggregation of these rouleaux is readily achieved by shearing the suspension.

The strength of aggregation depends not only on the fibrinogen or dextran concentration, and the molecular weight of dextran, but also on the species. The bridging model being favored over thirty years was proposed by Merrill et al. for plasma protein induced RBC aggregation and by Chien and Jan as well as Brooks for the neutral dextran macromolecule-induced RBC aggregation. Non-specifically adsorbed dextran or fibrinogen is supposed to bridge the adjacent RBCs. Dextran with a molecular weight lower than 40 kDa is not able to bridge the human RBCs. Adsorption measurements demonstrated a very low amount of dextran at the surface of human RBCs but failed to show adsorption of fibrinogen.

Asakura and Oosawa introduced the depletion concept of interaction. Depletion of polymers takes place if the loss of configurational entropy of a soluble polymer near the interface is not balanced by a positive interaction energy.

PROF. VALERY TUCHIN

Saratov National Research State University, Russia Research-Education Institute of Optics and Biophotonics,
Institute of Precision Mechanics and Control of RAS, Russia

Tomsk National Research State University, Russia
http://www.sgu.ru/en/person/tuchin-valery-victorovich#

e-mail: tuchinvv@mail.ru

Nanoparticle enhanced optical biomedical imaging, sensing and therapy

Nanoparticle mediated laser diagnosis and therapy of diseases is a novel modality realizing principles of theranostics which were recently formulated. Technologies for enhanced optical biomedical imaging, sensing and therapy based on gold nanoparticles (nanoshells, nanorods, nanocages, and nanostars), gold/-carbon nanotubes, TiO_2 nanoparticles and nanowires, and nanoparticle/PDT dye composites will be demonstrated for protection of skin damage from UV, providing cancer and inflammatory diseases treatment and cell optoporation and transfection. Nanoparticle delivery technologies in tissues will be shown.

A number of different applications, including gypsum-titania nanocomposites for indoor antimicrobial coatings, gold nanoparticles for optical imaging and therapy, and upconversion nanoluminophores for deep-tissue imaging will be presented

PROF. GERALD BREZESINSKI

Max Planck Institute of Colloids and Interfaces, Potsdam, Germany

e-mail: gerald.brezesinski@mpikg.mpg.de

Lipids and biomolecules confined in two-dimensional layers at the liquid/air interface

Monomolecular films at the air/water interface are interesting model systems to study different problems in biophysics and material science. Layer structures and interactions with dissolved biomolecules (DNA, peptides, enzymes) can be studied using highly surface sensitive techniques as pressure-area isotherm measurements, Brewster angle microscopy, different X-ray techniques, as well as Infrared Reflection Absorption Spectroscopy (IRRAS).

The basics of the techniques will be explained and some examples will be presented:
1) Amphiphilic molecules confined at the air-water interface show a rich polymorphism. The chain lattice structures have been determined by GIXD. In rare cases, molecular lattices are observed.
2) Counterion size effects in the Electrical Double Layer at highly charged monolayers. The preferential participation of the smallest ions in the electrical double layer (EDL) has been demonstrated for behenyl sulfate (BS) monolayers (0.64 C/m2) using X-ray reflectivity and a simplified total reflection X-ray fluorescence (TRXF) techniques.
3) Helical intermediates of amyloidogenic model peptides transforms into β-sheets depending on different triggers.
4) Functional carbon nanosheets prepared from hexayne amphiphile monolayers at room temperature: Carbon nanostructures including two-dimensionally extended nanosheets are important components for technological applications such as high performance composites, lithium storage, photovoltaics, or nanoelectronics. We used amphiphiles containing hexayne segments as metastable carbon precursors and self-assembled these into ordered monolayers at the air-water interface. Subsequent carbonization by UV irradiation in ambient conditions resulted in the quantitative carbonization of the hexayne sublayer.

DR. ALEŠ LAPANJE

Saratov State University, Russian Federation
link-my group: http://www.sgu.ru/en/node/5130/recordslab/ales-lapanje-group
link-whole laboratory: http://www.sgu.ru/en/node/5130/recordslab

e-mail: lapanje.ales@gmail.com

Electrostatic characteristics of bacterial cells and implications in biotechnology

It is generally accepted that bacterial cell surface is negatively charged however this cannot be easily explained by virtue of complexity of structure of bacterial cell lining. In addition to phospholipid membrane, bacterial cell lining is composed of cell wall, which is of different structure in Gram-negative and Gram-positive bacteria.

There are also many proteins that are present inside the cell wall and membrane and most of bacteria excrete polysaccharides, eDNA, alginic acids which contributes in formation of matrix. Therefore, the bacterial cell is in view of electrostatics very soft particle and it is hard to determine surface charge by conventional zeta potential measurements. However, by using Ohshima soft particle theory it is possible to determine surface charge and we can determine characteristic curves of electrophoretic mobility dependent on increasing ionic strength. These curves are different for different species as well as strains at each growth stage.

Based on this knowledge, it can be well determined at what time of which bacterial cells can be properly electrostatically manipulated. This approach using electrostatic manipulation can force bacteria to attach to defined surfaces or to form aggregates of defined size or structure.

DR. RADOSTINA GEORGIEVA

Institute of Transfusdion Medicine, Charité - Universitätsmedizin Berlin,10117 Berlin, Germany
www.charite.de

e-mail: radostina.georgieva@charite.de

Nanoparticles in targeted drug delivery and nanotoxicity

The red blood cells (RBC) represent a potential system to carry drugs to the desired site of therapeutic action. Additionally, RBC provide an extraordinary vehicle for the dissemination of drugs in the circulation. This carrier system is biocompatible, non-immunogenic, has a long life-span and a large capacity. Targeting of organs or tissues by RBC loaded with magnetite NPs can be achieved by magnetic focusing. Moreover, magnetite loaded RBC can be visualized by MRI, offering the opportunity for diagnostic monitoring of the therapy. Further opportunities are offered by conjugation of specific antibodies to the surface of RBC or by combination of magnetic and receptor targeting. In addition, RBC carriers can deliver high dosage of different drugs protecting them from inactivating reactions and minimizing side effects. As model drugs we used 5-fluorouracil (5 FU) and fluorouracil acetate (FUAC).

Another very new challenge consists in triggering the drug release at a desired site with defined time sequence and quantities. Opto-nanoporation has the potential to find application as a new tool for studying stimuli-responsive cross-membrane transport of molecules. We studied the permeability changes of the nanoparticle-functionalized membrane of RBCs upon laser irradiation and report on the laser-assisted controlled release of model drugs encapsulated in the RBC interior. Simultaneous release of two molecules, the dye 5(6)-carboxyfluorescein (5(6)-CF) and a rhodamine-labeled dextran (Rh-dextran), with different molecular masses of 376 and 7500 Da, respectively, was conducted. Practically, our approach is relevant for delivery of a combination of drugs, which is often needed, for example, in the treatment of cancer.

Last but not least the fabrication of biocompatible micro- and nanoparticles has attracted a widespread interest due to their potential application in biotechnology as tools for catalysis, sensing and separation and in medicine as systems for drug delivery, diagnostics and in vivo imaging. An increasing number of studies has been dealing with multicompartment systems motivated by the need of multifunctional, controllable and triggered carriers that are desired for example in drug delivery or as bioreactors and biosensors.

PROF. DMITRIY ATOCHIN

Cardiovascular Research Center
Massachusetts General Hospital, USA
http://cvrc.massgeneral.org/faculty/dmitriy-atochin-phd/

e-mail: atochin@yahoo.com

Drug delivery for protection against stroke

Cerebrovascular thrombosis is a major source of mortality after surgery, but thromboprophylaxis in this setting is limited because of the risk of perioperative bleeding.

To test the role of fibrinolysis in stroke, we used a mouse model in which preformed 2.5- to 3-micron-diameter fibrin microemboli are injected into the cerebral circulation. The microemboli lodge in the downstream precapillary vasculature and are susceptible to fibrinolysis.

We found that coupling tPA to carrier red blood cells prolongs tPA activity within the bloodstream and converts it into a thromboprophylactic agent. The utility of this new approach for preventing cerebrovascular thrombosis was demonstrated in our animal models of cerebrovascular thromboembolism.

Thrombomodulin (TM) is an endothelial glycoprotein that protects against thrombosis in a domain-specific manner. We fused a thrombomodulin with a single chain fragment (scFv) of a monoclonal antibody to mouse red blood cells. We demonstrated that RBC-targeted scFv/TM protects against stroke via anti-thrombotic and anti-inflammatory pathways.

These results suggest RBC/tPA and RBC/TM utility as thromboprophylaxis in patients who are at risk for cerebrovascular thromboembolism.

PROF. ALEXANDER YAKIMANSKY

Institute of Macromolecular Compounds of the Russian Academy of Sciences, St. Petersburg, Russia
http://www.macro.ru/en/index.html

e-mail: yak@hq.macro.ru

Chromophore- and luminophore-containing polymers for optoelectronics

Non-linear optical (NLO) nanostructured materials are of great interest for optoelectronics because they make it possible to change the frequency of the propagating light and to realize a communication between electric and optical signals through their light-perturbed electronic distribution. In the present work, thermally stable and heat resistant polyimides with covalently attached chromophore groups were synthesized by Mitsunobu reactions between OH- or COOH-functionalized polyimide and OH-containing chromophores. Some of the used azo-chromophores contained carbazole fragments to enhance polymer photoconductivity properties, which is necessary to create photorefractive holographic polymer media, or bulky side groups, preventing an undesirable centrosymmetric aggregation of chromophore groups. Second harmonic generation (SHG) coefficients, d33, for corona-poled films of these polymers were measured. Films with the thickness of 0.1-2.0 □m were spin-cast on glass substrates from polymer solutions in cyclohexanone. Corona-poling was performed for 40-60 min at 150-200°C (depending on glass transition temperature of a particular chromophore-containing polymer). Rather high d33 values (>50 pm/V) were achieved.

For some azo-chromophore containing polyimides, the refractive index dispersion and frequency dependences of d33 values were measured in the fundamental frequency range from 800 to 1400 nm. All studied samples possessed a rather high beam resistance at the fundamental wavelength, their nonlinear optical properties remaining unchanged after the action of more than 104 pulses. It was shown that the frequency dependence of d33 is red-shifted with respect to the absorption spectrum. Therefore, there is a frequency range where the polymer is practically transparent, while the d33 values are still rather high.

Acknowledgements
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DR. PAVEL KARATAEV

University of London, United Kingdom

John Adams Institute at Royal Holloway, Department of Physics
https://www.royalholloway.ac.uk/physics/home.aspx

e-mail: Pavel.Karataev@rhul.ac.uk

Nano-dimension, nano-structures and their applications in modern and future accelerators

Nowadays accelerators are sophisticated instruments used in industry and academia used for scientific research in physics, chemistry, biology, agriculture, etc., and, even, for inter-disciplinary research.

On the other hands accelerators are sources of intense ionization radiation. That means that people operating or using those facilities cannot stand nearby due to a danger to significantly damage their health. Therefore we need remotely controlled sensors enabling us to operate accelerator and inform us about where the beam is, where it is going, where it originates and when it arrives. To demonstrate the accelerator performance we must expand the ability of those sensors to tell us the transverse and longitudinal dimensions, angular divergence and energy spread.

In future linear colliders the beams of a few nanometer wide are required to achieve desirable luminosity. A nanometer size beam position has to be controlled and monitored with nanometer accuracy. To demonstrate the performance of such small beams the sensors must have nano-meter resolution which is a challenge the accelerator scientists are facing now. It required creative thinking and non-standard solutions to be found.

In the lecture the main aspects of nanometer dimensions and challenges in modern and future accelerators will be reviewed. The state-of-the-art in instrumentation used to monitor and control such small beam will be presented including its limitations and basic performance characteristics.

DR. MARIA N. ANTIPINA

Institute of Materials Research and Engineering, A*STAR Singapore
https://www.a-star.edu.sg/imre/Talent/ctl/StaffDetails/mid/16645/tid/13.aspx

e-mail: antipinam@imre.a-star.edu.sg

Proteins in the layered capsules – active compounds & building blocks

A major part of the present day biopharmaceuticals are proteins by nature. In humans, intake of foreign proteins can activate specific or unspecific components of the immune system, which will terminate the beneficial actions of the drugs and eliminate them from the organism. Optimization of the administration pathways also involves the development of concealing carriers capable of transporting the protein-based drugs directly to the diseased organs. From another hand, those proteins common components of human food represent a cheap and effective source of capsule building blocks. Indeed, proteins can be successfully used in the layered structures integrated by electrostatics [1], hydrogen bonding [2] or hydrophobic interactions [3].

This chapter uncovers the main aspects of the protein encapsulation, protection and release mechanism and also highlights the possibility and important benefits of using proteins in the capacity of capsule constituents.

References:

[1] Lvov, Y.; Ariga, K.; Ichinose, I.; Kunitake, T. Assembly of Multicomponent Protein Films by Means of Electrostatic Layer-by-Layer Adsorption. J. Am. Chem. Soc. 1995, 117, 6117-6122.
[2] Liu, M.; Zhang, Y.; Yang, Q.; Xie, Q.; Yao, S. Monitoring and Estimation of the Kinetics Parameters in the Binding Process of Tannic Acid to Bovine Serum Albumin with Electrochemical Quartz Crystal Impedance System. J. Agric. Food Chem. 2006, 54, 4087-4094.
[3] Shutava, T.G.; Balkundi, S.S.; Lvov Y.M. (–)-Epigallocatechin Gallate/Gelatin Layer-by-Layer Assembled Films and Microcapsules. J. Colloid Interface Sci. 2009, 330, 276-283.

DR. ANDREI V. SAPELKIN

School of Physics and Astronomy
Queen Mary University of London, GB
http://ccmmp.ph.qmul.ac.uk/directory/a.sapelkin

e-mail: a.sapelkin@qmul.ac.uk

Structure and morphology of matrix-free Ge quantum dots

Understanding the structure and morphology of nanoscale systems and linking this information for their functional properties is one of the key fundamental problems of modern nanotechnology. Remarkably, characterization of structure and morphology of quantum dots (QDs) is still an open problem. Direct visualization techniques such as TEM cannot always provide accurate information about the structure of small QDs, especially when structural disorder is present. Small systems can be sensitive to the probe and undergo in-situ transformations. There is also no single technique that can provide unambiguous structural information about the core, surface and interface in QDs. Thus the major new challenge today is in accessing the structural, electronic and optical properties of quantum dots on a sub-nanoparticle scale in order to understand complex relationships between structure, morphology and their contributions to the relevant physical properties.

