National Research Tomsk Polytechnic University
Saratov State University
Queen Mary University of London
Charite Medical University
Ghent University
Max Planck Institute of Colloids and Interfaces

7th International Conference "NANOPARTICLES, NANOSTRUCTURED COATINGS AND MICROCONTAINERS: TECHNOLOGY, PROPERTIES, APPLICATIONS"

May 12-15, 2016
Tomsk, Russia

PROGRAMME
Abstracts

AIM

The aim of the conference is bring researchers and practitioners together to intensify the scientific cooperation, to share the latest knowledge and to encourage academic growth in emerging nanotechnologies and nanomaterials science.

The Conferences brings together young 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 Conference 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 634050 Russia

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

COORDINATOR

Dr. Roman Surmenev

Dept. of Experimental Physics
Tomsk Polytechnic University
e-mail: surmenev@tpu.ru
cell: +7 903 953 09 69

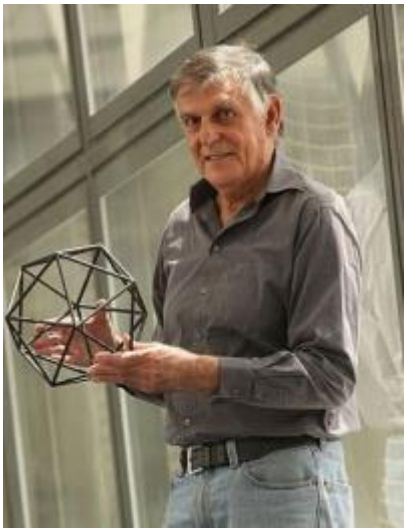
ACKNOWLEDGEMENTS
The event is supported by the Russian Fund for Basic Research, project # 16-03-20173.
The financial support in the frames of Marie Curie project (PIRSES-GA-2013-612673) is also acknowledged.
Best poster and oral presenters among young researchers will be acknowledged with the diploma.

Organizing committee:

Chair: Prof. A.N. Dyachenko, National Research Tomsk Polytechnic University (Tomsk, Russia)
Prof. G.B. Sukhorukov, Qeen Mary University of London (London, UK)
Prof. S.B. Venig, Saratov State University (Saratov, Russian Federation)
Assistant Prof. E.N. Atochina-Vasserman, University of Pennsylvania (Philadelphia, USA), RASA center in Tomsk (Tomsk, Russia)
Prof. D.A. Gorin, Saratov State University (Saratov, Russia), RASA center in Tomsk (Tomsk, Russia)
Dr. R.V. Ostvald, National Research Tomsk Polytechnic University (Tomsk, Russia)
Dr. A.Yu.Godymchuk, National Research Tomsk Polytechnic University (Tomsk, Russia)
Dr. R.A. Surmenev, National Research Tomsk Polytechnic University (Tomsk, Russia)
Dr. S.A. Baidali, National Research Tomsk Polytechnic University (Tomsk, Russia)
Mrs. E.N. Serebryakova, National Research Tomsk Polytechnic University (Tomsk, Russia)
O.Yu.Kondrateva, Saratov State University (Saratov, Russian Federation)
Dr. L. Rieznichenko, F.D. Ovcharenko Institute of Biocolloidal Chemistry of National Academy of Science of Ukraine

International Scientific Committee

Prof. G.B. Sukhorukov, Qeen Mary University of London (London, UK)
Prof. A.V. Kabanov, Center for Nanotechnology in Drug Delivery (USA)
Prof. Winterhalter, Mathias, Jacobs University Bremen gGmbH (Bremen, Germany)
Prof. H. Bäumler, Institute of Transfusion Medicine, University Hospital Charité, (Berlin, Germany)
Prof. G. Brezinski, Max-Planck Institute of Colloids and Interfaces (Golm/Potsdam, Germany)
Prof. M. Nayfeh, University of Illinois at Urbana-Champaign (Urbana-Champaign, USA)
Prof. M.D. C. Isidoro, University of Piemonte Orientale (Novara, Italy)
Prof. D.N. Atochin, Harvard Medical School (USA), RASA center in Tomsk (Tomsk, Russia)
Prof. S. Suzer, Bilkent University (Ankara, Turkey)
Prof. A. Skirtach, Ghent University (Ghent, Belgium)
Prof. E. Terreno, University of Torino (Torino, Italy)
Prof. C. Gao, Zhejiang University, (Hangzhou, China)
Prof. A. Gow, Rutgers University, USA, RASA center in Tomsk (Tomsk, Russia)
Prof. Y. Elerman, Ankara University (Ankara, Turkey)
Prof. S.B. Venig, Saratov State University (Saratov, Russian Federation)
Prof. D.A. Gorin, Saratov State University (Saratov, Russia), RASA center in Tomsk (Tomsk, Russia)
Prof. A.N. Pestryakov, National Research Tomsk Polytechnic University (Tomsk, Russia)
Prof. S.V. Panin, National Research Tomsk Polytechnic University (Tomsk, Russia)
Prof. O.L. Khasanov, National Research Tomsk Polytechnic University (Tomsk, Russia)
Prof. P.A. Strizhak, National Research Tomsk Polytechnic University (Tomsk, Russia)
Dr. A. Lapanje, Saratov State Universiy (Saratov, Russia)
Prof. S. Shtykov, Saratov State Universiy (Saratov, Russia)
Prof. V. Erokhin, CNR - Institute of Materials for Electronics and Magnetism (Parma, Italy)



12 May 2016
Nobel laureate lecture
Professor Dan Shechtman
(Technion (Israel Institute of Technology), Israel and Iowa State University, USA)

How to create good scientists and how to keep them

Place: from 13:00 till 14:15, Sport complex GARMONIA, Vysotskiy street 7, building 6

KEYNOTE SPEAKERS

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.

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, *si*RNA and proteins.

References:

[1] H. Bader et al. *Angew. Macromol. Chem.* 1984, 123/124:457; A. Kabanov et al. *FEBS Lett.* 1989, 258:343; M. Yokoyama et al. *Cancer Res.* 1990, 50:1693.
[2] M. Yokoyama et. al. *J. Exp. Clin. Med.* 2011, 3:8.
[3] R. Luxenhofer et al. *Biomaterials* 2010, 31:4972; Y. Han et al. *Mol. Pharmaceutics* 2012, 9:2302; A. Schulz, et al. *ACS Nano* 2014, 8 (3), 2686–96.
[4] A. Kabanov et al. Bioconj. Chem. 1995, 6: 639; A. Harada and K. Kataoka, Macromolecules 1995, 28: 5294.

Prof. Valery V. Tuchin
Research-Educational Institute of Optics and Biophotonics, National Research Saratov State University, 83 Astrakhanskaya str., Saratov 410012, Russia
Laboratory of Laser Diagnostics of Technical and Living Systems, Institute of Precision Mechanics and Control RAS, 24 Rabochaya str., Saratov 410028, Russia
Interdisciplinary Laboratory of Biophotonics, National Research Tomsk State University, 36 Lenin's av., Tomsk 634050, Russia
E-mail: tuchinvv@mail.ru

UV to THz Enhanced Tissue Imaging at Immersion Clearing: from in vitro to in vivo

Fundamentals and advances of tissue immersion clearing technology that provides enhanced microscopy and imaging of living tissues are presented. The technology is based on controllable and reversible tissue properties modification by their impregnation by exogenous or endogenous biocompatible clearing agents [1-4]. Tissue reversible dehydration and induced transverse and longitudinal shrinkage measured *in vitro* and *in vivo* will be discussed. The specific features of tissue clearing for enhanced transport of UV-THz through fibrous and loose connective tissues, as well as epithelial tissues are investigated using OCT, confocal, photoacoustic, Raman, linear and nonlinear fluorescence and SHG-microscopies. Enhancement of probing depth and image contrast in *in vitro*, *ex vivo*, and *in vivo* studies of a variety of human and animal tissues, including skin, fat, eye sclera, muscle, cerebral membrane, digestive tract tissue, cartilage, tendon, bone, blood vessels, and blood will be demonstrated.

References:

1. D. Zhu, K. V. Larin, Q. Luo, and V. V. Tuchin, "Recent progress in tissue optical clearing," *Laser Photonics Rev*. **7**(5), 732–757 (2013).
2. V.V. Tuchin, "*In vivo* optical flow cytometry and cell imaging," *Rivista Del Nuovo Cimento*, **37**(7), 375–416 (2014).
3. E. A. Genina, A. N. Bashkatov, Yu. P. Sinichkin, I. Yu. Yanina, V.V. Tuchin, "Optical clearing of biological tissues: prospects of application in medical diagnostics and phototherapy [Review]," *J. Biomed. Photonics & Eng*. **1**(1), 22–58, 2015.
4. V.V. Tuchin, "Tissue optical clearing: New prospects in optical imaging and therapy," in *BioPhotonics, IEEE International Conference*, pp.1-10, 20-22 May 2015; doi: 10.1109/BioPhotonics.2015.7304023

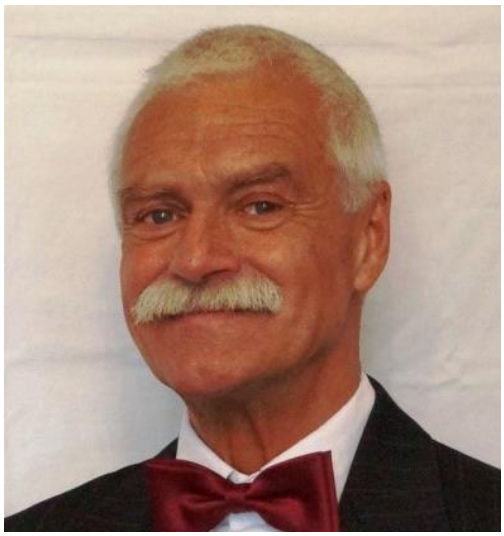
Prof. Valery Fokin

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.



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. A direct repulsion of the polymer from, or incompatibility with, the surface is not required. A polymer depletion layer is formed where the polymer segment density decreases towards the surface. As a consequence, this is accompanied by a parallel position dependent decrease of the osmotic pressure. This leads to the well-known depletion interaction and to the formation, as a rule, of reversible flocks of colloidal particles.

EU-Project http://www.epmmagazine.com/opinion/biocapan-project/

Prof. Gerald Brezesinski

Max Planck Institute of Colloids and Interfaces, Potsdam, Germany

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

Physical-chemical studies in 2D and 3D model systems of new cationic lipids for gene transfection

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.

We invite you to visit us at the course devoted to the structure analysis of condensed matter. Please examine the information listed below for course registration.

Course "Local structure and structural evolution in condensed matter by EXAFS and XANES analysis"

given by Dr. Andrei V. Sapelkin

School of Physics and Astronomy
Queen Mary University of London, GB

1. EXAFS and XANES: history and theory.
2. Experimental techniques and methods.
3. Data processing and analysis.
4. Analysis of crystalline, amorphous materials, nanoparticles, liquids and molecular systems.
5. Latest trends in EXAFS and XANES development.

Location: arriving soon

Data: 13 May 2016

Time: 12:00 – 14:00

Registration: if you intend to attend the course, kindly send your Name Surname, Affiliation, e-mail to the Coordinator before 05 May 2016.

There is ***no registration fee*** for this seminar.

Coordinator: Dr. Anna Godymchuk,
+7-906-947-50-27, Godymchuk@tpu.ru

POSTERS

May, 12, Thursday

Poster Session #1
P0-P14

Poster Session #2
P15-P29

May, 13, Friday

Poster Session #3
P29-1-P43

May, 14, Saturday

Poster Session #4
P44-P55

PROGRAMME

May, 12, Thursday

08:00 – 09:00	**Registration of participants**
09:00 – 09:30	**Welcome speech from Organizing Committee** ***Prof. A.N. Dyachenko,*** Vice-Rector for Research and Innovations, Tomsk Polytechnic University, Russia ***Prof. G. Sukhorukov,*** Queen Mary University of London, Great Britain, Saratov State University, Russia ***Prof. V. Fokin,*** University of Southern California, USA
09:30 – 11:30	**Section 1 - Drug delivery systems, microcontainers and theranostics**
Chairs: Ass. Prof. E. Atochina-Vasserman and Prof. G. Sukhorukov RASA Center, Tomsk Polytechnic University, Russia	
9:30 – 10:00	**(KEYNOTE LECTURE)** Prof. V. Tuchin, Saratov National Research State University **UV to THz Enhanced Tissue Imaging at Immersion Clearing: from in vitro to *in vivo***
10:00 - 10:30	**(KEYNOTE LECTURE)** Prof. A. Kabanov, University of Northern Carolina Chapel Hill, USA, Moscow State University, Russia **Polymeric micelles for drug delivery**
10:30 – 10:45	O. Gusliakova, Saratov State University, Russia **Size-dependent biodistribution of vaterite particles in the mice lungs**
10:45 – 11:00	Prof. A. Gow **(invited)**, Department of Pharmacology & Toxicology, Ernest Mario School of Pharmacy, Rutgers University, USA, RASA Center in Tomsk, Tomsk Polytechnic University, Russia **Functionalization and Core Materials Regulate Nanoparticle Interaction with the Lung**
11:00 – 11:15	Prof. D.N. Atochin **(invited)**, Cardiovascular Research Center, Cardiology Division, Massachusetts General Hospital, USA; RASA Center in Tomsk, Tomsk Polytechnic University, Tomsk **Drug delivery for protection against stroke**
11:15 – 11:30	Prof. D. Gorin **(invited)**, Saratov State University, Russia, RASA Center in Tomsk, Tomsk Polytechnic University, Russia **Microstructured surface and nanostructured microcapsules with controllable sensitivity to ultrasound for biomedical applications**
11:30 – 12:00	**Coffee-break / Poster Session #1**
12:00 – 14:00	**Section 1 - Drug delivery systems, microcontainers and theranostics**
Chairs: Dr A. Vladescu National Institute for Optoelectronics - INOE2000, Dr C Cotrut University Politehnica of Bucharest, Romania	
12:00 – 12:30	**(KEYNOTE LECTURE)** Prof. H. Riegler, Max Planck Institute of Colloids and Interfaces, Germany **Nanoaggregates, bubbles, droplets, and thin films: The influence of interfacial energies in confined systems**
12:30 – 12:45	A. Tomin **(invited)**, Ltd "Spektronika", Russia **Head of sales department equipment for cell and molecular biology**
12:45 – 13:00	Dr M. Antipina **(invited)**, Institute of Materials Research and Engineering A*STAR, Singapore **Proteins in the layered capsules – active compounds & building blocks**

13:00 – 13:15	Dr. J. Frueh **(invited)**, Harbin Institute of Technology, China **A mathematical approach to forecast bubble propelled micromotor paths in aqueous solutions**
13:15 – 13:30	Dr M. Kiryukhin **(invited)**, Institute of Materials Research and Engineering A*STAR, Singapore **Microcontainers in Functional Foods: Encapsulation, Protection and Targeted** Delivery of Lactoferrin
13:30 – 13:45	Prof. A. Yakimansky **(invited),** Institute of Macromolecular Compounds of the Russian Academy of Sciences, Russia **Molecular Polyimide Brushes with Polymethacrylate Side Chains and Their Applications as Membrane Materials and Nanocontainers**
13:45 - 14:00	Dr B. Parakhonskiy **(invited)**, Saratov State University **Calcium carbonate porous particles as perspective theranostic tool**
14:00 – 15:00	***Lunch***
15:00 – 16:45	**Section 4 - Nanostructured, nanocomposite materials, thin films and methods of their analysis**
Chair*:* Prof. A. Kabanov, Director, Center for Nanotechnology in Drug Delivery, USA	
15:00 – 15:30	**(KEYNOTE LECTURE)** **Prof. V. Fokin,** University of Southern California, USA **Catalysis and Complexity in Nanoscience: From Molecular Control to Applications**
15:30 – 16:00	**(KEYNOTE LECTURE)** Prof. H. Bäumler, Charité-Universitätsmedizin Berlin, Gemany **Novel Hemoglobin Particles—Promising New-Generation Hemoglobin-Based Oxygen Carriers**
16:00 – 16:15	Dr A. Sapelkin **(invited)**, Queen Mary University of London, Great Britain **Super-Resolution Imaging by Spectral Separation of Quantum Dots**
16:15 – 16:30	Prof. A. Pestryakov **(invited)**, Tomsk Polytechnic University, Russia **Nanogold and nanosilver catalysts for CO and alcohol oxidation**
16:30 – 16:45	Prof. N.A. Gippius **(invited)**, Skolkovo Institute of Science and Technology, Russia **Resonances in Metallo-Dielectric Photonic Structures**
16:45 – 17:15	**Poster Session #2**
17:15 – 18:15	**Joint section 6 and 7 (Biological aspects of nanomaterials application; New applications of nanotechnologies in medicine)**
Chair: Prof. E. Terreno, Department of Molecular Biotechnology and Health Sciences, University of Torino, Italy	
17:15 – 17:30	Dr L. Varticovski **(invited),** Center for Cancer Research National Cancer Institute **Stem Cells as a Source of Regenerative Tissues**
17:30 – 17:45	N. Dementeva, Tomsk State University, Russia **LC-MS analysis of the carcinogen-modified nucleobases obtained by acid hydrolysis of carcinogen-induced DNA**
17:45 – 18:00	Dr. A. Gusev, G.R. Derzhavin Tambov State University, Russia **Colloidal solutions of nanosilver exhibit fungicidal and phytostimulating activity in potato plants (Solanum tuberosum L.)**
18:00 – 18:15	Ass. Prof. E. Atochina-Vasserman **(invited)**, University of Pennsylvania School of Medicine, Philadelphia, USA; RASA Center, Tomsk Polytechnic University, Russia **Can mice help us find a cure for a rare cancer? The tale of three mice**
19:00 – 21:30	**Welcome Party**

May, 13, Friday

09:00 – 11:15	**Section 7 - New applications of nanotechnologies in medicine** **Section 1 - Drug delivery systems, microcontainers and theranostics**
Chairs: Dr. Andrei Sapelkin, Queen Mary University of London, Great Britain Prof. Dmitry Gorin, Saratov State University, Russia	
9:00 – 9:30	**(KEYNOTE LECTURE)** Prof. Gleb Sukhorukov, Queen Mary University of London, Great Britain **Recent Advances and Challenges in Multifunctional Encapsulation**
9:30 – 9:45	Dr Alina Vladescu **(invited)**, National Institute for Optoelectronics - INOE2000, Romania **Antibacterial properties of sputtered hydroxyapatite coating**
9:45 – 10:00	Dr Mihai Cosmin Cotrut **(invited)**, University Politehnica of Bucharest, Romania **Nanostructured coatings for adherence enhancement of the ceramics used in prosthetic restoration**
10:00 – 10:15	Dr Alexey Yashchenok **(invited)**, Remote Controlled Theranostic Systems Lab, Educational Research Institute of Nanostructures and Biosystem, Saratov State University, Saratov, Russia **Microparticles and Polymer Materials as effective SERS substrates for Label-Free Detection of Molecules and Intact Cells**
10:15 – 10:30	Prof. Alexander Majouga **(invited)**, Lomonosov Moscow State University, Russia **Development of Gold-Magnetite Hybrid Nanoparticles for Biomedical Application**
10:30 – 10:45	Sergey Filippov, Fund for Infrastructure and Educational Programs (RUSNANO Group) **Russian Engineering Contest in nanotechnology 2016: why you have to win?**
10:45 – 11:00	Dr Francesca Garello **(invited)**, Università di Torino, Italy **VCAM-1 targeted paramagnetic micelles for MR visualization of neuroinflammation**
11:00 – 11:15	Prof. Enzo Terreno **(invited)**, Department of Molecular Biotechnology and Health Sciences, University of Torino, Italy **MRI visualization of the release of doxorubicin from liposomes triggered by non thermal effects of Ultrasound**
11:15 – 11:45	**Coffee-break / Poster Session #3**
12:00 – 14:00	*Dr Andrei Sapelkin* ***(invited)****, Queen Mary University of London, Great Britain* ***Short course "Local structure and structural evolution in condensed matter by EXAFS and XANES analysis" (separate registration is available at the registration desk)***
11:45 – 14:00	**Section 1 - Drug delivery systems, microcontainers and theranostics**
Chair: Dr. Maria Antipina, Institute of Materials Research and Engineering, A*STAR Singapore	
11:45 – 12:15	**(KEYNOTE LECTURE)** **Prof. Gerald Brezesinski, Max Planck Institute of Colloids and Interfaces, Germany** **Physical-chemical studies in 2D and 3D model systems of new cationic lipids for gene transfection**
12:15 – 12:30	Dr Radostina Georgieva **(invited)**, Charité-Universitätsmedizin Berlin, Gemany **Micro- and submicro-particles as diagnostic and therapeutic tools**
12:30 – 12:45	Dr Ales Lapanje **(invited)**, Saratov State University, Russia **What is going on when we catch alive cargo inside the polyelectrolyte**

	capsules?
12:45 – 13:00	Artem Minin, IMP UrD RAS, Russia **Cell uptake of magnetic nanoparticles modified by DNA aptamer and investigated by magnetic relaxometry**
13:15 – 13:30	Prof. Irina Goryacheva **(invited)**, Saratov State University **New directions in biosensor development: multifunctional platforms and enhanced labels**
13:30 – 13:45	Meiyu Gai, Queen Mary University of London, Great Britain **A Method of printing 3D PEM films and patterned structures**
13:45 – 14:00	Olga Sindeeva, Saratov State University ***In vivo* Visualization and Magnetic Targeting of Nanocomposite Microcapsules containing Magnetite Nanoparticles**
14:00 – 15:00	***Lunch***
15:00 – 18:00	**Excursion (The museum of Beer)**
19:00 – 21:30	*Conference Dinner* *"Kupechesky Dom" Hotel*

