Third regional roundtable: Refractory, process industry, nanotechnologies and nanomedicine

ROSOV PINN 2017

Mountain Avala, Belgrade, Serbia
June 1-2, 2017

Programme and The Book of Abstracts

Organized by:
Serbian Society for Nanotechnologies and Nanomedicine
Serbian Society for Refractory and Process Industry
Vinča Institute of Nuclear Sciences, Belgrade
Lafarge BFC d.o.o. Beočin
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Dear colleagues,

We are pleased to welcome you on the mountain Avala, at the Third regional roundtable "Refractory, process industry, nanotechnologies and nanomedicine", ROSOV PINN 2017.

The roundtable is organized in four different parts: Refractory, including the preparation of mineral raw materials; Process industry, including the cement industry, glass industry, iron and steel and non-ferrous metallurgy; Nanotechnologies, which covers the general principles of nanotechnology and its place in the development of materials for special applications including alternative energy sources, sensors, carbon materials, etc.; and Nanomedicine including bone tissue engineering, dental materials, drug delivery, imaging agents, etc.

The desired intention of the organizers is to collect as many corporate actors, including producers, consumers and providers of services in the field of refractory and process industry in particular, and to open innovative ways of the penetration of new technologies based on nanotechnology in various types of industry, in order to create entirely new products. Completely new approaches and technological concepts are welcome.

We hope that you will have a nice time at our conference and establish new connections with your colleagues from scientific institutions and experts from the industry.

On behalf of the Organizing and Scientific Committee

Vukoman Jokanović

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Programme

General conference program

Thursday, June 1st 2017

08^{00}-09^{00} Registration

09^{00}-09^{30} Opening ceremony

09^{30}-11^{45} Plenary lectures

11^{45}-12^{15} Coffee break

12^{15}-13^{55} Invited lectures

13^{55}-15^{30} Lunch break

15^{30}-17^{35} Invited lectures

18^{00}-19^{30} Poster session

20^{00} Gala dinner

Friday, June 2nd 2017

09^{00}-10^{30} Plenary lectures

10^{30}-11^{00} Coffee break

11^{00}-12^{40} Invited lectures

12^{40}-13^{00} Break

13^{00}-14^{00} Closing ceremony and awards

Program of lectures

Thursday, June 1st 2017

Plenary lectures: 09^{30}-11^{15} (Hall 1)

Chairmen: Vukoman Jokanović, Milenko Plavšić

09^{30}-10^{15} **Graphene quantum dots – confining Dirac electrons**
Florian Libisch
Institute for Theoretical Physics, Vienna University of Technology, Vienna, Austria

10^{15}-11^{00} **NMR studies of intrinsic fields in ferromagnetic carbon**
Miroslav Požek
Department of Physics, Faculty of Science, University of Zagreb, Zagreb, Croatia

11^{00}-11^{45} **Importance of polymer-silicone interactions**
Milenko Plavšić
Faculty of Technology and Metallurgy, University of Belgrade, Belgrade, Serbia

Break until 12^{15}

Invited lectures: 12^{15}-13^{55}

Section: Refractory and Process industry (Hall 1)
Chairmen: Tatjana Volkov-Husović, Milorad Tomić

12^{15}-12^{40} **Why did that roll break?**
Vyacheslav Goryany
Karl Buch Walzengiesserei GmbH & Co. KG., Siegen, Germany

12^{40}-13^{05} **Implementation of image analysis on monitoring degradation of refractory samples: cavitation erosion behavior of mullite, zircon silicate and cordierite samples**

Tatjana Volkov Husović
Faculty of Technology and Metallurgy, Belgrade University, Belgrade, Serbia

13^{05}-13^{30} **Development of production technology of welding fillers in Serbia**
Nikola Bajić
Research and Development Center, IHIS Techno-experts d.o.o., Belgrade, Serbia

13^{30}-13^{55} **Sage extract as an inhibitor of steel and copper corrosion**
Milorad Tomić
University of Eastern Sarajevo, Faculty of Technology Zvornik, Republic of Srpska

Section: Nanotechnology (Hall 2)

Chairmen: Ivana Validžić, Ilija Nasov

12^{15}-12^{40} **Preparation and characterization of TiO_2 and ZnO nanostructures**
Andreja Gajović
Ruđer Bošković Institute, Zagreb, Croatia

12^{40}-13^{05} **Fundamental understanding of electronic and optical properties of the synthesized Sb_2S_3 material and possible application**
Ivana Validžić
Vinča Institute of Nuclear Sciences, University of Belgrade, Belgrade, Serbia

13^{05}-13^{30} **PVD nano coatings for optical applications**
Ilija Nasov
PLASMA – Center for Plasma Technologies, Skopje, R. Macedonia

13^{30}-13^{55} **Influence of oxygen-containing surface functional groups on charge storage properties of graphene oxide**
Zoran Jovanović

Vinča Institute of Nuclear Sciences, University of Belgrade, Belgrade, Serbia

Section: Nanomedicine (Hall 3)
Chairmen: Stevo Najman, Suzana Šegota

12^{15}-12^{40} **Neuroprotection and neuronal recovery under the oxidative stress achieved by enhanced lipid membrane interaction with flavonoids**
Suzana Šegota
Ruđer Bošković Institute, Zagreb, Croatia

12^{40}-13^{05} **Reprogramming of N-glycan biosynthesis and lipid metabolism in cancer**
Romana Masnikosa
Vinča Institute of Nuclear Sciences, University of Belgrade, Belgrade, Serbia

13^{05}-13^{30} **New approach to principles of energetic cell treatment**
Vukoman Jokanović
Vinča Institute of Nuclear Sciences, University of Belgrade, Belgrade, Serbia

13^{30}-13^{55} **Bone tissue engineering with triad-bioceramics, adipose mesenchimal cells, PRP**
Stevo Najman
Faculty of Medicine, University of Nis, Niš, Serbia

Lunch break until 15^{30}
Invited lectures: 15^{30}-17^{35}

Sections: Refractory and Process industry (Hall 1)
Chairmen: Milenko Rimac, Goran Lazić

15^{30}-15^{55} **Investigation of structure of NiCrAlY metal powder and coating deposited by diamond jet method**
Milenko Rimac

American University in Bosnia and Herzegovina, Tuzla, Bosnia and Herzegovina

15^{55}-16^{20} **Characterization of composite bioinert coating APS-Al_2O_3 25% w/w (ZrO_2-8%Y_2O_3) obtained by plasma spray method**
Mihailo Mrdak
Research and Development Center, IMTEL Communications a.d., Belgrade, Serbia

16^{20}-16^{45} **Defect inspection and demolition of the worn refractory wall**
Goran Lazić
Lafarge BFC, Beočin, Serbia

16^{45}-17^{10} **Technological development of steel production in Bosnia and Herzegovina from 1891 to 2016**
Sulejman Muhamedagić
Faculty of Metallurgy and Materials, University of Zenica, Bosnia and Herzegovina

Section: Nanotechnology (Hall 2)
Chairmen: Duško Borka, Nataša Jović Orsini

15^{30}-15^{55} **Charged particles interactions with carbon nanostructured materials**
Duško Borka
Vinča Institute of Nuclear Sciences, University of Belgrade, Belgrade, Serbia

15^{55}-16^{20} **Deposition of thin films using spray pyrolysis**
Nenad Radić
Institute of Chemistry, Technology and Metallurgy, Belgrade, Serbia

16^{20}-16^{45} **Tuning of magnetic heating by changing magnetic anisotropy in monodisperse and crystalline iron oxide-based nanoparticles**
Nataša Jović Orsini
Vinča Institute of Nuclear Sciences, University of Belgrade, Belgrade, Serbia

16^{45}-17^{10} **Oxide layers on alumina and their application in nanotechnology**
Bećko Kasalica
Faculty of Physics, University of Belgrade, Belgrade, Serbia

Section: Nanomedicine (Hall 3)
Chairmen: Vesna Babić Ivančić, Božana Čolović

15^{30}-15^{55} **Biomineralization – how to investigate it?**
Vesna Babić Ivančić
Ruđer Bošković Institute, Zagreb, Croatia

15^{55}-16^{20} **Bioactive coatings on the surface of titanium implants**
Božana Čolović
Vinča Institute of Nuclear Sciences, University of Belgrade, Belgrade, Serbia

16^{20}-16^{45} **Dental anthropology of prehistoric period on the territory of Serbia**
Đurica Grga
Faculty of Dentistry, University of Belgrade, Belgrade, Serbia

16^{45}-17^{10} **Physico-chemical properties of nanostructured cements based on calcium silicates**
Violeta Petrović
Faculty of Dentistry, University of Belgrade, Belgrade, Serbia

17^{10}-17^{35} **Nanostructural biomaterials: a pathway to clinical usage**
Vanja Opačić Galić
Faculty of Dentistry, University of Belgrade, Belgrade, Serbia

18^{00}-19^{30} Poster session

Friday, June 2nd 2017

Plenary lectures: 09^{00}-10^{30} (Hall 1)

Chairmen: Maja Dutour Sikirić, Miroslav Požek

09^{00}-09^{45} **Calcium phosphates revisited: How well their formation can be controlled?**
Maja Dutour Sikirić
Ruđer Bošković Institute, Zagreb, Croatia

09^{45}-10^{30} **X-ray photoelectron spectroscopy and its application in the analysis of industrial materials**
Nenad Bundaleski
New University of Lisbon, Faculty of Science and Technology, Caparica, Portugal

Break until 11^{00}
Invited lectures: 11^{00}-12^{40}

Section: Nanomedicine (Hall 1)
Chairmen: Dejan Marković, Đorđe Antonijević

11^{00}-11^{25} **Electrochemical investigation of inhibition of different active drug substances in immobilized enzyme**
Safija Herenda
Faculty of Natural Sciences, University of Sarajevo, Sarajevo, Bosnia and Herzegovina

11^{25}-11^{50} **Application of nanomaterials in preventive and restorative dentistry**
Dejan Marković
Faculty of Dentistry, University of Belgrade, Belgrade, Serbia

11^{50}-12^{15} **Clinical aspects of ISO standards in dental fillings engineering**
Đorđe Antonijević
Vinča Institute of Nuclear Sciences, University of Belgrade, Belgrade, Serbia

12^{15}-12^{40} **Challenges and dilemmas related to the application of scaffolds in nanomedicine**
Vladimir Biočanin
Faculty of Pharmacy and Health, University of Travnik, Travnik, Bosnia and Herzegovina

Break until 13^{00}
Closing ceremony: 13^{00}-14^{00}

13^{00}-13^{45} Vedran Vučić and Dušan Spasić: **From mythology to metaphysics**

13^{45}-14^{00} Vukoman Jokanović: **Closing speech and awards**

Abstracts

Plenary lectures

Graphene quantum dots – confining Dirac electrons

F. Libisch

Institute for Theoretical Physics, Vienna University of Technology, Vienna, Austria

Graphene, the first truly two-dimensional solid, attracts considerable attention due to its unique electronical properties. With a nearly linear dispersion relation, the dynamics of electrons near the Fermi energy of graphene closely mimics that of a massless Dirac Hamiltonian. Moreover, the regular honeycomb lattice gives rise of pseudospin degeneracy, suggesting an analogy to Dirac four spinors. Envisioned applications range from high-speed electronics to spintronic and valleytronic devices that profit from the long spin-lifetime and the additional valley degree of freedom in the band structure of graphene.

Exploiting the special properties of the charge carriers in graphene requires precise manipulation of Dirac electrons. Quantum dots present an essential building block, yet providing tailored confinement in graphene has remained challenging: purely electrostatic confinement fails due to the gapless band structure of graphene while patterning graphene nanostructures leads to edges that strongly affect the properties of the highly symmetric graphene lattice. I will review recent experimental efforts and our large-scale tight-binding simulations to realize nanostructured graphene quantum dots and constrictions highlighting the dominant role of edge effects. Sandwiching graphene by hexagonal boron nitride strongly reduces bulk disorder, yet transport measurements and simulations still consistently show strongly broken valley symmetries. A promising alternative combines electrostatic confinement with magnetic fields to achieve smooth confinement yielding well-defined spin and valley symmetries in experiment and theory. Such an approach provides an ideal scaffold for future graphene-based valleytronic and spintronic devices.

NMR studies of intrinsic fields in ferromagnetic carbon

M. Požek[1], D. Pelc[1], I. Marković[1], T. Cvitanić[1], J. C. C. Freitas[2], W. L. Scopel[3], W. S. Paz[2], L. V. Bernardes[4], F. E. Cunha-Filho[4], C. Speglich[4], F. M. Araújo-Moreira[4]

[1]Department of Physics, Faculty of Science, University of Zagreb, Zagreb, Croatia
[2]Department of Physics, Federal University of Espírito Santo, Vitória, ES, Brazil
[3]Department of Exact Sciences, Federal Fluminense University, Volta Redonda, RJ, Brazil
[4]Department of Physics, Federal University of São Carlos, São Carlos, SP, Brazil

The prospect of carbon-based ferromagnetic materials is extremely interesting from fundamental point of view, and promising for various applications. Recently, bulk ferromagnetic graphite was produced by introducing high concentrations of defects into pristine graphite, providing the opportunity to investigate the microscopic origin of carbon ferromagnetism. Here we present an investigation of the intrinsic magnetic field in ferromagnetic carbon, studied by nuclear magnetic resonance (NMR) of the carbon nuclei. The nuclear resonant frequencies without external applied fields are a measure of the local intrinsic fields, giving direct insight into the magnetism of carbon-based materials. We find a clear ^{13}C NMR signal in magnetic graphite, persisting up to temperatures above 200 K and with all the characteristics of ferromagnetic NMR, showing that the material is indeed intrinsically magnetic. We compare our results to quantitative DFT calculations of the microscopic field, showing that the magnetism originates in polarized point defects in the graphite structure. Finally, we discuss unconventional domain dynamics in ferromagnetic graphite uncovered by dynamical NMR measurements.

Importance of Polymer-Silicone Interactions

M.B. Plavšić[1,2], I. Pajic-Lijaković[1], M.M. Plavsić[1]

[1]Faculty of Technology and Metallurgy, Belgrade University, Belgrade, Serbia
[2]Engineering Academy of Serbia, Belgrade, Serbia

Silicon is the eighth most common element in the Universe by mass, and over 90% of the Earth's crust is composed of silicate minerals. It is most widely distributed in dusts and sands as various forms of silicon dioxide (silica) or silicates. Still the scientific interest for silicates had been being quite low until the European rediscovering of porcelain. Nowadays, silica is widely applied to make fire brick, and a large set of refractory materials, being used in linings for furnaces, kilns, incinerators, and reactors. They are also used to make crucibles and moulds for casting glass and metals. Silicate minerals are also in white-ware ceramics an important class of products usually containing various types of fired clay minerals. In addition traditional glass (silica based soda-lime glass) is well known to function in many of the same ways, and is also used for windows and containers.

But, much less is known the importance of silicon compounds in the bio- and biological materials and for the medical purposes -in general. For example there are evidences that silicon is important to nail, hair, bone and skin health. There is also evidence that persons with higher dietary silicon intake have higher bone density and that silicon supplementation can increase bone volume and density in patients with osteoporosis. In another point of view, silicon has been shown to improve plant cell wall strength and structural integrity, improve drought and frost resistance, decrease lodging potential, and boost the plant's natural pest and disease fighting systems. How to explain such a broad and important influence upon living organisms, of so (apparently) simple structures as silicon compounds!? The exact reasons of all those end-effects of such various processes are not jet clear. Still some important conclusion about the challenging issues described, can be drown. All of them come from fundamental understanding of structure and dynamics of cell macromolecule

The background that shear all, so diverse phenomena mentioned, are obviously the interactions of silicon compound with proteins, present in all the living cells, and been so important for their functions. So we face quite fundamental issues of silicone – bio-polymer interactions, producing last years very interesting and quite the surprising results. That all will be

presented more in detail in the lecture, but here could be quoted results on silicon compounds influence of protein conformational changes, and aggregation of some proteins. Also adsorption of some of them onto negative – charged silicon based surfaces etc. But besides such chemically common situations, there is evidence of very fine tuning of metabolic networks and insulin production due to silicone.

Those "network effects" further support interests, for different design possibilities, coming from application of silicon compounds: as very fine particles been active fillers for elastomer networks, as silicon- elastomer implants in human surgery and silicone derivates in pharmaceutical industry, in particular for drug delivery systems. Some of present authors' original results will be described as illustration for those effects.

Calcium phosphates revisited: How well their formation can be controlled?

A. Selmani[1], V. Čadež[2], I. Erceg[1], S. Šegota[2], D. Domazet Jurašin[2], M. Dutour Sikirić[2]

[1]*Department of Physical Croatia Chemistry, Faculty of Science, University of Zagreb, Zagreb,*
[2]*Laboratory for Biocolloids and Interfaces, Division of Physical Chemistry, Ruđer Bošković Institute, Zagreb, Croatia*

Calcium phosphates (CaPs), main inorganic component of bones and teeth, attract attention of scientists for a number of years due to their role in the normal and pathological mineralization, as well as in industrial processes. However, despite the considerable interest, the mechanisms of CaPs precipitation in biomimetic conditions have not yet been fully elucidated.

Recent studies, performed using advanced characterization techniques, enabled deeper insight into the processes that occur at the nanoscale, as well as better understanding of the role that amorphous and metastable phases have in CaPs formation, both *in vitro* and *in vivo*[6]

In addition to broadening fundamental understanding of CaPs formation, this new insights opened a wide range of possibilities for the development of simple protocols for preparation of novel biomaterials.

X-ray Photoelectron Spectroscopy and its application in the analysis of industrial materials

N. Bundaleski[1,2]

[1]*Vinča Institute of Nuclear Sciences, University of Belgrade, Belgrade, Serbia*
[2]*Universidade Nova de Lisboa, Faculdade de Ciências e Tecnologia, Caparica, Portugal*

X-ray induced photoelectron spectroscopy (XPS) is a powerful surface sensitive analytical technique. Providing quantitative composition analysis with typical sensitivity of 0.1 % and reliable information on chemical bonds of the first 15-30 atomic layers, XPS is highly suitable for characterization of surfaces and nanostructures. Additionally, this technique also becomes a standard tool for material characterization including the analysis of biological and other non-conductive samples.