We used a combination of x-ray absorption spectroscopy (XAS) in transmission and in optically-detected (OD-XAS) modes to understand the structural origins of light emission in small (~ 2-4 nm) oxygen-terminated and oxygen-free Ge quantum dots (QDs) prepared by colloidal synthesis. We have been able to obtain structural data directly from the light emission signals by utilising the ODXAS technique and thus linked directly light emission with the atomic-level structure. We found that both types of samples show significant degree of disorder. For the oxygen-terminated Ge QDs, it is the oxide-rich regions that play key role in the light emission. In oxygen-free samples pure Ge regions contribute to the light emission. Furthermore, numerical analysis of x-ray absorption near edge structure (XANES) has been performed to access the local symmetry information and clearly shows that these Ge regions retain diamond-type symmetry extending to the second coordination shell. Thus we show, that a combination of XAS and ODXAS can provide the link between the structure and light emission and gives access to the sample structure and morphology on nanoscale

PROF. ENZO TERRENO

Molecular & Preclinical Imaging Centers
Department of Molecular Biotechnology and Health Sciences
University of Torino (Italy)
www.cim.unito.it

e-mail: enzo.terreno@unito.it

Image-guided therapy: the advent of theranostic agents

Theranostics is a recently coined concept that was originally raised to refer to the efforts of integrating imaging and therapy. It is a highly interdisciplinary field, where imaging technology, chemistry, nanotechnology, biology, and medicine are strongly and jointly committed to develop clinically translatable protocols to significantly improve a therapy regime through the setup of a correct patient stratification and the design of personalized medicine procedures.

Theranostic agents represent a class of imaging probes properly designed to offer to pharmacologists and physicians a robust tool for the in vivo visualization of drug delivery/release and therapy monitoring. Particular relevant is also the development of imaging procedures (mostly based on fluorescent probes) that can allow surgeons to considerably improve the detection of the lesioned tissues during the intervention.

The advent of theranosis has been made possible also by the rapid progresses achieved in the field of imaging technologies. These achievements allow a very fast image acquisition and processing still maintaining very high levels of sensitivity and spatial resolution. Moreover, hybrid systems such as HIFU-MRI (HIFU: High Intensity Focused Ultrasound), already introduced in the clinical settings for imaging-guided hyperthermia treatments, have good chances to play a relevant role in the future development of innovative theranostic agents.

In this contribution, the different application areas of theranostic agents (imaging drug-delivery, drug release, monitoring therapy, interventional imaging) will be presented and discussed with the aim of providing the audience with an overview (though non-exhaustive) of the state-of-the-art in the field, with a window open to the future perspectives.

PROF. ALEXANDER KABANOV

Center for Nanotechnology in Drug Delivery,
Eshelman School of Pharmacy
University of North Carolina at Chapel Hill, USA
https://pharmacy.unc.edu/research/centers/cndd/
Laboratory for Chemical Design of Bionanomaterials, M.V. Lomonosov Moscow State University, Russia
http://nanozyme-msulab.ru/en/gallery.html

e-mail: kabanov@email.unc.edu

Polymeric micelles for drug delivery

Polymeric micelle drug carriers were invented a quarter of century ago.1 Today nearly a dozen of drug candidates based on polymeric micelles undergo clinical trials and one product, Genexol-PM, a polymeric micelle paclitaxel, was approved for cancer therapy in South Korea.2 The value proposition of currently developed polymeric micelle drugs include increased drug solubility, increased extravasation and targeting to disease sites (e.g. tumors) as well as increased drug activity with respect to multidrug resistant cancers and cancer stem cells (CSC). One class of polymeric micelles is small aggregates (10 to 100 nm) formed by amphiphilic block copolymers. Hydrophobic drug molecules incorporate in polymeric micelles through cleavable covalent bonds or non-covalent interactions. Latest developments in this field include poly(2-oxazoline)-based polymeric micelles that can carry unprecedented high loading of hydrophobic drugs, such as paclitaxel, as well as blends of several insoluble drugs.3 Such formulations can be administered at much greater doses and are more efficient in killing cancer cells. Another class of polymeric micelles incorporates charged drug molecules and macromolecules by forming electrostatic complex with ionic block copolymers. Upon reaching the target destination the micelles disintegrate and released their payload. This technology originally developed for antisense oligonucleotides,4 is now being used with chemotherapeutic agents, pDNA, siRNA and proteins.

References:

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PROF. LYUBA VARTICOVSKI

Laboratory of Receptor Biology and Gene Expression
Center for Cancer Research
National Cancer Institute, Maryland, USA

https://ccr.cancer.gov/Laboratory-of-Receptor-Biology-and-Gene-Expression/lyuba-varticovski

e-mail: varticol@mail.nih.gov

Personalized and Precision Therapy in Cancer

For the past 40 years, the standard paradigm for drug discovery and development has been comprised of the identification of disease-causing genes through pedigree analysis, GWAS or whole-genome sequencing, cloning of identified genes, purification of target proteins and high-throughput screening to identify potential drug leads, which are then optimized and tested in animal models and eventually human trials. Unfortunately, this paradigm is not working very well. Current drug-development programs are lengthy and costly. Only a small percentage of the drugs that enter development programs are making it past Phase I trials, with some of these eventually failing in Phase III trials80. Issues associated with the existing model are that relatively few diseases have a strong genetic basis (perhaps less than 10%), many diseases are a result of exposures and not all disease-causing genes are amenable to high-throughput screens or targetable with drugs.
The ability to predict the future behavior of an individual cancer is crucial for precision cancer medicine. The discovery of extensive intratumor heterogeneity and ongoing clonal adaptation in human tumors substantiated the notion of cancer as an evolutionary process. Random events are inherent in evolution and tumor spatial structures hinder the efficacy of selection, which is the only deterministic evolutionary force. I will review outlines how the interaction of these stochastic and deterministic processes, which have been extensively studied in evolutionary biology, limits cancer predictability and develops evolutionary strategies to improve predictions. Understanding and advancing the cancer predictability horizon is crucial to improve precision medicine outcomes.

Reference:
Lipinski KA et al., Cancer Evolution and the Limits of Predictability in Precision Cancer Medicine, PMC, 2015,.PMID: 26949746

PROF. ANDREW GOW

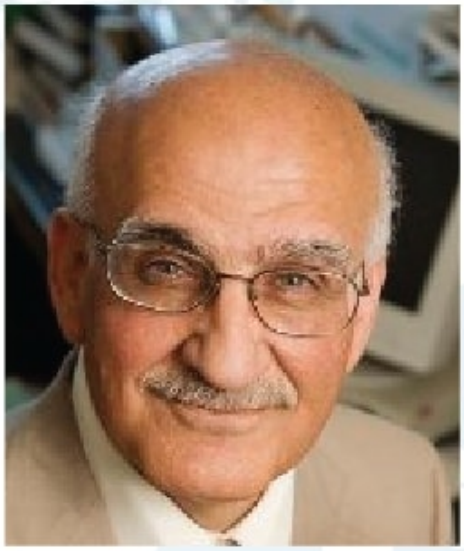
Department of Pharmacology and Toxicology,
Rutgers University, USA
http://pharmacy.rutgers.edu/content/faculty_profile_73

e-mail: gow@rci.rutgers.edu

The biological chemistry of lung lining fluid: A unique target for nanoparticle delivery

In this short lecture, the components of the lung lining fluid will be presented and in particular how the biological chemistry of this fluid varies within the lung. There are unique properties to this material that allows it operate as the air liquid interface within the respiratory system.

These properties are critical to normal lung function and their disruption can result in lung injury. However, this material also represents a unique target that can be capitalized upon to allow for targeted particle delivery to the both the pulmonary and systemic circulations.



PROF. MUNIR H. NAYFEH

Department of Physics,
University of Illinois at Urbana-Champaign, USA
https://physics.illinois.edu/people/profile.asp?m-nayfeh

e-mail: m-nayfeh@illinois.edu

Electrically pumped Er-Si nanoparticle core shell probes for near infrared bio-imaging

Nanoprobes are nanoscale systems that can be designed smartly to perform several functions when they are on a journey or mission in a human body. Rare-earth integrated with nano silicon is a promising near-infrared fluorescence bioimaging agent that can overcome the issues of photobleaching, phototoxicity and deep penetration. We recently developed an electrically pumped near infrared bioimaging material, in core-shell architecture, with emission at ~ 1540 nm, and potential for implantation and deeper penetration into biological tissues. We will present, in this talk, the optical response of silicon nanoparticles and erbium; how the core-shell material is constructed under a wet environment; as well as presents a mechanism for the process. The topographical characteristics, as well as the optical characteristics in the infrared in response to electron excitation, and the amenability for implantation will also be presented.

PROF. VALERY FOKIN

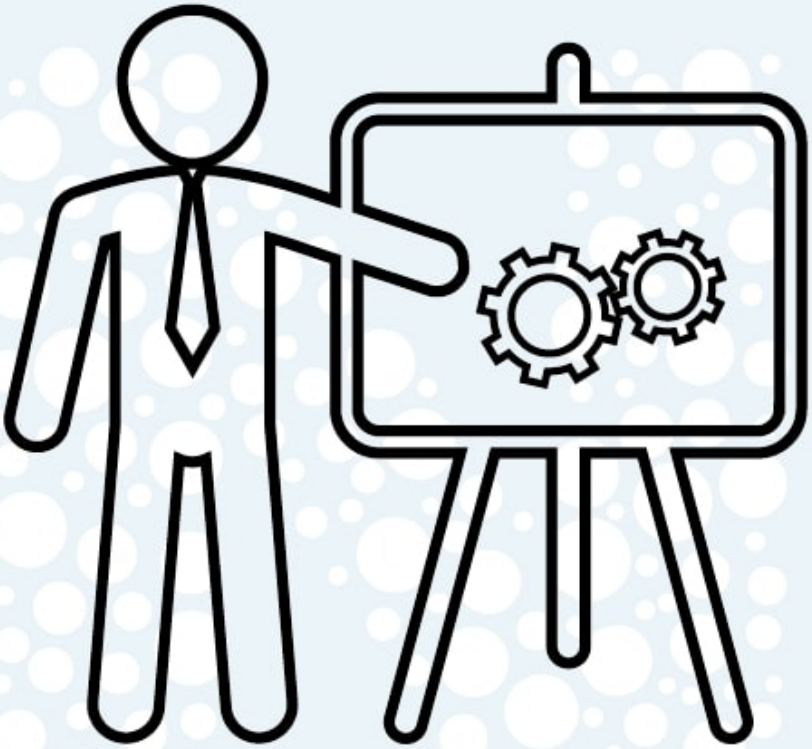
University of Southern California, Department of Chemistry, USA
http://chem.usc.edu/faculty/Fokin.html

e-mail: fokin@usc.edu

Catalysis and Complexity in Nanoscience: From Molecular Control to Applications

Nanotechnology, as a molecular science, depends on the efficient methods for controlled and dependable assembly of complex molecular architectures. These molecular architectures store and transmit information and, therefore, have a desired function. To succeed in this molecular construction endeavor, one requires exquisitely selective chemical transformations that can reliably introduce various functional groups in the product. Catalysis is at the heart of chemistry and disciplines that directly depend on it, for harnessing the complexity of catalytic processes offers unprecedented potential for making them useful on both laboratory and industrial scales.

Catalytic activation of energetic molecules, such as alkynes, will be used as example to illustrate this approach. Alkynes are among the most energetic hydrocarbons, and transition metals enable selective and controlled manipulation of the triple bond, opening the door to the wealth of reliable reactivity: transformations of alkynes into heterocycles and into a variety of molecules with new carbon–heteroatom bonds. The combination of catalytic alkyne functionalization followed by manipulation of the resulting products allows one to proceed from a system with high energy content to a system of lower energy in a stepwise fashion, thereby enabling controlled introduction of new elements of diversity in every step. Various macromolecular architectures prepared using these methods are finding increased use in nanoscience, biotechnology, and materials science.



POSTERS

POSTERS

May, 10, Tuesday

Session #1

P1. Johannes Frueh. X-ray Reflectometry on Flat and Curved Surfaces
P2. Meiyu Gai. A Theory of Microcontact printing of PEM thin films taking Line tension and electrostatic charges into account
P3. Alexandra Pershina. Approach to cobalt ferrite magnetic nanoparticles positioning on DNA
P4. Anna Popova. Nanostructured polymetallic system
P5. Ivan Sorokin. The use of metal additives in high-energy material with Alex nanopowder
P6. Turaj Suleymanova. The method obtaining arsenic trisulphide ethylene glycol medium
P7. Aliye Rzaeva. Development of receiving method of indium selenide in the non-aqueous environment
P8. Johan Loison. Spark Plasma Sintering for high coercivity magnets production
P9. Olga Guselnikova. Design of novel smart materials for ultrasensitive sensors based on surface-modified Au plasmonic thin films
P10.Alexander Grenadyorov. Deposition of nanocomposite nickel-doped amorphous carbon coatings by magnetron sputtering
P11. Semyon Goreninskii. Influence of the "solvent/non-solvent" treatment on the structure of PLLA electrospun scaffolds
P12. Alexey Chumakov. Catalytic naphtalene condensation as a means of producing nanostructured graphene: computational studies

Session #2

P1. Elizaveta Karepina. Dispersion of metal nanoparticles: role of pH and low-molecular surfactants
P2. Antonio Di Martino. Smart polysaccharides nanoparticles for controlled release of protein
P3. Timur Mukhametkaliyev. Biodegradable AZ91 magnesium alloy coated with a thin nanocrystalline hydroxyapatite for improvement the corrosion resistance in the field of implantology
P4. Maria Savelieva. Vaterite coated electrospun polymeric fibers for biomedical applications
P5. Apollinariya Rakina. Investigation of paracetamol release from electrospun poly (ε-caprolactone) scaffolds
P6. Yuliya Tolkachyova. Ultrasonication of Al2O3 nanopowders in aqueous suspensions
P7. Rimma Kaliyeva. Application of laser diffraction for particle size determination of ceramic powders
P8. Elena Popova. Uptake and Toxity of Magnetic Multilayer Microcapsules by Mesenchymal stem cells
P9. Vladimir Shipelin. Experimental data on risk assessment of silver nanoparticles

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Session #2

P10. Irina Danilova. Development of the materials with determined Hounsfield Units for nuclear medicine application
P11. Ekaterina Chudinova. Hydroxyapatite coating and silver nanoparticles assemblies on the surface of additive manufactured Ti6Al4V scaffolds
P12. Andrey Leonov. Comparative analysis of the size distribution of ZrO_2 nanopowders obtained from aqueous solutions of their salts