May, 14, Saturday

09:00 – 11:00	**Section 2 – Aerosol, emulsion systems and liquid drop streams** **Section 1 - Drug delivery systems, microcontainers and theranostics**
Chair: Prof. Pavel A. Strizhak, TPU, Russia	
9:00 – 9:15	Dmitry Antonov, Tomsk Polytechnic University, Russia **Temperature traces of water droplet flow moving through high-temperature gas**
9:15 – 9:30	Roman S. Volkov, Tomsk Polytechnic University, Russia **Features of evaporation of water droplets moving through high-temperature gas**
9:30 – 9:45	Roman I. Egorov, TPU, Russia **Combustion of the coal-water slurry fuels doped by metal micro-particles**
9:45 – 10:00	Prof. Pavel A. Strizhak, Tomsk Polytechnic University, Russia **Evaporation and explosive breakup of water droplets containing single nonmetallic inclusions**
10:00 – 10:15	Alena O. Zhdanova, Tomsk Polytechnic University, Russia **Suppression of the thermal decomposition reaction of the forest fuel material by liquid spray**
10:15 – 10:30	Maxim Piskunov, Tomsk Polytechnic University, Russia **Evaporating water droplets with single metallic inclusions in a high-temperature gas environment**
10:30 – 10:45	Dr Alexander Timin, Tomsk Polytechnic University, Russia **Gluthatione-responsive microcapsules for delivery of anticancer drugs**
10:45 – 11:00	Iaroslav Rybkin, Saratov State University, Russia **Why is it not easy to cover bacterial cells using electrostatic approach?**
11:00 – 11:30	**Coffee-break / Poster Session #4**
11:30 – 14:00	**Section 4 - Nanostructured, nanocomposite materials, thin films and methods of their analysis**
Chair: Prof. Nikolay A. Gippius, Skolkovo Institute of Science and Technology, Russia	
11:30 – 11:45	Prof. Sergey Lebedev, Tomsk Polytechnic University, Russia **Electrically and thermally conductive poly(lactic acid)-based polymer composites**
11:45 – 12:00	Prof. Irina A. Kurzina, Tomsk State University, Russia

	Investigation of the acide-based properties of the adsorbents on the based of aluminia oxide
12:00 – 12:15	Dr Alexey Safonov, Kutateladze Institute of Thermophysics SB RAS, Russia **Deposition Of Thin Composited Coatings Of Fluoropolymer And Gold Nanoparticles Having Surface Plasmon Resonance**
12:15 – 12:30	Manoel Jacquemin, Tomsk Polytechnic University, Russia **Study Of Indium Tin Oxide Powder Compaction Behavior**
12:30 – 12:45	Prof. Oleg Khasanov, Tomsk Polytechnic University, Russia **Novel methods for nanoceramics and nanocomposite processing**
12:45 – 13:00	Alexey Almaev, Tomsk State University, Russia **Hydrogen sensors based on thin nanocrystalline films of tin dioxide**
13:00 – 13:15	Prof. Alexander Korotkikh, Tomsk Polytechnic University, Russia **Effect of metal nanopowders on agglomeration at the burning of aluminized solid propellant**
13:15 – 13:30	Grigory Mamontov, Tomsk State University **Cr2O3/Al-Al2O3 composite catalysts for hydrocarbons dehydrogenation, prepared from aluminum nanopowder**
13:30 – 13:45	Alexandr Zamchiy, Kutateladze Institute of Thermophysics SB RAS Synthesis of the silicon oxide nanowires oriented arrays on different substrates
13:45 – 14:00	Olga Guselnikova, Tomsk Polytechnic University, Russia **Design of novel smart materials for ultrasensitive sensors based on surface-modified Au plasmonic thin films**
14:00 – 15:00	***Lunch***
15:00 – 17:30	**Excursion (Semilizhki cossack fort)**
18:30 – 21:00	Football match (Polytechnic Stadium, 19 Gvardejskoj divizii street 20) (meeting point ICC TPU)

May, 15, Sunday

09:00 – 11:00	**Section 4 - Nanostructured, nanocomposite materials, thin films and methods of their analysis**
Chair: Dr Bogdan Parakhonskiy, Saratov State University	
9:00 – 9:15	Dr Roman Surmenev, Tomsk Polytechnic University, Russia **Surface modification of biomedical implant materials by means of low-temperature plasma processing**
9:15 – 9:30	Prof. Yurii Sharkeev **(invited)**, ISPMS of SB RAS, Tomsk Polytechnic University, Russia **Biocomposites on the base bioinert metals and alloys and bioactive CaP coatings. Structure, properties and applications**
9:30 – 9:45	Dr Evgeny Galunin, Tambov State Technical University, Russia **The Chemistry and Technology for Large-Scale Synthesis of Graphene Nanoplatelets**
9:45– 10:00	Nadezda Shatrova, NUST "MISiS", Russia **Characterization and magnetic properties of cobalt (Co) nanoparticles synthesized by ultrasonic spray pyrolysis (USP) with following hydrogen reduction**
10:00 – 10:15	Prof. Alexander Ilyin, Tomsk Polytechnic University, Russia **The Diagnostics of the Electroexplosive Metal Nanopowders and the Products of Their Oxidation in Air**
10:15 – 10:30	Dr. Anna Godymchuk, Tomsk Polytechnic University, Russia **(Eco)toxicity assessment of engineered nanoparticles: we need a**

	physicochemical characterization
10:30 – 10:45	Dr Alexander Titkov, Institute of Solid State Chemistry and Mechanochemistry, Siberian Branch of the Russian Academy of Sciences, Russia **N-Lauroylsarcosine capped silver nanoparticle based inks for printed electronics**
10:45 – 11:00	Johan P. Loison, Tomsk Polytechnic University, Russia **Micro-structure and magnetic properties of Zn-doped SmFeN magnets produced by Spark Plasma Sintering**
11:00 – 11:30	**Coffee-break**
11:30 – 13:00	**Section 4 - Nanostructured, nanocomposite materials, thin films and methods of their analysis**
Chair: Dr Roman Surmenev, Tomsk Polytechnic University, Russia	
11:30 – 11:45	Alfa Ilela, Tomsk Polytechnic University, Russia **ZrO_2-Al_2O_3 nanopowders obtained by Nano Spray Method**
11:45 – 12:00	Dr Evgeniy Sevastianov, Tomsk State University, Russia **Acetone and ethanol sensors based on nanocrystalline SnO2 thin films with various catalysts**
12:15 – 12:30	Elena Fakhrutdinova, Siberian Physical-Technical Institute of Tomsk State University, Russia **Synthesis of Nanocrystalline TiOx Powder via Palsed Laser Ablation**
12:30 – 12:45	Dr Pavel Postnikov, Tomsk Polytechnic University, Russia **Preparation of Ordered Silver Angular Nanoparticles Array in Block-Copolymer Film for Surface Enhanced Raman Spectroscopy**
12:45 – 13:00	Anastasia Kachusova, Tomsk State University, Russia **The nanostructured multilayer absorber of electromagnetic waves at microwave**
13:00 – 13:30	***Conference closing Ceremony (best poster and oral young presenter awards)***
15:00 – 16:00	Workshops on Marie Curie Project (moderator Prof. D. Gorin) and Era-Net Rus Project (moderator Dr. R. Surmenev)

Abstracts (ORAL PRESENTATIONS)

MAY 12

Prof. D. Shechtman, Technion – Israel Institute of Technology, Israel
How to create good scientists and how to keep them

After receiving his doctorate, Prof. Shechtman was an NRC fellow at the aerospace Research Laboratories at Wright Patterson AFB, Ohio, where he studied for three years the microstructure and physical metallurgy of titanium aluminides. In 1975 he joined the department of materials science & engineering at Technion. In 1981-l983 he was on Sabbatical at the Johns Hopkins University, where he studied rapidly solidified aluminum transition metal alloys (joint program with NBS). During this study he discovered the Icosahedral Phase which opened the new field of quasiperiodic crystals. In 1992-1994 he was on Sabbatical at NIST, where he studied the effect of the defect structure of CVD diamond on its growth and properties. Prof. Shechtman's Technion research is conducted in the Louis Edelstein Center, and in the Wolfson Centre which is headed by him. He served on several Technion Senate Committees and headed one of them.

The main topic of the talk will be concentrated on the important question: how to create good scientists and how to keep them. He will also pay attention to the discovery, which has brought him the 2011 Nobel Prize in Chemistry. Prof. Shechtman observed a metallic solid (Al-14-at.%-Mn) with long-range orientational order, but with icosahedral point group symmetry, which is inconsistent with lattice translations. Its diffraction spots are as sharp as those of crystals but cannot be indexed to any Bravais lattice. The solid is metastable and forms from the melt by a first-order transition.

G. Sukhorukov, Queen Mary University of London/Nanoforce Ltd, United Kingdom
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.

Prof. Alexander Kabanov, Center for Nanotechnology in Drug Delivery, Eshelman School of Pharmacy, University of North Carolina at Chapel Hill, USA, Laboratory for Chemical Design of Bionanomaterials, M.V. Lomonosov Moscow State University, Russia
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, *si*RNA and proteins.

References:

[1] H. Bader et al. *Angew. Macromol. Chem.* 1984, 123/124:457; A. Kabanov et al. *FEBS Lett.* 1989, 258:343; M. Yokoyama et al. *Cancer Res.* 1990, 50:1693.
[2] M. Yokoyama et. al. *J. Exp. Clin. Med.* 2011, 3:8.
[3] R. Luxenhofer et al. *Biomaterials* 2010, 31:4972; Y. Han et al. *Mol. Pharmaceutics* 2012, 9:2302; A. Schulz, et al. *ACS Nano* 2014, 8 (3), 2686–96.
[4] A. Kabanov et al. Bioconj. Chem. 1995, 6: 639; A. Harada and K. Kataoka, Macromolecules 1995, 28: 5294.

Ass. Prof. E.N. Atochina-Vasserman, Pulmonary, Allergy & Critical Care Division, Perelman School of Medicine, University of Pennsylvania, Philadelphia, PA; RASA Center in Tomsk, Tomsk Polytechnic University, Russia

Can mice help us find a cure for a rare cancer? The tale of three mice

Pulmonary Iymphangioleiomyomatosis (LAM), a rare lung disease, is associated with mutational inactivation of the *Tuberous Sclerosis Complex (TSC1* and *TSC2)* tumor suppressor genes. Vascular endothelial growth factor-D (VEGF-D) was recently considered as a novel diagnostic biomarker for LAM. VEGF-D is expressed in a range of human cancers and has been associated with poor patient outcome. The precise mechanisms underlying how upregulation of VEGF-D is involved in the development of LAM pathology and whether these processes can be ameliorated therapeutically have not been investigated. Our preliminary data show that TSC2-null but not TSC2-expressing cells produce VEGF-D, an important lymphagiogenic and pro-metastatic factor. The experimental TSC2-null mouse LAM model exhibits increased levels of VEGF-D in the bronchoalveolar lavage fluid (BAL) and lung tissue. Importantly, treatment with axitinib, a selective inhibitor of VEGFR-1, -2 and -3, inhibits lymphangiogenesis and abrogates upregulation of VEGF-D in the TSC2-null mouse LAM model.

Neoplastic cells release soluble cell signaling factors that recruit myeloid-derived suppressor cells (MDSCs), critical facilitators of tumor cell survival, lymphangiogenesis, and metastasis. We indentified MDSCs in the BAL of the immunocompetent C57BL/6 mice with TSC2-null lung lesions but not with TSC2-expressing lesions. Based on our preliminary evidence we hypothesize that TSC2-dependent upregulation of VEGF-D recruits MDSCs which promotes TSC2-null cell growth and survival. In this study, we will determine whether targeting of VEGF-D signaling with axitinib inhibits VEGF-D dependent MDSCs recruitment and prevents TSC2-null lesion growth.

A. Gow, Department of Pharmacology & Toxicology, Ernest Mario School of Pharmacy, Rutgers University, USA; RASA Center in Tomsk, Tomsk Polytechnic University, Russia

Functionalization and Core Materials Regulate Nanoparticle Interaction with the Lung

In order to maintain their nano characteristics all nanoparticles are maintained with a surface functionalization. The toxicity of such materials have been traditionally tested by direct cellular injury. However, biological systems are more complicated and toxicity needs to be assessed considering the interaction of multiple cell types and the extracellular milieu. Here we demonstrate how we can assess these factors in the lung considering different mechanisms of fucntionalization and core material and size/shape. We will present a modeling system for these factors such that in silico toxicity can be assessed.

Prof. D. Atochin, Cardiovascular Research Center, Cardiology Division, Massachusetts General Hospital, USA; RASA Center in Tomsk, Tomsk Polytechnic University, Russia

Drug delivery for protection against stroke

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.

D.A. Gorin, Saratov State University, Saratov, Russia, RASA Center in Tomsk, Tomsk Polytechnic University, Tomsk, Russia

Microstructured surface and naostructured microcapsules with controllable sensitivity to ultrasound for biomedical applications

New type of drug delivery carriers that will combine some functions as in vivo navigation and visualization, sensing of important biological marker, remote release of bioactive substances by external influences has a good perspective for applications in biomedicine. The most important aspect is obtaining sensitivity of objects to external influences including ultrasound for remote release of bioactive substances realization. The Layer by Layer assembly technique and micropatterning are power tools for creation of such nano- and microstructured objects with tunable physical properties. It was demonstrated that by control of nano- and microarchitecture of prepared surface, core-shell structures and capsule and also by variation of surface hydrophobicity, volume fraction and chemical composition of polyelectrolyte and inorganic nanoparticles can be change a sensitivity of prepared objects to ultrasound. Obtained results are a very important for creation of new generation of drug delivery systems including drug depot, combined much functionality as navigation and visualization, in vivo monitoring of biochemical process, remote activated release of bioactive substances in vivo by ultrasound. The reported study was partly supported by RFBR № 15-29-01172 and 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).

V. Tuchin, National Research Saratov State University, Institute of Precision Mechanics and Control RAS, National Research Tomsk State University

UV to THz Enhanced Tissue Imaging at Immersion Clearing: from *in vitro* to *in vivo*

Fundamentals and advances of tissue immersion clearing technology that provides enhanced microscopy and imaging of living tissues are presented. The technology is based on controllable and reversible tissue properties modification by their impregnation by exogenous or endogenous biocompatible clearing agents [1-4]. Tissue reversible dehydration and induced transverse and

longitudinal shrinkage measured *in vitro* and *in vivo* will be discussed. The specific features of tissue clearing for enhanced transport of UV-THz through fibrous and loose connective tissues, as well as epithelial tissues are investigated using OCT, confocal, photoacoustic, Raman, linear and nonlinear fluorescence and SHG-microscopies. Enhancement of probing depth and image contrast in *in vitro*, *ex vivo*, and *in vivo* studies of a variety of human and animal tissues, including skin, fat, eye sclera, muscle, cerebral membrane, digestive tract tissue, cartilage, tendon, bone, blood vessels, and blood will be demonstrated.

References:

5. D. Zhu, K. V. Larin, Q. Luo, and V. V. Tuchin, "Recent progress in tissue optical clearing," *Laser Photonics Rev*. **7**(5), 732–757 (2013).
6. V.V. Tuchin, "*In vivo* optical flow cytometry and cell imaging," *Rivista Del Nuovo Cimento*, **37**(7), 375–416 (2014).
7. E. A. Genina, A. N. Bashkatov, Yu. P. Sinichkin, I. Yu. Yanina, V.V. Tuchin, "Optical clearing of biological tissues: prospects of application in medical diagnostics and phototherapy [Review]," *J. Biomed. Photonics & Eng*. **1**(1), 22–58, 2015.
8. V.V. Tuchin, "Tissue optical clearing: New prospects in optical imaging and therapy," in *BioPhotonics, IEEE International Conference,* pp.1-10, 20-22 May 2015; doi: 10.1109/BioPhotonics.2015.7304023

M. Antipina, IMRE A*STAR, Singapore

Proteins in the layered capsules – active

A major part of the present day biopharmaceuticals are proteins by nature. In humans, intake of foreign proteins can cause activation of specific or unspecific components of immune system eliminating the drugs from the organism and thus terminating their beneficial actions. 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, hydrogen bonding or hydrophobic interactions.

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.

M. Gai[a,b], J. Frueh[*a], T. Si[a], Gleb B. Sukhorukov[b], Q. He[*a]

[a] 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. E-mail: Johannes.frueh@hit.edu.cn, Qianghe@hit.edu.cn

[b] Queen Mary University of London, Mile End, Eng, 215, London E1 4NS, United Kingdom

A mathematical approach to forecast bubble propelled micromotor paths in aqueous solutions

Abstract: Bubble propelled particles driven by catalytic decomposition of a fuel are being considered for many applications as molecular motor systems. This talk discusses cases, when not only the development of one single bubble but an oscillating bubble development on one or more nucleation sites influences the motion speed and direction. The equations take bubble size, frequency, position as well as area of oxygen collection into account and are compared in theory and experiment. In the presented cases microcontact printed PEM Janus plates are used, the equation is however also compared with tube, capsule and particle experiments therefore 0-3D cases are covered by the approach. [1,2]

Figure. Analysis of the a) bubble 1 and b) bubble 2 radius of a particle with 2 nucleation sites; c) resulting speed of the interaction of the two bubbles in theory and experiment, d) final motional

direction from particle tracking compared with a semi-quantitative simulation (only Y simulated, X from measurement) and a X and Y simulation without taking particle rotation into account. Insets in a) and b) show the two bubbles observed in the microscope, with arrows pointing out the corresponding bubble. Inset in d) shows the real bubble. The semi-quantitative analysis shows errors within particle diameter. In both images black are the measurements and red simulated values. Dashed black lines are guiding the eye.

Acknowledgements
Natural Science Foundation of China (21573053, 21503058), the start-up grand of HIT. China Scholarship Council Nr.201406120038.

Dr. M. Kiryukhin, Institute of Materials Research and Engineering, Singapore

Microcontainers in Functional Foods: Encapsulation, Protection and Targeted Delivery of Lactoferrin

Lactoferrin (LF) is a multifunctional milk protein which possesses unique combination of high antitumor, antimicrobial, antiviral, anti-inflammatory, immunomodulatory, anti-oxidant activities, low cost and no toxicity. All this makes LF a perfect candidate as an active ingredient of functional foods for health – an emerging market that is rapidly expanding now. For full efficacy, intact LF has to be transported from intestine to lymphatic system through gut-associated lymphatic tissue (GALT). That is possible only for suckling infants with undeveloped digestive system as LF is highly susceptible to gastric digestion.

Our approach to overcome this challenge is encapsulation of LF by Layer-by-Layer assembled multilayered shells. The uniqueness of this layered material is that the shells thickness and functionality can be tuned precisely, including a) protection from a variety of external factors (pH, enzymatic degradation, oxidation by reactive oxygen species, etc.); b) specific adsorption on surfaces with certain chemistry or topography.

Here, I will report the microcontainers made of multilayered bovine serum albumin (BSA) - tannic acid (TA) shells; method of their assembly and kinetics of degradation under the action of simulated gastric and intestine fluids (SGF and SIF, respectively); approaches for LF loading into such microcontainers and encapsulation efficiency. I will show that BSA-TA microcontainers ensure LF protection against digestion in SGF. Finally, I will demonstrate how the microcontainers may be modified for enhanced adhesion towards epithelial cells (Caco-2/HT29 co-culture), where targeted release of LF should occur.