The main features in an XPS spectrum are photoelectron lines originating from core levels. Unlike most of the analytical techniques, analysis of photoelectron lines provides independently two sets of information – the composition from the line intensity and the chemical bonds according to their exact position and the shape. The overall information gained should be interpreted in a self-consistent way. This constraint appears to be a rigid filter in spectra analysis, preventing eventual misinterpretations.

Although mainly recognized as a scientific tool, XPS is now equally relevant in technological applications. An example of a field at which science strongly overlaps with application is corrosion, being a surface phenomenon that can be efficiently studied by XPS. One should have in mind that the samples originating from industrial practice significantly differ from 'scientific' ones. While the scientific research is mainly performed on well defined model systems, the former are usually non-uniform, of high roughness, containing defects and different impurities. Consequently, the approaches in XPS characterization of these two classes of samples should be very different in many cases.

In this talk, we will focus on the XPS characterization of materials encountered in industrial practice. The basic principles of XPS will be firstly introduced, including the general ways of spectra analysis. Particular attention will be paid to the analysis of in-depth and laterally non-uniform samples, as well as on the errors that appear when the nonuniformity is ignored. Then, several examples of XPS characterization will be showed, such as the surface analysis of stainless steel, analysis of industrial wastes (e.g.

red mud), aluminosilicates (geopolymers), but also different nanostructured materials (graphene, gold quantum dots buried in dielectric media, etc).

Invited lectures

Refractory and process industry

Why did that roll break?

V. Goryany[1], O. Myronova[2]

[1] Karl Buch Walzengiesserei GmbH & Co. KG., Siegen, Germany
[2] Institute of Metal Technologies, University of Duisburg, Duisburg Germany

The causes of a compound roll fracture have been investigated. The result of an FEM analysis showed that the occurring stresses could not have led to this fracture. The metallographic investigations in the area of the crack start site clearly have shown nonmetallic inclusions. They effect structural weak points and activate malfunctions. They have significantly accelerated the cracking process due to the local notch effect which significantly reduces the performance of the material and thus the service life of the roller shaft.

Implementation of image analysis on monitoring degradation of refractory samples: cavitation erosion behavior of mullite, zircon silicate and cordierite samples

T. Volkov Husović[1], M. Pavlović[1], M. Dojčinović[1], S. Martinović[2], M. Vlahović[2], Z. Stevic[3]

[1]University of Belgrade, Faculty of Technology and Metallurgy, Belgrade, Serbia
[2]University of Belgrade, Institute for Chemistry, Technology and Metallurgy, Belgrade, Serbia
[3]University of Belgrade, Technical Faculty Bor, Bor, Serbia

Cavitation erosion of mullite, cordierite and zircon silicate was investigated. Cavitation erosion test was applied using standard the ultrasonic vibratory cavitation set up with stacionary sample. Weight loss as well as

image analysis measurements were used for comparison of the different samples to the effects of cavitation. In this paper image analysis was implemented for monitoring degradation level during testing, as well as number of formed pits during the test, and their characteristics (average diameter and area). Thermal imaging analysis was focused on determination of temperature line profil histogram of temperature distribution at the end of experiment. Obtained results were be discussed in order to obtain optimal procedure to be followed for degradation determination caused by cavitation erosion.

Development of production technology of welding fillers in Serbia

N. Bajić

Research and Development Center, IHIS Techno-experts d.o.o.,
Belgrade, Serbia

Maintaining existing industrial equipment, production of modern devices and constructions requires large consumption of different quality welding fillers in Serbia. Serbia is a significant importer of welding fillers for the needs of almost all industrial branches, especially in the field of energy (thermal and hydroelectric power stations), mining (coal, non-ferrous metals, marbles etc.), extractive and processing metallurgy (steel mills, extraction and processing of copper and precious metals), shipbuilding (nine shipyards), machine building, automotive and military industries.

In order to substitute import and meet the basic needs of the domestic market for welding fillers, for a long time research activities have been directed towards the development of technology and mastering of experimental production of a large number of different quality welding fillers based on a significant share of domestic raw materials. The end result would be a new production facility in Serbia whose capacity should primarily meet domestic needs.

At the Research and Development Centre, IHIS Techno-experts d.o.o. Belgrade, a production technology for welding fillers was designed, a semi-industrial laboratory was equipped, new semi-industrial technological lines were designed and constructed, and also a part of the equipment for

semi-industrial production was purchased with the support of the Ministry of Science of Serbia. Using this production equipment test products were mastered on the basis of a significant proportion of domestic raw materials of satisfying quality. This created real preconditions for organized industrial production of fillers in the form of coated electrodes designed for the E welding process and flux-cored wires for the MIG / MAG, TIG and EPP welding processes and also auxiliary materials such as granulated agglomerated powder for the EPP welding process. Researchers at the Research and Development Center are working on the implementation and improvement of the designed technology and the development of new metallurgical qualities of fillers and auxiliary materials for welding until finding a strategic partner who would invest in launching the industrial production of welding fillers within Serbia.

Sage extract as an inhibitor of steel and copper corrosion

M.V. Tomić[1], M.G. Riđošić[1], R. Fuchs Godec[2], M.G. Pavlović[1]

[1]Faculty of Technology Zvornik, University of Eastern Sarajevo, Republic of Srpska
[2]Faculty of Chemistry and Chemical Engineering, University of Maribor, Slovenia

Protection of steel and copper from corrosion was caried out by processing corrosive environment using different concentrations of sage extract (0.5 g/dm^3, 1 g/dm^3 and 1.5 g/ dm^3) as a green inhibitor in 3% NaCl and 4% HCl solutions. The rates of steel and copper corrosion in the solutions prepared were measured using gravimetric analysis and electrochemical methods (the Tafel extrapolation method and electrochemical impedance spectroscopy).

The highest level of steel protection (z= 97.5%) in the 3% NaCl solution occurs with the concentartion of sage of 1.5 g/dm^3 for a six-hour time interval. Sage concentrations of 1.0 g/dm^3 and 1.5 g/dm^3 in the 3% NaCl solution exhibit a very good inhibitory action, since the average protction factors are z=78.5% and z=95.3% respectively. These results prove that sage can be used as a potential inhibitor of steel corrosion in the 3% NaCl solutions. Corrosion protection for steel in the 4% HCl is considerably lower, not more than z=64.5%, which means that sage can only be used as a green inhibitor for a shorter period of time.

The highest level of copper protection (z=60,04%) in the 3% NaCl is for the sage concentration of 1 g/dm^3, whereas for the concentration of 1.5 g/dm^3 it is z=53% for a six-hour time interval. However, the same solutions for the time intervals of 4 and 24 h have a catalytic action in the process of copper corrosion, so it is not recommended to use sage extract as a green inhibitor for copper in the 3% NaCl. The highest protection factor achieved in the 4% HCl is 59.96% in the solution which contains 1 g/dm^3 of sage extract. This value is not sufficient to recommend sage extract as an inhibitor of copper corrosion in the 4% HCl.

The results obtained from electrochemical measurements (electrochemical impedance spectroscopy, the Tafel extrapolation method) confirm the results obtained by gravimetric analysis, which makes them, therefore, recommendable as fast and reliable methods in corrosion testing.

Investigation of structure of NiCrAlY metal powder and coating deposited by diamond jet method

M. Rimac[1], M. Oruč[2], I. Bušatlić[2]

[1]American University in Bosnia and Herzegovina, Defense Technology Institute, Tuzla, Bosnia and Herzegovina
[2]Faculty for Metallurgy and Materials, University of Zenica, Bosnia and Herzegovina

Modern trends in the development of new materials are constantly setting new requirements regarding performance improvements and durability of materials in service. A special place is reserved for research of materials that operate at higher temperatures, wherein mechanical properties at high temperatures, creep, low cycle fatigue, and high-temperature corrosion are mainly investigated. One of the ways for improvement of the exploitation properties of materials which operate at higher temperatures is a method of surface modification, by deposition of metal coatings. Surface modification provides protection against high temperature, and also achievement of better material properties predicted for high temperature operating. In this work the microstructure of metal powder was investigated and NiCrAlY metal coatings were deposited onto superalloy A286, by the HVOF method process of Diamond Jet.

Investigation of microstructure of NiCrAlY metal powder and deposited metal coating, before and after the heat treatment were carried out using the

optical and scanning electron microscope, and by XRD structural analysis. Investigations have showed that the molten spherical particles of the metal powder of about 25μm in size, and metal coating consist of the same two phases: ϒ- a solid solution of chromium and nickel, and intermetal β-phase (NiAl) which is partially transformed to ϒ'- fazu (Ni_3Al) after the thermal treatment.

Investigations by scanning electron microscope, showed that the NiCrAlY metallic coating, consists of the molten and half-molten particles of metal powder, the rest of the broken particles (debris), and pores. In the structure of metallic coating the boundaries between the particles can be observed, as well as the boundary formed on the sphere between NiCrAlY metallic coatings and basic material of superalloy A286. The microstructure mainly consists of the following structural phases: ϒ- austenite (Ni), intermetal β-phase (NiAl), ϒ'- coherent intermetallic phase (Ni_3Al), α - aluminum oxide (Al_2O_3), yttrium oxide (Y_2O_3), and chromium oxide (Cr_2O_3). Identified yttrium oxide has a very important role in improving the performance of the coating.

Characterization of composite bioinert coating APS-Al2O3 25% w/w (ZrO2-8%Y2O3) obtained by plasma spray method

M. Mrdak

Research and Development Center, IMTEL Communications a.d., Belgrade, Serbia

Composites $Al_2O_3ZrO_2$ and $ZrO_2Al_2O_3$ are inert perspective biomaterials for use in implants due to their biocompatibility and mechanical properties that combine high flexural strength with high toughness. Ceramics Al_2O_3 has excellent biocompatibility and wear resistance, however, this ceramics has low flexural strength and toughness. In order to enhance the mechanical properties of Al_2O_3 ceramics, oxide ceramics ZrO_2 was added to it. Oxide ZrO_2 is inert in a physiological environment and has higher flexural strength, higher fracture toughness, and lower *Young's modulus*, compared with pure oxide Al_2O_3. Ceramics Al_2O_3 and ZrO_2 are extensively used for the production of hip prosthesis. By mixing both materials the mechanical strength can be increased. Also, the mix of ceramic materials

Al_2O_3 and ZrO_2 has a better resistance against uneven surfaces and damage under load during a luxation test compared to the pure ceramics Al_2O_3. The aim of this study was to analyze the mechanical characteristics (microhardness $HV_{0.1}$ and bond strength) and microstructure of the composite coating APS - $Al_2O_3(ZrO_2 8\%Y_2O_3)$ with a content of 25wt.%$ZrO_2 8\%Y_2O_3$ on an optical microscope (OM) and scanning electron microscope (SEM). Results of testing mechanical and structural characteristics indicate that the layers of ceramic coating $Al_2O_3ZrO_2$ can be successfully applied in orthopedic implants.

Defect inspection and demolition of the worn refractory wall

G. Lazić

Lafarge BFC, Beočin, Serbia

Defect inspection and demolition of the worn refractory wall are two of several very important, extensive and delicate operations, which make up the process of replacing the refractory wall on the production line of a raw material mixture, cement clinker. A very important factor is experience. Efficient and quality defect inspection is a prerequisite for safe and efficient performance of demolition of material within the plant of technological line, and thus for respecting deadlines in light of the available resources. We should know that defects inspection has more roles: 1. Collecting data on the location, size and stability of stickers in cyclones, pipelines, canals, and heat exchangers, hot gas generators and of course rotary kiln: 2. Collecting data on the position and the size of positions that would be subjected to reparation; 3. Creating a strategy for initial steps, weather for sticker demolition weather for the demolition of worn refractory wall.

Technological development of steel production in Bosnia and Herzegovina from 1891 to 2016

S. Muhamedagić, M. Oruč, I. Bušatlić, M. Rimac

Faculty of Metallurgy and Materials, University of Zenica, Bosnia and Herzegovina

More than hundred and twenty years metallurgy in Bosnia and Herzegovina represents a fundamental segment of Bosnian economic mosaic. Industrial production of iron in Bosnia and Herzegovina started with the construction of the first blast furnace in Vareš in 1891, which has processed Vareš ore. The concession for raising Ironworks in Zenica in 1892, have received the Austrian industrialists: The name of company was "Eisen und Sthalgewerkschaft Zenica" ("Association for Iron and Steel Zenica").

In Zenica the production and processing of steel has started in the summer of 1893, which was based on iron from Vareš and brown coal from Zenica, with capacity of 35 000 t/y. In the period from1947 to 1958 a new plants for the production and processing of steel with a capacity of 900 000 t/y were built. In the period between 1974 and 1982 a new production line of integrated steelworks was built, with the capacity of production and processing of steel of 1.3 million t/y. In 2005 a new technological line for electrical steel production with capacity of 1 000,000 t/y was put into operation.

For further operation of newly built drives Ironworks Zenica in 1958 it was necessary to provide a greater number of professional staff of metallurgical profession. On the initiative of Ironworks Zenica in 1961 the Faculty of Metallurgy and Metallurgical Institute were founded.

By linking production, education and science, educational and research activity has been updated according to the needs of the economy and society. In the rise of metallurgical practice and science in Zenica, Faculty of Metallurgy and Metallurgical Institute together have evolved, cooperated and assisted the Ironworks.

Nanotechnologies

Preparation and characterization of TiO_2 and ZnO nanostructures

A. Gajović[1], K. Juraić[1], M. Plodinec[1], D. Meljanac[1], D. Gracin[1], I. Panžić[1], J. Macan[2], I. Grčić[2], K. Salomon[3], N. Krstulović[3], M. Willinger[4]

[1] Ruđer Bošković Institute, Zagreb, Croatia
[2] Faculty of Chemical Engineering and Technology, University of Zagreb, Zagreb, Croatia
[3] Institute of Physics, Zagreb, Croatia
[4] Fritz-Haber-Institute der Max-Planck-Gesellschaft, Berlin, Germany

Thin films and one dimensional nanostructure arrays (in the form of nanorods, nanowires, and nanotubes) are of great interest because of their unique physical and chemical properties. Nanostructured ZnO has gained added interest because of its wide band gap (Eg ~ 3.37 eV) and large exciton binding energy (60 meV) with good carrier mobility, ease of synthesis and nontoxicity, while TiO_2 is known as material with excellent chemical and photochemical stability. TiO_2 exists in three different crystalline phases: anatase, rutile and brookite, but it was found that anatase (Eg ~ 3.2 eV) is photo-catalytically more active than other modifications. Ordered TiO_2 nanostructures, including nanoparticles, nanotubes, and nanorods have garnered much research for their use in solar energy applications. Nanotubes, which are aligned perpendicular to the conducting substrate, increase electron mobility within the nanotube by directing electrons along a shorter path than nanoparticles. The high surface area of nanotubes, compared to nanorods or flat surfaces, allows for more adsorption by electron donors such as molecular dyes, methil-amonium-halide perovskites and polymers, thus increasing solar photon absorption and charge collection. The possibility of modification the properties of nanostructured thin films of ZnO and TiO_2 for photovoltaic and photo-catalytic applications, by adjusting nanostructure and by activation of surfaces is explored.

ZnO is produced as film on glass or quartz, by deposition techniques as magnetron sputtering and pulse laser deposition, or on the other hand by spin coating of chemically prepared precursor using sol-gel method followed by annealing. Porous structures were formed by surface etching using plasma or fast heating. TiO_2 nanotubes arrays are formed by anodization of titanium foils or thin films spattered on transparent conductive oxide. For photo-catalytic application the surface was further modified by

processing in hydrogen atmosphere and/or modification with Ag nanoparticles. For structure characterization Raman spectroscopy, XRD methods, scanning and transmission electron microscopy methods were used. Optical properties were examined by UV-Vis spectroscopy, while photo-catalytic properties under sun-light and visible light was studied on salicylic acid as model pollutant.

The properties and application of different TiO_2 and ZnO nanostructures for photovoltaic cells as well as application of modified and decorated TiO_2 nanostructures for photo-catalysis will be presented.

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Fundamental understanding of electronic and optical properties of the synthesized Sb_2S_3 material and possible application

I. Lj. Validžić

Vinča Institute of Nuclear Sciences, University of Belgrade, Belgrade, Serbia

Since antimony sulfide´s (Sb_2S_3) could be a promising candidate in solar energy conversion industry (as an absorbing material), we concentrate on the detailed experimental and theoretical investigations of the structural, and generally poorly investigated electronic and optical properties of this synthesized material with desired electronic properties. Concerning the applications of this material in the area of photovoltaic devices, certainly one of the most important parameters is the band gap energy that determines what portion of the solar spectrum a photovoltaic cell will absorb. The main characteristic of the calculated electronic structure is the significant improvement of the band gap value. The values of experimental band gap energies, found for the synthesized Sb_2S_3 nanowires separated in the form of bundles and coalesced with each other in long bars, are lower than theoretical ones for approximately 0.3 eV. We explained those differences firstly by temperature differences, since the difference in the band gap energy at 300 K (at which experiments were performed) and at 0 K (which theory gives), for different semiconductors can vary between 0.10 and 0.22 eV. Unfortunately, there are no data concerning band gap energy difference (for

different temperature) for the semiconductor Sb_2S_3. Additional difference (assuming that the temperature difference makes a difference in energy of ~ 0.2 eV) of approximately 0.1 eV in the present work, can be explained by excitonic effects that cannot be neglected here due to the high calculated energy of an exciton. The excitonic effects calculated are important in understanding physical effects of the usage of Sb_2S_3 in solar cells and fundamental understanding of this semiconductor that missing so far in the literature. Obtained high dialectric constant ($\varepsilon \approx 11$), and in the same time high energy of exciton (probably Wannier- Mott excitons) ($Eex \approx 0.1$ eV and radius of exciton ax ≈ 0.9 nm ($me^* = 1.035me$ and $mh^*=1.843me$,)) make this semiconductor quite unique in comparison to other semiconductors used to date in solar cells, excitonic solar cells - Frenkel excitons. More detail analysis showed that there are arguments for the both basic types of excitons.

The semiconductor Sb_2S_3 surely could found better application, if we truly understand the electronic properties, such as band gap and energy of excitons, as important parameters for all processes concerning the solar energy device efficiency. In the same purpose, so in order to better understand Sb_2S_3 semiconductor we made a new Sb_2S_3/dye based working solar cell.