Session #3

P1. Manoel Jacquemin. Presentation of indium tin oxide powder compaction behavior
P2. Nikolay Gorshkov. Temperature-dependence of electric properties for the ceramic composites based on nanoscale potassium titanates
P3. Marina Novoselova. Capsules for colon-specific lactoferrin delivery
P4. Alla Pustovalova. Nitrogen-containing titanium dioxide thin films deposited via the reactive magnetron sputtering: structural features and phase transition
P5. Vjacheslav Semenov. Properties of ultra-thin Cu films grown by high power pulsed magnetron sputtering
P6. Pavel Kosmachev. Silica nanoparticles produced by DC arc plasma from solid raw materials
P7. Anastasia Pershukova. Nanocomposite coatings Si-Al-N formed by magnetron sputtering: microstructure and properties
P8.Polina Lapsina. Synthesis of nanopowders of transition metals and their systems
P9. Daria Martynova. Synthesis and properties of Ag/SiOx nanocomposites obtained by pulse laser ablation
P10. Anna Popova. Multilayer morphologically uniform films of titanium dioxide: morphology, optical characteristics and phase transitions
P11. Vitaly Okhotnikov. Synthesis of boron and nitrogen doped CVD diamond films in glow discharge plasma
P12. Nadezda Shatrova. Synthesis and characterization cobalt oxide (Co_3O_4) by ultrasonic spray pyrolysis (USP) with following hydrogen reduction to Co
P13. Elena Yunda. Stability of engineered nanopowders of zinc, nickel and aluminum in artificial surface water

POSTERS

May, 11, Wednesday

Session #4

P1. Vladimir Paygin. Investigation of the transparent ceramic optical properties based on ZrO2, produced by spark plasma sintering
P2. Oleg Tolkachyov. Structural phase transformations of the surface layer of SiC ceramics irradiated by intense electron beam
P3. Alisa Nikonenko. Phase composition and structure of titanium modified by copper ions
P4. Kseniya Mishchenko. Preparation of electroconductive aluminum-silicon oxide ceramic sensors modified with silver and bismuth nanoparticles
P5. Petr Khakhulin. The design of three dimensional cross-linked composite material based on dicyclopentadiene and surface-modified nanotubes
P6. Victor Kurtukov. Preparation of three dimensional cross-linked composite material based on dicyclopentadiene and surface-modified nanotubes
P7. Ales Buyakov. Porous Ceramic Composite ZrO2(Mg)-MgO for Bone Reconstruction of Visceral Area
P8. Elena Soldatenko. Influence of molecular structure, formation and transfer conditions of Langmuir-Blodgett films of BODIPY derivatives on their optical properties
P9. Alexander Zhigachev. Magnetic nanoparticles as mediators for nanomechanical actuation of biochemical systems by non-heating alternating magnetic field
P10. Kirill Niaza. Effect of hydrolysis on mechanical properties of PLA-based scaffolds
P11. Alexander Tsapkov. Adhesion strength evaluation of the hydroxyapatite coating on AZ31 magnesium alloy prepared by RF-magnetron sputtering
P12. Ruslan Levkov. Preparation and properties of porous oxide-hydroxide ceramic materials for osteoimplantology
P13. Aleksey Pustovalov. Production of metal powders by electric explosion of wire.

Session #5

P1. Maksim Barabashko. C60: low-temperature heat capacity and the speed of sound
P2. Ivan Rogov. Synthesis of Si-Sn-Ti alloy nanoparticles via electrospark erosion
P3. Kseniya Serebrennikova. New approaches for improving sensitivity of lateral flow immunoasay
P4. Alexander Ponomarev. Low-temperature electronic properties of epitaxial graphene
P5. Galina Naumova. Nanostructured sorbents and composites based on it
P6. Anastasia Shamieva. Structure and properties of technically pure aluminium modified via combined processing
P7. Yekaterina Khristunova. Preparation and investigation bioconjugates based on silver nanoparticles

POSTERS

May, 11, Wednesday

Session #5

P8. Tatiana Priamushko. Features of synthesis and structure of MOF UiO-66 for hydrogen storage
P9. Evgeny Glukhovskoy. The conduction mechanisms in the system of quantum dot in an organic matrix
P10. Olga Zakharova. Silver nanoparticles stabilized by surfactant effectively suppress Phytophtora late blight and Alternaria early blight of tomatoes causing an increase in productivity
P11. Antonina Vitalievna. Simple technic for studying of structure organogels
P12. Valentina Chebodaeva. Modification of calcium phosphate coatings by AlOOH nanoparticles-agents
P13. Dina Syromotina. Improvement of 3-D polycaprolactone scaffolds wettability using radio-frequency plasma
P14. Ekaterina Kovel. Bioluminescent enzymatic assay as a tool for evaluation of toxicity and antioxidant activity of fullerenols

Session #6

P1. Diana Ayrapetyan. Preparation of nanopowders suspensions with high stability
P2. Vera Podgaetskaya. Synthesis of nanosized ZrO2 containing slurries citrate spray drying method nano spray dryer b-90
P3. Anastasiya Olshtrem. Preparation and antimicrobial activity of surface-modified Au-nanourchins
P4. Seda Magomadova. Modification aluminum oxyhydroxide by the manganese and copper
P5. Anna Lashtur. Synthesis of nano titanium dioxide of applicable in medicine
P6. Valeriya Kudryavtseva. Effect of pulsed e-beam irradiation on properties of PLLA scaffolds prepared by Electrospinning and Solution Blow Spinning
P7. Ksenia Khrustaleva. Properties of alumina produced by vacuum spray method
P8. Anna Sharonova. Silver containing biocomposite
P9. Anna Belosludtseva. Simulation calculation of short-range order parameter for isolated graphene sheets with defects
P10. Anna Ivanova. Texture and microstructure development in hydroxyapatite coatings deposited by means of RF-magnetron sputtering
P11. Arina Peregudova. Examination of engineered nanoparticles size: what method to choose?
P12. Julia Papina. Surfactant adsorption on differently sized ZnO nanoparticles

X-RAY REFLECTOMETRY ON FLAT AND CURVED SURFACES

Johannes Frueh, China, Harbin Institute of Technology, Associate Professor

Johannes Früeh,, Meiyu Gai, Adrian Rühmc, Helmuth Möhwaldd, Rumen Krasteve, Ralf Köhlerf
Reflectometry is a important technique for determining structures in thin films. It can be used to determine density, thicknesses, roughnesses and superstructures. Until recently the fitting was limited to flat 2D structures, leaving many important structures like cables, shafts or implants unable to be determined by this technique. This talk not only introduces the basics of reflectometry to students, but also presents recent andvances to new surfaces to the students.

A THEORY OF MICROCONTACT PRINTING OF PEM THIN FILMS TAKING LINE TENSION AND ELECTROSTATIC CHARGES INTO ACCOUNT

Meiyu Gai, United Kingdom, Queen Mary University of London, PhD student
Meiyu Gai1,2, Johannes Frueh*1, Agnes Girard-Egrot3, Bastien Doumeche3, Qiang He1
1. Key Laboratory of Microsystems and Microstructures Manufacturing, Ministry of Education, Micro/Nano Technology Research Centre, Harbin Institute of Technology, Yikuang Street 2, Harbin 150080, China;
2. Queen Mary University of London, Mile End Road E1N4, London, England
3. Institut de Chimie et Biochimie Moléculaires et Supramoléculaires, Universite Claude Bernard Lyon 1, 43 boulevard du 11 Novembre 1918 F-69622 Villeurbanne cedex, France

In this talk a theory of microcontact printing is presented, which for the first time all relevant parameters (PEM-substrate, PEM-PEM (line tension of ripped PEM area), PEM stamp interaction, see Figure 1) of PEM pattern transfer are taken into account and a reproducible PEM transfer can be assured within 10 to 45 seconds (past systems used 30 minutes), whereby also the lower printing limit for the employed PEM type can be easily calculated.[1] A parameter that shows the quality of the PEM printing as well as estimating the printing possibility will also be presented (see formula 1). The system also works for sprayed PEM films, allowing a great reduction of production time. This method allows a convenient transfer of structured films, which is much more time and money saving than conventional photolithographic methods. In addition melting based side effects of microcontact printing are discussed.
$P=(PS-SP)\cdot(PS-L)$
Formula1: Printing parameter P which takes the PEM substrate (PS), stamp PEM (SP) and the line tension (L) into account.

APPROACH TO COBALT FERRITE MAGNETIC NANOPARTICLES POSITIONING ON DNA

Alexandra Pershina, Russian Federation, Tomsk Polytechnic University, Associate Professor
A.G. Pershina1,2
1. Siberian State Medical University, 2, Moskovsky trakt, 634050, Tomsk, Russia
2. National ResearchTomskPolytechnicUniversity, 30, Lenina Ave., Tomsk, 634050, Russia

The conjugates of magnetic nanoparticles with biomolecules promising for biomedicine and nanobiofabrication The research was aimed to study the regularities of superparamagnetic cobalt ferrite nanoparticles (CFNP) - DNA interactions and examine functional activity of received nanoconjugates, for instance, the ability of nanoparticle-attached oligonucleotides to interact with complementary molecules.
The CFNP binds to dsDNA and forms nanoconjugate, besides GC-pairs are preferable sites for nanoparticles bounding. The investigation of interaction between homo-oligonucleotides (ODN) and unmodified superparamagnetic cobalt ferrite nanoparticles has shown that the binding efficiency depends on nucleotide sequences and tunes by the changing of chemical composition of the medium. According to the obtained data there is a binding suppression of all oligonucleotides with the surface, apart from oligo(dG), in the presence of phosphate anions, as a result the approach to direct surface modification of magnetic nanoparticle by dG18T25 oligonucleotide has been implemented. The nanoconjugate has been characterized by TEM, FTIR-spectroscopy and XRD-analysis. The MNP-ODN nanoconjugate possessed superparamagnetic properties and was able to hybridize with the oligonucleotide complementary to sequences at the 5′-end. The direct modification of the nanoparticle surface by ODN can be an advantageous alternative to the multistage conjugation process, included surface modification, functional group formation, blocking of non-specific adsorption sites as well as washing after each step, and followed by monitoring at each stage.
The MNP-ODN nanoconjugate may be considered as a magnetic particle modified by "sticky ends" and used as a nucleic acid recognizing biosensor element. Likewise ODN-modified nanoparticles able to positioning on stretched ssDNA as well as the sequence-selective binding of CFNP to dsDNA may find application in the field of nanobiofabrication.

DEVELOPMENT OF RECEIVING METHOD OF INDIUM SELENIDE IN THE NON-AQUEOUS ENVIRONMENT

Aliye Bayram Rzaeva, Azerbaijan, Azerbaijan NAS, PhD

Indium is transferred by the tartaric acid in the strong complex. Then the selenizing solution (solution of selenium in borane) is added. The voluminous sediment of yellow color turns out. We determined the chemical composition of the sediment, the speed of allocation of the sediment from the solution. The thermal and radiographic analyses of the received indium selenide are carried out.

NANOSTRUCTURED POLYMETALLIC SYSTEM

Anna Popova, Russian Federation, FRC CCS SB RAS, Senior Researcher

In spite of nanostructured polymetallic powders (NPP) are considered as a prospective to use in microelectronics, medicine, magnetotechnique, catalysis, and others areas, the level of research of processes of synthesis and properties of such systems below, but specific properties is significantly higher in comparison with the nanostructured individual metals.
The report is devoted to analysis of the characteristics, properties of the NPP and perspectives of their application as multifunctional materials, carried out on the basis of generalization of data obtained by the authors above, as well as to new results of the study NPP Fe-Co, Fe-Ni, Co-Ni, Fe-Co-Ni, Fe- Pt, Cu-Ni and Ni-Cd, synthesized by co-reduction of aqueous solutions of metal precursors with hydrazine hydrate.
It was found that the above NPP have common character spatial organization of particles: nanocrystals of 7-20 nm (for all systems) form a highly compact aggregates (40-100 nm), which in turn form loose, porous agglomerates (200-250 nm), associated in loose formation of micron sizes. The state of the particle surface of the NPP and thermostimulated processes (desorption of gases, thermal decomposition of impurity inclusions, phase transformations) was studied. It was classified detected diagrams features of NPP phase states in comparison with their phase diagrams. It was considered features of the magnetic properties of nanosystems associated with phase states.

THE USE OF METAL ADDITIVES IN HIGH-ENERGY MATERIAL WITH ALEX NANOPOWDER

Ivan Sorokin, Russian Federation, Institute of Power Engineering, Tomsk Polytechnic University, Student

Usually a modification of metal fuel reduces theoretical value of high-energy materials (HEMs) specific impulse. Along with that some advantageous effects may exist which will be illustrated in this paper. For the theoretical estimation of the effect of metal additives on the energetic characteristics of HEM with Alex nanopowder and on the composition of condensed combustion products (CCPs) the thermodynamic calculations were carried out of the equilibrium composition of the combustion products for tested propellants, using the program Terra. Iron and boron additives cause the reduction of the combustion temperature and specific impulse compared to the base composition of HEM with Alex, but they also reduce the fraction of condensed phase in the combustion products. Partial replacement of Alex by iron leads to decrease in amount of CCPs: by 9.9 % in the combustion chamber and by 12.7 % at the nozzle outlet. Partial replacement of Alex by boron leads to decrease in CCPs amount in the combustion chamber by 24.0 % and to increase in CCPs amount by 5.8 % at the nozzle outlet due to changes in the phase composition of combustion products.

THE METHOD OBTAINING OF ARSENIC TRISULPHIDE ETHYLENE GLYCOL MEDIUM

Turaj Ibrahim Suleymanova, Azerbaijan, Azerbaijan NAS, junior researcher

Obtaining arsenic trisulphide in work results the interaction of sodium metaarsenite with sodium sulfide in ethylene glycol medium. It has been established that in pH medium 1-3 reaction of goes practically till the end. The chemical method determined the composition of sediment - As_2S_3. Carried out thermographic and X-ray analysis, studied morphology and optical absorption spectra of sediment and determined melting temperature.
Conditions of obtaining As_2S_3 studied the differential thermal, X-ray phase and microstructure analysis and optical of absorption spectrum method and its structure. Obtaining nano- and micro particles As_2S_3 investigated the conditions higher quality, the influence of pH medium and temperature.

CAPSULES FOR COLON-SPECIFIC LACTOFERRIN DELIVERY

Marina Novoselova , Kemerovo Institute of Food Science and Technology and Institute of Materials Research and Engineering, phD-student, reseacher

Lactoferrin is a multifunctional protein of the transferrin family, which can be found in the human and other mammals milk. On basis of many biological functions of lactoferrin, researchers have considered various possibilities of its application in health care, in the prevention and treatment of infectious and inflammatory diseases. The necessity of human lactoferrin is associated with various highly specific physiological effects generated in response to stimulation of a variety of highly specific receptors. One of the most important lactoferrin receptors are receptors on the intestinal mucosa and the GALT - related cells. However, lactoferrin is exposed to pepsin degradation in the gastrointestinal tract, decreasing its bioactivity after oral administration. Therefore, the protection of lactoferrin from the action of enzymes of the gastrointestinal tract at oral administration of lactoferrin is important task.
The objects of this study are developing and demonstrating of performance of encapsulation technology which enables lactoferrin to be delivered and released in a specific part of the gastrointestinal tract.
We obtained human lactoferrin in the bacterial system of E. coli previosly. Layer-by-layer method was selected as method of lactoferin encapsulation. Bovine serum albumin and tannic acid, in particular with the use of poly-L-arginine as the first layer, increasing the stability of the obtained microspheres were selected as the most promising materials for the microcapsules synthesis. Unlike LBL assembly of conventional polyelectrolytes, the LBL was formed by hydrogen/ hydrophobic bonds of BSA/TA. Efficiency of Parg/$(BSA\text{-}TA)_4$ capsules protection against gastric fluid and its digestion in intestine conditions were demonstrated. The effects of these capsules (empty capsules and encapsulated lactoferrin) on cell adhesion and viability were studied. The prolonged action of the encapsulated lactoferrin by compare with the free lactoferrin was shown.