Acknowledgement
We thank A*STAR, Biomedical Research Council, SG-NZ Foods for Health Grant for financial support of this work (Project 1414024010)

A. Yakimansky, Institute of Macromolecular Compounds of the Russian Academy of Sciences, Russia

Molecular Polyimide Brushes with Polymethacrylate Side Chains and Their Applications as Membrane Materials and Nanocontainers

Regular PI-g-PMMA and PI-g-PMAA graft-copolymers with a polyimide (PI) backbone and polymethylmethacrylate (PMMA) or polymethacrylic acid (PMAA) are synthesized via ATRP „grafting from" approach and characterized by NMR, FTIR, and SEC methods.

It is shown that rather well-performing pervaporation membranes may be prepared from PI-g-PMMA polyimide brushes with the pervaporation separation index PSI>70000.

The complexation of porphyrazines with PI-g-PMAA gives water soluble biocompatible nanoparticles, possessing a bright red emission. The nanoparticles were shown to be internalized and accumulated in the tumor cells on the nuclear membrane and nucleus. Cell investigations confirmed a high photodynamic activity of the nanoparticles. Whole-body fluorescent imaging experiments on mice

bearing metastatic colorectal carcinoma showed the selective nanoparticle accumulation in a model tumor.

Acknowledgement
The work is supported by the Russian Science Foundation (project no. 14-13-00200).

B. Parakhonskiy, Saratov State University

Calcium carbonate porous particles as perspective theranostic tool

Calcium carbonate is an important inorganic biomaterial thanks to its chemical stability, bioactivity, and biocompatibility. These properties have recently made it an interesting candidate for drug delivery systems. from their polymorphic modifications(vaterite, aragonite, and calcite), vaterite is an unstable phase, while calcite and aragonite are stable. The transition between these phases can be exploited as a payload release mechanism. Vaterite polycrystalline particles have further favorable properties like high porosity, large surface area, and negative zeta potential.In our work we present a novel technique for the synthesis and characterization of CaCO3 containers. Porous polycrystalline particles were fabricated with controllable average sizes from 400 nm up to 10 microns.

We demonstrate a several applications of vaterite particles: 1) as drug delivery sytem; 2) as sensor; 3) as template for polymer capsules like polyelectrolyte layer by layer capsules or alginate gel capsules.

Moreover, we report on studies of Encapsulation and release mechanisms of the molecules with various charge and molecular weight in different size and shapes vaterite containers. The possibility of functionalization vaterite containers with silver or gold plasmonic nanoparticles can provide the enhancement signal of adsorbed molecules. Vaterite containers behaviour in cell culture assays , evaluating their cytotoxicity, their influence on cell viability, and the particles' uptake efficiency.

Various release mechanisms and the perfect biocompatibility have proven the system's potential for future pharmaceutical applications.

Prof. Valery Fokin, University of Southern California, Department of Chemistry, USA

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.

A. Sapelkin, Queen Mary University of London, United Kingdom

Super-Resolution Imaging by Spectral Separation of Quantum Dots

We demonstrate a spectroscopic super-resolution (below the diffraction limit) imaging method taking advantage of the size-dependent emission wavelength in inorganic quantum dots. The key advantage of our approach in that a standard confocal microscope capable of spectral imaging (e. g Leica TCS SP2, Zeiss LSM 710 etc.) can be utilized to obtain super-resolution images. We assessed the resolution of our method directly using a DNA "ruler" and DNA origami structures demonstrating resolution down to 50 nm. Following these tests, we imaged tubulin structure in HEK293T embryonic kidney cells achieving resolution down to 40 nm. We show that, depending on the confocal system in use, acquisition times can be as fast as 2 ms per super-resolution image providing a route to live imaging below the diffraction limit.

R. Surmenev, **M. Surmeneva, National Research Tomsk Polytechnic University, Russian Federation**

Surface modification of biomedical implant materials by means of low-temperature plasma processing

Plasma treatment in different gas atmospheres or biocompatible calcium phosphate-based coating deposition procedures significantly affected the surface properties, including surface chemistry, topography, and wettability without inducing any significant changes in the bulk structure of the treated materials. The wettability of the modified surfaces was significantly improved after the plasma treatment. The relationship between cell adhesion, proliferation and polar component of the surface energy was revealed. The increase in the polar component after plasma modification significantly increased cell adhesion and proliferation on the treated surfaces compared to the untreated ones. This research was supported by the Russian Fund for Basic Research (15-08-08652), the Russian President's grant MK-7907.2016.8 and the State order NAUKA #11.1359.2014/K.

A. Vladescu, National Institute for Optoelectronics - INOE2000, Romania

Antibacterial properties of sputtered hydroxyapatite coating

During the last years, it is a challenge to develop medical implant, especially dental implants, with high biocompatibility, low risk of infection and long-term stability. For biocompatibility enhancement, the solution was to coat implant surface with biocompatible coatings with high osseointegration capabilities (e.g. hydroxyapatite). However, the infection remains a big problem, because the coatings proved to have low antimicrobial properties. Thus, the main aim of the paper was to improve the antibacterial properties of the hydroxyapatite by Ag addition into its structure.

The coatings were prepared by magnetron sputtering method with different Ag contents in order to find the optimum value for our propose. The elemental and phase composition, morphology and corrosion resistance were investigated. The antibacterial activity was evaluated using two bacteria: Staphylococcus aureus, Salmonella Typhimurium). The best hydroxyapatite with Ag content of 0.7 at. % proved to have the best resistance to the bacteria attack.

C. Cotrut, University Politehnica of Bucharest, Romania

Nanostructured coatings for adherence enhancement of the ceramics used in prosthetic restoration

The clinical success of the dental restorations depends on the bonding between NiCr or CoCr alloys and the ceramic layer. In clinical practice, numerous metal-ceramic dental restorations fail due to the ceramic fracture, leading to an earlier removal of the restoration. The aim of this work is to improve the bond strength between metal and dental ceramics in prosthetic restorations by addition of TiSiON coatings as interlayers between these two. The coatings were deposited on NiCr and CoCr dental alloys by using the cathodic arc method at various substrate bias voltage values (from -100V to -200V). The elemental composition, crystalline structure, mechanical properties, surface roughness,

contact angle and corrosion resistance of the coatings were investigated. The bond strength of the metal–ceramic system, with and without TiSiON interlayers, was evaluated by using a three-point bending test.
The maximum hardness (32 GPa) was determined for the coatings prepared at bias voltages between -100 and -150 V. All coatings proved to enhance the corrosion resistance in artificial saliva with pH =5 of both uncoated alloys. The TiSiON coatings prepared at -100 V and -150 V exhibited the best corrosion resistance. The main result of the bending test is that the addition of a TiSiON layer between CoCr or NiCr alloy and ceramic film improved significantly the bond strength between ceramic and metallic substrate. One may also observe that the bond strength increases with increasing bias voltage during film deposition.

S.A. Dyakov[a], S.V. Lobanov[a,b,c], T. Weiss[d], S.G. Tikhodeev[b,e] and N.A. Gippius[a,*]
Resonances in Metallo-Dielectric Photonic Structures
[a] Skolkovo Institute of Science and Technology, Moscow, 143025, Russia
[b] A.M.Prokhorov General Physics Institute, Russian Academy of Sciences, Moscow 119991, Russia
[c] School of Physics and Astronomy, Cardiff University, Cardiff CF24 3AA, United Kingdom
[d] 4th Physics Institute and Research Center SCoPE, University of Stuttgart, Stuttgart, Germany
[e]M.V. Lomonosov Moscow State University, Leninskie Gory 1, Moscow 119991, Russia
We review theoretical studies of a scattering-matrix-based numerical method to calculate the optical transmission properties and quasiguided eigenmodes in a two-dimensionally periodic photonic crystal slab of finite thickness. The appearance of well-pronounced dips in the transmission spectra of a PCS is due to the interaction with resonant waveguide eigenmodes in the slab. The energy position and width of the dips in transmission provide information on the frequency and inverse radiative lifetime of the quasiguided eigenmodes. We calculate the energies, linewidths, and electromagnetic fields of such quasiguided eigenmodes, and analyze their symmetry and optical activity. The electromagnetic field in such modes is resonantly enhanced, which opens possibilities for use in creating resonant enhancement of different nonlinear effects. Strong coupling between localized particle plasmons and optical waveguide modes leads to drastic modifications of the transmission of metallic nanowire arrays on dielectric waveguide substrates. The coupling results in the formation of a new quasiparticle, a waveguide-plasmon polariton.

Lyuba Varticovski, NCI, NIH, LRGBE, Bethesda, MD 20892
Stem Cells as a Source of Regenerative Tissues
The human body is comprised of over 200 different cell types that are organized into tissues and organs that provide viability and reproduction. Stem Cells are characterized by the ability to - renew themselves through asymmetric cell division - differentiate into a diverse range of cell types. Two categories of Stem Cells: Embryonic and Adult. Basic experimental stem cell research has opened up the possibility of many diverse clinical applications; however, translation to clinical trials has been restricted to only a few diseases. To broaden this clinical scope, pluripotent stem cell derivatives provide a uniquely scalable source of functional differentiated cells that can potentially repair damaged or diseased tissues to treat a wide spectrum of diseases and injuries. However, gathering sound data on their distribution, longevity, function and mechanisms of action in host tissues is imperative to realizing their clinical benefit. The large-scale availability of treatments involving pluripotent stem cells remains some years away, because of the long and demanding regulatory pathway that is needed to ensure their safety. The translation process begins with a basic discovery that has some potential for therapy in a disease or condition for which there is a significant unmet clinical need. The candidate product should have clinical support for its development. In the US, the sponsor company or organization should have a pre-pre-investigational new drug (IND) meeting with the Food and Drug

Administration (FDA) to explore the pathway and data needed for IND registration. The preclinical development programme should involve regulatory expertise that is available in the sponsor company or as consulting services to the organization to ensure that the data needed for an IND is developed properly and completely. Scientific inputs are always needed in the process of translation to ensure, for example, that the cell integrates and functions properly in the targeted tissue. The product development plan (PDP) for the cell product needs to be established, and advice again obtained on the PDP at a pre-IND meeting with the FDA. Similarly, the target product profile needs to be presented to the regulator to initiate clinical trials and is essential for marketing the product71. This phase also needs the input of experienced professionals. The manufacturing process and bioassays of cell potency must be carefully designed to ensure adequate quantities of product are available for the preclinical and clinical trials. Clinical advice is essential in preparing the design of clinical trials and the parameters needed to test for proof of concept in animal studies and to assess safety and efficacy in selected human populations. Once the preclinical development data is obtained, the sponsor must seek IND approval from the governing regulatory body to commence clinical trials. This step involves a formal application, face-to-face interviews, and revisions of the application to the regulator's satisfaction.

N. Dementeva, Tomsk State University, Russia

LC-MS analysis of the carcinogen-modified nucleobases obtained by acid hydrolysis of carcinogen-induced DNA

The commonly used method of analyzing carcinogen-induced DNA adducts that circulate in human blood is the hydrolysis of DNA samples by using a mixture of enzymes.

In the present study, we report the development of a new approach to analyse the DNA adducts using the hydrolysis of DNA with mineral acids and the application of LC-MS method for detection of adducts. Samples were prepared by mixing aliquot of DNA with 0.1 M HCl under heating, with further neutralisation. The LC-MS analysis was performed on a UPLC-ESI-q-TOF mass spectrometry system using C-18 column. Mass spectra were recorded in positive mode with 50–1000 m/z range. Comparative analysis with enzymatic digestion method of carcinogen-modified DNA samples demonstrated that both hydrolysis methods did not yield systematically different results. Therefore, method of acidic hydrolysis can be successfully applied for further analysis of naturally occurring adducts derived from serum of cancer patients by mass spectrometry method. Work was supported by Federal Targeted Programme for Research and Development in Priority Areas of Development of the Russian Scientific and Technological Complex for 2014–2020, "Development of molecular signatures for early detection of lung cancer" (№ 14.575.21.0064 from 05.08.2014).

A. Gusev, G.R. Derzhavin Tambov State University, Russia

Colloidal solutions of nanosilver exhibit fungicidal and phytostimulating activity in potato plants (Solanum tuberosum L.)

Colloidal silver is effective against pathogens, but as a fungicide in plant nanosilver preparations currently not widely used, although a number of advantages. We synthetized 10 nm nanoparticles. It was prepared water colloids of nanoparticles using 2 types of stabilizers - surfactant and PHMB. It were studied the effects of three times treatment of colloidal silver nanoparticles stabilized by surfactant and PHMB in concentrations of 3000, 2500 and 500 mg / l to potato plants yield and protection against Phytophtora late blight and Alternaria early blight in the field conditions. It was found that the most effective fungicide and stimulative of potato yield concentration of nanosilver is 3000 mg / l with surfactant. The increasing of potato yield amounted to 12.1%, while the share of large tubers increased by 6%. The same variant showed the greatest fungicidal activity practically does not differ from that of the standard fungicide treatment (positive control). Other suspensions affected to the plant productivity and protection of phytopathology lesser. The using of nanosilver was not

affected on such parameters of the yield as starch content, dry matter, vitamin C and nitrates content. It was not observed bioaccumulation of silver in the plants.
These results demonstrate the prospects of using of preparations based on silver nanoparticles in the system of protection of potato plants from Phytophtora late blight and Alternaria early blight.

In vivo Visualization and Magnetic Targeting of Nanocomposite Microcapsules containing Magnetite Nanoparticles

Oksana A. Mayorova1, Olga A. Sindeeva1*, Evgeny V. Tyutyaev2, Yana V. Tarakanchikova1, Oleg A. Kulikov2, Nikolay A. Pyataev2, Oksana V. Semyachkina-Glushkovskaya1, Dmitry A. Gorin1, Gleb B. Sukhorukov3
1Saratov State University, Saratov, Russia
2Ogarev Mordovia State University, Saransk, Russia
3Queen Mary University of London, London, United Kingdom

Application of controlled nano- and microcapsules as drug delivery systems is a very actual trend in medicine for the last few years. On this evidence, microcapsules have a number of advantages, such as high loading efficiency, possibility to add magnetic nanoparticles and fluorescent substances into a capsule that allows to track and control of microcapsules in vivo. The microcapsules contain magnetite nanoparticles (FeNP) and fluorescent dye – Cyanine 7 NSH-ester conjugating with bovine serum albumin (BSA-Cy7). The average size of microcapsule was 5±1 μm. However, analysis of microcapsule behavior in organism is complicated by numerous biological fluctuations. Organism could effects on microcapsule integrity and other significant features. In these experiments, it was studied how magnetic field acts on microcapsule biodistribution at different administration ways into a bloodstream. There are injections of microcapsule suspension into tail vein and into femoral artery respectively. In intraarterial administration of microcapsule suspension into femoral artery on right hind paw was carried out. In both cases left hind paw was exposed under a field of permanent magnet. It was established that femoral artery injection is more efficient than injection in tail vein for the next magnetic targeting of microcapsules in the opposite paw.

Acknowledgement
The work was supported by Government of the Russian Federation (grant №14.Z50.31.0004).

May 13

Prof. M. Nayfeh, University of Illinois at Urbana-Champaign, University of Illinois at Urbana-Champaign, USA
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.

A. Mikhailovich Yashchenok, Saratov State University, Russia
Microparticles and Polymer Materials as effective SERS substrates for Label-Free Detection of Molecules and Intact Cells
Plasmonic materials have received tremendous attention during the last decades due to their capability to squeeze electromagnetic wave into tiny structure by using light to produce electron density waves called plasmons. Strong environmental response of plasmonic materials could improve the sensitivity of chemical and biological sensors, in particular, surface enhanced Raman scattering (SERS) sensors and so-called theranostic systems. SERS is enabled by strong field enhancements in the vicinity of nanostructured metallic surfaces, which can effectively localize and focus incident electromagnetic fields. It is expected that SERS enables improved sensitivity, reduce costs, facile handling and could benefit to life (explosives detection), environmental (pollutants detection) and food (toxins detection) safety, as well as in biomedicine (diseases identification). The research focuses on the development of SERS active substrates by taking advantage of a template-assisted approach and self-assembly techniques. The substrates under development are targeted for application as interrogating systems in biodiagnostic and bioimaging.

A. Majouga, Lomonosov Moscow state university, Russia
Development of Gold-Magnetite Hybrid Nanoparticles for Biomedical Application
Nanobiotechnology, the combination of nanotechnology and molecular biology is a tremendously powerful technology. It holds a huge promise for the design and development of many types of novel products with potential applications in the fields of biology and medicine, including early disease detection through advanced noninvasive medical imaging, treatment through high site-specific drug delivery and protein purifications. Gold-Magnetite Hybrid magnetic nanoparticles have received significant attention recently and are actively investigated owing to their large potential for a variety of applications. Gold-coated magnetic nanoparticles are a class of nanoparticles that have attracted much attention because of their advantageous characteristics, such as their inertness, non-toxicity, super magneticity, ease of detection in the human body, a magnetic core that is protected against oxidation, their facilitated bio-conjugating ability, catalytic surface, and their potential for a variety of biological applications. Gold-coated nanoparticles have great biocompatibility with the human body with the ability to interact with biomolecules such as polypeptides, DNA, and polysaccharides.

I. Goryacheva, Saratov State University, Russia

New directions in biosensor development: multifunctional platforms and enhanced labels

Two perspective directions for development of modern biosensors for medical application will be presented. The first is development of bifunctional solid support, combining functions of substrate for immunoreagents binding and active signal transducer and modifier. The later allows to use new principles of signal generation and enhancement. A bright example of such bifunctional platforms is photonic crystal fibers (PCF). PCF enable to trap light in a hollow void inside fiber by surrounding it with a 2D periodic photonic crystal and as result to turn of the waveguiding properties of the fibers. An exploitation of PCF as a sensitive element of biosensor allows one to get an instant optical response to the change of analyzed medium's refractive index, absorption, luminescence or scattering coefficients of the medium. Such systems in perspective could be efficient solutions for biosensors development due to their high sensitivity, small size and low-cost instrumentation.

The second direction is the development of enhanced labels. Nanoscale size of quantum dots (QD) offers the prospect of creating of multiloaded nanostructures to illustrate novel concepts and promising labels for analysis. QD loaded nanostructures combined the ability of QD to produce luminescent, electrochemical or electrochemiluminescent signals and the high carrier capacity.

H. Bäumler, Institute of Transfusion Medicine, Charité-Universitätsmedizin Berlin, Germany

Artificial oxygen carriers, favorably hemoglobin-based oxygen carriers (HBOCs) are being investigated intensively during the last 30 years with the aim to develop an universal blood substitute. However, serious side effects mainly caused by vasoconstriction triggered by nitric oxide (NO) scavenging due to penetration of nano-sized HBOCs through the endothelial gaps of the capillary walls and/or oxygen oversupply in the pre-capillary arterioles due to their low oxygen affinity led to failure of clinical trials and FDA disapproval. To avoid these effects, HBOCs with a size between 100 nm and 1000 nm and high oxygen affinity are needed.

The synthesis of hemoglobin particles (HbPs) is based on co-precipitation of Hb with $MnCO_3$ immediately followed by addition of human serum albumin (HSA). HSA adsorbs on the surface of the formed particles and prevents agglomeration. The co-precipitated and adsorbed proteins are then cross-linked by glutaraldehyde and the $MnCO_3$ template is dissolved resulting in polymerized submicron HbPs. Measured by dynamic light scattering, the apparent average size of the HbPs is around 710 ± 60 nm. The fabrication procedure provides particles with a narrow size distribution and nearly uniform morphology. The content of hemoglobin (Hb) in the particles corresponded to 80% of the Hb content in native erythrocytes. To the best of our knowledge, spontaneous capturing of such high amounts of proteins in nearly uniform submicron particles is unique and has not been reported until now.

These HbPs posess a high oxygen affinity (p50 of 6 mmHg compared to Hb in solution the p50 is 26.5 mmHg). High oxygen affinity (low p50) is one of the most important properties of the new generation HBOCs. It is necessary to avoid vasoconstriction after an autoregulatory mechanism caused by oxygen oversupply in the pre-capillary arterioles and it is suggested a p50 of $5 - 10$ mmHg for the new cell-free HBOCs.

The effect of HbPs on the function of microvessels, was investigated in several experiments using an in vitro model [1]. Afferent arterioles, the microvessels in the kidney just preceding the glomerular capillary network, play a vital role in the regulation of renal blood flow. Their resistance is an essential determinant for the glomerular filtration rate, and they are very sensitive to changes in NO bioavailability. We demonstrate a successful perfusion of isolated mouse glomeruli with concentrated HbPs suspensions in vitro. Microperfusion experiments showed that concentrated HbP suspensions can easily pass through the glomerulus. Remarkably, the behavior of afferent arterioles perfused with HbPs concerning arteriolar tone and reactivity to Ang II was similar to the behavior of the control group perfused with APs in contrast to stroma free Hb solutions, which significantly enhanced the

vasoreactivity to Ang II. This finding together with the high oxygen affinity are highly promising prerequisites of the new type HbPs as a candidate for a novel blood substitute.