PVD nano coatings for optical applications

I. Nasov

PLASMA – Center for Plasma Technologies, Skopje, R. Macedonia

Surface engineering as a subset of materials science is changing the properties of the surface and sub-surface region of different materials in a desirable way. A variety of properties like physical, chemical, optical, mechanical, wear-resistant, corrosion-resistant properties at substrate surfaces can be altered by surface modification of materials.

In this work, physical vapor deposition (PVD) as method for surface modification and coating deposition on polymeric and metallic materials is described. The method is eco-friendly that can be managed at once, by one filling of PVD chamber, the cleaning, activation, surface modification and coating deposition occur consequently one by one process in the same PVD chamber.

Particularly, the novel selective nanocoatings are deposited on a polymer profiles made of composition (polycarbonate + graphite) or metallic substrates in order to achieve a required set of optical properties (appropriate absorbance and emittance).

These surface-modified substrates are used as solar thermal absorbers within the solar thermal collectors. One of the most important components of the solar thermal collector is the solar absorber to be effective, the absorber should exhibit wavelength selectivity, i.e. have maximum solar absorbance, minimum solar reflectance and thermal infrared emittance. A high solar absorbance is needed to collect as much of the incident solar radiation as possible and a low thermal infrared emittance is needed to minimize radiant energy losses.

Solar thermal collectors are mainly used for water and space heating. They capture incident solar radiation, convert it to usable thermal energy, and transfer the energy into a heat transfer fluid. All of this should be accomplished economically with minimum energy loss.

Recent R & D activities in PLASMA are oriented towards spectral selective coatings. These coatings are composed of islands of metal embedded in a three-dimensional matrix of dielectric. Recent research on mixtures of titanium nitride and titanium oxide at the PLASMA – Center for Plasma Technologies has yielded spectral selective coatings with a solar absorbance $\alpha > 0.95$ and an emittance epsilon, $\varepsilon < 0.06$. These TiN_xO_y coatings are manufactured by Physical Vapor Deposition process – combination of magnetron sputtering and cathodic arc evaporation deposition;

In this paper, we explain the collector efficiency, depending on temperature of the medium and depending on temperature difference between medium and ambient for determined selective coating; furthermore we compare the collector efficiency with different absorber designs, theoretically.

Influence of oxygen-containing surface functional groups on charge storage properties of graphene oxide

Z. Jovanović[1] , D. Bajuk-Bogdanović[2], S. Jovanović[1], Ž. Mravik[2], I. Holclajtner-Antunović[2], M. Vujković[2]

[1]Laboratory of Physics, Vinča Institute of Nuclear Sciences, University of Belgrade, Belgrade, Serbia
[2] Faculty of Physical Chemistry, University of Belgrade, Belgrade, Serbia

To face the energy challenges of the 21st century, the material science needs innovative approaches to energy conversion and storage. The carbon materials have a long history of energy-related applications and have witnessed a new rebirth after isolation of graphene. Thanks to a large specific surface area, electrical conductivity and rich surface chemistry the graphene oxide have attracted considerable attention for application in electrochemical capacitors. Being composed of individual layered sheets, the graphene oxide can be considered as ideal electrode materials since its surface is, in principle, readily available to electrolyte. However, the interplay of surface oxygen groups, their acidic/basic character, combined with structural complexity, all confined in a single sheet, provides a specific surface chemistry that has a pronounced role in collective behavior of graphene oxide as bulk material.

This talk will discuss the common underlying principles of charge storage mechanisms of carbon materials and recent advances in understanding of the role of surface chemistry on electrochemical behavior of graphene oxide.

Charged particles interactions with carbon nanostructured materials

D. Borka

Atomic Physics Laboratory, Vinča Institute of Nuclear Sciences, University of Belgrade, Belgrade, Serbia

Work in field of interaction of charged particles with nanostructured surfaces has attracted great research interest over the past years. It is strongly motivated because of the new fundamental knowledge and the possibility of many potential technical applications, like the design of next-generation electronics and biomedical sensors, surface characterization and modification, and probing of different functional materials.

In this lecture focus will be given on the theoretical description of charge particle interaction (ions and electrons) with carbon nanostructures. It will be investigated the interaction of charge particles with various carbon based targets from 1d (nanotubes) via 2d (single and multilayer graphene) to 3d (graphite) structures. The theoretical interpretation of the experimental data, using theoretical modeling and the Monte Carlo (MC) simulation of elastic and inelastic interactions of charged particles in carbon materials, will be presented. In general, the interaction process is governed by the response of the target to the external perturbation, the projectile, given by the dielectric function and the probability for elastic scattering of the projectile at target constituents. Also, it was shown that electron interaction with target material appears to be fundamentally different from the picture of ion interaction. Since electrons do not change their charge state a clear experimental distinction between the original projectiles (primaries) and secondary electrons generated with the interaction of primaries with the target material, is impossible, but theoretically, it is possible to identify and follow up all electron trajectories.

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Deposition of thin films using spray pyrolysis

N. Radić, B. Grbić

University of Belgrade, Institute of Chemistry, Technology and Metallurgy, Department of Catalysis and Chemical Engineering, Belgrade, Serbia

In the last decades thin film materials are the key elements of advances made in the fields of electronic, magnetic, optic, mechanical and chemical devices. The properties of material in the form of thin films significantly differ from properties of bulk material. Most of the thin film materials are integrated into various types of devices due to their specific properties (electromagnetic, optic, mechanical, chemical, anticorrosive…). The methods used for thin film deposition can be divided into two groups, physical or chemical. The physical methods include thermal evaporation (electron or molecular beam evaporation), sputtering, pulsed laser deposition, cathodic arc deposition, electrospray deposition and plasma electrolytic oxidation. The chemical methods are plating, sol-gel method, spin and dip coating, chemical vapor deposition, atomic layer deposition and spray pyrolysis. Spray pyrolysis offers several advantages in respect to other deposition techniques, like simple and inexpensive equipment, and reduced environmental stress. The basic principle involved in spray pyrolysis is: when a precursor droplet reaches the heated substrate, the rapid vaporization of water generates an increase in the concentration of precursor and acceleration of pyrolytic decomposition, well adherent films are deposited. Also, spray pyrolysis offers great diversity due to many process parameters which can be changed, such as: atomization technique, spray geometry, temperature, spraying duration, composition and concentration of precursor, types and flow rates of carrier gases etc. In this paper, the spray pyrolysis technique and the applications in thin films deposition were reviewed and illustrated with some examples. The spray pyrolysis method permits relatively fast and simple deposition of Al_2O_3, ZrO_2, Y-ZrO_2, TiO_2, TiO_2-WO_3, BaO, and Pt species on stainless steel substrate, rendering it as a good choice for the preparation of different coatings that can be applied as catalysts support, catalysts and photocatalysts.

Tuning of magnetic heating by changing magnetic anisotropy in monodisperse and crystalline iron oxide-based nanoparticles

N. Jović Orsini

Vinča Institute of Nuclear Sciences, University of Belgrade, Belgrade, Serbia

Nowadays, iron oxide nanoparticles (IONPs) are finding variety of biomedical applications due to their good tolerance by the human body, size-driven colloidal and magnetic properties at the nanoscale and possibility to render them multifunctional by coating engineering. IONPs can be simultaneously used as imaging contrast agent, drug-delivery nanocarriers and intracellular hyperthermia mediators. For the later application, *i.e*. the hyperthermic treatment of a malignant tissue, the conversion of electromagnetic energy into heat occurs in iron oxide nanoparticles when they are exposed to alternating magnetic field (AMF). This physical process is used for *hyperthermia* or *thermal ablation* of tumors. The amount of generated heat power is dependent on internal parameters of a system such as: the chemical composition, particle size and shape, the effective anisotropy of material, size and anisotropy dispersion, viscosity of a medium, but also on applied experimental conditions: magnetic field amplitude, H_0, and frequency, f. Hence, it is not an intrinsic property of the nanoparticle.

There are several physical processes which can governed the transformation of magnetic to thermal energy. In order to determine the dominant mechanism of heating under given experimental conditions (H_0,f), it is important to determine the regime which controls magnetic behavior of an ensemble of nanoparticles during the experimental time window, $\tau_{meas}=1/2\pi f$. In an oscillating external magnetic field system of magnetic nanoparticles can be in a state close to equilibrium (*i.e*. superparamagnetic), or in a metastable state. For superparamagnetic NPs losses are mainly induced by Brownian and Néel processes, while the classical hysteresis losses dominate in the ferromagnetic NPs. If the superparamagnetic (SPM) nanoparticles are exposed to a high frequency AMF, the heating can also arise from the onset of dynamic hysteresis. Among various parameters, the main parameter which controls the type of behavior is the ratio H_0/H_K, where H_K is the anisotropy field of the material. If $H_0/H_K << 1$, the system is in a SPM regime. If $H_0/H_K>1$, metastable behavior is favoured. Since $H_K=2K_{eff}/M_S$,

magnetic anisotropy constant, K_{eff}, is a parameter which can be considered as a crucial one in determining the mechanism of heating. K_{eff} is strongly influence by interparticle interactions, shape of NPs and can be changed significantly by slight variation in stoichiometry.

In this work, we studied the heating ability of monodisperse, oleic acid-coated IONPs as a function of AC magnetic field parameters: frequency, f in the range 229.3-828 kHz and field amplitude, H_0 in the range 3.98-23.87 kA/m. Their behavior has been discussed in the frame of the particle size, composition and magnetic anisotropy constant values.

Oxide layers on alumina and their application in nanotechnology

B. Kasalica

Faculty of Physics, University of Belgrade, Belgrade, Serbia

Aluminum as a representative of the group of the "valve metals" has a high affinity to oxygen from the atmosphere, and forms an oxide layer with it right on the metal surface. The thickness of such a naturally created oxide layer is about 5 nm which is tough and resistant to various influences. This accounts for the relatively good corrosion resistance of the aluminum metal. A growth of the oxide layer can be achieved by anodizing aluminum in suitable electrolytes. The electrolytes used for anodizing can be divided into two groups. The first group of the electrolytes forms an oxide layer with a compact amorphous structure. This kind of layer can grow up to 500 nm. The second group of the electrolytes builds an oxide layer with a porous structure, and its growth is not restricted. The size of the oxide pores thus formed by anodization can be controlled by anodizing conditions and have nanometer dimensions. Application of oxide layers obtained by electrolytic oxidation of aluminum has a very wide use of the construction industry, electronics and nanotechnology.

Nanomedicine

Neuroprotection and neuronal recovery under the oxidative stress achieved by enhanced lipid membrane interaction with flavonoids

S. Šegota[1], I. Crnolatac[2], V. Čadež[1], M. Jazvinščak Jembrek[3], Maja Dutour Sikirić[1], and Darija Domazet Jurašin[1]

[1]Division of Physical Chemistry Ruđer Bošković Institute, Zagreb, Croatia
[2]Division of Organic Chemistry and Biochemistry, Ruđer Bošković Institute, Zagreb, Croatia
[3]Division of Molecular Medicine, Ruđer Bošković Institute, Zagreb, Croatia

Flavonoids, polyphenolic biomolecules with antioxidative activity, have recently emerged as potential novel therapeutics for neurodegenerative diseases. The research of the flavonoids and their use for diagnostic and therapeutic purposes have created a need for understanding the complex interactions of cells with flavonoids, particularly neuroprotective ones like myricetin (aglycone) and myricitrin (glycoside). Membrane-flavonoid interactions are of crucial importance for both the cell uptake and toxicological investigations. The presence of flavonoids embedded within a lipid bilayer, can lead to changes in lipid packing by modifying interactions amongst the lipid headgroups and/or acyl tails. Therefore, investigation of flavonoids interaction with lipid membranes using IR spectroscopy, microcalorimetry, atomic force microscopy (AFM) and force spectroscopy (FS) have been undertaken.

Model membranes consisting of a lipid mixture of unsaturated phosphatidylcholine, sphinogomyelin and cholesterol (PC/SM/Chol) and P19 neurons were chosen enabling investigation of not only the nanomechanical properties of the neuronal membranes and their interactions with different molecular species, but also testing of flavonoid ability to inhibit lipid peroxidation and lipid structural reorganization in model membranes and neurons under oxidative stress in vitro.

Our research deciphered interactions of neuroprotective flavonoids, myricetin and myricitrin with model neuronal membranes and neuronal cells through their delicate response at physiological and oxidative stress environment. Obtained results pointed that the time needed to complete the oxidative reaction might be considered as the measure of flavonoid protec-

tive power. The nanomechanics (elasticity), surface topography (roughness) of model lipid membranes and P19 neurons as well as the thermodynamic and kinetic data that result from the oxidative damage are quantified for the first time showing specific effects on the elasticity of the supported lipid bilayers and neuronal cells at both physiological and oxidative stress conditions. Functionality of the flavonoids has been related to the organization and elasticity of the model neuronal membranes and neuronal cells.

Reprogramming of N-glycan biosynthesis and lipid metabolism in cancer

R. Masnikosa[1], Z. Cvetković[2], V. Vučić[3]

[1]Department of Physical Chemistry, Vinča Institute of Nuclear Sciences, University of Belgrade, Belgrade, Serbia
[2]Faculty of Medicine, University of Belgrade, Belgrade, Serbia
[3]Institute for Medical Research, Department of Nutrition and Metabolism, University of Belgrade, Belgrade, Serbia

There are four major classes of biomolecules in living things: nucleic acids (DNA, RNA), proteins, carbohydrates and lipids. Although the past decades have seen much progress in cancer genomics (deciphering cancer DNA sequence and structure) and proteomics (cancer-specific alterations in protein expression), we are still far away from having answers to the questions: what are the risk factors for cancer, how it starts, how it develops and how it spreads to other tissues (metastasis). In order to get deeper insight into cancer biology, biochemists turned to the studies of two other candidate biomolecules: glycans (glicomics) and lipids (lipidomics).

Glycosylation is a frequent modification of membrane and secreted proteins. This means that proteins carry covalently linked oligosaccharides, which present great diversity of structures. Glycoproteins are key molecules in health and disease. The plasma glycan signature of a healthy person is stable over time and provides a global reflection on an individual's health/disease status that can in principle be utilized in the context of personalized medicine, given that the associations between glycan signatures, particular diseases and their treatment are understood. Altered glycan structures were found on cell surfaces of almost all cancer cells studied. Furthermore, glycans are involved in fundamental processes that define cancer cell biol-

ogy, such as altered signalling, cell-cell communication, tissue invasion and metastasis. Cancer cell reprograms its byosinthesis of glycans, which are needed for further development of cancer tissue and the metastatic spread (e.g. for altered cell mobility). Glycans are, thus, potential early cancer biomarkers.

Major lipids in circulation are: triacylglicerols (TAG), cholesterol (CL) and phospholipids (PLs). TAG and PLs contain fatty acids (FA). Biosynthesis of FA and CL is restricted to liver and adipose tissue, while other tissues uptake lipids from the bloodstream. To be able to make FA and CL *de novo*, a cancer cell must reprogram its metabolism, but it also relies on elevated uptake of dietary lipids from circulation. Thus, tumor affects systemic lipid homeostasis, which can be detected through altered lipid profile of human plasma. Tumour shows a rapid growth, so it needs PLs as key cell membrane components, mainly phosphatidylcholine (PC) and phosphatidylethanolamine (PE). Compared to normal cells, cancer cells possess more PC and PE in their membranes, and also more saturated FA in their PLs. As a consequence, their membrane fluidity and signal transduction are changed, which affects their resistance to chemotherapy. A cancer risk, existence and progression may be correlated with altered levels of particular tissue and plasma PLs and FA. We studied lipid profiles in non-Hodgkin lymphoma (NHL), a heterogeneous group of haematologic malignancies of unknown ethiology. Altered plasma FA profile in NHL patients was linked to the clinical stage and aggressiveness of the disease, but also to the response to chemotherapy and clinical outcome. PLs were associated with the efficacy of chemotherapy and with the clinical outcome. Further studies on a larger number of patients, which would also investigate possible influence of gender, age and body mass index, are needed to assess a potential prognostic value of plasma PLs in patients with NHL.

New approach to principles of energetic cell treatment

V. Jokanović[1,2]

Vinča Institute of Nuclear Sciences, University of Belgrade, Belgrade, Serbia
ALBOS d.o.o., Belgrade, Serbia

In this study, various models were used to describe cell behaviour at various levels. Various approaches and theories were explained, with their limitations and advantages. Any of them cannot fully explain biological processes inside cells. Therefore, it seems that is necessary to develop a new approach, which can efficiently explain a relationship between the behaviour of physical fields in which cells are emerged and the cell behavior. Fortunately, during our previous investigations we developed two models, unique in literature, which well describe relationship between these physical fields and material structure, with exceptional agreement of our theoretical expectations and experimental examination.

On that base, it was assumed that similar kind of relationship can be applied for living systems, such as human cells. The agreement of theoretical data predicted by the models with corresponding experimentally obtained values for various kinds of human cells, found in literature, was satisfying.

Bone tissue engineering with triad – bioceramics, adipose-derived mesenchymal stem cells, platelet-rich plasma

S. Najman[1,2], J. Najdanović[1,2], S. Stojanović[2], V. Cvetković[3], M. Vukelić-Nikolić[1], J. Živković[1,2], D. Petrović[4], I. Vučković[5], Lj. Đorđević[3], P. Vasiljević[3]

[1]Faculty of Medicine, Department of Biology and Human Genetics, University of Niš, Niš, Serbia
[2]Faculty of Medicine, Department for Cell and Tissue Engineering, University of Niš, Niš, Serbia
[3]Faculty of Sciences and Mathematics, Department of Biology and Ecology, University of Niš, Niš, Serbia
[4]Faculty of Medicine, Department of Maxillofacial Surgery, University of Niš, Niš, Serbia
[5]Clinic of Stomatology, Department of Maxillofacial Surgery, Niš, Serbia

Bone tissue engineering (BTE) offers numerous solutions for successful treatment of bone defects which have numerous advantages over standard bone grafting. This is a multidisciplinary engineering field which gives opportunity for treatment of the patient with less trauma and easier procedure, based on interactions between the bone scaffold, appropriate cells and regulatory signals in order to form the functional bone tissue. BTE also gives models for the examination of the role of each BTE components, their mutual interactions and influence in bone formation process. Various biomaterials of natural and artificial origin are used as scaffolds for cells in BTE that enable the cells to adhere, migrate, proliferate and differentiate to create or mimic bone structure and function. A ceramic biomaterial hydroxyapatite, the main inorganic component of bones, is frequently used in BTE demonstrating the good biological and mechanical properties. Stem cells of various origin can be used for the purpose of BTE. In our research we used adipose-derived mesenchymal stem cells (ADSCs) that we induced *in vitro* toward osteogenic cells and endothelial cells prior the use, or we applied them as non-induced freshly isolated stromal vascular fraction of adipose tissue. Various regulatory signals such as growth factors give instructions to cells for differentiation and appropriate behavior in the formation and maintenance of the structure and function of bone tissue. In our BTE procedures platelet-rich plasma (PRP) is frequently used as a natural source of growth factors. PRP as the component of BTE construct simulates natural conditions during bone injury stimulating cell proliferation and differentiation toward osteoblasts. In our previous research we have used a variety of

in vivo BTE models, both orthotopic and ectopic implantation to mice, rats and rabbits, including a variety of *in vitro* methods for preparing stem cells and analyses of biocompatibility and biofunctionality of bone substitute materials. These studies showed that application of hydroxyapatite-based bioceramics combined with ADSCs and PRP in BTE could be a promising approach for bone regeneration.