DISPERSION OF METAL NANOPARTICLES: ROLE OF PH AND LOW-MOLECULAR SURFACTANTS

Elizaveta Karepina, Russian Federation, Tomsk Polytechnic University, Master student
Karepina Elizaveta, Godymchuk Anna, Kuznetsov Denis, Kosova Natalia

Metal nanoparticles have a high migration activity in environmental matrixes and can provoke high toxicity effects on plants and bacteria (Mohammed et al., 2011). Herewith, particle size and their aggregation degree are considered to be important factors determining nanoparticles cytotoxicity (Yamamoto et al., 2004). When entered an aqueous solution nanoparticles form dispersions characterized with spontaneous aggregation. To avoid aggregation of nanoparticles different stabilizers, including the carboxylate anions (Marques, Loebenberg et al. 2011), amino acids and fulvic acids (Perdue 2013) are commonly used. In this work the sodium acetate, oxalate, and citrate were used to disperse aluminum (90 nm) and zinc (60 nm) nanoparticles in buffer solution (10-2 M HEPES) of different pH value (7...8) and surfactant concentration (ionic strength - 0.001 to 10 mM); the concentration of nanoparticles in the suspensions was 1 mM. The particle size distribution, average size (dav) and zeta potential of the particles were measured by the method of dynamic light scattering with instrument Malvern Zetasizer Nano, USA. We have revealed that the increase of surfactant concentration 1) leads to stabilization of metal nanoparticles in sodium citrate solution, 2) has no significant effect on particles aggregation in sodium oxalate solution, and 3) provokes nanoparticles aggregation in sodium acetate solution. Experimental data have allowed revealing optimal conditions to create stable hydrosols of nanoparticles. Optimal condition to reach maximum dispersion degree and electrokinetic stability was found in sodium citrate solution at pH = 8: for aluminum particles dav = 116 nm, zeta potential = -40,6 mV, for zinc particles dav = 50 nm, zeta potential = -38,3 mV.
The work was supported by the Russian Fund for Basic Research (project # 15-03-06528_a).

PHASE COMPOSITION AND STRUCTURE OF TITANIUM MODIFIED BY COPPER IONS

Alisa Nikonenko, National Research Tomsk State University, student

Promising area of increase of operational properties of construction materials is an ion-beam modification. Using high-current flow of heavy ions of low energy it is possible to modify surface layer effectively, change its structural-phase state, to improve the tribological, mechanical properties, including fatigue strength of structural materials.
In this paper structural-phase state of the ion-modified surface layer of the VT-10 titanium samples was investigated by TEM, SEM and X-ray.
Modified layers with ion treatment during 6.0 and 7.5 minutes have a multilevel structure where there are zones with the different grain size, different phase composition and different microhardness.

TEXTURE AND MICROSTRUCTURE DEVELOPMENT IN HYDROXYAPATITE COATINGS DEPOSITED BY MEANS OF RF-MAGNETRON SPUTTERING

Anna Ivanova, Russian Federation, National Research Tomsk Polytechnic University, PhD student

The formation of dehydroxylated hydroxyapatite (HA) in the coatings deposited within radio frequency (RF) magnetron sputtering is considered as one of the obstacle of this method. The presence of OH-groups forming channels along c-axis in the hexagonal HA lattice is essential for HA structure formation. Absence or reorientation of OH-ions lead to structural changes, in particular to its decomposition and amorphyzation. Therefore, investigation of the influence of water content in the working atmosphere on the structure development of the RF-magnetron sputter deposited HA coatings is an urgent goal which is chased in this study. Furthermore, RF-magnetron sputtering is a line-of-sight deposition process where sputtered material is directed from a target towards a substrate. Therefore, the spatial arrangement of treated samples regarding the sputtered target is one of the parameters, which might influence the features of the formed films. This work was attempted to elucidate the fundamental aspects of RF-magnetron sputter deposition of HA thin films and to comprehend the relation between coating microstructure, texture and deposition conditions.

BIODEGRADABLE AZ91 MAGNESIUM ALLOY COATED WITH A THIN NANOCRYSTALLINE HYDROXYAPATITE FOR IMPROVEMENT THE CORROSION RESISTANCE IN THE FIELD OF IMPLANTOLOGY

Timur Mukhametkaliyev, Russian Federation, Tomsk Polytechnic University, PhD

The main goal of the current investigation was to evaluate a bioactivity and biomineralization performance of AZ91 magnesium alloy with hydroxyapatite (HA) coating developed by radiofrequency (RF)-magnetron sputtering method. In order to establish present research scanning electron microscopy (SEM), functional group identification by Fourier transform infrared (FTIR), phase structural analysis by X-ray diffraction (XRD) were performed. The prepared samples were immersed in simulated body fluid to study the formation of apatite-like precipitations, corrosion resistance and mass loss properties of the HA coating. Electrochemical polarization tests were accomplished to estimate the corrosion behavior of the HA coated and uncoated samples. Results testified to the remarkable capability of HA coating on improving the corrosion resistance of AZ91 alloy.

SPARK PLASMA SINTERING FOR HIGH COERCIVITY MAGNETS PRODUCTION

Johan Pierre LOISON, Russian Federation, National Research Tomsk Polytechnic University, student

SmFeN powder exhibits excellent intrinsic magnetic properties such as high Curie temperature, high saturation magnetization and large anisotropy field. The main challenge is the production of high density SmFeN magnets at low sintering temperature to avoid the decomposition into soft magnetic phase. Spark Plasma Sintering is a non-conventional method which allows to obtain dense materials in a short period of time at low temperature. In this work, we present the structural and magnetic properties of Zn-bonded SmFeN magnets obtained by SPS technique.

NITROGEN-CONTAINING TITANIUM DIOXIDE THIN FILMS DEPOSITED VIA THE REACTIVE MAGNETRON SPUTTERING: STRUCTURAL FEATURES AND PHASE TRANSITION

Alla Pustovalova, Tomsk Polytechnic University, PhD student

Titanium dioxide (TiO_2) has attracted lots of interest the past decades due to its potential applications such as solar energy conversion, environmental purification, and biomaterials. Recently, a number of studies have focused on the research of N-doped TiO_2 films prepared by a variety of physical and chemical methods. Among them, the reactive magnetron sputtering is one of the most attractive techniques providing the films production with a strong substrate adhesion and controlling the chemical and structural films properties. The nitrogen presence inhibits the TiO_2 rutile phase growth and stimulates the rutile-anatase transition in the film with nitrogen content increase in plasma discharge. Anatase is known as an effective material for photocatalysis. There is concept that anatase-rutile biphasic system can be promising for heterogeneous photocatalysis. The rutile phase is more chemically stable than the anatase at both low and high pH levels, the metallic ion dissolution rate in biological liquids can be decreased. Using the rutile films as surface layers on the implants can improve the biocompatibility.
This work presents the study results of the structural and phase changes of TiO_2 films due to nitrogen addition. X-ray diffraction (XRD) and Raman spectroscopy data showed the anatase-rutile transition through nitrogen incorporation. The change of surface morphology was observed with atomic force microscope (AFM). The nitrogen presence in the films is confirmed using X-ray photoelectron spectroscopy (XPS) with monochromatic Al K-α X-ray source.
Obtained data indicate: I) the size reduction of the surface structural elements with increasing the nitrogen content in plasma discharge; II) the anatase-rutile phase transition through the nitrogen incorporation into the film structure; III) the change of the film structural elements from the dome-shaped clusters to the fine-grained structure; IV) the XPS spectra confirm the interstitial nitrogen states in the films.

DESIGN OF NOVEL SMART MATERIALS FOR ULTRASENSITIVE SENSORS BASED ON SURFACE-MODIFIED AU PLASMONIC THIN FILMS

Olga Guselnikova, Russian Federation, Tomsk Polytechnic University, Ph. D. student

Plasmon-active noble metals nanostructures based on Ag, Au thin films become widely applied in the field of plasmonics and related sensing technologies. We proposed a method for development of new SERS based sensor systems for the heavy metal ions and organic contaminants detection. Proposed systems consist of plasmon-active periodical metal surfaces decorated with immobilized organic chelator or thermo-regulated polymer. Firstly, we developed a method for covalent modification of Au plasmonic thin films via interaction with arene-diazonium tosylates. Further, grafting of 4-carboxypheyl and 4-aminophenyl groups enabled to create a strong covalent linker between the surface and active functional grops. Thermo-regulated polymer (PNIPAAM) was grafted by interaction of NHS-activated carboxyl groups on the surface and NH2-PNIPAM derivative. The covalent linker was also used for functionalization by chelator molecule DTPA via acylation of amino groups on the surface. As model solutions we used solutions of heavy metal ions (Pb2+, Cu2+, Cd2+) for capturing by chelator and solutions of azo-dyes (crystal violet, metanil yellow, disperse red I) for thermos-regulating capturing by PNIPAM. The molecular recognition of contaminants resulted in the shift of SERS peaks position or arising of the new peak(s) in the latter case.

SMART POLYSACCHARIDES NANOPARTICLES FOR CONTROLLED RELEASE OF PROTEIN

Antonio Di Martino, Czech Republic, Tomas Bata University in Zlin, Ph.D student
Antonio Di Martino, Vladimir Sedlarik

Polysaccharides based nanoparticles have been thoroughly investigated for controlled release of therapeutic molecules. The ability to regulate the release rate according to the environment at the target site represents one of the main interests in drug delivery field.
The aim of this work was to prepare and characterize the pH and ionic strength sensitive chitosan-dextran sulfate based nanoparticles loaded with two model proteins, bovine serum albumin and trypsin, respectively.
Nanoparticles showed size in the range 120-250 nm, positive zeta potential (20-35 mV), stability and high loading capacity, up to 800mg of protein per mg of nanoparticles.
The release kinetics of the both proteins was significantly influenced by the external media properties. Furthemore, the initial burst effect reduction in physiological media was reduced.
Acknowledgements
This work was funded by the Czech Science Foundation (grant No. 15-08287Y) and Ministry of Education, Youth and Sports of the Czech Republic (grant No. LO1504).

TEMPERATURE-DEPENDENCE OF ELECTRIC PROPERTIES FOR THE CERAMIC COMPOSITES BASED ON NANOSCALE POTASSIUM TITANATES

Nikolay Gorshkov, Yuri Gagarin State Technical University of Saratov, researcher

The samples of sub-micro- scale ceramic composites based on nano-sized potassium polytitanate were prepared by three times calcination at 900 C° for 4 hours. From X-ray diffraction patterns, obtained materials have polycrystalline structure containing K2Ti4O9 , K2Ti6O13 and K2Ti8O17 .AC conductivity (σ ac) of sub-micro- scale ceramic composites based on nano-sized potassium polytitanate samples in the frequency range 0.01 Hz–1MHz were measured at different temperatures between 100 and 800 °C. The experimental data on σ ac frequency dependence were described by the the equation σ ac (ω) = σ dc +Aω s . The permittivity (ε) and dielectric loss (tan δ) increased with the temperature increasing and frequency decreasing. An equivalent circuit, describing the transport processes in the studied composite based on potassium polytitanate, was proposed using the Cole-Cole plot. From this circuit the grain contribution and grain boundary role were analyzed. The relaxation frequencies, determined from these plots, were used to calculate the activation energies Ea of relaxation process using log w versus 1000/T plots. The activation energy was also estimated from the temperature dependence of AC and DC-conductivity at low and high temperature range.

DEPOSITION OF NANOCOMPOSITE NICKEL-DOPED AMORPHOUS CARBON COATINGS BY MAGNETRON SPUTTERING

Alexander Grenadyorov, Institute of High Current Electronics SB RAS, postgraduate

Thin nanocomposite carbon films containing about 36 at.% Ni were deposited on silicon (100) wafers by simultaneous magnetron sputtering of graphite and Ni targets. The resistivity, surface morphology, structure, chemical composition and hardness of the C-Ni films were studied using four-probe method, atomic force microscopy, transmission electron microscopy, XRD analysis, energy dispersive spectroscopy and nanoindentation. The results indicated that the formation of Ni nanoparticles is observed, which are embedded in a thin (< 1 nm) carbon matrix and have a size of about 2-5 nm. The XRD analysis supports this conclusion. At nickel concentration about 36 at.% resistivity of the films is reduced to 6.6·10-4 Ohm·cm (for pure amorphous carbon film it is 1.6·10-2 Ohm·cm), and its hardness is reduced from 13 GPa (for pure amorphous carbon film) to 9 GPa. Also doping of the amorphous carbon film by nickel increased its root-mean-square surface roughness from 0.26 nm to 1.97 nm. C-Ni films can be used as barrier layers in thermoelements because both nickel and carbon are inert to thermoelement components (materials of Bi-Te groups), solder atoms (Sn, In, Cd, Pb) and contact metals (Cu, Cr, Ti, Ag, Au).

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Alla Pustovalova, Tomsk Polytechnic University, PhD student

Titanium dioxide (TiO_2) has attracted lots of interest the past decades due to its potential applications such as solar energy conversion, environmental purification, and biomaterials. Recently, a number of studies have focused on the research of N-doped TiO_2 films prepared by a variety of physical and chemical methods. Among them, the reactive magnetron sputtering is one of the most attractive techniques providing the films production with a strong substrate adhesion and controlling the chemical and structural films properties. The nitrogen presence inhibits the TiO_2 rutile phase growth and stimulates the rutile-anatase transition in the film with nitrogen content increase in plasma discharge. Anatase is known as an effective material for photocatalysis. There is concept that anatase-rutile biphasic system can be promising for heterogeneous photocatalysis. The rutile phase is more chemically stable than the anatase at both low and high pH levels, the metallic ion dissolution rate in biological liquids can be decreased. Using the rutile films as surface layers on the implants can improve the biocompatibility.
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SILICA NANOPARTICLES PRODUCED BY DC ARC PLASMA FROM SOLID RAW MATERIALS

Pavel Kosmachev, Tomsk State University of Architechture and building, PhD-student

Plasma synthesis of SiO_2 nanoparticles is presented. Solid high-silica raw materials (diatomite, quartzite and milled glass) were used. The obtained nanoparticles were characterized based on their morphology, chemical composition and size distribution. Scanning electron microscopy, transmission electron microsc opy, laser diffractometry, nitrogen absorption (Brunauer–Emmett–Teller method), X-ray diffraction and energy-dispersive X-ray spectroscopy were used to characterize the synthesized products. The obtained silica nanoparticles are agglomerated, have spherical shape and primary diameters between 10-300 nm. All samples of synthesized nanopowders were compared with commercial nanopowders.