[1] Bäumler, H. et al. Artificial Organs 38(8), 708–714, 2014
[2] Xiong, Y. et al. ACS Nano 7(9), 7454–7461, 2013

E. Terreno, Department of Molecular Biotechnology and Health Sciences, University of Torino, Italy

MRI visualization of the release of doxorubicin from liposomes triggered by non thermal effects of Ultrasound

In recent years, much attention has been devoted to exploit the synergy between in vivo diagnostic imaging and drug delivery. This interest has led to many studies focused to the design of in vivo procedures able to report on the release of a drug from its nanocarrier. Recently, it has been demonstrated that liposomes can release their content upon non thermal stimulation with pulsed low intensity non-focused Ultrasound. Among the available imaging modalities, MRI appears to be an excellent candidate to achieve this task in virtue of its great spatio-temporal resolution, ability to image deep tissues/organs, and wide availability of probes and contrast generating modalities. A successful approach to visualize the release of a drug from the aqueous core of liposomes consists of co-encapsulating a hydrophilic paramagnetic agent. Upon the entrapment, the MRI contrast is "silenced" and its activity is restored when the agent (as well as the drug) is released. We proved that the clinically approved MRI agent Gadoteridol acts as an in vivo imaging reporter of the release of Doxorubicin from a clinical-like liposome formulation. In this contribution, an implementation of this method aimed at further improving the therapeutic efficacy will be presented. The proposed methodology relies on the local sequential application of two different pulsed US: one tailored to trigger the release of the drug from the liposomes circulating in the tumour vasculature, and the other applied to increase the tumour vascular permeability in order to favour the diffusion of the drug in the tumour stroma. The protocol was tested on mice bearing a syngeneic breast cancer model. The combination of the two stimuli caused a marked increase intratumor drug concentration that, in turn, led to the complete regression of the lesion after three weeks of treatment.

F. Garello, Università di Torino, Italy

VCAM-1 targeted paramagnetic micelles for MR visualization of neuroinflammation

The need for specialized non invasive imaging techniques is increasing in order to better clarify the role and the spatio-temporal correlation between neuroinflammation and the onset of neurodegenerative diseases. Magnetic Resonance Imaging (MRI) with its remarkable spatial resolution and poor toxicity could be the technique of choice. In the herein reported work paramagnetic micelles targeting Vascular Cell Adhesion Molecule-1 (VCAM-1), over-expressed in case of inflammation, were designed and in vivo tested in a model of neuroinflammation. The cyclic nonapeptide CNNSKSHTC, able to bind VCAM-1 with high specificity, was synthesized and conjugated to DSPE-PEG2000 to formulate a lipid-based nanosystem including Gd-DOTAMA(C18)2 and Rho-DOPE. The scrambled version HSCNKNSCT was tested as control. VCAM-1 targeted micelles (size ca. 20 nm) showed a longitudinal relaxivity of 35 s-1mMGd-1 at around 1T. Targeted or scrambled micelles were iv injected in mice (n=20) bearing LPS induced neuroinflammation. The T1 signal enhancement calculated over pre images showed an increase at 24h p.i. of 39.3 ± 4.4 % ($p<0.01$) only in the inflamed striatum, with a T1 Signal Enhancement (SE) over the healthy contralateral emisphere of 31.1 ± 4.5 % ($p<0.001$). The inflamed region was clearly identified and detected only after targeted micelle administration. Histological studies proved micelle extravasation at the lesion site. Scrambled micelles and MultiHance showed a comparable T1 SE in the inflamed region, probably due to passive extravasation. In the future this nanosystem will be tested in animal models of neurodegeneration and the possibility to exploit it to efficiently deliver drugs intracerebrally will be envisaged.

G. Brezesinski, Max Planck Institute of Colloids and Interfaces, Germany

Physical-chemical studies in 2D and 3D model systems of new cationic lipids for gene transfection

Since the beginning of the gene therapy treatment concept in medicine efficient approaches in transferring nucleic acids into cells were developed. For this purpose different polynucleotide delivery systems (vectors) are required, which are divided into two major classes: viral and non-viral vectors. The most widely used non-viral vectors are lipid based delivery systems.

To develop new non-viral gene delivery devices with high gene transfer efficiency combined with low toxic effects, fundamental knowledge about structure/activity correlations of the lipid DNA complexes (lipoplexes) and their ability to interaction with cell membranes is needed.

New cationic lipids are permanently synthesized, and their physical-chemical properties have been characterized in 2D (monolayers at the liquid/air interface) and 3D (aqueous dispersions). The various lipids differ in the head group structure and the chain pattern. We used TRXF to quantify the number of charges per molecule at different pH values. The protonation degree of these cationic lipids is a crucial parameter for the binding behavior of polynucleotides. The phase state of the lipid chains has been measured by IRRAS. Furthermore, the adsorption of calf thymus DNA to the lipid monolayers has been quantified by IRRAS depending on the subphase pH value. The results will be discussed as a function of the chemical structure of the cationic lipids.

In bulk, SAXS/WAXS experiments were complemented by transmission electron microscopy (TEM) and cryo-transmission electron microscopy to characterize the lipid assemblies. The pure lipid systems as well as the lipoplexes have been investigated. Additionally, the type of the co-lipid has a strong influence on the self-assembly behavior of the investigated binary lipid mixtures.

R. Georgieva, Charité-Universitätsmedizin Berlin, Gemany

Micro- and submicro-particles as diagnostic and therapeutic tools

In modern medicine micron and submicron particles already have several applications as drug carriers and useful diagnostic tools. Biopolymer particles fabricated by the co-precipitation – cross-linking – dissolution technique (CCD-technique) are capable to carry drugs, enzymes, antibodies as well as nanoparticles. Several promising approaches for targeted drug delivery, triggered drug release, cell tracking, immune response and toxicity testing are currently under investigation.

A. Lapanje, Saratov State University, Russia

What is going on when we catch alive cargo inside the polyelectrolyte capsules?

Polyelectrolytes can be very efficiently deposited on charged surfaces. In that respect, according to the theory and molecular cellular morphology the surface of cells should be charged. In that respect, the biggest contribution to the negative charge of the cell surface is based on phosphate groups of the membrane phospholipids. Based on that assumption as well as on the assumption that cells are very similar to the nonliving micron sized particle, it was also demonstrated that polyelectrolytes can be deposited on cell surfaces. However, among all those assumptions two important facts has not been kept in mind: (i) cell surface is not composed only of cell membrane and (ii) cell is alive and it is therefore modifying it surface, is dividing and is responding to the environmental changes. In addition, especially bacterial cells are also very special in these two aspects. They are very metabolically diverse and they are very different in molecular composition and their molecular morphology. Here we demonstrated that this diversity extents also in electrostatic properties. We showed that surface charge is different for different bacterial species, strains as well as at different growth time points. This then affects the deposition of polyelectrolytes. In addition, bacterial cells are also electrostatically as well as mechanically very soft and the protocol for omitting aggregation has been needed to be developed,

which enabled us to observe changes in whole population of bacterial cells as well as on the level of separate single cells by using time laps microscopy.
As a result the deposition of polyelectrolytes on bacterial cells resulted in bacteria entrapment. Although during bacterial growth and division cells can escape this entrapment affects their physiology by increasing time for the first division, increasing protein expression and metabolic rate and can increase size of bacterial cells.

A.Minin, IMP UrD RAS, Russia
Cell uptake of magnetic nanoparticles modified by DNA aptamer and investigated by magnetic relaxometry
The iron core–carbon shell nanoparticles (Fe@C) were modified by aptamer NH2-AS1411 that specifically connects with the HeLa cells. The modification of the nanoparticles by aptamer was performed trough the carbodiimide reaction using EDC -activated COOH-Fe@C. The conjugation of magnetic nanoparticles to the cells was studied with the help of a novel technique based on NMR-relaxometry. This technique allows the determination of concentrations of nanoparticles in liquid at levels below 10^-4 mg/ml. A specific conjugation of the nanoparticles to the HeLa cells was established. The negatively charged cells Fe@C-COOH and positively charged cells Fe@C-NH2 were used to compare the uptake of nanoparticles by differently charged cells. The uptake of positively charged nanoparticles was more intensive.

A. Timin, National Research Tomsk Polytechnic University, Russia
Gluthatione-responsive microcapsules for delivery
New gluthatione-responsive microcapsules were prepared by layer-by-layer approach and sol-gel method. These prepared microcapsules were fully characterized using SEM, TEM, IR-spectroscopy and TGA analysis. They show biodegradable properties in the presence of gluthatione (10 mM, pH 7.4). Moreover, these microcapsules were used in vitro study on Hella cells. The drug release was detected inside Hella cells demonstrating a high perspective of these microcapsules in drug delivery systems.

M. Gai[a], J. Frueh[b], G. B. Sukhorukov[a]
[a]**Queen Mary University of London, United Kingdom**
[b] **Harbin Institute of Technology, China**
A Method of printing 3D PEM films and patterned structures
The talk will present a simple method of preparing 3D printed microcontainers comprised out of PEM. The method is similar to the one of Kiryukhin, with additionally taking surface forces and chain entanglements into account. The principle can be generally be used for transferring structured 3D patterns.

O. Gusliakova, Saratov State University, Russia
Size-dependent biodistribution of vaterite particles in the mice lungs
In creation of therapeutic methods there is one of the most important aspect – to choose optimal drug delivery system. The treatment of different lungs diseases runs more effective when drug can be deliver to the most deep sections that's difficult to realize. According to these reasons the study of calcium carbonate particles (vaterite) as a delivery system was conducted. The vaterite particles at different size (4 um, 1.2 um, 0.7 um) labeled by conjugate of BSA and Cy7 were injected into the lungs of mice through tracheostome at a dose of 0.6 mg (volume of 60 μl). Particles were dispersed in sodium chloride buffer 0.9% at the concentration of 10 mg/ml. The biodistribution of calcium

carbonate particles in mice lungs was observed using luminescence approach (In Vivo Imaging System). After sacrificed of mice the slides of lungs were prepared and investigated via Scanning Electron Microscopy. The evidence of more deep penetration of 0.7 um particles was obtained. The results are going to use for further investigation vaterite particle behavior in lungs and following biodistribution of drug loaded vaterite particles. The work was supported by the Government of the Russian Federation (grant №14.Z50.31.0004), Ministry of Education and Science (project №2952), Saratov State University, Tomsk Polytechnic University, Ogarev Mordovia State University.

May 14

H. Riegler, Max Planck Institute of Colloids and Interfaces, Germany
Nanoaggregates, bubbles, droplets, and thin films: The influence of interfacial energies in confined systems
In the case of confined (small) systems interfacial energies can contribute significantly to the overall system energy and thus affect or even dominate the system behavior. Well-known examples for these cases are nucleation and growth processes or the wetting/dewetting behaviour of thin films. We will present and analyze new experimental results on the nucleation and growth of aggregates of C60 (fullerenes) on nanostructured planar substrates and on the bubble formation initiated by an individual, localised nano size active nucleation site (a platinum nanoparticle catalyzing O2 from a H2O2 solution). In the context of the nucleation/precipitation studies we will analyze shortly the physics of spin casting as one of our main experimental techniques. With macroscopic sessile droplets we will analyze how local surface tension gradients and the resulting surface (Marangoni) flows affect the evaporation of individual droplets and the drop/drop-coalescence behavior including cases with reacting liquids.

R.I. Egorov, Tomsk Polytechnic University, Russia
Combustion of the coal-water slurry fuels doped by metal micro-particles
The waste derived coal-water slurries mixed with waste petrochemicals (CWSP) becomes very popular type of the perspective fuels nowadays. It gives the unique possibility to solve some very actual and contradictory problems: the utilization of the industrial wastes together with cheap and effective heat production. There are a lot of known CWSP compositions but optimization of the slurry content is needed to improve the fuel parameters for real applications.
We have doped the CWSP based on filter cake of bituminous coals (with ~40% of water and 10% of the waste oil fuel) by different metal micro- and nano-particles with aim to increase or stabilize the combustion temperature. The fine dispersed metal can change the thermal conductivity and capacity of the fuel as well as can add the calorific value due to the participation in combustion. Additionally such mixture allows the long-term storage of the fuel without agglomeration or lamination as it usually appears for liquid fuels.
The doping by small amount (mass ~2-3%) of aluminium micro particles leads to essential growth of the combustion temperature (for 50-150 degrees) together with its evident stabilization inside enough wide range of the ambient medium temperatures. The excessive doping (mass. 4-5%) leads to drastic decrease of the stability of the combustion temperature versus ambient media temperature.
The doping of the initial CWSP composition by mass 2% of TiO2 micro and nano-particles leads to stabilization of combustion temperature near maximum value that is possible for this type of the CWSP host.
The combustion delay time is growing with doping but these changes does not introduce any sufficient problems for future applications of the fuel.
The doping of the CWSP by metal particles is a very promising way to creation of cheap and effective industrial fuels based on coal- and oil-processing wastes as well as low-grade raw fossil fuels.

Prof. P.A. Strizhak, Tomsk Polytechnic University, Russia
Evaporation and explosive breakup of water droplets containing single nonmetallic inclusions
We experiment with evaporation and boiling of fixed water droplet containing a single nonmetallic (pure graphite; 2–4 mm in size) inclusion. Such heterogeneous droplets are placed in gaseous environment at a temperature of 300–1000 K. When evaporating heterogeneous liquid droplets with the graphite particles, a new phenomenon of explosive disintegration occurred with some of the droplets when heated. Different regimes took place: free surface evaporation of the droplet, bubble

boiling at the solid inclusion / liquid interface, explosive disintegration of a droplet into a group of small droplets and evaporation of small droplets. We determined lifetimes τh of the droplets and times which are typical for each regime. Also, curves indicating the influence of gas temperature and inclusion sizes on evaporation of heterogeneous droplets were displayed. Importantly, conditions for intensive vaporization at solid / liquid interface inside droplets and explosive breakup were discussed. To explain the explosive breakup phenomenon and conditions contributing this process, a simplified model heat and mass transfer was developed. To enhance heat transfer, we added small graphite inclusions (0.05 mm in size; mass concentration 2 %) in a heterogeneous liquid droplet with single large graphite particle. Decrease τh by 50 % in comparison with τh for water droplets without small particles took place when heated at a temperature of gas environment 350–600 K. At 850 K, τh for 15 μl heterogeneous droplets with small graphite inclusions increased by 8 % in comparison with τh for droplets of the same volume without small inclusions. To explain this, hypothesis on the formation of vapor film in the surface layer of 10 and 15 μl heterogeneous liquid droplets containing small graphite particles was offered. Moreover, applying such classical approach to heat transfer augmentation as surface roughness and porosity allowed decreasing the evaporation time of heterogeneous liquid droplets to 40%.

A.O. Zhdanova, Tomsk Polytechnic University, Russia

Suppression of the thermal decomposition reaction of the forest fuel material by liquid spray

Forest fires are an essential problem of our world. The main way for effective fire suppression is the fast delivery of water aerosol to the fire site. The complexity of the solution of forest fire extinction problem could be reduced by the determination of the volume of water that is enough to terminate the thermal decomposition reaction of the forest combustible materials (FCM). We want to compare the conditions of heat exchange at FCM surface in order to cool down the fuel material layer below the pyrolysis temperature with minimal amount of water and as fast as possible.

Different contributions to heat transfer are investigated in configuration composed initially by two layers. The following heat transfer models have been considered: the gas-vapor mixture above decomposing FCM; the homogeneous water film evaporation on the FCM surface; the evaporation of water film; the evaporation of droplets on the FCM surface, the water propagation into the pores of the FCM.

It was shown that the thermal decomposition of the FCM could be suppressed in less than 600 seconds in case of usage of the steam cloud (at continuous feeding of water aerosol) and when the thickness of the burned layer is up to 8cm.

The influence of the "buffer layer" (fallen parts of trees) was considered in order of interaction with water flow. It was established that the "buffer layer" is heated-up on a depth of less than 0.5 cm and the residual water layer thickness after evaporation is about 0.1cm.

Numerical investigations were performed for effect of gas-vapor mixture at temperatures from 300 to 800 K using the model "group of water droplets onto the FCM layer". The pyrolysis will stop in all range of possible temperatures when the droplets density is higher than one per two centimeters.

These results show that the increase of the vaporization intensity improves the deceleration of the pyrolysis in the FCM. The flooding the FCM surface with large amount of water can be avoided.

M. Piskunov, Tomsk Polytechnic University, Russia

Evaporating water droplets with single metallic inclusions in a high-temperature gas environment

Experimental research on evaporation was performed on fixed water droplets containing 1 mm or 2 mm single metallic (Al, Cu, Ti, Ni, carbon steel, stainless steel, brass, bronze; in size) inclusion which were placed in gaseous environment at a temperature of 300–1000 K.

Lifetimes of the water droplets containing metallic inclusions were determined when increasing the gas temperature from 298 to 900 K. To study evaporation mechanism of the heterogeneous water droplets under study in detail, we discussed hypotheses that explain the distribution of lifetimes in the tests. Furthermore, we found conditions for the effective cooling of metallic particles using the balance equations, the calculated warm-up times of inclusions and the differences between phase transfer energy, energy absorbed by water, as well as energy absorbed by metallic particles. Also, two evaporation regimes of water droplets with metallic particles took place when heated in high-temperature gases.

Evaporation process of the heterogeneous liquid droplets was recorded by high-speed video camera. Analytical balance with an accuracy of 0.001 g was used to weigh metallic inclusions. To measure the gas temperature, we applied type K thermocouples. Dosing devise Finnpipette Novus with variation step of 0.1 μl generated water droplets (5, 10 or 15 μl in volume). To provide for a gas analysis, a device Testo 300XXL was used. Heterogeneous liquid droplet fixed on the ceramic rod was placed in high-temperature gas environment by mechatronic mechanism.

Applying heterogeneous flows based on liquid droplets containing particles with high heat capacity and conductivity can be one of the possible techniques to enhance evaporation when cooling heated surfaces of equipment in thermal power stations and nuclear power plants.

R.S. Volkov, Tomsk Polytechnic University, Russia

Features of evaporation of water droplets moving through high-temperature gas

It was defined that to preserve the conditions of initial motion trajectories of liquid droplets in a high-temperature gases with corresponding Ug, it is necessary to make a provision of liquid dispersability when the inequality Rd>0.16 mm will be realized. At the same time it was found that about 85% of the droplets evaporated, and the droplets with sizes Rd<0.175 mm evaporated completely when water droplets with characteristic dimensions of 0.175<Rd<0.275 mm pass the distance of 1 m through the high-temperature gas flow. The conducted experiments illustrated that droplets with initial sizes 0.16<Rd<0.175 mm were not "taking away" by gases and evaporated almost completely.

The limited velocities of droplet flow (for Ug≈1.5 m/s) were determined when the conditions of complete deceleration and following turn of droplets of atomized liquid were reached. It was identified that the next values are the limited initial speeds of droplets when high-temperature gases "took away" them under considered conditions: Udlim=0.25 m/s at Rd=0.04÷0.09 mm; Udlim=0.35 m/s at Rd=0.09÷0.16 mm; Udlim=0.7 m/s at Rd=0.16÷0.23 mm; Udlim=1.05 m/s at Rd=0.23÷0.3 mm. It was also established in experiments that the initial concentration (γ) of droplets played the determining role in the displacement and evaporation of droplet flow. Thus, the growth of the volume concentration of droplets in the flow leads to slower evaporation in the area of high temperature combustion products. This effect is enhanced with increasing the initial droplet sizes. For example, the values of parameter ΔR at concentrations γ corresponding to 1·10-5 and 2·10-5 m3 of droplet/m3 of gas for droplets with sizes Rd≈150 μm equal to 0.55 and 0.47, and the parameter ΔR at the same values of γ for droplets with sizes Rd≈0.25 mm is 0.24 and 0.1, correspondingly.

I.S. Vojtkov, Tomsk Polytechnic University, Russia

Temperature traces of water droplet flow moving through high-temperature gas

This study examines the traces of water droplets moving through high-temperature combustion products (initial temperatures are 430–950 K). The temperature of a gas-vapor mixture in the area of droplets' traces is measured using low-inertia thermocouples (thermal lag is less than 0.1 s). The paper considers aerosol flows with droplets sizes of 0.04–0.4 mm and concentration of 3.8•10-5–10.3•10-5 m3 of droplets/m3 of gas, as well as individual droplets (size of 1.5–2.5 mm), and relatively large water massifs (sizes of 22–30 mm). The maximum gas temperature reduction in the trace of a moving liquid is ranged from 15 K to 140 K. The times of low temperature preservation of the gas-vapor

mixture in the droplets' trace are from 3 s to 30 s relative to the initial gas temperature. The study indicates how the following factors influence the integral characteristics of temperature traces of droplets: initial droplet sizes, initial velocities of the drip and high-temperature gas flows, volume concentration of droplets, temperature of combustion products, initial water temperature, and pulse duration. Heat and mass transfer models are developed based on the experimental data and using Ansys software. These models allow prediction of the temperature and concentration traces of droplets. The experimental and theoretical results are compared. The conditions are determined under which evaporation or heat transfer of gases with a moving liquid (energy is accumulated by the liquid) influence significantly the characteristics of temperature and concentration traces. The experimental data substantiate the hypothesis, which was previously put forward by the authors. The hypothesis suggested that the temperature traces of water droplets are preserved during quite a long time, even when the droplets are small. The experimental data is a key basis for the development of the drip systems of controlled gas temperature reduction via the intensification of phase transitions.