Biomineralization – how to investigate it?

V. Babić-Ivančić, L. Štajner

Laboratory for precipitation processes, Division for Materials Chemistry, Ruđer Bošković Institute, Zagreb, Croatia

From physico-chemical point of view biomineralization can be considered precipitation of inorganic salts in ecological systems and organisms. Formation of hard tissues in humans, animals and plants, such as bones, *teethes and tooth enamel*. is considered normal mineralization. Such tissues are also used as "deposit" for different ions, especially calcium and phosphates. Processes of mineral deposition in organic macromolecular matrix in soft tissue, such as: i) occurrence of urinary and/or kidney stones (urolithiases, nephrolithiasis), encrustates on urinary stents; ii) teethes caries; iii) gall stone; iv) precipitation in joints (gout); v) arteriosclerosis (deposition $CaCO_3$, limestone of the blood vessels) are considered pathological mineralization.

Studying such a complex processes, as biomineralization is, requires different of experimental methods used for the determination of formation and crystal growth mechanisms. For the more detail insight, liquid and solid phase are investigated simultaneously, the chemical composition structure, morphology and particle size distribution are determinated. The potentiometry, ionic chromatography and UV-Vis spectroscopy are usually used for determination of changes caused with formation from solution. The particle size distribution in suspension also determined, but the microscopy, powder X-ray diffraction, molecular spectroscopy, electron paramagnetic resonance, thermogravimetry and FT-IR are used for precipitates characterization.

Bioactive coatings on the surface of titanium implants

B. Čolović, V. Jokanović

Vinča Institute of Nuclear Sciences, Belgrade University, Belgrade, Serbia

Titanium and its alloys are widely used for fabrication of various implants (dental prostheses, bone fixation, artificial joints, etc.) due to their extraordinary chemical, physical and mechanical properties and excellent biocompatibility. But, the main drawbacks for their application are unsatisfactory biological and corrosion properties in acid or alkaline solutions and biological fluids. Therefore, surface modification of titanium and its alloys is necessary, by formation of thin oxide layers, using various methods of chemical and electrochemical preparation, or by deposition of hydroxyapatite coatings which enable tight bonding with surrounding bone tissue due to their bioactivity, and chemical and crystallographic similarity to the biological apatite within human bone.

Titanium oxide coatings, obtained in this study, showed very interesting nano-structural topography, with nano-patterns of thin walls between the mutually interconnected pores, characteristic for scaffold structure which might be suitable for cell adhesion and proliferation. Hydroxyapatite coatings of excellent adhesion strength were obtained by an innovative plasma jet method which also enabled formation of nanostructured hydroxyapatite coatings with unique microstructural features.

Dental anthropology of prehistoric period on the territory of modern day Serbia

Dj. Grga

Department for Conservative dentistry, School of Dental medicine, University of Belgrade, Belgrade, Serbia

Existing archeological research found numerous remains of material culture, which undoubtedly confirm continuous colonization of modern day Serbia, from mesolite to early neolith periods. Beside these traces, findings

of human skeletons of different gender and age have been common within the explored archeological sites. It has been shown that physical anthropology, in accordance with applied methodology and level of skeletal preservence, can add and raise knowledge on: prehistoric people appearance, their physical constitution, characteristics, habits, morbidity, life style and diet, customs, burial rituals. Lately, special attention has been given to research of teeth and jaws (especially lower jaw), for these parts of human skeletons represent preserved fragments, relatively isolated and resistant to external factors and devastation. Although they represent only fragments of human skeletons, preserved and protected, sometimes they can be the most single important source of valuable data, which can explain or give sense and significance to the whole research. Today, many different professionals such as physical anthropologists, archeologists, biologists, medical doctors and dental doctors engage in the field of dental anthropology. As well as for the engagement of different professional profiles, the same way protocols and applied methodologies are often heterogeneous and non compatible. It is hard to make quality synthesis and comparisons, and even harder to make reliable conclusions based on given data.

Goal of this study was to conduct an analysis of applied methodological procedures in up to date dental anthropology research with results indicating possibilities and needs of standardized methodology and introduction of new methods in this field of physical anthropology.

Analysis included research papers on dental anthropology within the last 50 years from Brotwel and Hillson, through Zivanovic and Mikic, to state of the art research of Stefanovic S, Djuric M, Grga Dj, Radvic M. It's especially interesting to mention a pioneer attempt of a multidisciplinary group of researchers to apply nanotechnology in unraveling the secrets of ancient teeth.

Based on the results of this analysis it can be concluded that there is a real necessity within dental anthropology as an integral field of physical anthropology, to rearrange protocols and define standard methods for the evaluation of teeth and jaws status of ancient civilizations.

Physico-chemical properties of nanostructured cements based on calcium silicates and hydroxyapatite

V. Petrović

Department of Restorative Dentistry and Endodontics, School of Dental Medicine University of Belgrade, Belgrade, Serbia

Clinical applications of commercial calcium silicates are limited by long setting time of these materials. The main advantage of nanomaterials compared to conventional, microstructured materials lies in the distinct activity of particles. Smaller size particles enhance the hydration of the material and have positive effect on the hardening and setting time.

The aim of our study was to investigate the physic-chemical properties of two newly synthesized nanostructured, fast-setting, biomaterials based on calcium silicates (CS) and a mixture of hydroxyapatite and calcium silicates (HA-CS). Solubility and porosity were tested after the storage of samples in artificial tissue fluid for 28 days (ISO 6876). We also evaluated pH changes and calcium-ion release from samples immersed in artificial tissue fluid for the same period using a calibrated pH meter and Spectrophotometer. CS and HA-CS were compared with Mineral trioxide aggregate (MTA Angelus, Londrina, Brazil). The greatest fluid uptake in all the materials tested, was observed after 24 hours of immersion. After 7, 14, 21 and 28 days, there were no significant changes in sample weight in any of the material tested. The obtained results indicate high initial porosity of all tested materials. The number of pores decreased with cement solidification, which was manifested by lower absorption of fluid over time, which was also recorded in this study. There were no significant differences between MTA and CS porosity. The porosity of HA-CS was significantly higher. After 28 days,, the solubility of MTA and CS was similar but the solubility of HA-CS was significantly higher compared to CS and MTA. The highest pH values and the highest calcium ion release were measured at 24h, for the all materials tested. Initially, pH values for CS and HA-CS were lower than MTA. The pH level decreased with-time, but was maintained alkaline for all the materials tested over 28 days. Initially, the calcium ion release from CS and MTA was higher than from HA-CS. The release of calcium also decreased over time, and there was no significant~~ly~~ difference in the calcium ion release between materials at the end of the experiment. Based on this, in terms of

physico-chemical properties, CS is comparable with MTA Angelus. HA-CS showed inferior phisico-chemical properties.

Nanostructural biomaterials: a pathway to clinical usage

V. Opačić Galić

Faculty of Dentistry, University of Belgrade, Belgrade, Serbia

Today, nanotechnology synthesizes new materials and devices with a wide range of application in medicine, electronics and in the energy production field. From the aspect of the safety of their use, the first consideration to be made is about their toxicity, because the reactivity of the nano-particles stems from their large active surface in relation to mass and volume. Nanoparticle often have different effects on tissue when compared to usual sized particles, even though they have the same chemical structure.

Synthetic materials used in medicine require numerous testings to assure their reliability in use and quality in every day clinical practice. Biomaterials are designed so to, after implantation in the human tissue, replace part of the living system or fill a certain biological function in close contact with the living tissue. They have the goal to develop active interaction with a biological system. That's why a preclinical evaluation is needed of their biological characteristics in different *in vitro* and *in vivo* assays. A potential negative effect that biomaterials can cause similar to the effects of medications or chemical substances: tissue irritation, sensibility of the organism, toxic effect on organ or tissue, genotoxic, mutagenic or carcinogenic effects.

The gonotoxic potential of newly synthesized nanostructural materials, with a calcium-silicate systems (CS) and hydroxyapatite (CS-HA) base, is tested with an alkaline version of Comet assay on human lymphocytes from peripheral blood (*in vitro* assay). With this test no induction of genotoxic damage was established on the DNA molecules. Biocompatibility of these materials is also tested by subcutaneous implantation of polyethylene tubes filled with freshly made materials in 40 Wistar rats (*in vivo* assay). By doing this, tissue tolerance on new nanomaterials was observed. The CS-HA mixture showed the best organized fibrous capsule around the material, without inflammation sings or compromisation of the connective tissue structure.

Lastly, biofunctionality and bioactivity of the new materials is tested by directly pulp capping the teeth of rabbits. Samples, where CS was used to directly cover the pulp, showed the best organized calcified tissue, and the formation of the so called osteodentine.

The result of these findings encourages further testings of nanostructural biomaterials for their clinical application and use in endodotics as a sort of endodontic cements.

Electrochemical investigation of inhibition of different active drug substances in immobilized enzyme

S. Herenda, J. Ostojić, Z. Bešić

Faculty of Natural Sciences, University of Sarajevo, Sarajevo, Bosnia and Herzegovina

Many in vivo and in vitro investigations were carried out on the active drug substances and their effects in the body, to determine if they act as inhibitors or activators of certain type of illness.

Immobilization of enzymes is an essential technique that contributes to the development of science, and through a variety of applications it facilitates many processes in various industries. Immobilization of enzymes is of great importance in the industry due to its technical advantages and great economic savings, which represent an important factor today. In addition to all the advantages that related to the application of enzymes, the immobilization of an enzyme on the electrode, offers the possibility of easier monitoring of such reactions by application of electrochemical methods. Other methods have their advantages, but also disadvantages that can be overcome by electrochemical methods. Electrochemistry makes it possible to monitor very fast reactions and to determine the mechanisms of various reactions between enzyme and substrate. This method enables monitoring of the interaction between the active drug substance, enzyme and substrate, as well as determining the reduction in the formation of symptomatic diseases in the organism.

Application of nanomaterials in preventive and restorative dentistry

D. Marković[1], T. Perić[1], B. Petrović[2]

[1]*Faculty of Dentistry, University of Belgrade, Belgrade Serbia*
[2]*Faculty of Medicine, University of Novi Sad, Novi Sad, Serbia*

In dentistry, like elsewhere, nanoscale is usually defined as being smaller than one-tenth of a micron in at least one dimension. Nanomaterials in dentistry include nanoparticles, nanofibers, nanotubes, nanowires, and any other nanoscaled materials or devices added to contemporary dental materials. Recently it has been recognized that nanobiomaterials play a significant role in caries prevention, prophylaxis and dental restorations, as they may better control cariogenic attack, and support reparatory and remineralizing processes.

The rationale for use of nanomaterials in caries prevention is based upon the interaction between a material and cells that affects cellular behaviors in terms of modifications in migration, adhesion, proliferation, and cell differentiation. Important nano-based approaches for caries prophylaxis and plaque biofilm management with biomimetic strategy are oral hygiene devices and dental products based on apatite nanoparticles, alone or together with casein phosphopeptides (CPP), stabilized amorphous calcium phosphate (ACP) nanocomplexes with a diameter of about 2 nm. CPP–ACP complexes reduce bacterial adherence, interfere with components of the intercellular plaque matrix and the enamel surface, significantly delaying the formation of dental plaque biofilm. The casein phosphopeptides stabilize calcium and phosphate ions through the formation of amorphous nanocomplexes with the diameter of 2 nm. In addition to that, there are evidences from experimental studies that non-aggregated and clustered hydroxyapatite nanocrystallite particles can absorb onto the bacterial surface, and after that interact with bacterial surface proteins affecting the binding mechanism of microorganisms to the enamel surface. These new nano based approaches for biofilm management are based on size-specific effects of the hydroxyapatite nanoparticles, and are thought to be more effective than traditional approaches that use conventional microsized hydroxyapatite in dental products. Finally, experimental attempts have been made in formation of enamel-like structures at ambient conditions using various organic additives

and scaffold molecules, mainly amelogenin, in conditions of slow and precisely controlled crystallization systems.

It has been clearly described that nanosized dental restorative materials have better functional, mechanical, and physical characteristics as well as superior biocompatibility in comparison to conventional materials. Silver nano particles have been incorporated in dental materials with the aim to prevent cariogenic bacterial colonization in the marginal gaps and on the material surfaces, since these particles exhibit antibacterial effects against a large number of dental plaque bacterial species. Similar to silver, zinc oxide nanoparticles has demonstrated antibacterial effects against several types of bacteria, including *S. mutans*. Quaternary ammonium polyethylenimine nanoparticles have been incorporated into dental materials due to their advantage that the antibacterial agent is copolymerized with the resin polymer network and is immobilized in the composite and not released or lost over time. Wear-resistant and biocompatible nanocomposite surface coatings for glass-ionomer and composite restorative materials for biofilm management are close to being used in dental practice. However, all these biomimetic restorations together with new plaque control strategies require extensive further research with respect to everyday clinical applicability.

Clinical aspects of ISO standards in dental fillings engineering

Dj. Antonijević[1,2]

[1]*Laboratory for atomic physics, Vinča Institute for Nuclear Sciences, Belgrade, Serbia*
[2]*Laboratory for anthropology, Faculty of Medicine, Belgrade, Serbia*

Fabrication of dental filling materials should be performed in accordance to protocols proposed by International Standard Organization (ISO). In this context, ISO 9917 standard for water based cements, ISO 6876 standard for dental root canal sealing materials and ISO 4049 standard for polymer based restorative materials require certain set of properties that should be fulfilled for materials' successful clinical application. The difficulties in formulating dental material composition arises from the fact that the compounds which positively affect one attribute may have adverse effect on another property. Nano-medicine provides enormous opportunities to overcome numerous issues that could not be resolved using micro- and macro- level sized particles engineering approaches. Nanotechnology aids

in processing variety of nanomaterials with innovative dental applications. Compressive strength of nano-particulated composite materials is significantly superior in comparison to the formulations without nano-particles additions. Nano-medicine also helps to overcome the issue of poor material setting time of calcium silicate cements in endodontics since the addition of nano-containing compounds increase the area for water absorption and consequently reduce materials' setting time. Some important clinically relevant attributes of dental filling materials are not covered by ISO standards. For instance, roughness of the composite fillings is directly related to the degree of bacterial accumulation; however the current ISO standard does not claim the adequate the surface topography of a dental material. Adhesiveness of the materials is another property of dental materials important because it influences the behavior at the dentine/enamel to material interfaces. This behavior may be effectively investigated at a nano level and conclusions have certain clinical importance. Therefore, novel standard criteria should be included into current protocols to set the limits for the properties related to antimicrobial effect, remineralizing potential, wettability, roughness, porosity etc. In conclusion, current ISO standards should be modified in order to follow the state of the art tendencies introduced to dental materials engineering through implementations of modern nanotechnologies.

Challenges and dilemmas related to the application of scaffolds in nanomedicine

V. Biočanin

Faculty of Pharmacy and Health, University of Travnik, Travnik, Bosnia and Herzegovina

Increased use of reconstruction procedures in oral and maxillofacial surgery has caused development of bone substitutes. Bone scaffold presents temporary structure with specific 3D design which should be integrated with surrounding host bone. Likewise, it should allow adherence and cell proliferation on its surface and production of extracellular matrix proteins. The ideal scaffolds should mimic the natural extracellular matrix (ECM) as much as possible, since the ECM found in natural tissues supports cell at-

tachment, proliferation, and differentiation, indicating that scaffolds should consist of appropriate biochemistry and nano/micro-scale surface topographies.

ALBO-OS is a new bone scaffold which consists of calcium hydroxyapatite (CHA) covered with polylactide co-glycolide (PLGA). *In vitro* studies with ALBO-OS showed high open porosity and fast attachment of stem cell on its surface. *In vivo* investigations of the synthesized scaffold were conducted over the cutaneous irritation and biofunctionality assays on rabbits and the test of acute systemic toxicity on mice. The results showed that the scaffold is not irritant and that it does not exhibit any symptoms of acute toxicity. Animal studies conducted on critical size defects made in calvaria of New Zealand rabbits demonstrated high degree of mineralization (better than BioOss® as a gold standard), even after 12 weeks of implantation. Clinical studies in humans should be conducted in order to confirm such a good results obtained with ALBOS.

Posters

Refractory and Process industry

Low cement and abrasion resistant castables - industrial production

V. Vučetić, J. Malešević, D. Stević

Real S, Belgrade, Serbia

Low cement castables (LCC) have a numerous advantages over conventional castables, such as high strength at critical temperatures at which the hydraulic bond is being terminated, higher density, lower consumption of water, faster drying, they are resistant to chemical attack and the metal slag.

The goal of this work was to develop LCC based on corundum, bauxite, andalusite, fireclay, silicon-carbide as the main component, and a combination thereof. The challenge was to reduce the cement content and replace the lack of hydraulic bond. For that purpose, and as a filler, there were number of combinations of different micro and nano components. Also, it was necessary to introduce adequate dispersing agents to minimize water demand, which, by the addition in a small percentage, have a great influence on the decrease of surface tension and improve the wetting of the particles.

In this way LCC as a final product represent a complex system made up of a large number of components, many of which are in a very small percentage, and their compiling into a homogenous mixture has required an investment in more efficient devices for dosing and mixers with countercurrent, or planetary mode.