VATERITE COATED ELECTROSPUN POLYMERIC FIBERS FOR BIOMEDICAL APPLICATIONS

Maria Savelieva, Saratov State University, Postgraduate student

Biocompatible polymer matrices modified with inorganic materials including hydroxyapatite, calcium carbonate $CaCO_3$ and calcium phosphate CaP have promising applications for designing of materials for bone tissue regeneration. In this study we fabricated and described the nanostructured composite based on electrospun polycaprolactone (PCL) fibers coated with porous $CaCO_3$. Such modification of fibers allows the functional properties of nanofibrous material to be achieved. In regard to bone tissue formation, the $CaCO_3$ is bioactive material due to its ability to form strong biomaterial-bone interface . The presence of calcium carbonate provides osteoconductive properties of PCL/$CaCO_3$ scaffold which are beneficial for bone reconstruction materials designing. Moreover, the porous structure of vaterite is suitable for loading of various substances (medicaments, growth factors, dyes, nanoparticles). Vaterite coatings on PCL electrospun fibers provide capabilities of functional substance storage and release in scaffold interior and environment. In such way PCL/$CaCO_3$ materials can be promising candidate for designing scaffolds provided with the function of cell growth control by incapsulated agent. In this research we present the simple but efficient technique of polymeric fibrous matrix mineralization by porous $CaCO_3$ and an ability to control the coating homogeneity, $CaCO_3$ mass and polymorph during mineralization process. Cytotoxicity tests showed that PCL/$CaCO_3$ scaffold did not release toxic substances and are suitable for cell cultivation. Acknowledgements: The reported study was supported by Government of the Russian Federation (grant №14.Z50.31.0004 to support scientific research projects implemented under the supervision of leading scientists at Russian institutions and Russian institutions of higher education).
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STRUCTURAL PHASE TRANSFORMATIONS OF THE SURFACE LAYER OF SIC CERAMICS IRRADIATED BY INTENSE ELECTRON BEAM

Oleg Tolkachyov, Tomsk polytechnic university, Ph. D. student

The work purpose is the analysis of structure, phase composition and properties of a surface layer of the silicon carbide ceramics irradiated by a low-energy intense electron beam.
Experimental investigations have shown that the irradiation of the SiC ceramics surface by intense pulsed beam of submillisecond duration leads to structural and phase changes. It was found that the modification of the surface properties of the ceramics is caused by phase transitions resulting in improvement of mechanical characteristics.

PROPERTIES OF ULTRA-THIN CU FILMS GROWN BY HIGH POWER PULSED MAGNETRON SPUTTERING

Vjacheslav Semenov, IHCE SB RAS, engineer

Because of the superior properties of copper, it has been of great interest as a conducting material to replace Al in device manufacturing and Ag in multilayer low-emission coatings. In this study, we investigated the influence of the ion-to-atom ratio at DC and high power impulse magnetron sputtering (HiPIMS) on the structural, optical and electrical properties of Cu films of thickness less than 25 nm. The ratio of ion flux to deposited atom flux at the substrate was varied by changing the impulse discharge current from 1 to 60 A and pulse repetition rate from 0.5 to 5 kHz. Properties of nanometer-thick Cu films were found to be very sensitive to the ion-to-atom ratio. The Cu films were deposited with island-type growth. Low-resistivity ultra-thin Cu films were obtained at moderate impulse discharge currents (17 A), pulse frequency of 3 kHz and ion-to-atom ratio of 1.5. We also determined the critical thickness at whixh Cu films exhibit continuous growth as 4-5 nm. At this thickness films deposited under optimum conditions have resistivity about 10 μΩ·cm that is 8 times smaller than at DC magnetron sputtering.

Keywords: Ultra-thin Cu film, HiPIMS, Electric Conductivity.

ULTRASONICATION OF AL2O3 NANOPOWDERS IN AQUEOUS SUSPENSIONS

Yuliya Tolkachyova, Tomsk Polytechnic University, student

Engineered nanopowders are more and more used in various manufacturing sectors. Meanwhile, for several application purposes it is highly needed to prepare aqueous suspension of nanoparticle being stable to spontaneous aggregation and sedimentation .

Ultrasonication is a commonly used approach to disperse fine particles in a water surrounding and this is able to prepare nonprecipitating hydrosols of differently composited nanoparticles having high aggregation stability. In this work we observed the effect of ultrasonic treatment on the particle size of two engineered Al2O3 nanopowders in aqueous suspensions by laser diffraction particle size analyzer SALD-7101 Shimadzu. Nanopowders were produced with plasmachemical and electroexplosive techniques.

According to TEM images, the average size of the plasmachemical Al2O3 nanopowder was 135 ± 55 nm. When been in distilled water (pH=6.5, particle concentration 1.2 g/L)the powder average size became 125 μm compared to 7 μm in 30 min sonicated suspension (40 W).

The second nanopowder, obtained by electrical wire explosion method, exhibited an TEM average particle size of 46 ± 22 nm . the ultrasound processing reduced the average size of particles from - 713 to 230 nm in the suspension.

Thus, the ultrasonic processing was not effective to completely disaggregate Al2O3 powders in aqueous suspensions under chosen experimental conditions. We plan to conduct an experiment by the preparation nanoparticles hydrosol using surfactants.

The work was supported by the Russian Fund for Basic Research (project # 15-03-06528_a).

APPLICATION OF LASER DIFFRACTION FOR PARTICLE SIZE DETERMINATION OF CERAMIC POWDERS

Rimma Kaliyeva, Tomsk Polytechnic University, student

Nowadays powders are used as raw materials for the manufacturing of number of materials and products. End-product properties depend on the particles size of the powder materials. In practice there are many methods of particles size analysis of powder materials. There is a need for modern production for the methods of measurement seeking for faster, most automated and reliable process of measurement of the particle sizes with high absolute accuracy. Laser diffraction method satisfies above requirements. However, the correctness of the results obtained by laser diffraction is greatly affected by the dispersion degree, particle concentration in suspensions and powder dispersion conditions. At the same time, for dispersive materials with different chemical nature the effect of each of these factors is strictly individual and can be detected only by experimentation. Because of this, the aim of this work is to demonstrate the effect of sample dispersion conditions on the results of laser diffraction measurement of particle size of some ceramic powders.

SILVER NANOPARTICLES STABILIZED BY SURFACTANT EFFECTIVELY SUPPRESS PHYTOPHTORA LATE BLIGHT AND ALTERNARIA EARLY BLIGHT OF TOMATOES CAUSING AN INCREASE IN PRODUCTIVITY

Olga Zakharova, G.R. Derzhavin Tambov State University, Assistant Director of Research Institute

Silver nanoparticles (AgNPs) - a well-known antibacterial agent. However, information about the impact on the treatment of AgNPs to Phytophtora late blight and Alternaria early blight as well as to morphometric and biochemical parameters of commercially valuable plants Solanaceae fragmented.
The present study examined the effect of treatment of surfactant-stabilized aqueous colloidal silver nanoparticles at a concentration of 3000 mg / l on the growth, development and yield of tomatoes, as well as their protective properties against Phytophtora late blight and Alternaria early blight in the field conditions. It was found that the quadruple treatment of plants by AgNPs during the growing season increases the surface area of leaves and, consequently, to an increase in photosynthetic efficiency. As a result, the yield of tomato was higher than the control at 34.78%. At the same time the qualitative composition of the fruits was not changed.
Increasing the productivity of tomato plants under the influence of nanosilver may have occurred due to the smaller number of affected Phytophtora late blight and Alternaria early blight. Nanosilver treatment causes increasing of the activity of antioxidant enzymes, which is probably due to the stimulation of phytoimmunity. This antifungal activity of AgNPs was close to benchmark the effectiveness of modern fungicides.
The study of plant tissues using SEM/EDS showed no bioaccumulation of silver. Our results may be used to develop new crop protection agents based on colloidal silver.

NANOCOMPOSITE COATINGS SI-AL-N FORMED BY MAGNETRON SPUTTERING: MICROSTRUCTURE AND PROPERTIES

Anastasia Pershukova, Tomsk Polytechnic University, undergraduate 1 year

Nowadays creation of superhard coatings having optical transparency in the visible spectrum is an extremely relevant problem. These coatings can be used as protection against mechanical damage of the glass parts of any kind of transport. Coatings of Si-Al-N-system can be used as such protection. However, the above-mentioned properties of the coatings are largely determined by the conditions of their formation under magnetron sputtering. The aim of this work is to investigate the structural-phase state and optical properties of Si-Al-N-coatings with varying thickness deposited on KV-quartz glass substrates by pulsed magnetron sputtering. By X-ray analysis it was shown that the pulsed magnetron sputtering technique forms nanocrystalline coatings on the basis of Si-Al-N-system with different thickness, having a single nanocrystalline AlN-phase with the wurtzite structure and having crystallites about 30 nm in size. Optical property research showed the maximum transmittance of ~80% is typical for Si-Al-N coatings with the smallest thickness (h = 3,4 μm). All the Si-Al-N coatings applied to the quartz substrate by pulsed magnetron sputtering have normal frequency dispersion of the refractive index.

NANOSTRUCTURED POLYMETALLIC SYSTEMS

Anna Popova, The Federal Research Center of Coal and Coal Chemistry of Siberian Branch of the Russian Academy of Sciences, researcher

In spite of nanostructured polymetallic powders (NPP) are considered as a prospective to use in microelectronics, medicine, magnetotechnique, catalysis, and others areas, the level of research of processes of synthesis and properties of such systems below, but specific properties is significantly higher in comparison with the nanostructured individual metals.
The report is devoted to analysis of the characteristics, properties of the NPP and perspectives of their application as multifunctional materials, carried out on the basis of generalization of data obtained by the authors above, as well as to new results of the study NPP Fe-Co, Fe-Ni, Co-Ni, Fe-Co-Ni, Fe- Pt, Cu-Ni and Ni-Cd, synthesized by co-reduction of aqueous solutions of metal precursors with hydrazine hydrate.
It was found that the above NPP have common character spatial organization of particles: nanocrystals of 7-20 nm (for all systems) form a highly compact aggregates (40-100 nm), which in turn form loose, porous agglomerates (200-250 nm), associated in loose formation of micron sizes. The state of the particle surface of the NPP and thermostimulated processes (desorption of gases, thermal decomposition of impurity inclusions, phase transformations) was studied. It was classified detected diagrams features of NPP phase states in comparison with their phase diagrams. It was considered features of the magnetic properties of nanosystems associated with phase states.

SYNTHESIS OF NANOPOWDERS OF TRANSITION METALS AND THEIR SYSTEMS

Polina Lapsina, The Federal Research Center of Coal and Coal Chemistry of Siberian Branch of the Russian Academy of Sciences, Researcher

The paper is devoted to the method of chemical synthesis of nanostructured powders of nickel, cobalt, and their binary systems of sparingly soluble carbonates at heating. An aqueous solution of hydrazine hydrate is used as the reducing agent. Phase composition and structure of nanocrystalline powders were analyzed by X-ray diffraction on Bruker D8 ADVANCE A25 powder diffractometer. The morphology of the powders was studied by complex of methods: SEM on a scanning electron microscope JEOL JSM6390 SEM, and with X-ray diffraction methods (KRM-1 and Bruker D8 ADVANCE A25). The work was carried out in a center of shared usage of equipment of The Federal Research Center of Coal and Coal Chemistry of Siberian Branch of the Russian Academy of Sciences (FRC CCC SB RAS) and Kemerovo State University. SEM analysis shows that powders consist of agglomerates of micron sized composed of particles of nanometer range. Sizes of nanocrystallites were calculated and determined its dependence on the synthesis conditions: nickel - 17-23 nm, cobalt - 23-33 nm, for binary systems is 15-20 nm. Investigation of shape and dimensional characteristics shows that all nanopowders, both nickel, cobalt and their systems, have multi-level spatial organization: nanocrystals (40 nm) - agglomerates of level I (100-700 nm) – agglomerates of level II (micron sized), capable of forming the loose agglomerates level III.

SYNTHESIS AND PROPERTIES OF AG/SIOX NANOCOMPOSITES OBTAINED BY PULSE LASER ABLATION

Daria Martynova, Tomsk State University, researcher

Research presents investigation of particles interaction in silver and silicone-content colloids prepared using pulse laser ablation method and study of nanocomposites properties based on it. Nanocomposites were prepared by mixing of Si/SiO2 and silver colloids with followed drying and calcination in air from 50 to 9000C. According to the FTIR spectroscopy data, with silver on the surface of Si/SiO2 formation of additional oxygen-deficient centers in the structure of silicon dioxide takes place at calcination temperature lower than in case of Si/SiO2. As follows from Raman spectroscopy, when silver particles are present on the surface of Si/SiO2 heating to 7000C leads to the formation of new defects: 3-membered cycles and non-bridging oxygen groups. Thus, results reliably show that silver facilitates the formation of the defects in the SiO2 structure. It was shown that interaction of silver with Si/SiO2 nanoparticles in water provided formation of surface compounds like powdered Ag/SiOx. Composites Ag/SiOx, which as it was revealed increase of structure defects number during support calcination reveal catalytic activity in low-temperature CO oxidation.

MULTILAYER MORPHOLOGICALLY UNIFORM FILMS OF TITANIUM DIOXIDE: MORPHOLOGY, OPTICAL CHARACTERISTICS AND PHASE TRANSITIONS

Anna Popova, The Federal Research Center of Coal and Coal Chemistry of Siberian Branch of the Russian Academy of Sciences, researcher

Titanium dioxide (TiO_2), as a photoactive, wide gap semiconductor, is a widespread to produce photocatalytic materials for various purposes.
We investigated the optical characteristics and phase transitions in multilayer morphologically uniform TiO_2 films obtained by thermal decomposition of organic-mineral film precursor. Precursor films were formed by spin coating of ethanol and titanium tetrachloride solution onto glass substrates. The phase composition of the films and the formation temperature of crystalline modifications of TiO_2 was determined by XRD-analysis. Observed experimentally temperature of formation of TiO_2 films with anatase crystal modification was 500°C. Multilayer morphologically uniform films were obtained by consistent coating of precursor on the film TiO_2. The thickness of a single film layer was defined by atomic force microscopy, it is 50 nm. Such films have low roughness. Optical characteristics of the TiO_2 films with thickness of 50 - 300 nm were obtained from the transmission spectra. For the film composed of five layers of TiO_2, dependence of refractive index on the wavelength was evaluated by the envelope method. It was calculated film thickness, values of refractive index depending on the wavelength, the absorption coefficient and the absorption index, as well as it was obtained the spectral dependence of transmittance. According to IR-spectroscopy obtained films are firmly bonded to the glass substrate material. By electron microscopy, it was shown that TiO_2 films allow fixing the nanoparticles of photocatalyst P-25 on the surface of the glass substrate. Experimentally it was shown, as an example was photoreduction of Ago particles from the aqueous solution of $AgNO_3$, that the incorporation of the photocatalyst P-25 nanoparticles into the TiO_2 film can increase the efficiency of photocatalytic Ago reduction by increasing the number of active surface sites.