S. Lebedev, Tomsk Polytechnic University, Russia

Electrically and thermally conductive poly(lactic acid)-based polymer composites

Electrically and thermally conductive polymer composites on the basis of biodegradable poly(lactic acid) (PLA) were studied in this work. Pristine single-walled carbon nanotubes (CNTs) and powder of natural graphite (G) were used as fillers in polymer composites. PLA-based composites were prepared by melt-compounding method. The volume resistivity of PLA/CNT composites can be changed by more than ten orders of magnitude compared to that for neat PLA. The thermal conductivity of PLA/G composites can be changed from the thermal conductivity of neat PLA up to 2.7 Wm–1K–1.

A.V. Livanova [1], E.P. Mesheryakov[1], T.S. Minakova[1], R.A. Zotov[2], I.A. Kurzina[1]

Investigation of the acide-based properties of the adsorbents on the based of aluminia oxide

[1]National Research Tomsk State University, 36, Lenina ave., Tomsk, 634050, Russia
2 LTD "NIOST" , 634067, Tomsk, Kuzovlevsky tract 2, Building 270

In this work the study of acid-base properties of the surface by pH-meter methods of alumina adsorbents based on bayerite and pseudoboehmite obtained by calcining the alkaline products of hydration heat-activated aluminum hydroxide and modified with sodium and potassium ions on the basis of pseudoboehmite. Kinetic curves for all of the samples are above the neutral level. Sharp alkalinization at the initial time, a large rate of change in pH indicate the presence on the surface of the main centers of strong aprotic type. After modifying of alkali ions increases the basicity of the surface and increases the dynamic capacity of the adsorbents towards water vapor. It was shown that the adsorption-regeneration multicyclic samples leads to changes in surface acidity and water absorption capacity associated with changes in texture. Thus, the method of estimating the acid-base properties of the surface aluminum oxides studied is representative of the characteristics of samples derived from them and in multiple drying cycles changes.

A. Safonov, Kutateladze Institute of Thermophysics SB RAS, Russia

Deposition Of Thin Composited Coatings Of Fluoropolymer And Gold Nanoparticles Having Surface Plasmon Resonance

In this work method of deposition nanocomposite coatings with unique optical properties is described. The method assumes deposition of two thin layers: gold nanoparticles by gas-jet method and fluoropolymer by hot wire CVD. As a result were converted to nanoparticles encapsulated inside fluoropolymer matrix. The fluoropolymer matrix stabilizes and protects the gold particle from the environment. The method allows us to control the size and concentration of the metal nanoparticles in fluoropolymer matrix.

The optical properties of deposited coatings were examined. The samples have the surface plasmon resonance at different wavelengths. The surface morphology of obtained composite coatings was observed by the scanning electron microscopy (SEM). The results of this research can be interested in the production of coatings for solar cells, sensors and other electronic devices.
The reported study was partially supported by RFBR, research project No. 15-38-20411a.

M. Jacquemin, Tomsk Polytechnic University, Russia
Study Of Indium Tin Oxide Powder Compaction Behavior
The performance of the thin conductive ceramic coatings on the touch screens of modern electronic devices depend strongly on the quality of sputtering targets. Stable characteristics of the devices can only be achieved by using ceramics, with a low residual porosity and its uniform distribution in the target's volume. We carried our study on 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.

O. Khasanov, Tomsk Polytechnic University, Russia
Novel methods for nanoceramics and nanocomposite processing
Novel methods of shaping dry nano- and micro-scaled powders into required parts using non-cavitational powerful ultrasound assistance and/or collector mold have been developed and patented. The collector shaping has been applied for B4C, SiC nanoceramics consolidation by spark plasma sintering. Applications of the patented methods to produce a lot of functional, structural ceramics and composites have been described.

(Eco)toxicity assessment of engineered nanoparticles: we need a physicochemical characterization
A. Godymchuk, D. Kuznetsov, A. Gusev, E. Yunda, E. Karepina, N. Kosova
Tomsk Polytechnic University, Russia
Although, it is clear a priori, that nanoparticles radically change their properties when entering the atmosphere and hydrosphere, nevertheless there is still lack of information about physicochemical behavior and fate of nanoparticles in liquid biological and environmental media. This does not so far allow predicting the behavior of nanoparticles and establish regular correlations between the physicochemical state of engineered nanoparticles and their cytotoxic effects.
The analysis of nanomaterials in different matrixes should not be limited to the determination of the composition and concentration since their behavior is affected also by particle number, charge, size and size distribution, surface area, structure and shape, state of aggregation and elemental composition. When entered the environment nanoparticles physicochemical properties are significantly changed. They are altered by abiotic factors such as pH, salinity, temperature, natural organic matter, etc.
The presentation includes both the experimental research of the team and the survey on the physicochemical properties, fate, and toxicity of engineered nanoparticles in the environment including atmosphere and liquid surroundings.
The work is supported by the Russian Fund for Basic Research (project # 15-03-06528_a).

A. Korotkikh, Tomsk Polytechnic University, Russia
Effect of metal nanopowders on agglomeration at the burning of aluminized solid propellant
The paper presents the results of measurement of the burning rate of aluminized solid propellant (SP) and parameters of sampled condensed combustion products (CCPs) including their particle size

distribution, chemical and phase compositions. Effect of iron and amorphous boron nanoadditives in SP based on AP, butadiene rubber and Alex nanopowder on the combustion characteristics was studied. It was found that the partial replacement of Alex by 2 wt. % of iron in SP leads to 1.3–1.4 fold increase in the burning rate in the pressure range of 2.2–7.5 MPa. At the same time the agglomeration of nanometal fuel is slightly increased: the mean diameter of agglomerate particles in CCPs is increased up to 1.2 fold and the content of agglomerates is increased up to 1.4 fold. The content and the mean diameter of fine oxide particles are reduced to 16 % and 13 % respectively. Upon partial replacement of Alex by 2 wt. % of boron the burning rate is practically unchanged with respect to that for basic SP with Alex. However the agglomeration is significantly enhanced, which is manifested at the increase in the agglomerate particles content in CCPs composition by 1.8–2.2 times, at the increase by 1.6–1.7 times in the agglomerates mean diameter as well as in the increase in the metal fraction, which is involved in agglomerates formation, by 1.6–1.9 times. The content and the mean diameter of the fine oxide particles are reduced more significantly than in the case of iron introduction, namely, by 1.2–1.3 times and 1.3–1.4 times, respectively.

G. Mamontov, Tomsk State University, Russia

Cr2O3/Al-Al2O3 composite catalysts for hydrocarbons dehydrogenation, prepared from aluminum nanopowder

Aluminum nanopowder (10-150 nm) was treated hydrothermally in mild conditions (60-95 oC, at atmospheric pressure) and aluminum-alumina composite with high porosity and specific surface area was obtained. Cr2O3/Al-Al2O3 catalysts were prepared using the aluminum-alumina composite by impregnation techniques and tested as catalyst in reaction of C4-hydrocarbons dehydrogenation. Cr2O3/Al-Al2O3 catalysts had high activity and stability in dehydrogenation of n- and i-butane.

A. Zamchiy, Kutateladze Institute of Thermophysics SB RAS

Synthesis of the silicon oxide nanowires oriented arrays on different substrates

Oriented arrays of silicon oxide nanowires SiOx ($x \geq 2$) were synthesized by gas-jet electron beam plasma chemical vapor deposition. The synthesis was performed on different substrates (monocrystalline silicon, glass, indium tin oxide on monocrystalline silicon, stainless steel) coated with tin catalyzed micron-size particles.

The synthesis of nanowires was conducted via vapor–liquid–solid mechanism of growth and included following stages: heating of substrate with tin catalyst to operating temperature; treatment of the substrate with hydrogen plasma; synthesis of silicon nanowires by adding of monosilane.

Experiments were carried out in a vacuum chamber with forevacuum exhausting. The working gases were hydrogen and mixture of 5% monosilane and argon (source of monosilane) and oxygen which was fed directly into the vacuum chamber. The chamber was equipped with a forevacuum electron gun with a plasma cathode. It generated 600eV electron beams with a current of 40 mA.

Scanning electron microscope investigations showed presence dense array of aligned nanowire bundles ("microropes") on all types of substrates. Each "microrope" has few tens microns length, one micron diameter, is consisted of numerous curved-shape nanowires and has catalyst particle cap. Energy dispersive spectroscopy reveals that the synthesized silica nanowires are composed of silicon and oxygen with the atomic ratio of Si:O about 1:2.

The reported study was supported by grant Russian Foundation for Basic Research #15-08-05394 a.

O. Guselnikova, Tomsk Polytechnic University, Russia

Design of novel smart materials for ultrasensitive sensors based on surface-modified Au plasmonic thin films

Plasmon-active noble metals nanostructures based on 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 arenediazonium tosylates. Further, grafting of 4-carboxypheyl and 4-aminophenyl groups enabled to create a strong covalent linker between the surface and organic chelator or thermo-regulated polymer. The molecular recognition of contaminants resulted in the shift of SERS peaks position or arising of the new peak(s) in the latter case. As heavy metal ions and organic contaminants are considered as harmful to human health and source to pollute the biosphere, sensitive and selective determination of toxic heavy metals with a cost-effective and convenient procedure is of paramount important. The design of new express sensor systems allows to increase food and environment safety and to improve the quality control.

May 15

A. Pestryakov, Tomsk Polytechnic University, Russia
Nanogold and nanosilver catalysts for CO and alcohol oxidation
In this work it was carried out the comparison of the catalytic activity of Au and Ag NPs supported in titania for liquid phase n-octanol oxidation as well as gas phase CO oxidation under modification with metal oxides and treatment with H2 and O2 atmospheres. The results show a significant influence of both titania modifier and pretreatment in hydrogen or oxygen, upon the selectivity and yield of n-octanal formation as well as CO conversion. It was found that modifiers influence the structural and electronic properties of gold and silver nanoparticles and also stabilize their active forms. It is interesting that pre-treatment in reactive atmospheres has a different effect on the activity of silver and gold metals despite of their similar chemical nature. Moreover, it was revealed that silver catalyst, as an analog of gold catalyst, showed a 12 % of n-octanol conversion after treatment. Finally, modification of the systems with metal oxide together with processing with reactive atmospheres enhanced up to 6 and 10 times the catalytic activity of silver and gold catalysts, respectively. Comparison of catalytic and spectroscopic data showed that partly charged metal clusters are probable active sites of the catalysts in the studied process.

Prof. Y. Sharkeev, ISPMS of SB RAS, Tomsk Polytechnic University, Russia
Biocomposites on the base bioinert metals and alloys and bioactive CaP coatings. Structure, properties and applications
In modern medical practice implants consisting of bioinert metals (titanium, zirconium, or niobium) and their alloys and biocompatible coatings based on calcium phosphates are widely used.
Two step method of severe plastic deformation including abs-pressing and multiple rolling was used to form an ultrafine-grained state with average size of grain-subgrain structure elements 0.1–0.2 μm in the bioinert metals and alloys. The considerable improvement in 1.5–2.5 times of the physical&mechanical characteristics was abtained.
To bioactivate implants and to strengthen their osseointegration with bone tissue, the calcium phosphate coating containing calcium phosphate compounds native to bone tissues were deposited on their surface. The efficient and simple methods of microarc oxidation in aqueous solutions of electrolytes and rf-magnetron sputtering method were suggested to obtain calcium phosphate coatings with good physical and chemical properties on the implant surface.
The coatings based on calcium phosphates are biocompatible and promote osseointegration with bone tissue. The optimal range of roughness of the calcium phosphate coatings, *R*a = 2,5 μm, that promoted osseogenous differentiation of stromal stem cells, was established.
Examples of the biocomposites based on ultrafine-grained titanium and calcium phosphate coatings used in medical practice are presented.
The author are grateful to their colleagues for participation in this work in all stages, processing, and discussion of the results obtained and preparation of publications.

E. Galunin, Tambov State Technical University, Russia
The Chemistry and Technology for Large-Scale Synthesis of Graphene Nanoplatelets
There exist various methods for producing graphene nanoplatelets (GNPs). Previously, we reported that the optimal way for the large-scale synthesis of GNPs comprises intercalation of graphite by (NH4)2S2O8 in H2SO4, cold expansion of the obtained intercalation compound, ultrasonic exfoliation and de-intercalation thereof. Thus, the aim of the present work was to determine the synthesis conditions for obtaining high-quality GNPs on a large scale. Thus, it was demonstrated that the ability of graphite for cold expansion and exfoliation depends on the degree of defectiveness of its crystal

structure. Highly defective graphite structures are not prone to intercalation, exfoliation and expansion, whereas more perfect ones can be transformed more easily. Besides, it was assumed that for efficient exfoliation of the graphite materials it is required that the power of ultrasonic radiation be above a certain threshold value, whereas the concentration of that power in the working volume of the flow-type radiator and time of residence of graphite particles in the process zone should also exceed specific thresholds. Finally, it was found that the efficiency and direction of those transformations depends on the power of the ultrasonic radiation and concentration of the processed graphite material.

"The present work was performed within the Federal Target Program "Research and Development in Priority Areas of the Scientific and Technological Complex of Russia for 2014-2020" (State Contract No. 14.577.21.0091 of July 22, 2014; Unique Identifier for Applied Scientific Research: RFMEFI57714X0091)."

N. Shatrova, NUST "MISiS", Russia

Characterization and magnetic properties of cobalt (Co) nanoparticles synthesized by ultrasonic spray pyrolysis (USP) with following hydrogen reduction

Magnetic nanoparticles have a lot of applications like storage devices, microwave absorption devices, ferrofluids, different medical applications and so on. Among different types of magnetic nanoparticles cobalt nanopowders take a special place due to its magnetic and catalytic properties. Cobalt nanoparticles applied for microwave adsorption devices, magnetic liquids used for a magnetic resonance tomography, catalyst in the Fischer-Tropsh process and many others. Different methods and conduction of synthesis have impact on properties of nanosized cobalt.

The ultrasonic spray pyrolysis (USP) of 10 wt. % aqueous solution of Co(NO3)2 followed by thermal reduction of received cobalt oxide Co3O4 in hydrogen atmosphere was used to prepare cobalt nanopowders.

Temperatures of pyrolysis were 1000 °C. Temperatures of reduction were 220, 240, 250, 270, 300 and 350 °C. The phase composition, particle size distribution, morphology and the basic magnetic properties such as coercive force, saturation magnetization and residual magnetization of the observed nanopowders were studied.

The dependence of receiving conditions on cobalt nanosized powders properties was found out. The coercive force of cobalt nanoparticles increases with the average particles size growth. These experimental results are compared with previous results for cobalt nanopowders obtained by different methods.

A. Ilyin, Tomsk Polytechnic University, Russia

The Diagnostics of the Electroexplosive Metal Nanopowders and the Products of Their Oxidation in Air

Diagnostics of nanosystems with more significant parameters for characterization of unstable and metastable states is proposed in the paper. This is a new direction in diagnostic branch of science new industrial applications of nanosystems. The process of development of the Standards of Russian Federation in nanosystems diagnostics has been started a few years ago. The standards of four thermal activity parameters are proposed in the paper. A new device «Thermomet-1» has been worked out for measurement of the thermal activity parameters.

The aluminium nanopowder produced in conditions of wire electrical explosion was used in the present investigation. The aluminum nanoparticles had the next characteristics: the average surface diameter was 160 nm, the shape of the particles was spherical, the metal aluminium content was 91 wt. %, the diameter distribution of the particles had approximately regular logarithmic function. The device «Thermomet-1» was used in this investigation for measurement of the thermal flows density within the range from 10 up to 100 W/m2 during combustion of aluminium nanopowder samples of various weights.

It was established, that for the samples weighing from 0.800 up to 0.812 g the speed of energy density growth changed from 1.68 up to 2.65 W/s·m2. The non-stationary burning was observed at the first stage of aluminium nanopowder combustion in air. The average values of the heat density growth for the first and the second stages of aluminium nanopowder combustion were equal to 2.19 and 3.79 W/s·m2, correspondingly. The correlation between the thermal energy density and the content of aluminium nitride and aluminium oxide in combustion products was established.

E. Fakhrutdinova, Siberian Physical-Technical Institute of Tomsk State University, Russia

Synthesis of Nanocrystalline TiOx Powder via Palsed Laser Ablation

Nowadays titanium dioxide has been extensively studied for their unique physicochemical properties and diversity of applications. Pulsed laser ablation (PLA) in liquid medium has recently been proven as an effective and "pure" way to prepare nanoparticles. In this study we obtained nanocrystalline titanium dioxide powder using PLA in distilled water. Synthesis of TiOx powder was carried out in 2 steps. In the first step was obtained turbid and slightly blue colloidal solution by PLA of metal target in distilled water with using Nd: YAG laser (wavelength 1064 nm, frequency 20 Hz, pulse duration 7 ns). In the second step the colloidal solution was subjected to drying at 60 °C. Obtained dark blue powder of TiOx consists of nearly spherically shaped particles in mean size 9-16 nm. Specific surface area was 80-120 m2/g. X-ray diffraction showed that TiO2 nanocrystal powder consists of 65% and 35% of anatase and brookite phases, respectively. Brookite phase content was found to reduce considerably after the heat treatment to up to 400 ºC, however, rutile phase was not detected. Absorption spectra before and after heat treatment show the absorption edge shift and an increase of absorption in visible region. Probably, it is related to existence of defect states in TiO2 and also the presence of small amount of metal titanium in the composition of TiO2. Reduction of defect states occurs during the heat treatment, and according to the X-ray patterns complete oxidation of metallic titanium to TiO2 also takes place. PLA-prepared TiOx nanopowder demonstrates higher photocatalytic activity in comparison to commercial Degussa P25 TiO2.

A. Titkov, Institute of Solid State Chemistry and Mechanochemistry, Siberian Branch of the Russian Academy of Sciences, Russia

N-Lauroylsarcosine capped silver nanoparticle based inks for printed electronics

Silver nanoparticles stabilized with amino and fatty acid (C12) derivative - N-lauroylsarcosine with the average size of about 10 nm have been obtained via the reduction of the silver nitrate with hydrazine in o-xylene and benzyl alcohol at room temperature. The effect of the synthesis conditions on the morphology, size and interaction of the silver nanoparticles with the capping agent was investigated by transmission (TEM), scanning (SEM) electron microscopy, powder X-ray diffraction (XRD), IR-Spectroscopy. Thermal decomposition and removal of the capping agent from the surface of nanoparticles has been studied by thermogravimetric analysis (TG). The TG study showed that the N-lauroylsarcosine is removed from the surface of nanoparticles in two stages at a temperature of 110-200 ° C while carboxylic acids with a long chain (C10-C12) are removed at higher temperatures, 200-300 ° C. It was found that depending on the method of synthesis N-Lauroylsarcosine can interact with the surface of silver in a different ways. Due to this effect silver nanoparticles can be dispersed in solvents of different nature. Inks consisting of the silver nanoparticles (20 wt.%) capped with N-Lauroylsarcosine have been prepared in o-xylene and butanol . Their physical properties and stability have been studied. Silver layers were spin coated on polyimide films using the developed inks. The structure and electrical properties of the conductive layers obtained at different curing temperatures has been studied.

This study was supported by the Russian Science Foundation, research project No. 15-13-00113

J.P. Loison[1], S.A. Ponomareva[1,2], V.V. An[1] and O.L. Khasanov[1], [1]Tomsk Polytechnic University, Russia, [2]Université Grenoble Alpes, France

Micro-structure and magnetic properties of Zn-doped SmFeN magnets produced by Spark Plasma Sintering

SmFeN alloy is a good candidate for permanent magnet instead of NdFeB in high-temperature applications. It has similar magnetic properties and higher Curie temperature for lower price. The main challenge is the production avoiding the decomposition into soft magnetic phase. One of the ways to obtain this bulk material is to use non-conventional sintering technique as Spark Plasma Sintering (SPS) and low melting point metals as binders. In this work, we present the study of structural and magnetic properties of Zn-bonded SmFeN magnets obtained by SPS technique.