In front of abrasion resistant concretes are putted even more rigorous requirements than in front of LCC in terms of the need to have a high hardness and abrasion and chemical resistance, at low, as well as at high temperatures. There are two main factors responsible for meeting these demands:

the basic aggregate material must have a high hardness; and bond strength between the aggregate grains must be high. In order to meet the abrasion resistance, there have been used aggregates such as corundum, bauxite, or basalt, i.e. materials known for their hardness; and cement as a binder, with addition of micro and nano components for the purpose of reinforcement and filling up the micron pores in the material.

In both the low cement and abrasion resistant castables it is possible to add steel or organic fibers, depending on the location and conditions of application as well as the characteristics of the final product to be achieved.

Real S has developed a whole range of these products competitive to the world's largest producers, many of which have found application in the cement industry, non-ferrous metals industry, forging plants, power plants, etc., in places exposed to the most rigorous environment effect.

Influence of the type of nucleating agent and the conditions of the heat treatment on the properties of lithium-aluminum-silicate glass-ceramics

N. Vučetić[1], V. Vučetić[2]

[1] University of Turku, Faculty of Chemical Engineering, Turku, Finland
[2]Real S, Belgrade, Serbia

Classic metal and non-metal materials more difficult to meet very high requirements set by the further development of new technologies, such as high strength and hardness, chemical and physical stability, corrosion resistance, refractoriness and thermal stability, etc. Glass-ceramic materials emphasize as the materials which are capable to fulfill of these and other demands. Glass-ceramic materials are obtained by crystallization of the glass containing metal oxides which act as nucleating agent.

From nucleating agents depends on whether there will be the formation of crystalline phases and structures that can be called glass-ceramic, and what features will have. Another factor affecting the characteristics of the glass-ceramic is the temperature at which the crystallization is carried out.

The paper shows the effect of various nucleating agents and heat treatment on the properties of the Li_2O-Al_2O_3-SiO_2 glass-ceramics, i.e. how the

properties of the glass-ceramics of the same composition can be modulated by the choice of nucleating agent and the conditions of the heat treatment.

The conclusion is that the choice of nucleating agents depends on the composition of the initial glass and the material properties pursued. For Li_2O-Al_2O_3-SiO_2 glass with a lower Al_2O_3 content most efficient nucleating agent is P_2O_5, while the glass with a higher content of Al_2O_3 the most effective is TiO_2 in combination with ZrO_2.

There are shown various models of heat treatment and their effect on obtaining product substantially different characteristics, although starting from the same glass composition. It is the best to adjust the heat treatment to the composition, in order to avoid the formation of products of unsatisfactory quality and economic losses due to higher consumption of energy and time than is really necessary.

The influence of nanofiller on the properties of biocompatible silicone based on different network precursors

D. Manjenčić[1], S. Cakić[2], B. Pilic[1], V. Aleksić[3], J. Budinski-Simendić[1], S. Rackov[1], I. Ristić[1]

[1]University of Novi Sad, Faculty of Technology, Novi Sad, Serbia.
[2]University of Niš, Faculty of Technology Leskovac, Leskovac, Serbia
[3]University in Eastern Sarajevo, Faculty of Technology, Zvornik, Republic of Srpska, BiH

The choice of starting network precursors for elastomeric material preparation is highly important in order to obtain materials for specific types of exploitation. During the cross linking of macromolecules, with the choice of type and quantity of the components, it is possible to fine tuning material flexibility, mechanical and chemical characteristics. Silicones, more precisely polysiloxanes, are for sure one of most interested class of elastomeric materials. For decades silicones are under huge interest of academic and industrial researches so the fields of their potentially usage are broad (electronics, personal care products, structural engineering and textiles, medicine, sports equipment...). Silicones, because of their extraordinary properties are predestined for biomedical purposes because they are bioinert, transparent and they have excellent oxygen permeability. Great biocompatibility is partly because of its low chemical reactivity, low surface energy and

hydrophobicity of polydimethylsiloxane. The purpose of this work was to determine branched structures and characteristics of linear organofunctional siloxanes. For synthesis were used vinyl-functionalized siloxanes and also polysiloxanes with adding of nanofillers. Cross linking of materials based on polydimetylsiloxanes and their compounds was performed on 80˚C in vacuum. The chemical structure of the obtained materials was confirmed on the basis of the FTIR analysis, which confirmed the assumed mechanism of crosslinking of used silicone precursors. The influence of nanofillers on the mechanical and thermal properties of the obtained silicon is studied in detail, wherein was present a clear trend of improvement of mechanical properties of the silicone with the addition of nanofillers. Influence of nanofillers on the thermal properties of the silicone is confirmed based on DSC results.

Historical development of fire analysis

V. Matić, Lj. Simurdić, M. Dragoljić

Ministry of Internal Affairs of the Republic of Srpska, Banja Luka, Republic of Srpska

This paper is a historical overview of the scientific and technological development and achievements, with initial aim to study fire behavior and its spreading, fire resistance testing of construction and other materials and forensics fire debris analysis. The need to understand how fire behaves occurred 2.5 million years ago, during the Paleolithic Period, when the human race first began to develop its skills for fire usage. However, the initial evolution in fire studying (seen as the main cause for many fires to lead to human casualties and significant material damage and consequent loss) began with the development of basic tools used for remote measurement of temperatures and heat flow, and later for material testing for inflammability, burning, as well as residual fire trace analysis. This beginning was traced back to the nineteenth century, with the discovery of the thermoelectric effect and the First Law of Thermodynamics, in other words the creation of tools for calorimetric temperature and heat flux measurement. Forensics, as a science, started to develop in the late nineteenth century and, at that time, there was no mention of the fire debris analysis, as we know it today. Taking into consideration the protection of life and property (ASTM etc.), early in

the twentieth we have been introduced to the development of scientifically based fire standards (ASTM, etc.). In the meantime, engineering innovation managed to develop electromechanical equipment, which automatically records data measured from fire experiments. This step is seen as extremely important for a detailed study on fire behavior analysis. In addition, the first extraction techniques of fire debris are presented for forensic purposes (the steam distillation and solvent extraction). Identification of flammable liquids in these extracts was originally done with the mere detection of odors, after that it was based on the boiling point, specific gravity, and refractive index, until the occurrence of infrared and mass spectrometry. In the second half of the twentieth century, with the development of measurement technology (digital equipment and computers), there has been a great improvement in the field of fire behavior test methods and construction and other materials fire resistance testing. Extraction of fire debris was still being done in suitable solvents, but there was an innovation, more precisely, the absorption on activated carbon, which is also practiced today, along with modern method of micro-solid phase extraction (SPME). The major milestone in the evolution of fire debris analysis is gas chromatography and infrared spectrometry. Since then and until now, mostly technical advancements of gas chromatography are being developed, such as the use of capillary columns, mass spectrometry as a detection technique, and finally, the use of comprehensive two-dimensional gas chromatography. Thanks to advanced technology and the development of analytical methods and techniques, the forensic fire debris analysis has improved significantly. Currently, more and more attention should be placed on preventive actions and measures, with the primary aim to prevent the fire, or when a fire nevertheless occurs, to minimize suffering, casualties and material damage. These goals can be achieved by consistent application of standards related to the protection of life and property and with compulsory testing of structures endurance and materials used in construction. There had been around 7.000 fires at various facility premises and more than 2.000 forest fires registered in the Republic of Srpska, over the last ten years (2007 - 2016). In fires, explosions and other disasters, 142 people died and the estimated total material damage caused by fire is over 27 million Euros. To conclude, there is an unquestionable need to raise awareness of the importance of fire testing and testing structures endurance and materials to fires, the development of fire protection systems and the improvement of fire debris analysis. At the same time, a permanent advancement of the existing fire standards is necessary as well as to introduce some new standards in this area.

Microstructure and Mechanical Properties of Thixomolded® Si_p- and C_f-reinforced Magnesium Metal-Matrix-Composites

O. Myronova

Institute of Metal Technologies, University of Duisburg, Duisburg, Germany

Enhancement and development of modern technology requires development of materials with new complex mechanical and performance properties.

As an important lightweight engineering material, magnesium alloys have been attracting much attention for weight critical structural applications due to its low mass density, high specific stiffness and strength, high damping capacity and excellent castability, especially when a high strength/weight ratio is required.

A successful use of magnesium in the field of automotive construction or for special applications which require mechanical and thermal stability can be achieved by reinforcement.

It is generally accepted that the reinforcement with hard inclusions in forms of particles or short fibers enhances the mechanical properties of the magnesium metallic matrix.

Thixomolding® makes it all possible. Thixomolding® is a fully-automatic, resource-saving and eco-friendly process belonging to the group of Thixoforming processes which are also called semi-solid processes that is used to produce magnesium alloy components.

It allowed silicon-particle or carbon-fiber additions to be admixed to the feedstock and to fabricate Si_p- and C_f-reinforced Mg-MMC components with uniform distribution of particles/fibers in the matrix and good bonding between metallic matrix and reinforcement.

AZ91D, MRI153M and MRI230D Magnesium alloy-based composite components reinforced by silicon particles and short carbon fibers manufactured with the Thixomolding® machine of University Duisburg-Essen have been investigated in present studies.

The microstructure and compressive properties of the composites were characterized.

Drying and heating of refractory material in the cement industry

G. Lazić

Lafarge Holcim, Beočin, Serbia

Various refractory materials are used in concrete processes inside rotary kiln in cement industry like materials based on spinel, aluminosilicate materials, high alumina materials on the base of calcined bauxite, electrofused corundum with and without SiC and chamotte. Some of them are used in the shaped form (bricks of various dimensions and shapes), while others are used in unshaped form (refractory mortars, self compacting and gunning mixes). All these materials should be prepared for the process by heating following well defined heating diagrams.

Beside refractory brick on the base of spinel ($Mg{\cdot}Al_2O_3$), specific attention should be paid to the other unshaped mixes (concretes and gunning mixes). These materials should possess good chemical and abrasion resistance to the phases contained in cement clinker. Therefore their density, phase design, adhesion properties and resistance to thermal shock should be optimized at high level. Some of them are used for hot reparation of refractory walls because they are heated extremely fast. It is a real challenge to design these materials to be maximally adjusted in accordance with the process since their heating and drying is extremely fast.

Novel material obtained from poplar fluff and potential application in industry

V. Dodevski[1], B. Janković[2], A. Devečerski[1], S. Krstić[1], M. Kragović[3], M. Stojmenović[1]

[1]*Institute of Nuclear Sciences "Vinča", Laboratory for Materials Sciences, University of Belgrade, Belgrade, Serbia*
[2]*Faculty of Physical Chemistry, University of Belgrade, Department of General and Physical Chemistry, Belgrade, Serbia*
[3]*Institute for Technology of Nuclear and Other Mineral Raw Materials, Belgrade, Serbia*

Activated carbon was successfully prepared using poplar fluff as a very cheap and renewable raw material. The samples were prepared by

carbonization under N_2 atmosphere up to 850 ºC, and then activation in CO_2 atmosphere at different both temperatures (750 and 850 ºC) and times of activation (1 and 2 h). Physicochemical properties of crude, carbonized and activated poplar fluff were studied by using element analysis, XRPD, FTIR and SEM. Preliminary experiments on wastewater from facility of lead and zinc mine Grot showed that after treatment with activated carbon as adsorbent, the content of the most abundant heavy metals significantly decreased.

ISO-JET burners and its application in kilns for ceramic industry

V. Vučetić[1], N. Vučetić[2], S. Grujić[1]

[1]Real S, Belgrade, Serbia
[2]University of Turku, Faculty of Chemical Engineering, Turku, Finland

This type of burner is used in industrial furnaces for temperatures up to 1800 °C, where it is used as fuel natural gas or LPG (Liquefied Petroleum Gas). There can be achieved oxidizing, neutral or reducing atmosphere in the furnace.

The application of these burners comparing to the conventional considerably saves energy, i.e. shortens the firing time. Structure of burner consists of special refractory formats, i.e. insulating refractory concrete. There is cca 500 kg of refractory lining less heated by one burner.

By its dimensions burners are designed so that it can be installed on existing furnaces and thus they achieve energy savings. It is possible to install this type of burner onto electric furnaces during reconstruction for gas fuel application.

Refractory composite: tungsten carbide with homemade tungsten silicides

J. Luković[1], D. Milovanović[1], R. Kumar[2], N. Stanković[1], V. Maksimović[1], B. Matović[1], T. Volkov-Husović[2]

[1] Vinča Institute of Nuclear Sciences, Belgrade, Serbia
[2] Indian Institute of Technology-Madras (IIT Madras), Chennai, India
[3] Faculty of Technology and Metallurgy, University of Belgrade, Serbia

Tungsten and tungsten based materials have excellent stability at high temperatures, high melting point, very high hardness, low friction coefficients, low reactivity, high oxidation resistance, and good thermal and electrical conductivity. This combination of properties makes them a suitable for application in hard metal industry. Composite materials made of commercial tungsten carbide (WC) with the addition of homemade tungsten silicides (WSi_2 and W_5Si_3) were made. Firstly we found optimal conditions for synthesis tungsten silicides from elementary powders. Examination of a change in phase composition during synthesis was performed by changing temperature and time of heating. Obtained powders were added to WC in different mass percentages (5 and 10 wt% of added silicides). Then, mixtures were spark plasma sintered at 1600 °C at a heating rate of 100 °C/min and a load of 50 MPa for 5 min in a vacuum. Nanoindentation tests were performed on sintered samples, as well as cavitation erosion testing accompanied by measuring of mass changes and the profilometry measurements to scan the surface. Microstructure and morphology were determined by scanning electron microscopy (SEM). We found that these materials exhibit great cavitation erosion resistance presented by the minimal loss of mass. The results show that in spite of high porosity obtained materials have an excellent resistance to the erosion cavitation testing.

Warm upsetting tests with cylindrical molybdenum and wolfram samples

V. Goryany, M. Hinnemann, O. Myronova

University of Duisburg-Essen, Duisburg, Germany

The resistance of a modern ceramic material – silicon nitride – was examined by cyclical high temperature and compressive loads by the use of warm upsetting tests at cylindrical molybdenum and wolfram samples. Furthermore, flow curves of these samples were determined for different temperatures.

Nanotechnologies

Electron guiding through aluminum capillary

D. Borka[1], C. Lemell[2], K. Tőkési[3,4]

[1]Atomic Physics Laboratory (040), Vinča Institute of Nuclear Sciences, University of Belgrade, Belgrade, Serbia
[2]Institute for Theoretical Physics, Vienna University of Technology, Vienna, Austria
[3]Institute for Nuclear Research, Hungarian Academy of Sciences (Atomki), Debrecen, Hungary
[4]ELI-ALPS, ELI-HU Non-profit Kft., Szeged, Hungary

It was shown that electron transmission through insulating capillaries appears to be fundamentally different from the simple picture of highly charged ion guiding governed solely by Coulomb deflection. Electrons can be both elastically and inelastically scattered upon close interaction with the surface (primary projectiles) and can produce secondary electrons. The aim of the research is to learn about fundamental properties of both the electron guiding by metallic capillaries and the processes of electron-surface interaction that define guiding properties, as well as to investigate possible applications. In this work we present a realistic computer simulation of electron transmission through an aluminum (Al) capillary based on a Monte Carlo Simulation (MCS) and classical transport theory (CTT). We have performed simulation of 250 eV electron guiding through a single aluminum tube of a diameter of 3.0 mm. We performed calculation for two capillary lengths, 50 and 100 mm, and two electron incidence angles, $\varphi = 3^{\circ}$ and $\varphi = 6^{\circ}$ and analyzed energy spectrum of transmitted electrons through the capillary. We also compare simulations with the Al bulk dielectric function and with the Al surface dielectric function because we do not know the surface roughness of the inner capillary wall we can only guess the microscopic angle of incidence responsible for the spectrum. For a perfectly flat inner wall surface we used the surface dielectric function and if it is very rough the result will tend towards the bulk result.

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Comparison of dynamic light scattering and laser diffraction study of early stages of amorphous calcium phosphate formation

V. Čadež[1], I. Erceg[2], D. Domazet Jurašin[1], A. Selmani[1], S. Šegota[1], M. Dutour Sikirić[1]

1Ruđer Bošković Institute, Zagreb, Croatia
2Faculty of science, University of Zagreb, Zagreb, Croatia

Excellent biological properties of amorphous calcium phosphate (ACP), precursor of crystalline calcium phosphates (CaPs), as well as its major role in the normal and pathological biomineralization of vertebrates continues to motivate interest in elucidating its formation. Crucial part of ACP formation mechanism is aggregation at different scales, i.e. calcium and phosphate ions associate forming prenucleation clusters, which aggregate to spherical ACP nanosized particles, which in turn aggregate to chain-like aggregates.

The aim of this study was to apply dynamic light scattering and laser diffraction, two widely used techniques for particle size's determination, in order to follow aggregation kinetics of ACP particles at nano to micron scale at two different supersaturations. Precipitation of ACP was initiated by fast mixing of equimolar reactant solutions. Induction time for nucleation of crystalline phase, i.e. time needed for the commencement of ACP transformation, was determined from potentiometric measurements. Furthermore, formed ACP was characterized by FT-IR spectroscopy, transmission electron microscopy (TEM) and atomic force microscopy (AFM).

During induction time spherical particles and their chain like aggregates characteristic for ACP were formed, as confirmed by FTIR, AFM and TEM. The initial formation rates, as well as the size of the particles, depended on the initial supersaturation. Although the precipitation conditions differed in DLS and laser diffraction studies (mode of mixing, reaction volume), a general conclusion that aggregation of ACP particles is a process which simultaneously takes place at different length scales leading to highly poly-

disperse precipitate, can be drawn. This points to a possible way of controlling ACP formation by controlling aggregation on chosen scale.