SYNTHESIS OF BORON AND NITROGEN DOPED CVD DIAMOND FILMS IN GLOW DISCHARGE PLASMA

Vitaly Okhotnikov, Tomsk Polytechnic University, engineer

We report the study and comparison of boron and nitrogen doped CVD diamond films properties, synthesized in high-current glow discharge PACVD reactor. $CH_3OH/B(OCH_3)_3/H_2$ gas/liquid and $N_2/H_2/CH_4$ gas mixtures were used as the precursor gas respectively. Using this method, we have deposited films with p+ and n- conductivity types with varying degrees of embedded charge carriers concentration. Comparative analysis was used to determine the limits of this method and obtained materials applicability, as well as for researching the dependence of their properties upon the process conditions and the doping level. During the study, the composition of diamond films, their doping level and impact evaluation of growth parameters on the electrical characteristics were investigated. The doped diamond may be very prospective for applications in the field of diamond electronics as a component for constructing of semiconductor structures.

SYNTHESIS AND CHARACTERIZATION COBALT OXIDE (CO3O4) BY ULTRASONIC SPRAY PYROLYSIS (USP) WITH FOLLOWING HYDROGENREDUCTION TO CO

Nadezda Shatrova, NUST "MISiS", Engineer, teaching assistant

Nowadays nanosized Co3O4 and Co powders are perspective materials that have a wide area of applications. Application properties of nanosized powders depend on its size, shape and phase composition. USP method allows obtaining nanopowders and nanostructured powders of metals, metal oxides and composites. USP method allows control a composition and particle size by production conditions.
Nanostructured Co3O4 powders were synthesized by a spray pyrolysis method. Temperatures of pyrolysis were 700, 800, 900, 1000 and 1100 °C. Obtained cobalt oxide Co3O4 nanostructured powders were reduced to metal cobalt by thermal treatment at hydrogen atmosphere. Temperature of reduction for all samples was 300 °C.
The phase compositions, particle size distribution, morphology of the both Co3O4 and Co nanosized powders were studied. Moreover, such magnetic properties of metal cobalt as coercive force, saturation magnetization and residual magnetization were investigated. The impact of pyrolysis condition on the characteristics of nanosized Co3O4 and Co powders is shown.

PREPARATION OF THREE DIMENSIONAL CROSS-LINKED COMPOSITE MATERIAL BASED ON DICYCLOPENTADIENE AND SURFACE-MODIFIED NANOTUBES

Victor Kurtukov, Tomsk Polytechnic University, PhD student

Petr Khakhulin, Victor Kurtukov

Three-dimensional polymer composites with various carbon fillers can be applied in a wide range of ways due to their excellent mechanical properties, thermal and electrical conductivity, as well as their self-recovery ability. Synthesis of cross-linked polymer composites is a relatively new trend in material science. Carbon nanotubes with high thermal and electrical conductivity are excellent fillers for synthesis of composite materials with enhanced properties. Moreover, nanotubes' surface can be modified with organic functional groups using aryl diazonium salts.
To date, polydicyclopentadiene (PDCPD) is one of the most promising engineering plastics. Synthesis and evaluation of nano-composite materials are the main task of the research.
As a result of this research, we developed new method for preparation of cross-linked nano-composite material based on PDCPD and surface-modified single-wall carbon nanotubes (SWCNT) using olefin ring-opening metathesis polymerization (ROMP).

PREPARATION OF ELECTROCONDUCTIVE ALUMINUM-SILICON OXIDE CERAMIC SENSORS MODIFIED WITH SILVER AND BISMUTH NANOPARTICLES

Kseniya Mishchenko, Institute of solid state chemistry and mechanochemistry SB RAS, Junior Staff scientist

In order to obtain electrodes for recording of cardiac micropotentials in a wide range of frequencies, a process for modifying of the aluminum-silicon oxide ceramic matrix with bismuth or silver nanoparticles was investigated. It was found that when impregnating aluminum-silicon oxide ceramics with aqueous or organic solutions of the silver compounds with subsequent drying and calcinations, both the total amount of silver and its distribution over the thickness of the sample essentially depend on the nature of the silver precursor solution. Thus, when impregnating the aluminum-silicon oxide ceramics with an aqueous or alcoholic solution of silver oxalate or with an aqueous solution of silver nitrate followed by its reduction with formic acid, the silver content in the ceramic matrix does not exceed 15% and it is mainly distributed in the near-surface layer. The highest degree of impregnation (39%) and uniform distribution of silver throughout the volume of the sample are achieved by treatment of the ceramic matrix with a branched silver carboxylate (silver caprate) solution containing 250 g/L Ag, followed by drying and calcination of the samples at 250 °C.

It was shown that bismuth-containing electroconductive ceramics can be obtained by its impregnation with a solution of bismuth formate or caprylate followed by its calcination in vacuum at 280°C.

The results of the study show that the ceramic sensors modified with silver nanoparticles have a direct current drift of less than 5 nV/s while the noise level does not exceed ± 200 nV, which allows development of the measuring apparatus from 300 nV.

MODIFICATION ALUMINUM OXYHYDROXIDE BY THE MANGANESE AND COPPER

Seda Magomadova, Tomsk Polytechnic University, student

A procedure of bulk modification of aluminum oxyhydroxide during synthesis using manganese ion and copper ion as the modifying agents were studied. The influence of the concentration of manganese and copper in a solution for the hydrolysis of nanosized aluminum powder on the phase composition of the samples and the content of manganese and copper in samples were studied. The phase composition was studied by means of synchronic thermogravimetric (TG)–differential scanning calorimetry (DSC) analysis and X-ray phase analysis (XPA). It was shown that an increase in the concentration of manganese and copper in the solution for hydrolysis raises the content of unreacted aluminum and X-ray amorphous hydroxides in the modified samples. It is established that the phase composition of the modified samples depend on the content of manganese and copper.

THE DESIGN OF THREE DIMENSIONAL CROSS-LINKED COMPOSITE MATERIAL BASED ON DICYCLOPENTADIENE AND SURFACE-MODIFIED NANOTUBES

Petr Khakhulin, Tomsk Polytechnic University, PhD student

Petr Khakhulin, Victor Kurtukov

The three-dimensional polymeric composite with various carbon fillers has a wild range application due to high mechanistic properties, thermal and electrical conductivity and self-healing properties. Cross-linked polymeric composite materials synthesis is a recent trend in the development of new materials. The carbon nanotubes with high thermal and electrical conductive properties are excellent fillers for the synthesis of composite with enhanced characteristics. Moreover, the carbon nanotubes can be modified by organic functional groups using diazonium chemistry.
Polydicyclopentadiene (PDCPD) is one of the most promising engineering plastics now. The synthesis and evaluation of PDCPD composite materials filled by nanosized materials are a primary concern.
We developed a new conventional method for preparation of cross-linked nanocomposite based on PDCPD and surface-modified single wall carbon nanotubes (SWCNT) via ring-opened metathesis polymerization (ROMP). Previously we described an application of arenediazonium tosylates for modification of carbon and metal surfaces under mild condition.

PREAPRATION AND ANTIMICROBIAL ACTIVITY OF SURFACE-MODIFIED AU-NANOURCHINS

Anastasiya Olshtrem, Tomsk Polytechnic University, Student

To date, gold nanoparticles attract increasingly greater attention. Primarily, this is explained by their unique properties, such as antimicrobial activity and ability to enhance plasmon resonance in SERS (Surface enhanced Raman scattering). However, it is known that chemical, physical and biological properties depend on the shape, structure and size of the gold nanoparticles. Herein, gold nanourchins have proven themselves.
In our study, we investigate the potentialities of the diazonium salt chemistry to functionalize gold nanostars with 4-nitrobenzenediazonium, 4-aminobenzenediazonium and 4-carboxybenzenediazonium tosylates. Synthesized nanoparticles were characterized by the methods: UV-Vis, transmission electron microscopy (TEM), scanning electron microscope (SEM), SERS.
Modified AuNSs were associated with two Gram-positive and Gram-negative bacteria: Staphylococcus epidermidis and Escherichia coli respectively. The result demonstrates that both bacterial cell surface interact with nanostars surface chemistry, hence affecting toxicity.

PREPARATION OF NANOPOWDERS SUSPENSIONS WITH HIGH STABILITY

Diana Ayrapetyan, Tomsk Polytechnic University, student

Diana, Airapetyan1, Anna Godymchuk1,2,3
1. National Research Tomsk Polytechnic University, Tomsk, Russia
2. National University of Science and Technology "MISIS", Moscow, Russia
3. Tambov State University named after G.R. Derzhavin, Tambov, Russia

The rapid development and introduction of nanotechnologies requires new knowledge about biological and physicochemical properties of manufactured nanomaterials. One of the key issues of (eco)nanotoxicology is to accumulate experimental data about nanoparticles behavior in liquid surroundings. It is necessary to prepare suspensions with specified dispersion and rheological properties for the study of ecotoxicological properties of superfine material. In this paper we establish the features of aggregation and sedimentation stability of aqueous suspensions of industrial nanopowders, depending on the sample preparation conditions. The object of investigation is differently sized alumina nanopowders: an average particle size is from 30 to 150 nm. We show the effect of synthesis conditions, morphology, particle size, and the presence of low molecular weight surfactant in the dispersion medium on dispersion and electrokinetic properties of nanoparticle suspensions. Sedimentation and aggregate stability of obtained suspensions is measured by the change in the particles size distribution (laser diffractometer SALD-7101 Shimadzu, Japan), zeta potential of particles in suspensions (NanoSetaSizer Malvern analyzer), and the degree of dispersed phase precipitation in the prepared suspensions using a digital spectrophotometer APEL PD – 303.
The work is supported by the Russian Fund for Basic Research (project # 15-03-06528_a).

PRESENTATION OF INDIUM TIN OXIDE POWDER COMPACTION BEHAVIOR

Manoel Jacquemin, Tomsk Polytechnic University, student

Presentation of compaction behavior of Indium Tin Oxide (ITO) powder with different granulation size. The aim is to describe the consolidation behavior of this powder using compaction curves and relative density after sintering. In this study the powder has been pressed by collector pressing method and sintering in conventional furnace.

INVESTIGATION OF THE TRANSPARENT CERAMIC OPTICAL PROPERTIES BASED ON ZRO2, PRODUCED BY SPARK PLASMA SINTERING

Vladimir Paygin, Tomsk Polytechnic University, post-graduate student

Transparent ceramics based on cubic zirconia (ZrO_2) stabilized by 10 mol. % of yttrium oxide (Y_2O_3) produced by spark plasma sintering (SPS) at temperatures 1300-1400 oC for 10 min. Heating rate and pressure were varied. The obtained samples represented higher density, close to theoretical and high light transmittance in the infrared region. The effect of the sintering parameters on the optical properties of the ceramics was discussed.

EFFECT OF PULSED E-BEAM IRRADIATION ON PROPERTIES OF PLLA SCAFFOLDS PREPARED BY ELECTROSPINNING AND SOLUTION BLOW SPINNING

Valeriya Kudryavtseva, Tomsk Polytechnic University, student

V. L. Kudryavtseva1, P.G. Kuznetsov1, D. V. Ponomarev2, E. N. Bolbasov1, G.E. Remnev2* and S.I. Tverdokhlebov1*
1 Institute of Physics and Technology, Tomsk Polytechnic University, Tomsk, Russia
2 Institute of High Technology Physics, Tomsk Polytechnic University, Tomsk, Russia
*corresponding author

The effect of nanosecond pulsed electron beam irradiation on properties of polylactic acid (PLLA) scaffolds was investigated. Nonwoven nanofiber materials were formed by Electrospinning (ES) method and Solution Blow Spinning (SBS) method with subsequent annealing at 90 °C for 10 hours. The scaffolds modification was performed employing TEA-500 Pulsed Electron Beam Accelerator (Tomsk Polytechnic University) with absorbed dose from 26 to 260 kGy. The absorbed dose was monitored by the change in optical density of standard film badge dosimeter. Properties of the scaffolds were examined by means of Viscosity measurement, X-Ray Diffraction analysis, Fourier Transform Infrared Spectroscopy, Differential Scanning Calorimetry and Scanning Electron Microscopy. It was shown that pulsed electron beam exposure leads to the reduction of polymer molecular weight, recrystallization, and changes in surface morphology.
Pulsed electron beam modification of PLLA scaffolds significantly changes their physical and chemical properties that allows assuming this method as a potential technology for polymer degradation rate manipulation and production of polymer materials with required properties which may not be achieved by any other method.

UPTAKE AND TOXITY OF MAGNETIC MULTILAYER MICROCAPSULES BY MESENCHYMAL STEM CELLS

Elena Popova, Peter the Great St.Petersburg Polytechnic University, Engineer

In this study we demonstrated that polyelectrolyte microcapsules with magnetic nanoparticles can be successfully internalized by MSCs with high efficiency. These cells can accommodate up to 30 capsules in single cell and showed the more efficient uptake while capsules are given to cell suspension rather than the cell are adhered to surface. We demonstrated efficient (~98%) magnetic sepatation of microcapsules associated cells, with only one caspule sufficient for such effect. Microcapsules show very mild toxicity while internalized in at modest cell:capsule ratio (<1:10).
Magnetic polyelectrolyte microcapsules being impregnated into stem cells show great promise as diagnostic, therapeutic and investigational tool proving externally controlled cell delivery using magnetic field.

EXPERIMENTAL DATA ON RISK ASSESSMENT OF SILVER NANOPARTICLES

Vladimir Shipelin, Federal Research Center of Nutrition and Biotechnology, Senior Researcher, PhD

Analysis of the literature indicates that currently nanoscale silver is one of the most widely studied nanomaterials in terms of its toxic effects on biological objects including studies on laboratory animals in vivo. However, the available toxicological studies largely inconsistent, which may be due either to differences in the samples used nanosized silver or the lack of a unified methodology in the formulation of the biological experiment. In this study, we investigated the most common and practically important in Russian form of nanosized colloidal silver stabilized PVP when administered into the gastrointestinal tract of experimental animals (rats and mice) in the 92-day experiment using a wide variety of integrated, functional, morphological, biochemical, cytological (ex vivo) and proteomic indicators. The aim of the research was to assess the safety of doses of Ag NP. According to the results of the 3-month experiment on the influence of silver NPs stabilized with polyvinylpyrrolidone, on the body of laboratory animals using complex laboratory tests included in official guidelines for the safety assessment of NMs, operating in Russia, it was possible to establish safe levels of exposure of the most widely produced and used form of nano-sized silver in Russia. In the future, it will go to the question of its hygienic rationing in products and environmental objects.