A. Ilela, Tomsk Polytechnic Univeristy, Russia

ZrO2-Al2O3 nanopowders obtained by Nano Spray Method

This paper presents some properties of zirconia-alumina composite nanopowders obtained by Nano Spray Dryer B-90. The combination ZrO2 with Al2O3 can significantly improve the mechanical properties of the ceramics.

Suspensions for the synthesis were prepared from salts solutions Al(NO3)3 and ZrOCl2 by the co-precipitation method with ammonia. The salts concentrations are 0,25, 0,5, 1 M. The nanopowders were annealed at temperature 1200 ºC for 3 hours.

The using of concentration ratio [ZrO2+]: [Al3+] = 1:1 allows to receive the powders with the highest value of specific surface areas: 26,54 m2/g (minimum SSA is 0,70 m2/g). The results of SEM showed that the powders have a spherical shape and some particles of Al2O3-ZrO2 composites encapsulate of ZrO2.

Nano Spray technic provides to produce the powders without monoclinic phase of ZrO2. The best results were obtained for solution [ZrO2+]: [Al3+] = 1:1. The XRD-analysis shows the presence of t-ZrO2, c-ZrO2 and α-Al2O3 with mass content 54,1, 12,6, and 33,3%, correspondently.

N. Maksimova, Tomsk State University, Russia

Acetone and ethanol sensors based on nanocrystalline SnO2 thin films with various catalysts

Recently increasing interest has been expressed about early diagnosis of some diseases based on human breath analysis. It has been discovered that some compounds in human breath can be used as biomarkers of the presence of diseases. Acetone in the human breath is an important marker for noninvasive diagnosis of type 1 diabetes. The detection of small acetone concentration in such a complex gas mixture as the human breath requires a highly sensitive and selective acetone sensor. In this paper the electrical and gas-sensitive characteristics of sensors based on nanocrystalline SnO2 thin films with noble (Pt, Pd, Au) and 3 d-transition metals (Co, Ni) additives in the bulk and on the surface has been studied. Thin (~100 nm) tin dioxide films were grown in magnetron by dc sputtering of a tin–antimony alloy target in oxygen–argon plasma. It was shown that the obtained sensors are characterized by a high response to small acetone concentration. Of greatest interest are gold modified films with the addition of cobalt in the volume: Au/SnO2:Sb, Au, Co. Using different operating temperatures of the sensors gives a possibility of the selective detection of acetone and ethanol vapors at 1ppm level.

A. Almaev, Tomsk State University, Russia

Hydrogen sensors based on thin nanocrystalline films of tin dioxide

This work presents the results of investigation of the effect of Ag and Y additives introduced into bulk of the thin nanocrystalline films of tin dioxide on the electrical and gas-sensitive properties of hydrogen sensors and the stability at long – term operation. Two types of the films with different deposited on the surface dispersed catalysts Pt/Pd/SnO2:Sb, Ag, Y and Ag/SnO2:Sb,Ag, Y were studied. The thin films of tin dioxide were obtained by magnetron sputtering of tin – antimony alloy target at the direct current. It is shown that additives Ag, Y in the presence Pt/Pd on the surface provide the maximum values of the response to hydrogen at Tmax=670 K. In the case of the deposited catalytic Ag the response to hydrogen is considerably lower and Tmax>713 K. A common feature of two types of the films is the high stability of their properties under the periodical influence of hydrogen in long-term tests. Furthermore, in according with results of experiments test specimens have weak dependence on humidity changes. It is very important result for development stability gas sensors, which find an application for medicine and air quality monitoring.

P. Postnikov, Tomsk Polytechnic University, Russia

Preparation of Ordered Silver Angular Nanoparticles Array in Block-Copolymer Film for Surface Enhanced Raman Spectroscopy

We report a single-step method of preparation of ordered silver nanoparticles array through template-assisted nanoparticles synthesis in the semidried block copolymer film. Ordered nanoparticles were prepared on different substrates by the proper choice of solvents combination and preparation procedure. In particular: block copolymer and silver nitrate were dissolved in the mix of tetrahydrofuran, toluene, and n-methylpyrolidone. During short spin-coating procedure ordering of block copolymer, evaporation of toluene and preferential silver redistribution into poly(4-vinylpyridine) block occurred. Rapid heating of semidry film initiated silver reduction, removing of residual solvent and creation of ordered silver array. After polymer removing silver nanoparticles array was tested as a suitable candidate for subdiffraction plasmonic application - surface-enhanced Raman scattering (SERS). Enhancement factor was calculated and compared with literature data.

A. Kachusova, Tomsk State University, Russia

The nanostructured multilayer absorber of electromagnetic waves at microwave

Nanostructured composite materials have opened a new era for multifunctional materials (such as reflection, absorbing, conducting etc.). In particular, multiwalled carbon nanotubes (MWCNTs) can be applied in order to improve electromagnetic properties in composites. The nanocrystal pattern ferrites and magnetic glass-coated microwires are used extensively in microwave engineering. Composite materials, containing barium hexaferrite powders and/or MWCNTs and/or microwires as fillers and epoxy resin as matrix were prepared. The multilayer samples were studied. The reflection and transmission coefficients were measured by coaxial method at frequency range of 0.01 – 18 GHz. The results obtained indicate the possibility of the use of composite materials in multilayer coatings for shielding and absorption of microwave radiation at microwave frequencies.

Why is it not easy to cover bacterial cells using electrostatic approach?

Author: I. Rybkin, Saratov State University, Russia

Abstract: Physical nature of bacterial cells is described by negative charges of phospholipids. From this point it is appropriate way to cover cells by polyelectrolytes. However, bacterial cell surface and physiological properties complicate relatively straightforward methods of polyelectrolyte depositions.. Formation of cell wall affects directly changing in electrostatic properties of bacterial cell and extremely depends on the growth stages. To efficiently deposit polyelectrolytes on bacterial surface, on one hand it is important to prepare the most efficient method based on physicochemical principles, electrostatic properties and on other hand it is needed to have in mind the physiology of particular

bacteria. Therefore, our aims were: (i) changing of electrostatic properties of cells on the efficiency of deposition of polyelectrolytes on cell surface, (ii) to establish protocol for covering bacterial cells.

In prior of deposition of polyelectrolytes we measured surface potential by Ohshima method to describe bacterial electrostatic properties at different growth stages. We used different strains of: Staphylococcus aureus, Bacillus pumilus, Escherichia coli K12 and Top10. The measurement of electrophoretic mobility was performed in the gradient of NaCl solutions of different ionic strengths. Surface softness parameter and charge was calculated as well.

Based on our results we determined surface potential of each measured cell types and we distinguished physiological changes at different growth stages, cell species as well as strains. The most importantly, it seems that for some bacteria the most appropriate stage to modify their surface by polyelectrolytes is exponential phase than by using cells in lag or stationary phases. Based on these results we were able to prepare a protocol, which enabled highly efficient covering of separated alive bacterial cells by polyelectrolytes.

ABSTRACTS (POSTERS)

May, 12, Thursday

Poster Session #1
P0-P14

P0)
Intrinsic peroxidase–like activity of Fe-core/carbon shell nanoparticles: kinetic study and application for determination of glucose
Author: N. Surgutskaia, Tomsk Polytechnic University, Russia
Abstract: The new catalyst based on Fe-core/carbon shell nanoparticles (Fe@C) for quantitative determination of glucose was investigated. The analytical method based on peroxidase mimetic activity of Fe@C in the reactions with 3,3,5,5-tetramethylbenzydine (TMB) in the presence of H2O2. Fe@C is environmentally friendly, safe and bioinert catalyst. The kinetics parameters displayed a good affinity of Fe@C with peroxidase substrates. The influence of the surface modification and thickness of carbon layer on the catalytic activity of Fe@C were investigated. Based on this catalytic reaction Fe@C can be used for the glucose detection in water solutions over a range 1-20 μM.

P1) Magnetic nanoparticle-pHLIP conjugate for tumour MRI
Author: Alexandr a Pershina, Russian Federation, Tomsk Polytechnic University
Abstract: pH-Low insertion peptide (pHLIP) is a promising tumour targeting molecule due to the ability to penetrate across the membrane of cells in acidic extracellular environment. The conjugation of pHLIP with iron oxide magnetic nanoparticles (Fe3O4) allows obtaining the specific contrast agents for MR imaging of tumour.
The nanoconjugate based on superparamagnetic iron oxide (Fe3O4) nanoparticles, modified by silane derivatives and functionalized due to covalent bond formation with a pH-sensitive peptide (pHLIP) has been designed. pHLIP was fixed on the Fe3O4-APS-NH2 surface using hetero-functional cross-linker 6-maleimidohexanoic acid N-hydroxysuccinimide ester (EMCS). The structure of obtained nanoconjugate was examined by TEM and FTIR spectroscopy. The stable suspension of Fe3O4-APTMS-pHLIP (155 nm, PdI 0.09 and z-potential – -22 mV) with relaxivity coefficient r2 equaled to 117.21 mmol-1 s-1 was obtained. The low cytotoxicity of the received nanoconjugate was proved using flow cytometry-based Annexin V/7-AAD staining, MTT- and LDH-assay. Fe3O4-APTMS-pHLIP nanoconjugate was tested as targeting MRI contrast agent for cancer imaging in the LLC tumour-bearing mice.
This work was supported by Russian Scientific Fund (grant No.14-15-00247)

P2) The Growth Features of Magnetron Sputtered Amorphous Silicon Thin Films
Author: Dmitry M. Mitin, Alexey A. Serdobintsev, Alexey V. Markin, National Research Saratov State University
Abstract: Amorphous silicon (a-Si) is widely used in the electronics and optoelectronics devices. For this reason modeling of sputtering processes and the development of a-Si thin films synthesis methods along with the study of their properties is one of the most actual tasks.
Theoretical calculation of energy transfer during the sputtering process on the basis of the Sigmund-Thompson distribution describing the initial energy spectrum of sputtered atoms has been carried out. The mean free path length of sputtered silicon atoms, the ratio of unscattered silicon atoms and deposition flow power in the magnetron sputtering system have been calculated. A correlation between calculated data and practical results on the example of the silicon thin films properties vs synthesis pressure dependences has been shown.
In the considered range of pressure the average free path length of the sputtered silicon atoms changes more than by 14 times. With growth of pressure the ratio of the sputtering atoms losing energy in case of collisions with atoms and ions of working gas increases up to 54%. Deposition flow power is

significantly various: on the considered interval of pressure the maximum and minimum value differs by 4-5 times.

The critical pressure value used in the magnetron system is equal to $4 \cdot 10^{-4}$Torr. The ratio of unscattered silicon atoms must be above 73% to effectively control the properties.

- Roughness and irregularity of films varies proportional to the synthesis pressure.
- The film thickness decreases with increasing gas pressure in the chamber.
- The difference in the profiles of Raman spectra of amorphous silicon in the range from 200 to 480 cm^{-1} indicates the structural difference of the films.

P3) The use of metal additives in high-energy material with Alex nanopowder

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

Abstract: 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.

P4) Improve Temozolomide stability by loading in Chitosan-carboxy enriched Polylactide NPs. In vitro evaluation.

Author: Antonio Di Martino, Czech Republic, Centre of Polymer Systems, University Institute, Tomas Bata University in Zlin, Ph.D

Abstract: Antonio Di Martino, Pavel Kucharczyk, Zdenka Kucekova, Petr Humpolicek, Vladimir Sedlarik

Centre of Polymer Systems, University Institute, tr. T. Bati 5678, 76001 Zlin, Czech Republic

Abstract

Temozolomide (TMZ) is a chemotherapeutic agent which demonstrated promising activity in treatment of some brain cancers and other solid tumors. However, treatment is still a challenge due to the fast degradation of TMZ in the active form 5-Monomethyltriazenoimidazole-4-carboxamide which is not reach the tumor site, in therapeutic concentration [1].

In this work, TMZ was physically entrapped into an amphiphilic carrier obtained by grafting carboxy-enriched polylactide to chitosan backbone. Obtained nanoparticles demonstrate diameter in the range 100-150 nm, high stability in physiological media and ability to accomodate up to 800 □g of TMZ per mg of polymer.

TMZ loaded in CS-PLA showed higher stability over, in particular in physiological solution at pH 7.4. In vitro cell tests demonstrate improvement of TMZ effectiveness when loaded into the carrier, compared to the free drug.

Acknowledgement

This work was founded by the Czech Science Foundation (grant No. 15-08287Y).

References

[1] Chen C, Xu T, Lu Y, Chen J, Wu S. The efficacy of temozolomide for recurrent glioblastoma multiforme.Eur J Neurol. 2013;20 (2): 223-230

P5) Effect of Na+ and Mg++-electrolytes on the stability of Ni nanoparticle suspensions

Author: Diana Ayrapetyan, Russian Federation, Tomsk Polytechnic University, student
Abstract: The rapid development and introduction of nanotechnologies requires new knowledge about biological and physicochemical properties of manufactured nanomaterials in different environmental matrixes in terms of their potential (eco)toxicity. One of the key issues of (eco)nanotoxicology is to accumulate experimental data about nanoparticle's behavior in liquid surrounding, physiological and environmental solutions.
This work is aimed at the experimental study of acid-basic, electrokinetic and dispersive properties of nanoparticles suspensions in buffering saline simulating physiological liquid. The object of investigation is Ni nanoparticles with an average particle size of 100 nm, the powder was produced with wire electrical explosion. We show the effect of ionic strength (0.01…1 M) of Na+ and Mg++-electrolytes on the pH variation, particles size distribution and conductivity of Ni nanoparticles suspensions.

P6) Preparation of Ordered Silver Angular Nanoparticles Array in Block-Copolymer Film for Surface Enhanced Raman Spectroscopy
Author: Pavel Postnikov, Russian Federation, Tomsk Polytechnic University, principal researcher
Abstract: We report a single-step method of preparation of ordered silver nanoparticles array through template-assisted nanoparticles synthesis in the semidried block copolymer film. Ordered nanoparticles were prepared on different substrates by the proper choice of solvents combination and preparation procedure. In particular: block copolymer and silver nitrate were dissolved in the mix of tetrahydrofuran, toluene, and n-methylpyrolidone. During short spin-coating procedure ordering of block copolymer, evaporation of toluene and preferential silver redistribution into poly(4-vinylpyridine) block occurred. Rapid heating of semidry film initiated silver reduction, removing of residual solvent and creation of ordered silver array. After polymer removing silver nanoparticles array was tested as a suitable candidate for subdiffraction plasmonic application - surface enhanced Raman scattering (SERS). Enhancement factor was calculated and compared with literature data.

P7) Formation And Growth Of Nanoparticles From A Mixture Of Isotopes In A Magnetic Field Of Low-Temperature Plasma Under Cooling
Author: Vyacheslsav Myshkin, Russian Federation, Tomsk, Professor
Abstract: The results of studies on the influence of magnetic field on the processes of the formation of the dispersed phase at the stage of quenching of low-temperature nitric and oxygen plasma were brought in paper. For optimization of the composition of the plasma forming gas was carried out the equilibrium composition by thermodynamic modeling. It has been found that the external magnetic field has a significant influence on the formation of the disperse phase in the vapor mixture of carbon and iron.

P8) Magnetron sputtered La0.6Sr0.4Co0.2Fe0.8O3 nanocomposite interlayer for solid oxide fuel cells
Author: Andrey Solovyev, Russian Federation, Tomsk Polytechnic University, assistant professor
Abstract: A thin layer of a La0.6Sr0.4Co0.2Fe0.8O3 (LSCF) is deposited between the electrolyte and the La0.6Sr0.4Co0.2Fe0.8O3/Ce0.9Gd0.1O2 (LSCF/CGO) cathode layer of a solid-oxide fuel cell (SOFC) by pulsed magnetron sputtering using an oxide target of LSCF. The films had low porosity and a mainly columnar microstructure. The effects of annealing in temperature range of 200 to 1000 °C on the crystalline structure of the LSCF films have been studied. The films, with nominal thickness of 250-500 nm, are crystalline when annealed at temperatures above 600°C. The crystalline structure, surface topology, morphology of the films were determined using X-ray diffraction (XRD), atomic force microscopy (AFM) and scanning electron microscopy (SEM), respectively. To study the electrochemical characteristics of the deposited films solid oxide fuels cells using 325 nm thick LSCF films as interlayer between the electrolyte and the cathode have been fabricated. The LSCF interlayer improves the overall performance of the SOFC by increasing the interfacial area between the

electrolyte and cathode. The electrolyte-supported cells with the interlayer have larger on 30% the overall power output compared to that achieved with the cells without an interlayer. The LSCF interlayer could also act as a transition layer that improves adhesion and relieves both thermal stress and lattice strain between the cathode and the electrolyte. Our results demonstrate that pulsed magnetron sputtering provides a low-temperature synthesis route for realizing ultra-thin nanocrystalline LSCF films layers for intermediate- or low-temperature solid oxide fuel cells.

P9) The nonisothermal model of the initial stage of ion implantation process

Author: Elena Parfenova, Russian Federation, Tomsk Polytechnic University, graduate student, engineer

Abstract: Due to material processing with charged particle fluxes, the purposeful change of the surface layer material state is possible, thus improving its operating abilities. Achievement of important results requires a detailed study of the processes occurring during processing. Surface treatment is accompanied by different physical and chemical factors that affect each other and influence the formed macroscopic properties of work materials. The physical phenomena occurring in the substrate during beam of charged particles processing are studied by many authors. The computer simulation has a big significance for this research, because the role of each separate factor can't be experimentally investigated. The paper is aimed at investigating the nature of interaction of two different scale processes - impurity diffusion and mechanical stress wave propagation.

P10) Preparation of Ordered Silver Angular Nanoparticles Array in Block-Copolymer Film for Surface Enhanced Raman Spectroscopy

Author: Oleksiy Lyutakov, Czech Republic, UCT Prague, researcher

Abstract: We report a single-step method of preparation of ordered silver nanoparticles array through template-assisted nanoparticles synthesis in the semidried block copolymer film. Ordered nanoparticles were prepared on different substrates by the proper choice of solvents combination and preparation procedure. In particular: block copolymer and silver nitrate were dissolved in the mix of tetrahydrofuran, toluene, and n-methylpyrolidone. During short spin-coating procedure ordering of block copolymer, evaporation of toluene and preferential silver redistribution into poly(4-vinylpyridine) block occurred. Rapid heating of semidry film initiated silver reduction, removing of residual solvent and creation of ordered silver array. After polymer removing silver nanoparticles array was tested as a suitable candidate for subdiffraction plasmonic application - surface enhanced Raman scattering (SERS). Enhancement factor was calculated and compared with literature data.

P11) Studying of quantum dots monolayers formation at the different acidity

Author: Ilya Gorbachev, Russian Federation, Saratov State University, PHD student

Abstract: The main target of this work is a studying of a process of QD monolayer formation at a different subphase acidity. The variation of a acidity has an effect on the electrostatic interaction between surfactant molecules at the high pH and on the dissolution of quantum dots at the low pH values and as a result on a monolayer packaging type. In the present work the process of QD monolayer formation at the subphase acidity of 2,3,7 and 12 were studied by the compression isotherm method and Brewster angle microscopy and transmission electron microscopy. The acidity has an effect on the quantum dots monolayer formation process. So an increasing of the pH value leads to increasing molecule mean area that connected with electrostatic repulsion between ionized surfactant head groups, but a decreasing of the pH value leads to particularly dissolution of quantum dots.

P12) The Structure And Properties Of Fluoropolymer Films Deposition By Hwcvd Method

Authors: Nikolay Timoshenko, Kutateladze Institute Of Thermophysics Of The Siberian Branch Of The Russian Academy Of Sciences, Senior researcher

Abstract: The paper used method HWCVD (Hot Wire Chemical Vapor Deposition) [1,2] for the deposition of thin films a fluoropolymer. The method is the activation of the precursor gas

hexafluoropropylene oxide (C3F6O) on a hot filament of catalyst (nichrome). The method allows to control the structure of the resulting film by changing the parameters in the deposition process and, accordingly, coating properties, including wetting.
It was shown the influence of activating temperature filament on the morphology and a rate coating deposition.
It is found that at a temperature of activated filament about 600°C the film is formed with a smooth uniform structure and at the temperature about 900 °C film has already powdery structure.
Management of the structure of the films enables to control its properties, including wettability.
The work was supported by the RFBR grant 15-38-20411

P13) Biodegradable PLLA scaffolds surface modification by RF magnetron sputtering of different calcium-phosphate targets
Author: Natalia Bogomolova, Tomsk Polytechnic University, Student
Abstract: Biodegradable materials, in particular polylactic acid (PLLA), are widely used in the biomedicine and tissue engineering. Different physical and chemical methods are studied for biodegradable polymers biocompatibility improvement, including radio frequency magnetron sputtering (RFMS). The present study proposes PLLA scaffolds surface modification by RFMS of four different calcium phosphate targets: hydroxyapatite (HAP), tricalcium phosphate (TCP), amorphous calcium pyrophosphate (CPP) and dicalcium phosphate dihydrate (DCPD). The effect of RF plasma magnetron discharge on the biodegradable scaffolds fibers structure was investigated by atomic force microscopy, scanning electron microscopy and X-ray fluorescence analysis. Comprehensive analysis of the PLLA surface properties after modification leads to the conclusion about the most suitable calcium phosphate target.