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Structural and electronic properties of $BiFeO_3$

M. Čebela[1], D. Zagorac[1], J. Zagorac[1], M. Rosić[1], M. Miroković[1], J. Radaković[2], K. Batalović[2]

[1]Materials Science Laboratory, Institute of Nuclear Sciences Vinča, Belgrade University, Belgrade, Serbia
[2]Laboratory for Nuclear and Plasma Physics, Institute of Nuclear Sciences Vinča, Belgrade University, Belgrade, Serbia

Bismuth ferrite ($BiFeO_3$), as a promising room temperature single-phase multiferroic material, has attracted extensive research activities recently due to its fundamental importance and potential technological applications (data storage, spin valves, spintronics, sensors, etc). Well-crystallized single-crystal $BiFeO_3$ nanopowder has been successfully synthesized with the hydrothermal method. Phase composition of the synthesized samples was determined by the x-ray diffraction (XRD) analysis, and it has been observed that synthesized material crystallizes in the space group *R3c*, as a α-$BiFeO_3$ phase, which was confirmed by the previous experiments. In addition, a structure prediction has been performed and 11 additional $BiFeO_3$ modifications have been proposed. In the next phase, an *ab initio* optimization of predicted structures has been performed. Furthermore, structural and electronic properties of multiferroic $BiFeO_3$ were investigated using density functional theory (DFT) within generalized gradient approximation (GGA). Calculated lattice parameters were in very good agreement with the experimental data. Similarly, the electronic spectroscopy measurements have shown that $BiFeO_3$ has an direct band gap of 2.71 eV, which is in good agreement with *ab initio* calculations.

Synthesis, calcination and characterization of $CoMoO_4$ nanopowders by GNP method

M. Rosić[1], D. Zagorac[1], M. Čebela[1], D. Jordanov[1], B. Babić[1], A. Zarubica[2], B.Matović[1]

[1]Vinca Institute of Nuclear Sciences, Centre of Excellence-CextremeLab, University of Belgrade, Belgrade, Serbia
[2]Department of Chemistry, Faculty of Science and Mathematics, University of Niš, Niš, Serbia

Nanosized $CoMoO_4$ powder was synthesized by glycine nitrate procedure (GNP). The synthesized samples were investigated by DTA, X-ray diffraction (XRD), Fourier transform infrared (FT-IR) spectra, Field emission scanning electron microscopy (FESEM), and nitrogen adsorption method. The photocatalytic activity of obtained $CoMoO_4$ nanopowders was estimated by the photocatalytic degradation of crystal violet in aqueous solution. This work has provided simple and effective method for controlling the composition and morphology $CoMoO_4$, which revealed a potential new approach in inorganic synthesis methodology. A single-phase α and β crystalline form of $CoMoO_4$ compound was confirmed by X-ray diffraction (XRD). The photocatalytic testing of $CoMoO_4$ nanopowders showed that these nanostructured materials can be promising solutions in photocatalytic processes toward green chemistry and sustainable development.

New polymorphs of barium sulfide under pressure and investigation of electronic properties on *ab initio* level

D. Jordanov[1], D. Zagorac[1], K. Doll[2], J. Zagorac[1], M. Rosić[1], B. Matović[1]

[1] Vinča Institute of Nuclear Sciences, Centre of Excellence-CextremeLab, University of Belgrade, Belgrade, Serbia
[2]Institute of Theoretical Chemistry, University of Stuttgart, Stuttgart, Germany

One of the main goals of the inorganic and theoretical chemistry is to find the new compounds, possibly with advanced properties. In this study we have performed *ab inito* modeling of barium sulfide under pressure, using three different approaches: Hartree-Fock, GGA-PBE and hybrid B3LYP, with special focus on structural aspects and electronic properties. We investigate the electronic properties of experimentally known structures, as well as novel predicted modifications of BaS. We predict new BaS polymorphs which have not-yet been synthesized or calculated in the BaS system, e.g. we have found TlI type modification as a metastable structure, which might be observed at elevated pressures and/or temperatures. We offer new possibilities of tuning the band gap in pure BaS by employing different barium sulfide modifications which can have great application in opto-electrical technologies.

Thermal diffusivity of polyethylene at different levels of crystallinity

M. Nešić[1,2], M. Popović[2], D. Miličević[2], M. Rabasović[3], D. Markušev[3], E. Suljovrujić[2], S. Galović[2]

[1]School of Electrical Engineering, University of Belgrade, Belgrade, Serbia
[2] Vinča Institute of Nuclear Sciences, University of Belgrade, Belgrade, Serbia
[3]Institute of Physics, University of Belgrade, Belgrade-Zemun, Serbia

Thermal diffusivity of high-density and linear low-density polyethylene at different levels of crystallinity, at room temperature, is evaluated in this work. The levels of crystallinity were measured by differential scanning calorimetry while the microstructure of poly-crystal phase was observed by atomic force microscopy. Thermal diffusivities are estimated from the measurements of photoacoustic amplitude and phase characteristics of the samples by applying a newly developed, self-consistent, inverse procedure. The level of crystallinity was correlated to the level of thermal diffusivity of each sample. Our results indicate that thermal diffusivity is not affected only by the level of crystallinity, but also by the microstructure of the poly-crystal phase of the observed material.

Dependence of thermal diffusivity of low-density polyethylene on sample thickness

M. Nešić[1,2], M. Popović[2], M. Rabasović[3], D. Miličević[2], E. Suljovrujić[2], D. Markušev[3], S. Galović[2]

[1]School of Electrical Engineering, University of Belgrade, Serbia
[2] Vinča Institute of Nuclear Sciences, University of Belgrade, Belgrade, Serbia
[3]Institute of Physics, University of Belgrade, Belgrade-Zemun, Serbia

Thermal diffusivity of low-density polyethylene samples of various thickness, and prepared using different procedures, is evaluated by transmission gas-microphone frequency photoacoustics. The samples' level of crystallinity, determined from the differential scanning calorimetry measurements, demonstrated that all of the used samples had different levels of crystallinity, depending not only on the preparing procedure, but also on the sample thickness. Therefore, in order to evaluate the samples' thermal diffusivity, it was necessary to apply a newly developed self-consistent fitting procedure for the interpretation of the photoacoustic measurements. The estimated values of thermal diffusivity were in the range of the expected literature values. Besides that, the obtained results indicate the correlation of the values of thermal diffusivity with the thickness of the samples, which depends on the preparing procedure. The results indicate the necessity of additional investigation of thermal transport mechanisms in macromolecular systems.

Exploration of thermal transport mechanism in macromolecular systems

S. Galović[1], A. Chizov[2], M. Nešić[1], M. Popović[1], D. Čevizović[1]

[1]Vinča Institute of Nuclear Sciences, University of Belgrade, Belgrade, Serbia
[2]Bogoliubov Laboratory of Theoretical Physics, Joint Institute for Nuclear Research, Dubna, Russia

In this review, we put emphasis on the interpretation of two essential aspects of thermal diffusivity measurements of various polyethylene samples by photoacoustics: the dependence on the level of crystallinity and the dependence on the microstructure of the crystal phase. We develop a modified two-phase model in which the carriers of thermal energy in the samples' crystal phase are not only phonons but also polarons, because the morphology of macromolecules enables rotational degrees of freedom of the side groups of macromolecules. By applying the developed model, we obtain good agreement between experimentally observed data and theoretical predictions.

Magnetic properties of nickel vertical posts

J. Potočnik, M. Popović, Z. Rakočević

[1]*Vinča Institute of Nuclear Sciences, University of Belgrade, Belgrade, Serbia*

In this work, nickel (Ni) thin film was deposited by electron beam evaporation of Ni using Glancing Angle Deposition technique onto the glass substrate with the thickness of 150 nm. Characterization of the obtained Ni film was performed by Scanning Electron Microscopy (SEM) and by Magneto-Optical Kerr effect measurements (MOKE). The asymmetry of coercivity, measured at the azimuthal angles that are 180 degrees apart, was observed. The deviation from the uniaxial magnetic anisotropy originates from the appearance of the polar magnetization component, which means that the MOKE measurement combines polar and longitudinal Kerr effect. To obtain the proper hysteresis loops from the individual Kerr effects, we have to add and subtract the two loops measured at the azimuthal angles that are 180 degrees apart. By observing the different shapes of hysteresis loops and different coercivity values, it can be assumed that the rotation of the magnetization does not represent only simple domain wall movement even at $\varphi = 0$ degrees, which is close to the easy axis direction. This indicates that the easy axis is oriented out of the plane of the sample.

ZnO hexagonal nanorods grown by vapor-liquid-solid deposition method

D. Kisić[1], M. Nenadović[1], Đ. Veljović[2], Z. Rakočević[1]

[1] *Vinča Institute of Nuclear Sciences, Laboratory of Atomic Physics, University of Belgrade, Belgrade, Serbia*
[2]*Faculty of Technology and Metallurgy, University of Belgrade, Belgrade, Serbia*

ZnO nanorods were grown by vapor – liquid – solid method (VLS), on the silicon monocrystal substrate, of the (1 0 0) preferential orientation. A thin layer of gold, 5 - 10 nm thick was deposited on the silicon substrate. Deposition of ZnO was performed in the home made VLS deposition system, by heating ZnO powder up to temperature of 1350°C, while Ar was used as a carrier gas. The deposition process lasted for 2 hours. The samples were analyzed by Scanning electron microscopy (SEM) and Energy dispersive X-ray spectroscopy (EDS). Nanorods of the regular hexagonal structure were formed, up to 1μm in length, and ranging from 500 nm to 900 nm in diameter. EDS confirmed supposed chemical composition of these nanostructures, showing high concentration of zinc and oxide.

Xenon implantation effects on the structural and optical properties of reactively sputtered titanium nitride thin films

M. Popović, M. Novaković, M. Mitrić, Z. Rakočević, N. Bibić

Vinča Institute of Nuclear Sciences, University of Belgrade, Belgrade, Serbia

The present study deals with irradiation effects induced by xenon ions (Xe^+) on titanium nitride (TiN) thin films. TiN films thickness of 260 nm obtained by using dc reactive sputtering were irradiated with 400 keV Xe ions. The irradiation doses were 5×10^{15}, 10×10^{15}, 15×10^{15} and 20×10^{15} ions/cm^2. The properties of irradiated films varying with ion fluence are investigated by means of Rutherford backscattering spectrometry, X-ray diffraction, transmission electron microscopy and spectroscopic ellipsometry. It was found that the Xe ions induce contraction and rhombohedral distortion of TiN lattice. The columnar structure was partially destroyed after irradiation, which introduce up to 1.5 at.% of Xe within the structure mostly concentrated around the projected ion range. The generation of defects due to the presence of heavy ions changes the optical constants of implanted films. It was found that the optical band gap of TiN films was reduced after xenon ion implantation.

Formation of monolayer polystyrene nanospheres by using different deposition methods

A. Modrić-Šahbazović[1], M. Novaković[2], I. Gazdić[1], V. Đokić[3], Z. Rakočević[2]

[1]University of Tuzla, Faculty of Natural Sciences and Mathematics, Tuzla, BiH
[2]University of Belgrade,Vinca Institute of Nuclear Sciences, Belgrade, Serbia
[3]Faculty of Technology and Metallurgy, University of Belgrade, Belgrade, Serbia

Nanosphere lithography, an inexpensive and high throughput technique capable of producing nanostructure arrays, relies on the formation of a monolayer of self-assembled nanospheres. Homogeneity of monolayer polystyrene (PS) is influenced by many factors, such as the method of obtaining, choice of solvents, concentration of solution and the substrate preparation itself. We have compared three methods of obtaining monolayer polystyrene on Si (100) wafers: horizontal dripping, evaporation under an angle, and spin coater, while ethanol, sodium dodecyl sulfate and Triton X-100 were used as solvents. Polystyrene spheres used in experiment were dimensions of ~150 nm in diameter. The obtained PS structures were characterized by using both optical and scanning electron microscopy. We have demonstrate that the most homogenous and dense PS monolayer was obtained by spin coating with ethanol as a solvent. The speed of rotation as well as the concentration of the solution found to be crucial for uniform and periodic monolayer deposition on the large scale.

Gold nanoparticles: from synthesis through ultrasonic spray pyrolysis to different bio-medical applications

M. Shariq[1,2], P. Majerič[1], D. Jenko[3], A. Rai Dixit[2], R. Rudolf[1,4]

[1]University of Maribor, Institute of Materials` Technology, Slovenia
[2] Indian Institute of Technology (Indian School of Mines) Dhanbad, Jharkhand, India
[3] Institute of Metals and Technology, Ljubljana, Slovenia
[4]Zlatarna Celje d.o.o., Celje, Slovenia

The research work presents synthesis of gold nanoparticles (AuNPs) through re-designed Ultrasonic Spray Pyrolysis (USP).

In the first step, the research was focused on the study of precursor solutions which were obtained from different metal salts, such as gold acetate, gold chloride and gold nitrate. They are easily available and relatively cheap on the market.

In the second step, the study was focused on its feasibility with the USP and on optimization of synthesis parameters such as concentration of the precursor solution, carrier and reduction gas flow rates, evaporation and reaction temperatures with the aim achieving the relevant properties of AuNPs.

In the final part, some AuNPs` applications in different bio-medical fields are presented, such as drug delivery carriers, thermal ablation agents etc. Hence, it follows the presentation of our biocompatibility tests which were carried out on AuNPs.

Multilayered nanocoatings deposited by PVD method for potential antimicrobial surfaces

A. Trajkovska Petkoska[1], I. Nasov[2]

[1]*University St. Kliment Ohridski-Bitola, Faculty of Technology and Technical Sciences Veles, R. Macedonia*
[2]*Plasma–Center for Plasma Technologies,Skopje R. Macedonia*

Stainless steel is a precious material due to its durability, resistance to corrosion and ease of cleaning; it is the icon of cleanliness for home and commercial kitchens, restaurants, hospitals, pharmaceutical, bioprocessing and food facilities, but it readily collects bacteria over time. Stainless steel surfaces can attract variety of microorganisms even at room temperature, they can easily attach to untreated stainless steel surfaces. All objects in common use or in public areas that could potentially be in contact, handled or touched by people, could have inherent antibacterial properties to inhibit the proliferation of pathogens upon their surface, which can cause infections.

One way to create antibacterial surfaces is by introducing silver or copper into the steel or to make a Cu- or Ag-based coating on to the surface. Coating techniques are very attractive nowadays; they could develop surfaces that not only kills bacteria but is very hard and resistant to wear and tear that is very important during cleaning and exploitation of those surfaces.

In this work, creating potential antibacterial surfaces on stainless steel by Physical Vapor Deposition (PVD) method is described. The method allows depositing a thin film onto variety of basic materials. During the process, variety of metals (targets) can be deposited like, copper and/or silver. Under certain conditions in PVD chamber they evaporate in a vacuum atmosphere. Due to a potential difference between the products (target and other part that need to be coated), ions move on the surface where they condense creating the desired coating. By changing of deposition parameters in PVD chamber is possible to make creation of customized functional nanolayers of one or different potential antibacterial metals as well as retardant and protection layers (e.g Ti-based layers) that can regulate the release of antibacterial ions towards the surface. In this way it is possible to make slow and long lasting antibacterial effect of the coated surfaces of stainless steel.

The antibacterial effect is due to present antibacterial ions (Cu, Ag, or their mixture) that diffuse through multilayered structure of the coating. The most possible mechanism for antibacterial activity of these nanolayers is release of antibacterial ions towards the surface and destroying of cell membranes of bacteria by blocking its nutrition, altering its protein properties and interrupting the cell division cycle.

Acknowledgement: In this work, scanning electron microscope, model JEOL JSM-7200F, is used for material characterization of multilayered structure of the coating. Special thanks to Mr. Toshiyuki Kanazawa (JEOL Demo Center, Paris-France) and Mr. Slavko Zizek (JEOL, Scan Doo, Slovenia) for performing this characterization.

Study of the interaction of nonionic and cationic surfactants using a nanomaterials based surfactant sensor

M. Hajduković, M. Samardžić, S. Petrušić, O. Galović, M. Sak-Bosnar

Josip Juraj Strossmayer Univeristy of Osijek, Department of Chemistry Osijek, Croatia

Nonionic surfactants (NS) are used in a wide range of products for cosmetic, industrial, agricultural and household applications. In combination with ionic (cationic or anionic) surfactants they improve some functional performances of commercial products, but also have ecotoxic properties, therefore their determination is of great importance. The most commonly used class of NS are ethoxylated nonionic surfactants (EONS) that are frequently used in mixtures with cationic surfactants (CSs) to develop product formulations that combine the properties of both CSs and EONSs. Therefore, the influence of the chemical nature and concentration of EONSs on the potentiometric titration of CSs was investigated.

A new potentiometric sensor, sensitive to cationic surfactants was prepared, containing MWCNTs modified with a sulfate group and cetylpyridinium ion (CP) embedded in a plasticized PVC membrane. As a conducting substrate, graphite of spectroscopic grade was employed. The chemical modification of MWCNTs with CP cations significantly improved the most important analytical and practical sensor properties.

The titration curves of cetylpyridinium chloride (CPC) alone and those with the addition of EONS containing different number of ethoxy (EO) groups were compared. The standard solution of sodium dodecyl sulfate (NaDS, c = 4 mM) was used as the titrant.

EONSs affected the titration curves, moderately reducing their extent and inflection. The number of EO groups did not significantly influence the titration curve or the reliable quantification of CSs.

The influence of the EONS concentration on the potentiometric titration of CSs was investigated too. It can be concluded that an increase of EONS concentration resulted in a slight decrease of inflection at the equivalence point, but not influencing CSs determination.

Optical properties of Ti_xO_y films obtained by cathodic arc plasma deposition

V. Jokanović[1,2], B. Čolović[1], A. Trajkovska Petkoska[3], A. Mraković[1], M. Nenadović[1], M. Ferrara[4], I. Nasov[5]

[1]Vinča Institute of Nuclear Sciences, University of Belgrade, Belgrade, Serbia
[2]ALBOS Doo, Belgrade, Serbia
[3]University St. Kliment Ohridski, Faculty of Technology and Technical Sciences, Veles, R. Macedonia
[4] TE-STT-SCIS, Laboratorio Sviluppo Componenti ed Impianti Solari, Portici (NA), Italia
[5]Plasma Doo, Skopje, R. Macedonia

Nanometric titanium oxide (Ti_xO_y) films were obtained by cathodic arc plasma deposition and their structural and optical properties were investigated. Phase analysis by X-ray diffraction and infrared spectroscopy showed the presence of anatase, rutile, Ti_2O_3, Ti_4O_7 and amorphous phases. Scanning electron microscopy analysis showed well-developed surface morphology with nano-patterns. Spectroscopic ellipsometry revealed film thicknesses of 53 and 50 nm, variable refractive indices dependent on the light wavelength and close to zero extinction coefficients for wavelengths higher than 500 nm. Band gap values for direct and indirect electron transitions were determined on the base of Uv-Vis spectroscopy data and using Tauc equation.