BIOLUMINESCENT ENZYMATIC ASSAY AS A TOOL FOR EVALUATION OF TOXICITY AND ANTIOXIDANT ACTIVITY OF FULLERENOLS

Ekaterina Kovel, Siberian Federal University, student

Fullerenols are nanoscale particles, water-soluble polyhydroxylated derivatives of fullerenes (allotropic form of carbon), bioactive compounds and perspective pharmaceutical agents. Luminescent assay based on the system of coupled enzymatic reactions catalyzed by bacterial luciferase and NADH:FMN-oxidoreductase was developed and adapted for monitoring toxicity and antioxidant activity of fullerenols. Advantages of bioassay are simplicity, high rates and possibility to determine toxicity of general and oxidative types in solutions of nanoparticles. Two homologous fullerenols, C60O2-4(OH)20-24 and Fe0,5C60(OH)xOy (x+y=40-42), were used as models; their ability to increase or decrease toxicity of water media was studied and compared in a wide range of fullerenol concentrations including ultralow ones. The fullerenols suppressed bioluminescent intensity at concentrations > 0.01 g/L and > 0.001 g/L for C60O 2-4(OH)20-24 and Fe0,5C60(OH)xOy, respectively, hence, lower toxicity of C60O 2-4(OH)20-24 was demonstrated. Antioxidant activity of the fullerenols was studied in model solutions of organic and inorganic oxidizers. Changes of toxicities of general and oxidative type were determined under exposure to the fullerenols; detoxification coefficients were calculated. Fullerenol C60O 2-4(OH)20-24 revealed higher antioxidant ability in a wide concentration range: 10-17-10-5g/L. The difference in toxicity and antioxidant activity of the fullerenols was explained with their electron donor/acceptor properties and different catalytic activity.

SILVER CONTAINING BIOCOMPOSITE

Anna Sharonova, Tomsk Polytechnic University, PhD student

Hydroxyapatite (HA) coated implant is more susceptible to bacterial infection as the micro-structure surface which is beneficial for osseointegration, could also become a reservoir for bacterial colonisation. A good way to overcome this challenge is functionalization of implant surface with silver nanoparticles (AgNPs) as antibacterial agent. The aim of this study was to introduce the antibacterial effect of silver to the structure of multilayer biocomposite.Biocomposite based on a three-layer system (Fig.1a): the first one is 1000 nm thick layer of nanocrystalline hydroxyapatite, the second one is layer of silver nanoparticles and the third one is layer of calcium phosphate with a thickness of 150 nm deposited on titanium substrate. The multilayer system was prepared by a combination of electrophoretic deposition of silver nanoparticles and calcium phosphate deposition by radio frequency magnetron sputtering. Dynamic Light Scattering, Nanoparticle Tracking Analysis, X-ray diffraction (XRD), scanning electron microscopy (SEM), and energy dispersive spectroscopy (EDX) have been used to characterize the prepared AgNPs stabilized with polyvinyl pyrrolidone (PVP). The PVP-stabilized AgNPs were synthesized in aqueous solutions with a diameter of the metallic core of 70 ± 20 nm, and negative charge of -20 mV. Scanning electron microscopy showed that the silver nanoparticles were evenly distributed over the surface. The release of silver ions from the biocomposite in phosphate buffered saline (PBS) solution was measured by atomic absorption spectroscopy (AAS). After 3 days immersion into PBS around 30% of the incorporated silver is released. According to SEM results, were no signs of cracks on the surface of coating after immersion, indicating the superior mechanical stability of the multilayered films in physiological environment. By a semi-quantitative turbidity test was found antimicrobial effect against Escherichia coli.

SIMULATION CALCULATION OF SHORT-RANGE ORDER PARAMETER FOR ISOLATED GRAPHENE SHEETS WITH DEFECTS

Anna Belosludtseva, TUCSR, student

In this work we developed the software for the efficient calculation of the short-range order parameter in the isolated sheet of graphene with defects, as well as the calculations are made, which showed that the short-range order parameters for each of the impurity configuration types have different values and can be positive or negative. Depending on the value of short-range order parameter will change the electronic contribution to the properties of graphene. Thus, it is the presence of certain defects in the graphene structure may be responsible for changes in conductivity type to the semiconductor graphene metal and influence the value of the specific resistance of the material.

STABILITY OF ENGINEERED NANOPOWDERS OF ZINC, NICKEL AND ALUMINUM IN ARTIFICIAL SURFACE WATER

Elena Yunda, Université Grenoble Alpes, Master student

The aim of the present study was to investigate the influence of exposure conditions on the behaviour of three engineered metal nanopowders when exposed to artificial surface water. The impact of sonication power output and time was evaluated in terms of time-resolved metal release and change in zeta potential. Suspensions with two different particle loadings, 10 mg/L and 100 mg/L, of zinc, nickel and aluminium nanopowders were sonicated either for 2 or 10 min using two power output settings. The obtained results show that both particle loading and sonication intensity significantly influence the behaviour of the particle suspension. The released amount of metals in solution did not correlate with the particle loading and was found highly time-dependent. Sonication of the nanopowder suspensions resulted for all powders in an enhanced amount of released metals in solution and influenced the surface charge.
In all, generated data shows that while studying toxicity of nanoparticles the observed effect must be correlated with how the experimental procedure influence the surface properties and the particle stability/transformation.

COMPARATIVE ANALYSIS OF THE SIZE DISTRIBUTION OF ZRO2 NANOPOWDERS OBTAINED FROM AQUEOUS SOLUTIONS OF THEIR SALTS

Andrey Leonov, Tomsk Polytechnic University, postgraduate student

ZrO2 particles sizes were determined using scanning electron microscopy (SEM) and laser diffraction (LD). Studied powders were obtained by chemical precipitation (ZrO2-CP) and spray drying (ZrO2-SD) from aqueous solutions of zirconium oxychloride and zirconyl nitrate, respectively. According dry powders analysis data, ZrO2-CP consist of irregular-shaped particles, forming aggregates with size around 100 microns. ZrO2-SD powder was determined as hollow spherical granules consisting of individual particles. LD data has shown that increase of sonication time (40 W) has provoked decrease of the median volume weighted diameter (dV50) due to destruction of aggregates and hollow granules for ZrO2-CP and ZrO2-SD in an aqueous medium, respectively. In case of using isopropanol for particles ultrasonic dispersion, dV50 slightly above comparing with values in an aqueous medium and not changed much over time. However, pretreatment of ZrO2-SD isopropanol-based suspension in ultrasonic bath (110 W) during 30 minutes has provoked disaggregation of hollow granules from initial powder.

SYNTHESIS OF NANO TITANIUM DIOXIDE OF APPLICABLE IN MEDICINE

Anna Lashtur, Tomsk Polytechnic University, student

Review of basic method of obtaining of titanium dioxide on the ammonium fluoride technolodgy with the possibility of applicable in medicine.

C60: LOW-TEMPERATURE HEAT CAPACITY AND THE SPEED OF SOUND

Maksim Barabashko, B.Verkin Institute for Low Temperature Physics and Engineering of the National Academy of Sciences of Ukraine, Junior Researcher

The trapping of atoms or molecules in porous media such as fullerite C60 can endow the resulting materials with remarkable new properties. Thus, understanding the thermodynamic properties of pure fullerite C60 and dynamical aspects of trapping in these systems is of both fundamental and practical importance. The heat capacity of pure fullerite C60 has been investigated in the temperature interval 1.2 120 K by using an adiabatic calorimeter [1].
The sample of fullerite C60 was prepared from a high purity (99.99%) C60 powder (SES, USA) with a grain size of about 0.1 mm. Before the experiment, the fullerite C60 sample was held at 350 C in special device for 48 h under the condition of dynamic evacuation. This was done to remove the gas impurities from the sample. Analysis of the contributions of translational, rotational and intramolecular degrees of freedom to the heat capacity has been done [2]. The linear term to the heat capacity below 3 K has been explained by the existence of low energy tunnelling levels in the fullerite orientational glass. The limiting Debye temperature at $T \rightarrow 0$ K ($\Theta_0 = 84.4$ K) for the translational vibrations and the Einstein temperature $\Theta_{E,lib} = 32.5$ K for librations have been estimated. The experimental heat capacity, associated to the translational and rotational vibrations, agrees well with the spectrum of density of states. The temperature dependence of the average Debye sound velocity has been estimated by using data of the phonon contributions to the heat capacity.

SYNTHESIS OF SI-SN-TI ALLOY NANOPARTICLES VIA ELECTROSPARK EROSION

Ivan Rogov, Tomsk Polytechnic University, Master student

Silicon as an electrode material in Li-ion batteries demonstrates a high capacity, energy density and relatively low average voltage and does not meet problems with cyclability. To increase the cycle life Si-Sn-Ti alloy nanoparticles can be used.
A suspension of Si-Sn-Ti nanoparticles with the mean size about 10 nm in the liquid medium was successfully obtained with electrospark erosion (ESE) technique. It has been established that the ESE technique has a good potential as a fabrication technique of Si-Sn-Ti alloy nanoparticles.

PRODUCTION OF METAL POWDERS BY ELECTRIC EXPLOSION OF WIRE.

Aleksey Pustovalov, Tomsk Polytechnic University, Junior Researcher

The work represents the research results of the possibility of metal nanopowders production by the electric explosion of wire. There are presented some general patterns allowing you to select the initial conditions for the explosion to obtain powders with desired properties. We studied some properties of the obtained powders.

NEW APPROACHES FOR IMPROVING SENSITIVITY OF LATERAL FLOW IMMUNOASAY

Kseniya Serebrennikova, Tomsk Polytechnic University, Master Student

Nowadays, one of the most common methods of determination of diagnostically important biological active substances is immunochromatographic assay, also known as lateral flow immunoassay. The main advantages of this method are the rapidity, ease of use and visual detection of results.
Gold nanoparticles are usually used as a label for visual detection of test results. However, growth in use of lateral flow immunoassay requires higher sensitivity (especially for analytes with low molecular weight) and converting visual evaluation of analysis by principle yes/no into quantitative analysis.
The express-method of procalcitonin detection using principle of lateral flow immunoassay and colloidal gold as a label was developed. The main approaches for improving sensitivity of lateral flow immunoassay, such as application of different registration methods, using different types of gold nanoparticles (shape and size) and silver enhanced method were concidered.

DEVELOPMENT OF THE MATERIALS WITH DETERMINED HOUNSFIELD UNITS FOR NUCLEAR MEDICINE APPLICATION

Irina Danilova, Tomsk Polytechnic University, student

Nuclear medicine is a prospective area of application of nanocomposite materials, where the issue of the day is the development of new tissue-equivalent materials for the manufacture of test objects. Most of the phantoms are made of plastic with a close to human tissues X-ray density (Hounsfield Units). A set of materials with predetermined HU will allow to create phantoms for radiobiological purposes with high accuracy of imitating human body.
This can be achieved by mixture the metallic additives and ABS plastic base. However, the specifics of radiobiological investigation have strict requirements for the uniformity of the materials structure. For instance, the microtomograph SkyScan 1176 intended for in vivo studies, has 9 μm resolution. With such resolutions the large inclusions will be visible on the tomographic images. The solution of this problem is using the nanoparticles whose dimensions are much smaller than resolution of the setting.
Aim of this work is to create the composite materials based on ABS with nano-sized metal impurities. The materials with different physical properties were obtained. The HU were gained with the tomographic method. The tests of resistance to gamma-radiation and electron beam were conducted. The dependences between HU and the impurity concentration were obtained.

LOW-TEMPERATURE ELECTRONIC PROPERTIES OF EPITAXIAL GRAPHEME

Alexander Ponomarev, Tomsk Polytechnic University, Assistant professor

Low-temperature peculiarities of density of states (DOS) in epitaxial graphene have been described by the temperature Green function method. Calculation was conducted in the frame of relaxation time approximation, taking into account the multiple elastic scattering of electrons on impurities and structural inhomogeneities of the short-range order type.
We have found that:
1. Change of the defect structure of graphene leads to its metallization because of increase of the contribution to DOS at the Fermi level.
2. The depth of the DOS minimum increases when temperature rises in a perfect graphene (without impurities) and decreases in graphene saturated by gas. This result is confirmed by the experimental data.
Thus, taking into account the multiple elastic scattering of electrons on impurities and structural inhomogeneities of the short-range order type we managed to investigate the effects of doping or degassing in graphene and describe the low-temperature behaviors of DOS near Fermi energy.

NANOSTRUCTURED SORBENTS AND COMPOSITES BASED ON IT

Galina Naumova, Saratov State University, master sudent

S.B. Venig, R.K. Chernova, V.G. Serzhantov, V.P. Splyukhin, N.N. Shcherbakova, E.I. Selifonova, G.N. Naumova, A.A. Selifonov, E.G Glukhovskoy

In the real work it is shown that receiving effective bactericidal composites depends on nanostructure of a glauconite. We have patented technology of creation of nanoporous materials of various fractions. The specific surface and porous structure five high-disperse the glauconite adsorbents are investigated, adsorption isotherms – a desorption are constructed. Existence of loops of a hysteresis on isotherms of the 4th type testifies to the dominating structure of a mesotime of 2-50 nanometers in size.
Dependence of sorption ability the glauconite fractions in relation to antibiotics from degree of nanostructure of the relevant fractions is shown. The kinetics and key parameters of sorption of antibiotics on fractions of a glauconite are calculated. On the example of a nanocomposite of a tetracycline with fine fraction of a glauconite (5 microns) its high biological activity in relation to S. Aureus strain is shown. These parameters are effectively applied in veterinary science, agriculture and medicine since positive influence of enterosorbents on an organism is proved.
The research supported by grant of the Russian Science Foundation (project № 14-12-00275) and the National Research Saratov State University

INVESTIGATION OF PARACETAMOL RELEASE FROM ELECTROSPUN POLY (E-CAPROLACTONE) SCAFFOLDS

Apollinariya Rakina, TomskPolytechnic University, student

Electrospun poly (ε-caprolactone) (PCL) nanofibrous scaffolds with different paracetamol concentration were studied. The scaffolds were fabricated by means of classical singel nose electrospinning method. Paracetamol was chosen as model poorly water-soluble drug, and it was incorporated by the dissolution technique. Scanning electron microscopy showed that drug dosage affects the morphology of nanofibers. An in vitro drug release study in PBS medium for PCL scaffolds with 2 wt. % loaded paracetamol revealed its instant release within 10 minutes.