P14) Structural and chemical transformations of aluminum nanopowder particles at combustion in air
Author: Liudmila Root, Tomsk Polytechnic University, Associate Professor
Abstract: Aluminum nanopowder combustion process passed in two stages. On the first stage hydrogen burned out at 600-800 °C. In this process the shape of the particles and their phase structure did not change significantly. In certain conditions, when sample weight of aluminum nanopowder was higher than the critical one, the appearance of bright emission and the increase of temperature up to 2200-2400 °C happened. The combustion process accelerated and passed into the gas phase with the further formation of the condensation products from the gas phase. The established earlier oscillatory processes at 2200-2400 °C, that are acceleration and inhibition of the combustion, contributed to the formation of common and double-leveled whiskers. Chemical analysis revealed that the thread-like crystals were the aluminum nitride whiskers. As the result of aluminum nanopowder combustion in air up to 63 wt. % of aluminum nitride as a separate crystalline phase was formed in combustion products.
As the result of aluminum nanopowder combustion in magnetic field (0.32 Tesla) the micro-sized single crystals of aluminum nitride 1-4 mm2 in area and 2-6 mkm in thickness were synthesized. The synthesis of single crystals under nonequilibrium conditions occured in several stages, which were the stabilization of combustion products with stored energy, their supercooling and crystallization in a heat wave.
The spherical aluminium nanoparticles undergo structural changes in a combustion process. Depending on the conditions, they either sintered or transformed into whiskers or single crystals. The unknown earlier phenomenon of atmospheric nitrogen chemical bonding at combustion of metal powders, as well as boron and silicon powders in air occured as the result of deactivation of atmospheric oxygen at high temperatures.

May, 12, Thursday

Poster Session #2

P15-P29

P15) Evaluation of the bone tissue mechanical structure after induced alimentary Cu-deficiency followed by supplementary injection of Cu nanoparticles in rats

Author: Oskar Sachenkov, Kazan federal university, research fellow

Abstract: The paper studies the evaluation of mechanical structure of bone tissue with Cu- deficiency in the body. The studies have been conducted on the bones of rats subjected to a complete Cu-deficient diet and the Cu-deficient diet, followed by rehabilitation diet. Within the frames of research testing on bending of animals' femoral bones was conducted, the scheme for flexure of the axes "move-force" midsection was drawn. The Young's modulus, ultimate normal and tangential stress limits were defined. Bones were scanned on micro-CT. Porosity and fabric tensor was built. The animals under research were divided into three groups: a) with Cu-deficiency, b) Cu-deficiency within 5 weeks with the following rehabilitation, c) Cu-deficiency within 8 weeks with the following rehabilitation. Depending on time and Cu-deficiency in the body the analysis of the obtained mechanical and structure characteristics was performed. The effect of Cu-deficiency on bone tissues' rigidity, porosity, strength and degree of anisotropy was detected. It was also shown that Cu-deficiency within 5 weeks and further rehabilitation the mechanic properties of the bone tissues are restored and the hardening analogue takes place. The recovery does not take place at the Cu-deficiency within 8 weeks, what the authors connect with the tissue texture nonlinear transformation.

P16) Effect of long-term storage on nanomaterials properties

Author: Olga Kyrmakova, Tomsk Polytechnic University, Postgraduate student

Abstract: The production and application of nanomaterials is rapidly expanding. Therefore the problem of their properties change during long-term storage becomes essential. The properties of metal nanopowders after long-term storage under ambient conditions were studied and presented in this work. The aluminum, copper, iron nanopowders were produced by the method of electrical explosion of wires. The investigation was carried out by X-ray and thermal analysis, scanning electron microscopy, IR-spectroscopy. The estimation of the flame propagation velocity in the bulk layer of nanopowders was carried out. The results can be used for diagnostic of fire hazard of nanomaterials and protection of the enterprises against fire and explosion.

P17) Influence of the "solvent/non-solvent" treatment on the structure of PLLA electrospun scaffolds

Authors: Goreninskii S.I., Stankevich K.S., Bolbasov E.N., Filimonov V.D., Tverdokhlebov S.I.
National Research Tomsk Polytechnic University

Abstract: Biodegradable scaffolds for tissue engineering produced by electrospinning are three-dimensional structures widely used in regenerative medicine. The further modification of such structures allows improving of their properties including biocompatibility, chemical reactivity, radiopacity, etc. Previously, our group reported a poly(L-lactic) acid-based (PLLA) thin films surface modification method utilizing "solvent/non-solvent" treatment. The aim of current research was to reveal an optimal "solvent/non-solvent" system for PLLA-based scaffolds modification. Composition of the solvents mixture may influence morphology and crystallinity of the PLLA. Elecrospun scaffolds made of PLLA (PL 18, Mw= 230500 g/mol, PURAC) were treated with toluene/ethanol mixtures with different proportions. By using scanning electron microscopy it was shown that treatment with mixture of toluene and ethanol in selected proportions has no significant effect on the fibrous structure of the scaffold. Results obtained by X-Ray diffraction analysis confirm that chosen "solvent/non-solvent" mixture doesn't affect material crystallinity. Thus, "solvent/non-solvent" system that has no significant influence on the structure and properties of PLLA electrospun scaffolds was found and can be used for further modification.

P18) Vaterite coated electrospun polymeric fibers for biomedical applications

Authors: Maria Savelieva, Saratov State University, Postgraduate student
Abstract: Biocompatible polymer matrices modified with inorganic materials including hydroxyapatite, calcium carbonate CaCO3 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 CaCO3. Such modification of fibers allows the functional properties of nanofibrous material to be achieved. In regard to bone tissue formation, the CaCO3 is bioactive material due to its ability to form strong biomaterial-bone interface [1]. The presence of calcium carbonate provides osteoconductive properties of PCL/CaCO3 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/CaCO3 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 CaCO3 and an ability to control the coating homogeneity, CaCO3 mass and polymorph during mineralization process. Cytotoxicity tests showed that PCL/CaCO3 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). References: [1] R.Z. LeGeros, Chem. Rev. 108 (2008) 4742–53.

P19) Medical nanofilms of titanium oxynitride deposited by reactive magnetron sputtering

Authors: E. L. Boytsova, L.A. Leonova, National Research Tomsk Polytechnic University
Abstract: Nanofilms are widely used in recent years in different fields of technologies especially in medicine. The methods of thin film coatings depositing are commonly in demand for the obtaining of new materials, including nanostructure. Films for medical purposes, used for many kinds of implants and vascular stents, should improve qualities of the products: biocompatibility, stability of properties and composition, reducing the impact on the surrounding tissue. The complex Ti-O-N-film is one of the most promising coatings for coronary stents [1].

The aim of this work is investigation the sputtering conditions influence, particularly, the bias voltage Ub = 0-100 V on changing the chemical properties of the composition and morphology of Ti-O-N-films under prolonged contact with physiological liquid (solution NaCl 0,9%) [2].

The substrates for depositing bilateral coatings were the crystal plate of NaCl (10 × 10 × 1 mm). Plasma gases were oxygen (O2) and nitrogen (N2). Coating deposition parameters: cathode material was Ti, the operating pressure in the chamber 0.1 Pa, the power 1 kW, current 3A, the working gas leakage rate 5 ml/min, the bias voltage from 0 V to -100 V. The ratio of the partial pressure pure gases N2 and O2: p(O2)/p(N2) = 1/1, deposition time 60 minutes.

Using of X-ray fluorescence analysis (RFlA, Thermo Electron QUANT'X) it was established that Ti-ON coatings are chemically stable, and negative electric bias (Ub = -100 V) leads to the growth of amorphous phase with respect to the nanocrystalline structure for Ub =0 [3].

References

P20) Investigation of interaction between bimodal fluorescent-magnetic nanoparticles based on CQD and living cell using flow cytometry

Authors: Anna Belousova, IIP, junior scientist
Abstract: The interaction between the bimodal fluorescent-magnetic nanoparticles and living cells such as HeLa and different macrophages were investigated using the flow cytometry method. The nanoparticles contained carbon quantum dots and core-shell iron-carbon nanoparticles. The interaction between carboxilated (negatively charged) and aminated (positively charged) nanoparticles has been studied, the uptake mostly of the positively charged nanoparticles into the cells has been established.

P21) Multilayer Morphologically Uniform Films Of Titanium Dioxide: Morphology, Optical Characteristics And Phase Transitions

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

Abstract: Titanium dioxide (TiO2), 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 TiO2 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 TiO2 was determined by XRD-analysis. Observed experimentally temperature of formation of TiO2 films with anatase crystal modification was 500°C. Multilayer morphologically uniform films were obtained by consistent coating of precursor on the film TiO2. 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 TiO2 films with thickness of 50 - 300 nm were obtained from the transmission spectra. For the film composed of five layers of TiO2, 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 TiO2 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 Ag0 particles from the aqueous solution of AgNO3, that the incorporation of the photocatalyst P-25 nanoparticles into the TiO2 film can increase the efficiency of photocatalytic Ag0 reduction by increasing the number of active surface sites.

P22) Synthesis of boron and nitrogen doped CVD diamond films in glow discharge plasma

Authors: Vitaly Okhotnikov, Tomsk Polytechnic University

Abstract: 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(OCH3)3/H2 gas/liquid and N2/H2/CH4 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.

P23) Structural and phase transformations in the Ti - ZrO2 + Y2O3 system formed an intense electron beam

Authors: Ann Ashchepkova, Tomsk Polytechnic University

Abstract: The "film (Ti) /(ZrO2 + Y2O3 ceramics) substrate" system was investigated after irradiation by an intense pulse electron beam. It was found the formation zirconate titanate in the surface layer of the systems film / substrate. It was shown that high-speed metallization of the surface layer in the ZrO2 + Y2O3 ceramics leads to increase of its fracture toughness.

P24) The design of three dimensional cross-linked composite material based on dicyclopentadiene and surface-modified nanotubes

Authors: Petr Khakhulin, Victor Kurtukov, Tomsk Polytechnic University

Abstract: 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.

P25) Preparation of three dimensional cross-linked composite material based on dicyclopentadiene and surface-modified nanotubes

Authors: Petr Khakhulin, Victor Kurtukov, Tomsk Polytechnic University

Abstract: 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).

P26) Effect of pulsed e-beam irradiation on properties of PLLA scaffolds prepared by Electrospinning and Solution Blow Spinning

Authors: V. L. Kudryavtseva, P.G. Kuznetsov, D. V. Ponomarev, E. N. Bolbasov, G.E. Remnev and S.I. Tverdokhlebov, Tomsk Polytechnic University

Abstract: 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.

P27) Shape – And Size – Controlled Synthesis Of Magnetite Nanoparticles For Mri And Drug Delivery

Authors: Aleksey Nikitin, Aleksander Savchenko, Aleksander Majouga, , National University of Science and Technoional Unilogy "MISiS"

Abstract: Magnetic nanoparticles, in particular magnetite nanoparticles (MNPs), are widely used in various fields of technology and biomedicine due to their unique physicochemical properties. Magnetite nanoparticles are relatively nontoxic and biodegradable nanomaterial. Therefore, it is possible to use such nanoparticles for biomedicine as therapeutic agents as well as contrast agents for MRI. Size, shape and chemistry surface of MNPs are general characteristics that determine physicochemical properties such nanomaterials.
The purpose of this work was to study the effect of different organic acids on the final shape, size, and physicochemical characteristics of MNPs, as well as a study of T2 – relaxation parameter. For this purpose, a number of syntheses of MNPs based on thermal decomposition of iron acetylacetonate (III) in the presence of various acids, namely oleic acid, 4-biphenylcarboxylic acid, cyclopropanecarboxylic acid and indan-2-carboxylic acid were carried out. MNPs were characterized by dynamic light scattering, transmission electron microscopy, X-ray diffraction, thermogravimetric analysis and Mössbauer spectroscopy. Moreover, the magnetic properties of the resulting nanomaterials were measured. For transfer of MNPs from the organic into the aqueous medium and to prevent aggregation MNPs were functionalized and coated with biocompatible copolymer based on pluronic F127. Then T2-relaxivity was studied. Finally, we are going to carry out experiments in vivo with given samples. More detail information about this experiment will be presented.
The authors knowledge financial support from Ministry of Education and Science of the Russian Federation (14.607.21.0132, RFMEFI60715X0132).

P28) Simulation calculation of short-range order parameter for isolated graphene sheets with defects

Author: Anna Belosludtseva, TUSUR

Abstract: 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.

P29) Stability of engineered nanopowders of zinc, nickel and aluminum in artificial surface water

Authors: Elena Yunda, Université Grenoble Alpes, Master student

Abstract: 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.

May, 13, Friday
Poster Session #3

P29-1-P43

P29-1) Surfactant adsorbtion on differently sized ZnO nanoparticles
Author: Julia Papina

P30) Quantitative characteristics of a translocation of nanomaterials in three-unit food chains of hydrobionts.
Authors: Sergey Morgalev, Tomsk State University, Ingeneer-researcher
Abstract: Accumulation of platinum and nickel nanoparticles by the size Δ50=5 nm from environment is investigated in hydrobionts: Chlorella vulgaris Beijer, Daphnia magna Straus, Danio rerio and Cyprinus carpio. Distinctions in bio-accumulation at receipt from environment by cultivation and when feeding daphnia and fishes by organisms of lower level of a food chain are determined.
Nanoparticles which fall into the hydrosphere associated with the cells Chlorella vulgaris Beijer (BAF ≈ 10000). Nanoparticles accumulate in the Daphnia magna Straus bodies (BCF = 1000-2500). This process poses a risk for consumers to higher trophic levels. Accumulation of nanoparticles in the transmission through the food chain with Chlorella, contaminated nanoparticles exceeds the accumulation of the environment in 4 - 7 times. This is because the Daphnia consume concentrated nanoparticles. Nanoparticles accumulate in fish directly from the hydrosphere (BAF≈900), as well as enter from the food chain (BCF≈300). When using a products fishery undergoing contamination of nanoparticles, the biggest danger is the whole fish and the organs and tissues such as scin, muscle and skeleton. The possibility of translocation and accumulation of nanoparticles at different levels of the trophic chain, and consequently - the vulnerability of agro- and aquaculture with nanoparticle contamination is shown.

P31) Advanced Aspects of the Production of Catalytic Systems Used for Growing Carbon Nanotubes by Thermal Decomposition
Authors: Nariman Memetov, Tambov State Technical University
Abstract: Catalysts employed in the manufacture of CNTs via chemical vapor deposition usually represent solid solutions of oxides and transition metals containing an inert matrix, active components, and promoters. To ensure their quality, one should determine a set of characteristics and control techniques. In this regard, the objective of the present work was to develop accessible quality control methods for catalysts used in the industrial synthesis of CNTs. The analysis of catalyst batches synthesized under constant conditions showed that there exist significant fluctuations from batch to batch. The relative discrepancies of the weight loss during calcination, specific yield and surface area of the CNTs were found to be 110.0, 64.9 and 45.6 %, respectively. After introducing the additional controlling factor – normed flow rate of dehydrated air, they decreased down to 24.0, 8.5 and 15.4 %, respectively. The effective flow rate of air per unit weight of the finished catalyst was experimentally determined to be 54.8 kg/kg.
The present research was performed within the framework of the cooperation between Russian higher education institutions, state scientific institutions and organizations implementing complex projects to create high-tech production (RF Government Decree No. 218 of April 9, 2010; Contract No. 02.G25.31.0123 of August 14, 2014).

P32) Texture and microstructure development in hydroxyapatite coatings deposited by means of RF-magnetron sputtering
Authors: Anna Ivanova, Maria Surmeneva, Roman Surmenev, Diederik Depla, Tomsk Polytechnic University, Russia, Ghent University, Belgium
Abstract: 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.

P33) C60: Low-Temperature Heat Capacity And The Speed Of Sound

Authors: A. Ponomarev ,M. Bagatskii, V. Sumarokov, M.. Barabashko, and A.. Dolbin, B. Sundqvist, B.Verkin Institute for Low Temperature Physics and Engineering of the National Academy of Sciences of Ukraine

Abstract: 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.

P34) PMIDA-modified Fe3O4-based magnetic nanoparticles for MRI of liver lesions induced by O. felineus

Authors: A.M. Demin, A.G. Pershina, A.E. Sazonov, V.P. Krasnov, L.M. Ogorodova, Postovsky Institute of Organic Synthesis of RAS (Ural Branch), senior resercher

Abstract: Modification of Fe3O4 magnetic nanoparticles (MNPs) by N-(phosphonomethyl)iminodiacetic acid (PMIDA) was studied. The starting MNPs were obtained by precipitation from solutions of Fe3+/Fe2+ salts or mechanochemical synthesis. The modified MNPs were characterized by the physicochemical methods; their magnetic properties were studied. It has been shown that modified MNPs can be used as MRI contrast agents while studying the liver lesions induced by O. felineus. It has been found that PMIDA-modified MNPs obtained by precipitation exhibit higher MRI contrast properties in vivo (at a dose 0.6 mg/kg). The in vitro experiments demonstrated the low toxicity of these nanoparticles (in MTT-assay).

The work was partially supported by RFBR (14-03-00146) (synthesis of nanoparticles) and RSF (14-15-00247) (in vivo and in vitro experiments).

P35) Synthesis of the antibody ICO406-conjugated Fe3O4 magnetic nanoparticles for separation of the CD117-expressing cancer stem cells

Authors: A.M. Demin, A.V. Ponomarev, A.E. Barmashov, O.S. Burova, M.A. Baryshnikova, V.P. Krasnov, Postovsky Institute of Organic Synthesis of RAS (Ural Branch), senior resercher

Abstract: The Fe3O4 magnetic nanoparticles (MNPs) modified by N-(phosphonomethyl)iminodiacetic acid and then conjugated to ICO406 antibodies to c-kit (CD117) were obtained and characterized by the physicochemical methods. The antibody immobilization on the MNP surface was carried out using 1-ethyl-3-(3-dimethylaminopropyl) carbodiimide. It has been demonstrated that MNPs obtained are highly efficient in immunomagnetic separation of the CD117-positive stem cells from the disseminated melanoma cells. The work was partially supported by RFBR (14-03-00146).

P36) Effect of methods for wo3 and tio2 layers deposition upon the performances of electrochromic devices based thereon

Authors: V.V.Bakhmetyev, D.O.Amosov, E.V.Sokhovich, V.S.Zemko, S.V.Mjakin, A.A.Eruzin, Saint-Petersburg State Institute of Technology (Technical University),

Abstract: Electrochromic materials based on tungsten oxide are widely applied in various devices with adjustable optical transparency. In addition to WO3 reversibly turning to blue color depending on the applied voltage and current, other components of electrochromic devices also affect their performances. Of particular importance is a layer often comprising titania and providing the electron discharge at voltage polarity changes during coloration-bleaching cycles.

In this study the efficiency of WO3-TiO2 based electrochromic windows is comparatively studied depending on the method of each layer deposition, including sol-gel synthesis and magnetron sputtering. The highest coloration efficiency is achieved in the case of TiO2 magnetron deposition under optimal conditions in combination with WO3 layer synthesis using a sol-gel technique involving metal tungsten conversion into poly(peroxotungstic) acid (PPTA) followed by drip drying, PPTA alcosol preparation and hydrated tungsten oxide deposition onto a glass support with a SnO2:F conducting coating. The study is supported by the RFBR grant No. 14-07-00277 and Department of Chemistry and Materials Science of the RAS (Program No.7).

P37) Modeling AMF impact on kinetics of drug release from MNP carriers

Authors: Y. Golovin[1-3], D. Golovin[2], N. Klyachko[1, 3], A. Majouga[1, 3], A. Kabanov[1,4]
[1]M.V. Lomonosov Moscow State University, Chemistry Department. 1, Leninsky Gory., Moscow, Russia, tel. / fax: +7 (495) 9391671
[2] G.R. Derzhavin Tambov State University, Nanocenter, 33, Internatsionalnaya st., Tambov, Russia, tel. / fax: +7 (4752) 532680
[3]National Research Technological University "MISIS", 4, Leninsky ave., Moscow, Russia, tel. / fax: +7 (495) 2372226
[4]Center for Nanotechnology in Drug Delivery, UNC Eshelman School of Pharmacy, University of North Carolina at Chapel Hill, NC, 27599, USA

Abstract: Various plausible acceleration mechanisms of drug release from nanocarriers composed of single domain magnetic nanoparticle core with attached long macromolecule chains incited by low frequency alternating magnetic field are discussed. The most important system characteristics affecting the MF exposure impact are determined. Impact of several reasonable mechanisms is estimated analytically or obtained using numerical modeling. Some cases providing manifold release acceleration as a result from exposure in MF are found.