Ultrasmall iron oxide nanoparticles for positive contrast MR imaging: structural, colloidal and magnetic properties

B. Babić-Stojić[1], V. Jokanović[1], D. Milivojević[1], M. Požek[2], Z, Jagličić[3], D. Makovec[4], N. Jović Orsini[1], M. Marković[1], K. Arsikin[5], V. Paunović[5]

[1]*Vinča Institute of Nuclear Sciences, University of Belgrade, Belgrade, Serbia*
[2]*Department of Physics, Faculty of Science, University of Zagreb, Zagreb, Croatia*
[3]*Institute of Mathematics, Physics and Mechanics, Ljubljana, Slovenia*
[4]*Department for Materials Synthesis, Jožef Stefan Institute, Ljubljana, Slovenia*
[5]*Institute of Microbiology and Immunology, School of Medicine, University of Belgrade, Belgrade, Serbia*

Ultrasmall crystalline iron oxide nanoparticles (USPIO NPs), with majority of the particles less than 3 nm in size dispersed in an organic fluid, were synthesized by polyol method. ZFCFC bifurcation and *ac* susceptibility peaks reveal that the nanoparticles are superparamagnetic with a blocking temperature $T_B \sim 10$ K. Considerably reduced measured magnetic field dependent magnetization at $T > T_B$, compared to the calculated dependence for noninteracting superparamagnetic NPs with a log-normal distribution of particle sizes, can be well described by modifying this distribution with field dependent average magnetic particle diameter. NMR relaxivity measurements on water diluted nanoparticle dispersions at magnetic field 1.5 T gave longitudinal and transverse relaxivity values $r_1 = 0.028$ mmol^{-1} s^{-1} and $r_2 = 0.050$ mmol^{-1}s^{-1} which resulted in the relaxivity ratio, $r_2/r_1 = 1.8$. The USPIO NPs dispersions have shown the properties of positive T_1 MRI contrast agents: increasing MR signal intensity in the T_1-weighted image with increasing iron concentration in a wide concentration range. Cytotoxicity studies revealed that the USPIO NPs dispersions did not exert any significant cytotoxic activity on the B16 mouse melanoma cells at Fe concentrations of 1 mmol and below.

Nanomedicine

The influence of new nanostructured endodontic materials on human stem cells from the apical papilla

B. Ćetenović[1], D. Trišić[2], B. Čolović[1], V. Jokanović[1], D. Marković[2]

[1]Vinča Institute of Nuclear Sciences, University of Belgrade, Belgrade, Serbia
[2]Clinic for Pediatric and Preventive Dentistry, School of Dentistry, University of Belgrade, Belgrade, Serbia

Lately, fully innovative sol-gel method with high-temperature self-propagating reaction was used for the synthesis of new nanostructured endodontic materials, in combination with different radiopacifiers: bismuth (ALBO-MPCA$_1$) and barium (ALBO-MPCA$_2$). The aim of this paper was to investigate chemico-physical properties and analyze the influence of synthesized materials on human stem cells from the apical papilla (*SCAP*) in comparison to MTA$^+$ (Cerkamed, Stalowa Wola- Poland).

Phase analysis before and after hydration was performed using XRD and FTIR, while the morphology of the samples was studied by SEM. Materials' alkalinity was measured using pH-meter, while the amount of released ions was determined by ICP-OES. The biocompatibility of materials' eluates (24 h, 7-day and 21-day) was tested using the neutral red uptake assay. The interaction of the tested materials with cell cultures was performed using inverted microscope.

Samples mostly consisted of agglomerates built up from nanoparticles (90 and 500 nm), preferably spherical and rode-like with the homogenous distribution of the phases. The pH values of MTA$^+$ were alkaline but significantly lower than in case of ALBO-MPCA$_1$ and ALBO-MPCA$_2$ ($p<0.05$). The concentration of released calcium and aluminum ions decreased, while the concentration of bismuth (ALBO-MPCA$_1$, MTA$^+$), barium (ALBO-MPCA$_2$) and magnesium (in the case of all tested materials) increased during 21 days. The percentage of relative cell viability decreased with the increase of time ($p>0.05$). In direct contact with investigated materials, *SCAP* cells showed fibroblast-like morphology, as the dissolved materials' particles concentrated along the cells and/or their cytoplasmic extensions.

The results show that the synthesized materials are adequately designed, possessing the appropriate surface morphology, which is of importance for their bioactivity. The biocompatibility of synthesized materials measured by

neutral red uptake is comparable to the control material MTA+, and therefore these materials can be recommended for further clinical studies.

Surface characterization of glass ionomer cements stored in various solutions using nanoindentation and SEM/EDX techniques

B. Petrović[1], D. Marković[2], T. Perić[2], S. Kojić[3], G. Dubourg[4], E. Gjorgievska[5]

[1]Faculty of Medicine, University of Novi Sad, Novi Sad, Serbia
[2]Faculty of Dentistry, University of Belgrade, Belgrade, Serbia
[3]Faculty of Technical Sciences, University of Novi Sad, Novi Sad, Serbia
[4]BioSense Institute, Novi Sad, Serbia
[5] Faculty of Dentistry, Cyril and Methodius University, Skopje, R. Macedonia

The aim of this *in vitro* study was: to determine the nanomechanical properties of the surface of glass ionomer materials (modul of elasticity and hardness using nanoindenter), ion concentrations at the surfaces of glass-ionomer-based materials with respect to different storage media and different pH environments; to examine the recharge ability of the materials after NaF immersion; and to assess the morphological changes at the material surface using scanning electron microscope and energy dispersive spectroscopic techniques (SEM/EDx). Three glass-ionomer-based materials, Fuji Triage (FT), Fuji VIII (FVIII) and Fuji IX GP (FIX), were analyzed. The sample consisted of 60 cured cement disks (n=20 disks of each tested material, 10x1.5mm). Five disks of each material were stored in 4 different storage media (I- saline, II- acidic solution ph=2.5, III- acid solution ph=5.5, IV- NaF solution ($c=500/10^6$). All samples were subjected to the same indentation cycle using a 1 mN maximum force giving penetration depths in the range of 500-1500nm and corresponding contact areas of the order of a few μm^2, EDx analysis was conducted in 3 randomly selected spots of each experimental disk identifying primarily following ions: O, Al, Sr, Si, F, Na, P, Ca. SEM was used to determine morphological characteristics of the material surface. Differences between the experimental groups have been analyzed using Student`s t-test with the level of significance set at $p<0.001$. FT showed the highest fluoride content at the surface of the material. The lowest amounts of fluoride ions were detected at the surfaces of the FT disks

stored at low pH environments, and this difference was statistically significant ($p<0.001$) SEM analysis of the surface morphology revealed numerous voids, cracks and microporosities in all experimental groups. More homogenous material structure with more discrete cracks was observed in samples stored at neutral pH environment, compared to disks stored in acidic solutions. Hardness of the tested materials decreased from 0.154GPa (after fluoride recharge) to 0.042 (in acidic environment). Observed Young's modul varied from 2.6GPa to 0.478GPa depending on material type (Fuji VIII>Fuji IX>Fuji Triage) ($p<0.001$), and storage media (fluoride immersion, saline, acidic solutions) ($p<0.001$). The tested materials could be considered as promising dental materials with satisfactory nanosurface characteristics due to their relatively high fluoride content, but also the ability to extensively reabsorb fluoride ions, especially in acidic environments, thus suggesting powerful cariostatic potential. Nano-modification of conventional GIC could be achieved by incorporation of nano-sized fillers, reducing the size of the glass particles, and introducing nano-sized bioceramics to the glass powder which requires additional research.

In vivo assessment of ALBO-OS scaffold made of calcium hydroxyapatite and PLGA

B. Čolović[1], Dj. Antonijević[1], D. Marković[2], M. Petrović[3], J. Sopta[3], V. Jokanović[1]

1 Vinča Institute of Nuclear Sciences, University of Belgrade, Belgrade, Serbia
2 Department of Pediatric and Preventive Dentistry, Faculty of Dentistry, University of Belgrade, Belgrade, Serbia
3Clinic for Maxillofacial Surgery, Faculty of Dentistry, University of Belgrade, Belgrade, Serbia

The potential of a porous calcium hydroxyapatite scaffold with PLGA thin film on its surface (named as ALBO-OS), as a bone substitute, was examined in *in vivo* biofunctionality assays and compared with Geistlich Bio-Oss®, considered the gold standard. Structural and morphological properties of ALBO-OS were analyzed by SEM and AFM and micro CT. The biofunctionality assays were performed on New Zealand white rabbits using ALBO-OS and Geistlich Bio-Oss® for filling full-thickness defects of critical size. The evaluated parameters were: the presence of cells of immune response, neoangiogenesis, fibroplasia, and the percentage of mineralization. The appearance of bone defects 12 weeks after ALBO-OS implantation showed the presence of a small number of immune response cells, significantly reduced number of capillary buds, low intensity of fibroplasia and high degree of mineralization which all indicated that the inflammation process has been almost completely completed and that the newly formed bone was in the final phase of remodeling. All biofunctionality assays proved that ALBO-OS is suitable for application as a bone substitute in maxillofacial surgery. Furthermore, it showed numerous advantages over Geistlich Bio-Oss®, reflected mainly as a lower number of giant cells around implanted material and higher degree of mineralization in newly formed bone.

Variations in mesiodistal tooth dimensions depending on gender and side of the dental arch

M. Živković Sandić[1], N. Stefanović[1], J. Čivović[1], M. Popović Bajić[2], B. Glišić[1]

[1]Department of Orthodontics, Faculty of Dental Medicine, University of Belgrade, Belgrade, Serbia
[2]Department of Restorative Dentistry and Endodontics, Faculty of Dental Medicine, University of Belgrade, Belgrade, Serbia

Tooth dimension variations are common among individuals, but can also depend on patient's gender or the side of the dental arch. These variations are important in orthodontics because they can influence the development of different malocclusions.

The aim of this study was to investigate variations in tooth size of the left and the right side of the maxillary and mandibular arch and between genders.

The study involved 25 healthy subjects (15 females and 10 males) whose plaster models were scanned using the Next Engine 3D Scanner. Mesiodistal tooth dimensions were measured using the Geomagic Software. The mesiodistal crown width was measured as the greatest distance between the contact points on the interproximal surfaces of the tooth crowns. Upper and lower incisors, canines, premolars and first molars were measured on both the left and the right side of each dental arch. Tooth sizes were compared according to gender and side of the dental arch.

Mesiodistal tooth dimensions did not show statistically significant differences between males and females, except for lower canines, which were significantly smaller in females. No statistically significant differences were found when comparing the left and the right side of the dental arch, except for upper second premolars, which were larger on the right side.

Tooth dimensions were not significantly different between genders and between left and right sides of the dental arch.

Direct pulp capping with novel nanostructural material based on calcium aluminate cement

I. Radović[1], L. Davidović[1], N. Stojanović[1], M. Ćuk[1], S. Živković[2], V. Jokanović[3]

[1]University of East Sarajevo, Faculty of Medicine, Foča, Republic of Srpska
[2]Department of Restorative Dentistry and Endodontic, Faculty of Dentistry, University of Belgrade, Belgrade, Serbia
[3]Vinča Institute of Nuclear Science, University of Belgrade, Belgrade, Serbia

Direct pulp capping is a therapeutic procedure of placing a dental material on exposed pulp to induce formation of dentine bridge and healing.

The aim of this study was to investigate histological effects of novel nanostructural material based on calcium aluminate cement on sheep pulp tissue.

The study was conducted on 10 teeth of two sheep (*ovis aries)*. After class V preparation on the bucal surfaces, pulp was exposed and the perforations were apped with new nanostructural material based on calcium aluminate cement. New material was synthesized at the Vinča Institute for Nuclear Research, and contains calcium aluminate, calcite and barium sulfate in ratio of 1:2:2. All cavities were restored with glass ionomer cement. The observational period was 28 days after which the animals were euthanized and histological preparations were made.

Histological analysis showed that dentin bridge was formed in almost all samples (not observed in one sample). Inflammation of the pulp was mild to moderate. In most samples neoangiogenesis with proliferation of existing blood vessels was observed.

Nanostructural material based on calcium aluminate cement shows favorable therapeutic effect in direct pulp capping of sheep teeth. However, further studies related to biological effect of the cement to pulp and periodontal tissue should be performed.

Resin-modified and conventional glass-ionomer cements: SEM evaluation of adhesion to the hard dental tissues

L. Davidović[1], I. Radović[1], S. Živković[2]

[1]University of East Sarajevo, Faculty of Medicine, Foča, Republic of Srpska
[2]Department of Restorative Dentistry and Endodontic, Faculty of Dentistry, University of Belgrade, Belgrade, Serbia

Glass-ionomer cements (GIC) are dental material widely used in modern dentistry. Lack of proper adhesion is one of the most common problems in restorative dentistry and the main cause of microcracks and consequent microleakage.

The aim of this experiment was to assess the quality of bond between two types of GIC class V restorations and hard dental tissues by Scanning Electron Microscopy (SEM).

Clinical study included 20 intact teeth extracted for orthodontic resons. Class V cavity was prepared on vestibular and oral surfaces of all teeth (3×2×2 mm). Conventional GIC Fuji II was applied on vestibular surface while resin-modified GIC Fuji II LC was placed on oral surface of teeth. Teeth were kept in saline before SEM analysis was performed. After splitting teeth in vestibulo-oral direction, sections were coated with thin layer of precious metal in vacuum apparatus. Samples were observed using SEM JEOL JSM-5300 at maximum voltage of 30kV using different magnifications. SEM images were obtained using JVC GC-X3E on films ILFORD FP4 PLUS 125 (125 ASA, 22DIN, EI125/22). Image analysis and measurement of the size of microcracks were performed in the computer software SemAfore 4.

Microleakage was lower with Fuji II LC than Fuji II. Microcracks were observed in 65% of restorations restored with Fuji II and 35% restored with Fuji II LC. SEM analysis showed the average gap between Fuji II LC and dentine was 9 μm while this value for Fuji II was 17 μm. The difference was statistically significant.

It can be concluded that better bond between material and hard dental tissue was achieved with resin-modified GIC.

Opto-magnetic imaging spectroscopy as a viable diagnostic procedure

B. Lisul[1], M. Petrović[1], Dj. Koruga[2], Dj. Grga[1]

[1]School of Dental Medicine, University of Belgrade, Belgrade, Serbia
[2]Faculty of Mechanical Engineering, University of Belgrade, Belgrade, Serbia

The objective of this study was to investigate the potential of another novel optical procedure - opto-magnetic imaging spectroscopy (OMIS) in characterization of oral cavity tissues (normal and pathologically changed). So far, OMIS was used on non-organic compounds (water), biological tissue (healthy skin), contact lenses and live microorganisms (viruses).

OMIS is a method that uses the interaction of a certain material (water, tissues, microorganisms etc.) with visible light to provide information on magnetic properties (paramagnetic, diamagnetic) of examined specimens. Main tool in achieving this is the light of wavelengths ranging from 400 to 700nm. Light is composed of both electrical and magnetic compounds. The material of interest is first exposed to the white light under a right angle (90°) and reflected non-polarized light contains data on electro-magnetic components of material. On the other hand when the surface of material is illuminated by white light under a certain angle (Brewster angle) the reflected light is polarized and carries data on just the electrical components of material. Difference between the two gives us information on magnetic parameters of the examined material. The procedure is performed with the NL-B53 device (digital camera CANON, model IKSUS 105, 12,1 MP and self-incorporated light source extension - 6 LED diode sets) and through a specific algorithm (MATLAB) designed at the Faculty of mechanical engineering, University of Belgrade. For the purposes of this pilot study at the School of dental medicine in Belgrade four different oral cavity tissue types (material) were isolated and used - tumor tissue, presumable normal oral tissue, normal tooth tissues - enamel and dentin.

By processing the images and data through a convolution algorithm based on basic pixel analysis in red and blue channels, significant differences in intensity of the peaks were determined between all tissue types (tumor tissue - 40-100nm, normal tissue - 0-25nm, normal tooth tissues - enamel - 60 - 120nm, dentin - 0 - 50nm).

Opto-magnetic imaging spectroscopy provides viable information into differences between different types of tissues in the oral cavity. For a potential standardization of this procedure further research is necessary.

Isotopic analysis of the skeletons from Roman period with archaeological site Viminacium

I. Mikić, M. Korać

Institute of Archaeology, Belgrade, Serbia

For the implementation of the isotopic analysis of samples of teeth more than 100 skeletons were available, which originated from necropolises Pećine and Više Grobalja from Viminacium which are excavated during period 1978-1987 year. Chronologically this skeletal material was classified in the period I-IV century. First permanent molars were used for the analysis. Enamel with a total of 25 first permanent molars was investigated. The bones of a rabbit and red deer were used as a control.

The aim of this study was to examine of isotope ratio $^{87}Sr/^{86}Sr$. Analyzes were carried out in collaboration of researchers from the Anthropological Institute of the University Ludwig Maximilian in Munich. Tooth enamel was formed on the first permanent molar collecting certain residues starting from the intrauterine period up to 3 years of age. In this way, a ratio formed by stable isotopes of strontium $^{87}Sr/^{86}Sr$, which is characteristic for the region where the person who has been subjected to this study, was born, i.e. spent his early childhood. The bones of animals were used to determine the ratio of strontium bioavailability to the place of burial. Based on these results it can be said with confidence that the persons who have no overlapping value of strontium, migrated to Viminacium in later life.

To summarize, the study of isotopic ratios in the necropolises Pećine and Više Grobalja only corroborated the fact of multiethnicity of Viminacium in ancient times because that relationship in some cases, particularly in the case of the necropolis Više Grobalja were not consistent with the values predicted for the area. The population was very heterogeneous originating from Europe and Asia.