PREPARATION AND INVESTIGATION BIOCONJUGATES BASED ON SILVER NANOPARTICLES

Yekaterina Khristunova, Tomsk Polytechnic University, master student

The interest of interaction between nanoparticles and biomolecules increased every year. The big area in this research takes the interaction of metal nanoparticles and antibodies. In this work we demonstrate the synthesis and investigation bioconjugates based on silver nanoparticles by instrumental methods. The first step consist of the synthesis nanoparticles, which were received by chemical reduction of silver nitrate in sodium borohydride. TEM showed that they have spherical shape and size distribution from 10-20 nm. On second step were synthesised bioconjugates with bovine serum albumin and human immunoglobulin against encephalitis, which were characterized by TEM, FTIR-spectroscopy, UV- spectroscopy and voltammetry.

MAGNETIC NANOPARTICLES AS MEDIATORS FOR NANOMECHANICAL ACTUATION OF BIOCHEMICAL SYSTEMS BY NON-HEATING ALTERNATING MAGNETIC FIELD

Alexander Zhigachev, Derzhavin Tambov State University, postgraduate student

In the past decade nanomechanical approach to biochemical systems actuation has appeared. This method involves application of magnetic nanoparticles (MNP) controlled by non-heating low-frequency (LF) alternating magnetic field (AMF). Specificity at cellular or molecular level and spatial locality is its key advantage as compared to magnetic hyperthermia. However current experimental studies have weak theoretical basis. Models of magneto-mechanical actuation in non-heating LF AMF are presented in the article. Single core-shell, rod-like, Janus MNPs as well as dimer constructed of two MNPs with macromolecules immobilized on their surface are considered. MNPs binded with macromolecules or cellular membranes can affect their functions and properties. This could be widely used in therapy, in particular for targeted drug delivery. Aggregate constructed of two and more particles can strongly affect surrounding macromolecules; force on the order of several hundreds of piconewton is predicted. Opportunity of controlled in vitro and in vivo aggregate assembly is discussed.

CATALYTIC NAPHTALENE CONDENSATION AS A MEANS OF PRODUCING NANOSTRUCTURED GRAPHENE: COMPUTATIONAL STUDIES

Alexey Chumakov, Saratov State University, PhD student

Graphene and its derivatives are one of most promising and heavily studied nanomaterials possessing a wide range of physical and chemical characteristics leading to their application in photoelectronics , medicine , material science etc. One of the possible methods of graphene synthesis is catalytic condensation of aromatic polycyclic hydrocarbons such as naphthalene. Although these reactions are well-known and have been studied since the beginning of XX-th century, quantum chemical computations of such processes have not been performed yet.
Therefore, the aim of this study is use computational methods to examine path of reaction of naphthalene condensation in order to choose the most promising catalyst (such as (Pt, Pd, Ni, $PdCl_4$ or $AlCl_3$) for future synthesis. According to calculation results, Ni and Pd appear to be the most effective catalysts for the studied process.
The research is supported by grant of the Russian Science Foundation (project №14-12-00275) and the National Research Saratov State University.

INFLUENCE OF MOLECULAR STRUCTURE, FORMATION AND TRANSFER CONDITIONS OF LANGMUIR-BLODGETT FILMS OF BODIPY DERIVATIVES ON THEIR OPTICAL PROPERTIES

Elena Soldatenko, Saratov State University, PhD

The aim of this work was investigated the influence of the molecular packing features on the spectral and photophysical properties of thin films.
Langmuir layers were formed from chloroform solutions of the studied compounds using NT-MDT apparatus (Russia). Thin films were obtained by transfer of layers onto glass substrate at temperature 293–295 K and in diapason of surface pressure (π = 0–1 мН/м). Transfer of layers from water surface was carried out according to the Langmuir-Schaeffer method, n = 1–30 layers. Absorption spectra of films and solutions were recorded by SF-104 (Aquilon) spectrophotometer in the wavelength range of 190–1100 nm and fluorescence spectra – by spectrofluorimeter Cary Eclipse (Varian) in the wavelength range of 500–800 nm, at the excitation wavelength of 480 nm and the slit widths of the excitation and emission of 10 nm; a sample was set at an angle of 60 degrees with respect to the incident light.
The obtained results make it possible to use the studied compounds as materials for opto- and nanoelectronics.
The work was supported by the Program of the Ministry of Education and Science of the Russian Federation in the framework of the state task for Ivanovo State University to carry out research work in 2014–2016 (Grant No 4.106.2014/K) and partially supported by the Grant of the President of the Russian Federation (MK-8835.2016.3) and the RFBR (Grant No 16-03-01028 and No 15-33-20002).

THE CONDUCTION MECHANISMS IN THE SYSTEM OF QUANTUM DOT IN AN ORGANIC MATRIX

Yaroslav Pereverzev, Saratov State University, Postgraduate student

The manifestation of the specifics of current transport through the QD is interesting for studying and keeping - important for practical applications. Therefore, in this study the electrical properties of these systems have been investigated.
QD monolayer's composed of the organic matrix formed on the surface of water and transferred to a solid substrate using a Langmuir- Blodgett technology.
The studies were conducted using scanning probe microscopy AFM modes, STM. Images of the surface were obtained, current-altitude curves, current-voltage characteristics as a function of distance "probe-to-surface", absorption and transmission spectra in the visible and infrared ranges.
In current-current high-rise characteristics change when you change the height of observed current spikes during approach and retraction of the probe is likely related to the expression of surface and quantum effects.
Depending on the distance of the tip-surface were recorded CVC series, whose form changed and witnessed the change of current mechanisms in the tip-sample system.
At the initial stage of the CVC measurements noted the changing nature of current that can be associated with the modification of the samples (e.g. evaporation or burning of the organic matrix due to local heating when current flows). To confirm this fact CVC were obtained depending on the annealing temperature and duration of exposure to ultraviolet radiation.
The study was supported by a grant from the Russian Science Foundation (project №14-12-00275) and the National Research Saratov State University.

MODIFICATION OF CALCIUM PHOSPHATE COATINGS BY ALOOH NANOPARTICLES-AGENTS

Valentina Chebodaeva, Tomsk Polytechnic University, graduate student

New potential medical applications with AlOOH nanoparticle composite calcium phosphate microarc coatings have been investigated. Charge of implant surface plays a significant role in the material's biocompatibility. This paper investigates the effect of modification of calcium phosphate biocoating using specific method of nanoparticle precipitation. The optimal mode of the
precipitation of AlOOH nanoparticle have been found. Such parameters allow to form the coating with the specific morphology which characterized uniform distribution of aluminum. The results of energy-dispersive X-ray spectroscopy demonstrate that microarc biocoating composition includes aluminum (4 at.%)

SIMPLE TECHNIC FOR STUDYING OF STRUCTURE ORGANOGELS

Antonina Saenko, Tomsk Polytechnic University, student

Structure gels, occupying an intermediate position between a liquid and a solid, causes their specific physical and chemical properties and reactivity.
Organogel synthesized on the basis of polymethylmethacrylate (PMMA) and polymethacrylate acid (PMAC), filled with polyethylene glycol (PEG 200) and low-molecular-weight component (CF_3COOH). The method of color reactions shown that indikatory- phenolphthalein, Congo red, cresol red define the pH of the medium in the range of alkaline.Studied methods of solubility of gels in solvents such as toluene, isopropyl alcohol, sodium hydroxide, and dimethylformamide.
It is shown that the gel electrolyte MMA – MAC – PEG is highly soluble in dimethylformamide and sparingly soluble in isopropyl alcohol.
In turn, isopropyl alcohol and dimethylformamide are good solvents for the polymer gel electrolyte MMA – MAC – PEG – CF_3COOH, however, in DMF the dissolution occurs more rapidly.

POROUS CERAMIC COMPOSITE ZRO2(MG)-MGO FOR BONE RECONSTRUCTION OF VISCERAL AREA

Ales Buyakov, Tomsk State University, Master student

Bone integrity regeneration in terms of postoperative recovery and aesthetic due to the cancer resection or injuries is one of very important issues.
Ceramics are ident to inorganic bone matrix by the type of chemical bonds and it is compensated, that is why ceramics does not have electrochemical interaction with an organism. Using of ceramic implants eliminates postoperative and deferred in time sharp reactions to the implant and remain constant chemical composition and properties of the implant. This allows to avoid revision surgery for extracting implants.
In this work we are studying the possibility of creating biologically-active and osteoinductive replacement material based on zirconia-magnesia composite and the way of its application in the field of reconstructive surgery of the visceral area. the ability of
Pore structure and phase composition of ceramic composite materials ZrO2(Mg)-MgO at different sintering temperatures and concentrations were studied. Was determined the main mechanical characteristics of the material and was shown, that they are close to the characteristics of natural bone tissues.
The methods of personalized osteoimplants creation, based on computer tomography, three-dimensional modeling and 3D prototyping were developed. Further, were studied the properties of sintered material and it has been found that there is no acute or chronic cytotoxicity.
It has been shown that material structure has positive effect on the pre-osteoblast cells proliferation. In-vitro studies of pre-osteoblast cells, cultivation on material surface has shown a good cell adhesion, proliferation and differentiation of MMSC by osteogenic type.

FEATURES OF SYNTHESIS AND STRUCTURE OF MOF UIO-66 FOR HYDROGEN STORAGE

Tatiana Priamushko, Tomsk Polytechnic University, master student

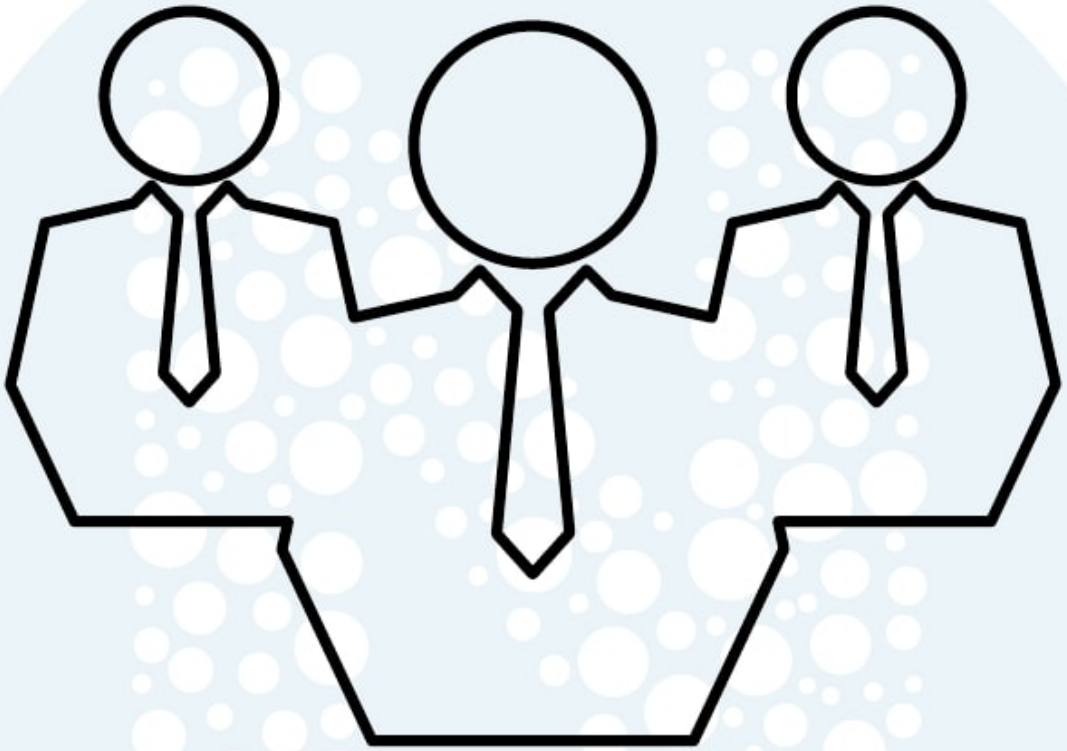
Metal-organic frameworks (MOFs) based on Zr have attracted great interest as a hydrogen storage materials. One of the most perspective materials for it is UiO-66 had a high porosity and stability at high temperatures and pressures. Moreover, UiO-66 can be synthesized in many ways. In this work three types of synthesis were used. After synthesis there is activation process which included vacuum drying and heating with 200°C for 15 hours. To study MOFs properties following methods were used: TGA, XRD, SEM and BET analysis.

SYNTHESIS OF NANOSIZED ZRO2 CONTAINING SLURRIES CITRATE SPRAY DRYING METHOD NANO SPRAY DRYER B-90

Podgaetskaya V. V.*, Ilela A. E.*, Seitkazy A. E.*, Sadykova V. R.**

*National Research Tomsk Polytechnic University
** Tomsk State Pedagogical University

Used solutions are 1 M and 0.1 M $ZrO(NO_3)_2$ and $ZrOCl_2$; $C_6H_8O_7$ or $Na_3C_6H_5O_7$. Suspensions were obtained by reverse precipitation with ammonia.
The resulting powder was dried at room temperature during the day. then at a temperature of 150 ° C for 3 hours. After drying, the powders were subjected to annealing at a temperature of 450 ° C for 1 hour.
On the basis of the XRD data shows that the crystalline phase of zirconium oxide appear after 450 °C.
In the system with citric acid discovered tetragonal, monoclinic and cubic phases of zirconium oxide. In the system with sodium citrate – tetragonal and cubic phases. The use of spray drying shows that in these systems there is more phases of zirconium oxide.
On the basis of DSK-analysis found that crystalline phase of zirconium oxide is formed, upon dilution with sodium citrate, and tribasic carboxylic acids. Exo-effects are from 420 ° C to 700 ° C, respectively.



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INJECT

OOO NPP "Inzhekt" is one of Russia's leading designers and serial manufacturers of optoelectronic components, producing over 30 types of laser diodes, superluminescent diodes, photodiodes, etc. "Inzhekt" was set up as a successor to the department of quantum electronics of NII "Volga" research institute founded in 1973.

At the moment, OOO NPP "Inzhekt" employs more than 260 highly qualified specialists in quantum electronics, semiconductor physics, and semiconductor device manufacturing technologies.

The enterprise's research and manufacturing facilities are represented by a design department and a technology department that carry out research and development, and a production line capable of full-cycle manufacturing of semiconductor laser emitters, starting with manufacturing semiconductor substrates. The production cycle includes epitaxy of semiconductor structures, subsequent process cycle of shaping crystal structures, application of ohmic contacts and optical coatings, device assembly and packaging, gauging and testing.

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Currently OOO NPP "Inzhekt" is designing and mass-producing a range of laser diodes with optical output power above 4000 W in continuous operation mode and laser diode stacks with pulse optical power over 6 kW.

We offer opportunities of industrial collaboration and application of high-power semiconductor laser diodes manufactured by OOO NPP "Inzhekt" as components for emitters in cutting-edge equipment. Our laser diodes provide high beam output power, durability and resistance to physical and thermal impact (-60 to +70 °C), high efficiency (>50%) and low power consumption. Our quality management system is compliant to the requirements of GOST R ISO9001-2001 and GOST RV 15.002-2003 standards.

We are always ready for the opportunities of producing optoelectronic and laser systems according to your specifications and welcome industrial collaboration in areas taht you may suggest.

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Tomsk polytechnic University, Building #8

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