P38) Wall morphology of chitosan-based hollow cylindrical materials with a layered structure

Author: Natalia Gegel, Saratov State University

Abstract: Chitosan is a biocompatible aminopolysaccharide, which predetermines its use in bioengineering. This polymer exhibits polycationic properties in an acidic medium and, under certain thermodynamic conditions, can generate 3D layered structures. These structures have valuable

prospects for practical use as drug delivery systems, hydrogels, rods, vascular prostheses, etc. The presence of amino groups in the chitosan macromolecule determines the conditions of its dissolution, essentially depending on pH. In an acidic medium the side amino groups are protonated to form a water-soluble chitosan polysalt, while in an alkaline medium the saltic groups are converted into amino groups to form an insoluble polybase.

In this paper, this reaction of polymer-analogous polysalt → polybase conversion was used to prepare chitosan-based hollow cylindrical materials (microtubules) with an internal diameter of 0.5–5 mm and a wall thickness in the micron range. Microtubules were prepared from aqueous acidic chitosan solution with inorganic and organic alkaline agents (salting-out agents). Scanning electron microscopy revealed that the microtubule wall had a layered structure, the transverse dimension of each layer varying within 1.5–9.0 μm. The influence of the salting-out agent nature on the wall morphology and the size of fragments of the layered structure of the microtubule was established. The formation of this layered structure is explained in terms of the Liesegang rings phenomenon. Presumably, frontal diffusion of the salting-out molecules in a chitosan solution is accompanied by layer-by-layer deposition of macrochain sections. This may be due to a significant difference in the diffusion coefficients of high- and low-molecular-weight reagents and the effect of the formation of an entanglement network of fluctuating nature in the polymer solution. Our chitosan microtubules can be considered as a promising model for the replacement of damaged capillary vessels and nerves.

P39) Theranostic multimodal potential of magnetic nanoparticles actuated by non- heating low frequency magnetic field in the new generation nanomedicine

Author: Alexander Zhigachev, Derzhavin Tambov State University

Abstract: Most promising branches of new generation biomedicine are presented. namely magnetic nanotheranostics using remote control of functionalized magnetic nanoparticles (f-MNPs) by means of alternating magnetic fields (ACMF) and is mainly focused on new approach which utilizes non-heating low frequency magnetic fields (LFMF). This approach is compared to traditional ones which utilize radio frequency heating ACMF, like magnetic resonant imaging (MRI) and radio frequency magnetic hyperthermia. Innovation principles and specific models of biostructures' non thermal magneto-mechanical actuation by MNPs' rotational oscillational motion in LFMF are described. Discussed instrumentation family allows monitoring biostructures in situ, delivering drugs to target tissues and releasing them with controlled rates, controlling biocatalytic reaction kinetics, inducing malignant cells apoptosis and more. Parameter optimization of LFMF effect on f-MNPs and subsequent f-MNPs impact on molecular targets may improve treatment efficiency, locality and selectivity on molecular or cellular levels and allow implementing both drug and drugless, i.e. pure nanomechanical, therapy, in particular anti-cancer therapy.

It is shown that specifically designed high gradient MF enables therapy impact localization in the internal tissues in the region ranging from fraction of millimeters to a few centimeters and controlled 3D scanning of affected region if necessary. The approach described above has many advantages over known ACMF utilizing diagnostics and therapy strategies such as versatility, high penetrability to the tissues, ease of dosage and control, molecular level of localization, higher safety and lower cost.

P40) Influence of amplifiers on permeability of a prokaine through a skin membrane of in vitro

Authors: Galina N. Naumova, National Research Saratov State University
Chernova R.K., Doronin S.Yu., Danchuk A.I., Selifonova E.I., Aleshkina O.Yu., Zagorovskaya T.M., Syrova O.B., Glukhovskoy E.G.

Abstract: One of actual problems of modern medicine is search of alternative ways of introduction of the medicinal substances (MS) to a human body. One of possible ways is creation the transdermal of the therapeutic systems founded on a mass transfer of drugs through a membrane of skin of the person and possessing a number of advantages in comparison with oral administration of drugs.

Experiment was made by in vitro in the special two-cell-like chamber consisting of donor and acceptor chambers. As a membrane skin of the person has been used.

In this work influence of some amplifiers of permeability of drugs on a mass transfer of a procaine through a skin membrane was studied. Parameters of a mass transfer of a procaine in absence and in the presence of amplifiers are determined: stream of ions, diffusion coefficient, permeability coefficient, coefficient of activity of penetration. The made experiment has allowed to simulate the mechanism of penetration of a procaine through a skin barrier. The calculated parameters of a mass transfer allow to estimate the mechanism of operation of amplifiers of permeability of a procaine through a skin barrier.

The research supported by grant of the Russian Science Foundation (project №14-12-00275) and the National Research Saratov State University

P41) Synthesis of nanozised Y2O3:Eu and YAG:Eu luminescent phosphors and characterization of their surface properties

Authors: Tamara S. Minakova, National Research Tomsk State University
T.S.Minakova1, O.N.Panysheva1, V.V.Bakhmetyev2, S.V.Mjakin2, L.A.Lebedev2, A.B.Vlasenko2, A.A.Nikandrova2, S.P.Bogdanov2, M.M.Sychov2
1Tomsk National Research State University, Tomsk, Russia
2Saint Petersburg State Institute of Technology, St.Petersburg, Russia

Abstract: One of the most important factors providing the efficiency of luminescent phosphors in medical applications relates to their surface properties responsible for biocompatibility, interactions with the applied drugs and luminescence behavior. In this study the surface properties are characterized for nanosized Y2O3:Eu and YAG:Eu medical purpose phosphors obtained using Pechini method and self-propagating high temperature synthesis.
IR spectroscopy of their surface revealed the presence of hydroxylated carbonates probably due to the destruction of organic ingredients in both of the synthesis procedures yielding carbon-containing products incompletely removed at the subsequent annealing.
Measuring pH change kinetics of water upon suspending the phosphor samples indicated weakly basic properties of both Y2O3:Eu and YAG:Eu surfaces and increase in their basicity with Eu content.
A model describing the composition of acid-base centers with various pKa values on the surface of YAG:Eu phosphors is suggested on the basis of the obtained results.
The reported study was funded by RFBR according to the research project No. 16-33-00998 мол_а.

P42) Features of synthesis and structure of MOF UiO-66 for hydrogen storage

Author: Tatiana S. Priamushko, Tomsk Polytechnic University

Abstract: 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.

P43) Features of monolayers formation of arachidic acid–naphthalene mixtures

Author: Elena M. Soldatenko, National Research Saratov State University

Abstract: Nowadays approach to the preparation of graphene based layered structures actively studied. The most promising technology for obtaining of large surface area graphene is 'bottom-up' approach (graphene sheets self-assembly of the polycyclic aromatic hydrocarbon individual molecules). A typical representative of this approach is the Langmuir-Blodgett method.
In the present work we investigated the of Langmuir monolayers consisting of arachidic acid and naphthalene mixture. We have calculated the area per molecule by method of compression isotherms. Area per unit of arachidic acid molecules in a solid state condition varied slightly. This indicates the absence of naphthalene molecules embedded in the space between the aliphatic groups of the surfactant molecules.

Furthermore, character of the pi-A curves in the collapse indicated of the evidence of the naphthalene presence in the multilayer structure and its impact on the formation of wrinkles. In order to explain of this specificity is assumed that amount of embedded between surfactants layers naphthalene molecules increases with increasing its share in arachidic acid solution at multilayer structure formation.

The research supported by grant of the Russian Science Foundation (project №14-12-00275) and the National Research Saratov State University.

May, 14, Saturday

Poster Session #4
P44-P55

P44) Application of scanning tunneling microscopy for analysis of CdSe/CdS/ZnS quantum dots electron structure
Author: Yaroslav E. Pereverzev, National Research Saratov State University
Abstract: The CdSe/CdS/ZnS quantum dots monolayer were formed with Langmuir Blodgett technique and transferred on a solid substrates of glass with ITO (InSt oxide). The scanning tunneling microscopy (STM) were used in the present work for analysis of quantum dots films electrical properties in particular electron spectrum. A few peaks were observed in the normalized differential I(V) on samples at the studied voltage range. Existing of these peaks could be explained by the tunneling of electrons from quantum dots permitted states in the STM probe. Comparing of data received with TEM and theoretical calculations shows match quantitative and qualitative in the quantum object size 8 – 9 nm. The analysis of studied quantum object electron spectrum features allows assess a first three energy level location counted from the bottom of bulk material conductive band.
The research is supported by grant of the Russian Science Foundation (project №14-12-00275) and the National Research Saratov State University.

P45) The Langmuir films of quantum dots mixed with liquid crystal formation
Author: Alexey S. Chumakov, National Research Saratov State University
Abstract: At present, the quantum dots are very interesting and promising material for photovoltaic devices. One of the most important applications of devices with quantum dot layers is a solar cell. Quantum dots (CdSe/CdS/ZnS) and liquid crystal (4'-n-octyl-4-p-cyanobiphenyl) Langmuir monolayers at the water-air surface have been studied by method of surface pressure-area isotherm. We choose this thin-film forming method because it is simple and not expensive, and yields perfect layers with quantum dots. In addition, the stabilization of quantum dots dispersion in liquid crystal matrices has been studied. Monolayers on the water surface and films on solid substrate were obtained at various conditions: concentration, different mixed ratio and different temperature. With some conditions we can have true-monolayer – without forming complex three-layer structure of liquid crystal. Films morphology has been studied by AFM and STM methods. The conditions under which the film covered substrate homogeneously have been achieved.
The research supported by grant of the Russian Science Foundation (project №14-12-00275) and the National Research Saratov State University

P46) Optical and electronic properites of graphene-based materials
Author: Olga Sedelnikova, Nikolaev Institute of Inorganic Chemistry SB RAS, Russia
Abstract: Graphene, a one-atom-thick material, is very promising material for a wide range of practical applications. Ideal graphene has the linear dispersion of π-bands around the K point and has the highest electron mobility of any known materials. However, it appears that graphene surface could contain structural defects which may change electronic, transport, optical, and plasmonic properties, and this is the main concept of nanoengineering of defect structures on graphene.
Recently it was showed that deformation of graphitic surface can change electronic band structure and electron excitation properties notably. The density of states depends sensitively on the local curvature of corrugated layer affecting optical response. The bending of graphite layer or stacking order was found to remove restrictions on the electron transitions being forbidden in the flat material for certain light polarization. As a result, for both rippled and twisted graphene-based materials new peculiarities in the optical absorption spectrum and EEL spectrum were found. The results performed in our work

showed that both optical absorption and plasmonic properties of graphite-like structures can be controlled by simple deformation of network without any topological changes that could potentially be used in optoelectronic devices.

This work was supported by the Russian foundation for Basic Research (Grant 16-33-00515).

P47) The plasmonic photothermal therapy effects on transplanted tumors in rats

Author: Alla Bucharskaya, Saratov State Medical University

Abstract: The aim of this study was to evaluate the morphological changes in transplanted liver tumors after multiple intravenous administration of gold nanorods (GNR) and plasmonic photothermal therapy (PPTT). Methodology. 24 male outbred albino rats with transplanted liver cancer PC-1 were randomly divided into three groups (6 rats in group): group 1 - without exposure, group 2 - with a single injection of GNR and PPTT, group 3 - with double injections of GNR and PPTT, group 3 - with triple injections of GNR and PPTT. Size of the nanorods was 41±8 nm (length) and 10±2 nm (diameter), and concentration of the nanorods in the suspension was 400 μg/ml, which corresponds to optical density of 20 at 808 nm. To prevent nanoparticles aggregation in biological tissue and enhance biocompatibility nanoparticles were functionalized with thiolated polyethylene glycol. One day after injection the tumors were irradiated by the NIR 808-nm diode laser LS-2-N-808-10000 (Laser Systems, Ltd., St.-Petersburg, Russia) during 15 min at power density 2.3 W/cm2. Temperature control of the tumor heating was provided by IR imager IRI4010 (IRYSYS, UK). The withdrawal of the animals from the experiment and sampling of tumor tissue for morphological study were performed 24 hours after the PPTT. The standard histological staining was used for morphological study of transplanted tumors. The determination of gold concentration was conducted for 1 g of tumor tissue by atomic absorption spectroscopy on spectrophotometer Dual Atomizer Zeeman AA iCE 3500 (Thermo Scientific Inc., USA).

After triple intravenous injection of gold nanorods the maximum gold content was revealed in the tumor tissue and PPTT had most pronounced damaging effect in rats with transplanted tumors manifested in necrobiotic changes of tumor cells.

P48) Special behavior of calcium fluoride in adsorption, photo-sorption and donor-acceptor interactions

Authors: Irina A. Ekimova, SSMU

Special behavior of calcium fluoride in adsorption, photo-sorption and donor-acceptor interactions

Irina Ekimova1, Tamara Minakova2, Evgeny Meshcheryakov2, Mariya Tikhonova3

1Siberian State Medical University, Tomsk, Russia

2National Research Tomsk State University, Tomsk, Russia

3Tomsk State University of Control Systems and Radioelectronics

Abstract: In this paper a comprehensive study of the adsorption, photo-sorption, x-ray sorption, photo-catalytic and donor-acceptor surface properties of the alkaline earth metal and magnesium fluoride is conducted. It is shown that the calcium fluoride has a number of features within the range of magnesium, calcium, strontium and barium fluorides. This is the predominance of aprotonic acid centres on the surface, confirmed by the method of pH meters, adsorption Hammett indicators and IR spectroscopy for CO adsorption; less strong interaction with water vapor together with a larger capacity of monolayer coating; photo-sorption ability in relation to simple gases (02, H2, CH4, CO, CO2) which does not fit to the periodic pattern; oxygen x-ray sorption, associated with X-ray radiation induced by color centers; activity in the dark reactions of hydrogen oxidation, photo-oxidation of H2, CO, photolysis of CO2.

The estimation of different types of CaF2 heat treatment influence on the surface properties showed that acid-base surface parameters were changed in the strongest way in the course of a sample serial training in oxygen and then in hydrogen.

The originality of calcium fluoride behavior was explained as the peculiarities of calcium and fluorine atoms electronic structure. These regularities of experimental nature allowed suggesting a quantum-chemical model of the processes occurring on calcium fluoride surface in the aquatic environment.

P49) The Influence of the Electron Beam on the Structural and Energetic State of Aluminum Nanopowder

Author: Andrei Mostovshchikov, Tomsk Polytechnic University, Russia

Abstract: The influence of electron beam irradiation (360 keV) on the thermo chemical properties of aluminum nanopowder was investigated. The aluminum nanopowder was obtained in the conditions of electric explosion of an Al conductor in the argon atmosphere using the equipment UPG-4G, developed in Tomsk Polytechnic University. Aluminum nanopowder consisted of spherical particles, the distribution of which was close to lognormal with the maximum at 120 nm. It was established, that thermal oxidation effect increased by 20 % after electron beam treatment according to the data obtained by differential thermal analysis. Furthermore, using X-ray diffraction method it was revealed, that in the aluminum crystal lattice micro tension increased and coherent scattering region decreased 1.5 times. Hence, electron beam treatment changed structural and energetic state of aluminum nanopowder. There was formed structure with high stored energy in aluminum nanopowder. Apparently, stability of oxide-hydroxide shell on the nanoparticly surface decreased due to high-energy electron beam treatment.

P50) Photocatalytic coatings with improved sorption and mechanical characteristics based on modified potassium polytitanate and polyvinyl butiral

Author: Igor Burmistrov, Saratov State Technical University of Yu. A. Gagarin

Abstract: This paper present research on the properties of multilayer photocatalytic composite coatings based on polyvinyl butyral filled with potassium polytitanate. The composite coating consists of two layers: substrate of polyvinyl butyral modified with crosslinking and adhesive agent and photoactive layer comprising polyvinyl butyral binder and photocatalytic filler based on potassium polytitanate. Both layers was obtained by polyvinyl butyral dissolving in ethyl alcohol and adding into the solution

P51) Adhesion properties of silver-containing three layer hydroxyapatite coatings

Author: M.S. Tkachev, M.A. Surmeneva, R.A. Surmenev, Tomsk Polytechnic University, Russia

Abstract: A three-layer system of hydroxyapatite – Ag nanoparticles – hydroxyapatite (HA-AgNPs-HA) coating with an thickness of 1.2 μm was formed by combination of methods of radio-frequency (RF) magnetron sputtering and electrophoretic deposition. Radiofrequency sputtering was used to prepare HA layers, AgNPs layer produced by electrophoretic deposition method. Energy-dispersive X-ray spectroscopy, method wos used to study of presence of AgNPs. Adhesion of coatings was investigated by scratch test method. Scanning electron microscopy and optical microscopy used to qualitatively estimate the deformation mechanisms of the biocomposites after the scratch test.

P52) Investigation of the Morphology and Wettability of Hydroxyapatite Coating Deposited on the Surface of AZ31 Magnesium Alloy

Author: E.S. Melnikov, M.A. Surmeneva, R.A. Surmenev, Tomsk Polytechnic University, Russia

Abstract: Hydroxyapatite (HA) coating was fabricated by means of radio frequency (RF) magnetron sputtering using the target of pure HA powder, which was prepared by mechanochemical activation method. The magnesium alloy (AZ31) samples were polished and ultrasonically cleaned in acetone, deionized water and then dried at room temperature. The morphology and wettability parameters were investigated using scanning electron microscopy and contact angle measuring system, respectively. The HA coating with the thickness of 970 nm was deposited. The coating homogeneously covered the surface of the substrate. The wettability studies demonstrated that the HA coating significantly affected wettability parameters of the bare AZ31 magnesium alloy. RF-magnetron sputtering allowed

to produce the HA coating with a lower water contact angle and a higher free surface energy. Thus, based on the obtained results, it is concluded that the increase in the surface energy, in particular, the increase in the polar component of the surface energy as well as the change of the surface chemistry, surface hydrophilicity and water contact angle can improve interaction between surfaces and cells. Therefore, the HA coated AZ31 magnesium alloy is a prospective material for biomedical applications.

P53) Polylactide and hydroxyapatite based composites. Features of the structure and biochemical properties

Authors: Shapovalova Ye.[1], Susukina V.[1], Kzhyshkowska Yu.[1,2], Kurzina I.[1]
[1]National Research Tomsk State University, 36, Lenina ave., Tomsk, 634050, Russia
[2] Institute of Transfusion Medicine and Immunology, Medical Faculty Mannheim, University of Heidelberg, Theodor-Kutzer Ufer 1-3, Mannheim, 68167 Germany

Abstract: The composites based on polylactide (PL) and hydroxyapatite (HA) with the content of components 50:50 and 75:25 were examined in a present study. PL and HA were mixed at 40 C, which was followed by the sonication procedures and its precipitation in ethanol. The analysis of the following composite materials revealed that their chemical-crystallographic characteristics of individual components remained intact after varying its dispersion and material crystallinity degree. PL-HA material of the ratio 75:25 were characterized by the lowest degree of crystallinity - 20.5 % and the average crystallite size up to 28.8 nm showed an increased roughness and dispersive component of surface energy. In comparison to PL the composite has a high capacity for osseointegration. Assessment of the immune system cells showed that the macrophages are most viable in the presence of pure PL and composite PL-HA 75/25; the intense secretion of proinflammatory cytokines was not detected. In total, the findings of our study confirmed that the composite materials based on the polylactide and hydroxyapatite are good perspective for obtaining of biocompatible and bioresorbable implants for the bone tissue regeneration.
This Research is supported by Tomsk State University Competitiveness Improvement Program. The work was partially supported by the project Russian Foundation for Basic Research RFBR # 15-08-05496_a.

P54) Hybrid biocomposites of silver nanoparticles and hydroxyapatite coating on the surface of titanium

Authors: A.A. Sharonova, M.A. Surmeneva, M. Epple, R.A. Surmenev, Tomsk Polytechnic University, Russia, University of Duisburg-Essen, Germany

Abstract: 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: 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). 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.

P55) Nanomechanical Actiation of Biochemical Systems by Magnetic Nanoparticles

Authors: Y. Golovin, S. Gribanovsky, D. Golovin, A. Zhigachev, N. Klyachko, A. Majouga, M. Sokolsky, A. Kabanov, Derzhavin Tambov State University