Isotopic analysis of skeletons from the period of the Great Migration from the archaeological site Viminacium

I. Mikić, M. Korać

Institute of Archaeology, Belgrade, Serbia

Early 21st century is marked by an initial stage of the development of methodology and procedures of isotopic analysis of the light and heavy components of the human skeleton. In this case, the strontium isotope analysis, and the main question is an issue which parts of the skeleton are the most reliable for sampling. The goal of this research were artificially deformed skulls from three sites in Bavaria (Altenberg, Peigen and Straubing).On the other hand the samples were taken and the deformed artificial skull from Viminacium which are assigned according archaeological data to Gepids. All samples were taken from teeth and skull base, and there were a total of six from Bavarian sites and six from Viminacium. Analysis was expanded in 2004 when the samples were taken from 17 more samples of teeth and bones, also with artificially deformed skull.

Among other things, strontium values are better grouped in teeth samples then from the bones. All skeletons have been dated to the period of VI century.

Comparing the results that have been reached, samples were taken from Viminacium showed contrasting value compared to the one foreseen for the region around Viminacium, while samples from the Bavarian area proved to be a people of local origin.

Synthesis and characterization of nanocomposite alginate hydrogels with silver nanoparticles and honey components for potential applications in wound treatments

J. Stojkovska[1], N. Stanojević[1], M. Pavlović[1], P. Petrović[1], I. Jančić[2], M. Milenković[2], B.Obradović[1]

[1]Faculty of Technology and Metallurgy, University of Belgrade, Belgrade, Serbia
[2]Department of Microbiology and Immunology, Faculty of Pharmacy, University of Belgrade, Belgrade, Serbia

Alginate hydrogels are widely used as wound dressings due to biocompatibility, softness and high sorption capacity, thus providing moisture regulation in wounds as well as rapid granulation and reepithelization of the damaged tissue. Still, these hydrogels are further investigated for potentials to extend functionality with some additional properties such as antimicrobial activity and bioactivity. Silver has been known for centuries as a potent antimicrobial agent while honey is traditionally used in wound treatments inducing antibacterial and anti-inflammatory effects as well as stimulation of angiogenesis and wound healing. Consequently, several commercial wound dressings have been developed containing silver usually in ionic form as well as dressings immersed in honey. The aim of this work was to develop nanocomposite alginate hydrogels containing silver nanoparticles (AgNPs) and honey components since AgNPs were reported to be more potent than silver ions. AgNPs were synthesized in aqueous solutions of honey (50 wt %) by chemical reduction at slightly alkaline pH of ~7.5. The obtained solution was mixed with Na-alginate followed by alginate gelation so to produce nanocomposite hydrogels in forms of sheets, microbeads and microfibers. Presence of AgNPs was confirmed by UV-visible spectroscopy and transmission electron microscopy (TEM) while silver content was determined by atomic absorption spectrometry (AAS). Interactions of alginate molecules with AgNPs as well as honey components were analyzed by Fourier transform infrared spectroscopy (FTIR). Antibacterial activity of the obtained nanocomposite hydrogels was confirmed in suspensions of *Staphylococcus aureus* and *Escherichia coli*. The obtained results have indicated potentials of novel nanocomposite Ag/alginate hydrogels with honey components for potential applications in wound treatments yielding non-sticky, antibacterial and bioactive dressings.

Testing of cytotoxicity of calcium aluminate systems

O. Janković[1], S. Živković[2], T. Stanojković[3], Ž. Žižak[3], I. Besa[3], R. Josipović[1], I. Kuzmanović Radman[1], N. Knežević[1], A. Đeri[1]

[1]University of Banja Luka, Faculty of Medicine, Department of Restorative Dentistry, Program Dentistry, Banja Luka, Bosnia and Herzegovina
[2] Department of Restorative Dentistry and Endodontics, Faculty of Dental Medicine, Belgrade, Serbia
[3]Institute for Oncology and Radiology, Belgrade, Serbia

Biocompatibility is a property of materials that allows them to perform a specific function within the host organism, without leaving any unwanted consequences. In practice, the tissue that is in contact with the material must not show any potential cytotoxic, genotoxic, mutagenic and allergenic effects.

The objective of this study was to examine the potential cytotoxic effect of the experimental calcium aluminate cement, in vitro, using the MTT assay on human lung fibroblasts (MRC-5).

Testing of cytotoxicity of materials was done on a cell culture in vitro, using MTT (3-(4,5-dimethylthiazol-2-yl)-2,5-diphenyltetrazolium bromide), at the Institute of Oncology, Belgrade, in accordance with the recommendations of international ISO standard (ISO 10993-5: 2009, Part 5: Test for cytotoxicity: in vitro method). We examined the cytotoxicity of nanomaterials based on calcium aluminate systems (CA), calcium silicate systems (CS) and a mixture of hydroxyapatite and calcium silicate systems (HA-CS). White MTA (MTA Angelus®) is used as a control material. Normal cell lines - MRC-5 (normal human lung fibroblasts) were used during the test, obtained from ATCC (American Type Culture Collection). The cells were grown in a monolayer culture, in complete nutrient medium at temperature 37°C, in air supplemented by 5% CO_2 and saturated water vapor. The cytotoxic effect of tested tetraoxanes was estimated indirectly, by determining the survival of the target cells upon their growth in the presence of these agents.

Only CS-HA showed mild cytotoxic (anti-proliferative) activity, while the other cements were inactive, even at the maximum concentration applied.

Experimental calcium aluminate cement confirmed its cytocompatibility in this study. It is recommended that the biocompatibility of this nanomaterial should be examined also through other biocompatibility tests, as well as clinical studies.

Marginal microleakage of newly synthesized nanomatherials based on calcium aluminate systems

R. Josipović, S. Živković, O. Janković, N. Gajić, I. Kuzmanović Radman, A. Đeri

Department of Restorative Dentistry, Program Dentistry, Faculty of Medicine, University of Banja Luka, Bosnia and Herzegovina

Nanotechnology and nanomaterials today represent the foundation and future of modern medicine and dentistry. Research into the field of nanomaterials should confirm their benefits, but also accelerate their use in everyday dental practice. The aim of this study was to test, using dye penetration method, marginal microleakage of newly synthesized nanomaterials based on calcium aluminate systems compared to MTA after their application in interradicular perforation of extracted teeth.

The study included 36 extracted human molars. Newly synthesized nanomaterials based on calcium aluminate systems were tested. Mineral trioxide aggregate (MTA Angelus, Londrina, Brazil) was used as control. Marginal microleakage was evaluated using dye penetration test 6 months after the application of materials in experimentally prepared interradicular perforations in extracted human molars. Dye penetration was analyzed using light microscope at 30x magnification (Leica DM 2000). The values were expressed in millimeters, and the result statistically analyzed using one-way ANOVA test.

The lowest mean penetration (mm) was measured for MTA (1.40), while slightly higher marginal penetration values were observed in calcium aluminate cements (1.73) without statistically significant differences.

Materials based on calcium aluminate systems were comparable to commercial calcium silicate material MTA.

Direct pulp capping with Biodentine® and novel nanostructural materials based on calcium silicate systems and hydroxyapatite

M. Popović Bajić[1], V. Petrović[1], V. Opačić Galić[1], B. Bolka Prokić[2], V. Jokanović[3], M. Živković Sandić[4], S. Živković[1]

[1]Department of Restorative Dentistry and Endodontics, Faculty of Dental Medicine, Belgrade
[2]Faculty of Veterinary Medicine, University of Belgrade, Belgrade, Serbia
[3]Vinča Institute of Nuclear Sciences, University of Belgrade, Belgrade, Serbia
[4]Department of Orthodontics, Faculty of Dental Medicine, University of Belgrade, Belgrade, Serbia

Direct pulp capping is an important therapeutic method which should provide the formation of the dentine bridge and healing process. The aim of this study was to investigate the effects of Biodentine® and new nanostructural materials based on calcium silicate systems and hydroxyapatite on exposed dental pulp of Vietnamese pigs.

The study comprised 40 teeth and two Vietnamese pigs (24 months old). After class V cavity preparation, the pulp on each tooth was exposed using a small round bur. In the first experimental group (10 teeth) the perforation was covered with Biodentine® (Septodont, Saint-Maur-des-Fosses, France). In the second experimental group, the perforation was covered with a new nanostructural material based on calcium silicate systems (CS) (10 teeth) and in the third experimental group the perforation was covered with compound of calcium silicate systems and hydroxyapatite (HA-CS) (10 teeth). In the control group, exposed pulp was covered with Pro Root MTA® (Dentsply Tulsa Dental, Johnson City, TN, USA) (10 teeth). All cavities were restored with glass ionomer cement (GC Fuji VIII, GC Corporation, Tokyo, Japan). Observation period was 28 days. After sacrificing the animals, histological preparations were done to analyze the presence of dentin bridge, an inflammatory reaction of the pulp, pulp tissue reorganization and the presence of bacteria.

Complete or incomplete dentin bridge was observed in all teeth (experimental and control groups). Inflammation of the pulp was mild to moderate in all groups. Neoangiogenesis and many odontoblast like cells responsible for dentin bridge formation were detected. Necrosis was not observed in any case, neither the presence of Gram-positive bacteria in the pulp.

Histological analysis indicated favorable therapeutic effects of Biodentine® and new nanostructural materials based on calcium silicate systems and hydroxyapatite for direct pulp capping in teeth of Vietnamese pigs.

Reinforcement of immature traumatized tooth – case report and literature review

A. Vuković[1], M. Ralević[2], M. Ćaldović[2], D. Marković[1], V. Jokanović[3]

[1]Clinic for Pediatric and Preventive Dentistry, School of Dentistry, University of Belgrade, Belgrade, Serbia
[2]Helath center "Dr Simo Milošević", Belgrade, Serbia
[3]Vinča Institute of Nuclear Sciences, University of Belgrade, Belgrade, Serbia

Pulp necrosis is possible unfavorable outcome in immature teeth after traumatic dental injuries. Therefore this clinical situation represents a challenge for pediatric dentist due to wide root canal and open apex. Furthermore, the restoration of immature endodontically treated traumatized teeth is challenging due to thin dentin walls of the root which are prone to fracture. Therefore special attention is necessary regarding the choice of materials. The aim of this report was to present a case endodontic treatment and restoration of immature traumatized tooth, with discussion regarding characteristics of materials needed for intraradicular reinforcement. Endodontically treated immature teeth which are structurally compromise could be restored with different kind of posts such as cast posts, glass fiber posts carbon fiber post or prefabricated titanium post. The use of core system using hybrid resin material enables better fracture resistance of root canal. Although restoration of structurally compromised root canal with custom cast post has been considered the gold standard due to significantly higher fracture thresholds, there are experimental and clinical studies which favor fiber-reinforced composite with a fiber post strengthening the post core. However, none of materials has ideal properties and clinical decision regarding choice of restoration should involve individual and multidisciplinary assessment considering characteristics of the patient, immature teeth and material.

Biostimulative effects of diode laser on stem cells from apical papilla (SCAP) in tissue engineering

D. Trišić[1], M. Lazarević[1], V. Jokanović[2], D. Marković[1]

[1]*Faculty of Dental Medicine, University of Belgrade, Belgrade, Serbia*
[2]*Vinča Institute of Nuclear Sciences, University of Belgrade, Belgrade, Serbia*

The reconstruction of large bone defects in the maxillofacial region remains a significant clinical problem in the case of extensive bone loss due to pathological events such as trauma, inflammation, and surgical treatment of tumors. Different approaches for mandibular reconstruction include bone graft transplants, implants of different biomaterials or bone transport methods. Tissue engineering is a rapidly developing field, which combines the disciplines of materials science and biotechnology to develop tissue constructs that can be implanted into the human body. There are three main components in tissue-engineered bone: cells, a tissue scaffold, and cell signaling factors. In order to fabricate tissue-engineered bone, beside these three main components, there are at least four conditions that need to be satisfied: sufficient number of cells with osteogenic capacity, an appropriate scaffold to seed the cells on to, factors to stimulate osteogenesis, and sufficient blood supply. The porous nature of scaffolds allows good cell penetration into the scaffold and results in uniform tissue distribution in the construct. At the cellular level, diode laser causes biochemical, bioelectric and bioenergetic changes, leading to increased metabolism, cell proliferation and maturation, increased quantity of granulation tissue and reduction of inflammatory mediators, inducing the healing process. Proliferative effect of diode laser on various dental stem cells has been shown. Stem cells of the apical papilla (SCAP) have been identified as an important population of mesenchymal stem cells in regenerative dentistry. Laser irradiation of the SCAP enhances proliferation capacity and mitochondrial activity, and further provides better potential for osteogenic differentiation, with regards to applied power. Further research should be focused on diode lasers application on SCAP prior to seeding cells into the scaffolds, with the purpose of creating new bone tissue.

Cytocompatibility assessment of titanium surface coated with hydroxyapatite by plasma jet deposition

M. Magić[1], B. Čolović[2], V. Jokanović[2], S. Vasilijić[3], D. Vučević[3], D. Marković[4]

[1]Department of Oral Surgery, School of Dentistry, University of Belgrade, Belgrade, Serbia
[2]Vinča Institute of Nuclear Sciences, University of Belgrade, Belgrade, Serbia
[3]Institute for Medical Research, Military Medical Academy, Faculty of Medicine, University of Defence, Belgrade, Serbia.
[4]Department of Paediatric and Preventive Dentistry, School of Dentistry, University of Belgrade, Belgrade, Serbia

The aim of this work was to study the cytocompatibility of titanium samples coated with hydroxyapatite by using an innovative plasma jet method.

The cytotoxicity of hydroxyapatite coated titanium discs (diameter 10mm, thickness 2mm) (HA-samples) was compared to that of high pure titanium discs (Ti-samples) by using a murine fibroblast cell line(L929), according to the regulative of ISO-10993-5 guideline. In addition, the proliferation of human peripheral blood mononuclear cells (PBMNCs) stimulated with phytohemaglutinine was assayed by ^{3}H-thymidine incorporation. The release of Ca, P and Ti ions in culture medium used for conditioning of the samples for 3 days was determined by inductively coupled plasma/optical emission spectroscopy analysis. Controls were inert polystyrene discs of the same dimensions.

Both HA- and Ti-samples inhibited the metabolic activity and proliferation of L929 cells which was followed by reactive oxygen species (ROS) production and cell death localised in close contacts with the discs. Conditioned media of both Ti- and HA-samples inhibited the proliferation of human PBMNCs. Based on all applied assays andISO-10993-5 guidelines the samples were considered as non-cytotoxic since the cytotoxicity did not exceed 30%. The inhibitory effect of HA-samples on metabolic activity of L929 cells and PBMNC proliferation was higher than the effect of Ti-samples and the phenomenon was associated with unexpectedly higher release of Ti ions in conditioning media.

The hydroxyapatite titanium samples coated using plasma jet method can be considered as non-cytotoxic. Since the method enabled good adhesion and stability of the HA coating, this implantation material deserves to be tested *in vivo*.

Drug release kinetics from hydroxyapatite device

B. Čolović, V. Jokanović

Vinča Institute of Nuclear Sciences, University of Belgrade, Belgrade, Serbia

Calcium hydroxyapatite (CHA), as one of the most important ceramic materials in bone tissue engineering, was investigated as a drug delivery device. Tigecycline, a potential antibiotic in treatment of osteomyelitis was used as a model drug. It was mixed with CHA powder and the obtained mixture was compressed into tablets. The tigecycline release rate from these tablets in a pH 7.4 phosphate-buffered saline solution was measured by a UV-VIS spectrophotometer. The release time varied from 5 to 30 days, depending on the applied pressure during tablet compression and drug concentration. A new drug release mechanism determining the relationship between pore sizes and drug release rate was suggested.

Application of 3D printing for jaws reconstruction

V. Biočanin[1], Dj. Antonijević[2], S. Živković[3], D. Marković [3], D. Đurić [4], V. Jokanović[2]

[1]Faculty of Pharmacy and Health, University of Travnik, Travnik, Bosnia and Herzegovina
[2]Vinča Institute of Nuclear Sciences, University of Belgrade, Belgrade, Serbia
[3]School of Dentistry, University of Belgrade, Belgrade, Serbia
[4]Faculty of medical sciences, University of Kragujevac, Kragujevac, Serbia

Traditional reconstruction of the jaw defects requires complex surgical procedures with the use of autologous bone grafts, such as microvascular fibular and ileac graft. In recent years, three dimensional (3D) printing has become more important in maxillofacial surgery. 3D printing allows three dimensional renderings to be realized as physical objects with the use of a printer.

The aim was to show possibilities and advantages of 3D printing of jaw bone in jaw bone reconstructions.

It is important to note that two-dimensional (2D) radiographic images, such as x-rays, magnetic resonance imaging (MRI), or computerized tomography (CT) scans, can be converted to digital 3D print files, allowing the creation of complex, customized anatomical and medical structures. We used CT-scans of mandible and maxillofacial bones, and converted it in highly accurate 3D printed models.

3D printing allows more specific reconstruction of the resected fragment of the jaw and getting better functional and aesthetic results and preparation of patients to further dental rehabilitation. Advantages of this methodology are the possibility of simultaneous performance of reconstruction and resection and shortening of the time of surgery. In the future, we plan to realize 3D printing of the jaws with calcium hydroxyapatite (CHA) covered with poly(lactide- co-glycolide) (PLGA).

Biofunctionality of porous scaffold made of porous hydroxyapatite and PLGA - animal model research

N. Sjerobabin[1], M. Petrović[2]

[1]KBC Dr Dragiša Mišović, Belgrade, Serbia
[2]Clinic for Maxillofacial surgery, School of Dentistry, University of Belgrade, Belgrade, Serbia

Calcium hydroxyapatite and other calcium phosphate materials have been widely used as bone replacements for more than two decades. However, poor mechanical features led to their limited use. In case when they are combined into the composite materials together with polymer/biopolymer thin films like PLGA, porous hydroxyapatite (pHAP) can offer excellent conditions for cell infiltration, growth and activity which is necessary in bone tissue engineering.

Biofunctionality of pHAP-PLGA composite scaffold was investigated after implantation into defects of critical size of 6 mm in the region of parietal bone in rabbits. After 3, 6, 9 and 12 weeks the animals were sacrificed, and tissue samples were prepared for pathohistological analysis. By means of the optical microscopy the following parameters were determined both quantitatively and qualitatively: the size of the defect, the presence of giant cells, the presence of neoangiogenesis, the presence of basophils, the presence of nonspecific inflammation in the tissue, the appearance of the newly created bone, the presence of fibroplasia in the tissue and the percentage of mineralization.

The result showed that the pHAP-PLGA composite scaffold led to the creation of the new bone together with considerable presence of mineralization in critical sized defects.