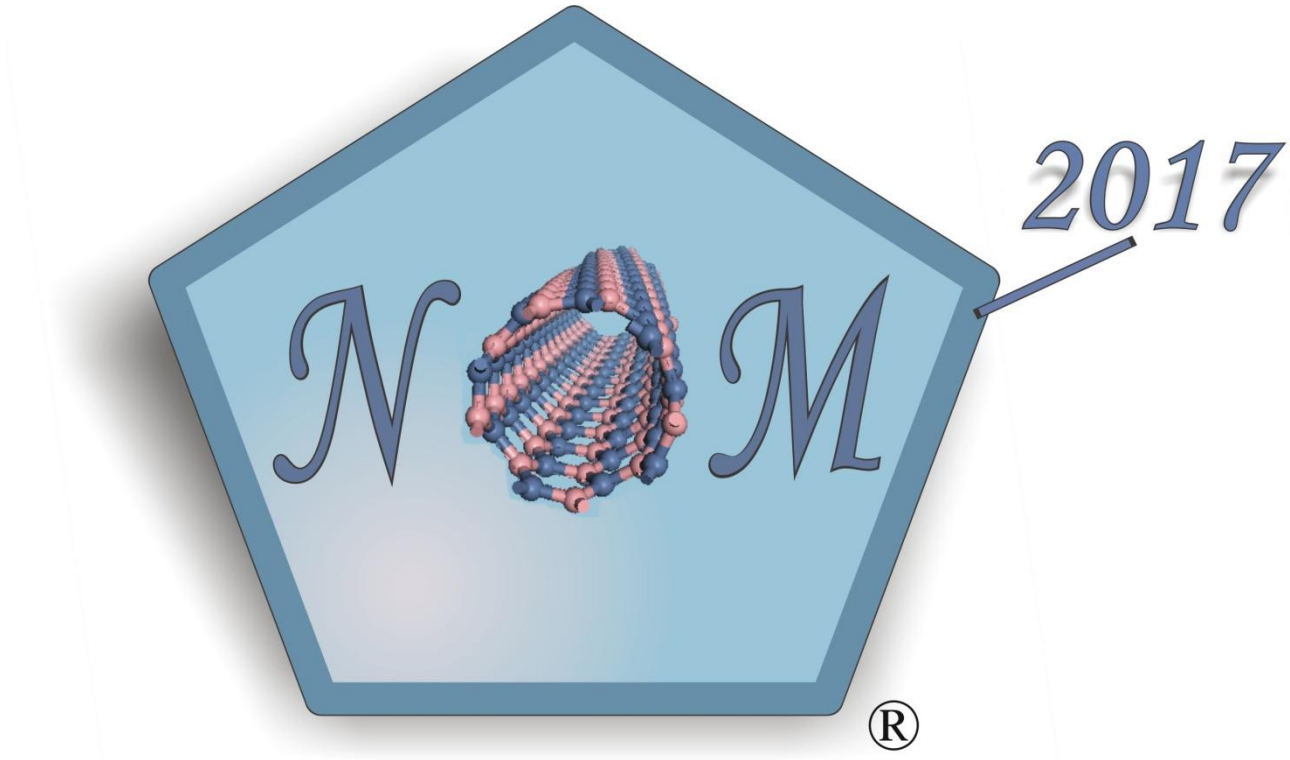
VŠB – Technical University of Ostrava
Nanotechnology Centre

NanoOstrava 2017



5th Nanomaterials and Nanotechnology Meeting

May 22-25, 2017
Ostrava

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Dear Conference participants, Visitors and Colleagues,

We welcome you to the NanoOstrava 2017 - 5th international biennial 'Nanomaterials and Nanotechnology Meeting' in Ostrava, which is the centre of the Moravian-Silesian region and, at the same time, the third largest city in the Czech Republic. The symposium will be held at VŠB-Technical University of Ostrava, which has more than 160 years of existence. The University provides bachelor's, master's and doctoral studies at seven faculties and two university degree programs in full-time and combined forms.

The conference has been organized under cooperation of scientists from the Nanotechnology Centre, Institute of Physics and Department of Physics (VŠB–TU of Ostrava) and Institute of Geonics AS CR.

The meeting is a platform to facilitate open discussions between scientists, students and representatives from companies with a vested interest in furthering the development of nanomaterials and nanotechnology.

Conference is organized in several sessions with plenary lectures focusing on important areas of Nanomaterials and Nanotechnologies.

1. Nanomaterials and nanoparticles
2. Advanced computational modeling of materials and nanostructures
3. Terahertz technology and nanostructures in photonics and electronics
4. Photovoltaic nanomaterials and physical nanoscience
5. Bionanotechnology – "green" principles for nano
6. Nanotechnologies for medicine

We wish you successful and fruitful conference – and enjoy Ostrava!

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Welcome from NanoOstrava 2017 Organizing Committee Chair

On behalf of NanoOstrava 2017 Organizing Committee, it is my honour and pleasure to welcome you to the NanoOstrava 2017, 5th Nanomaterials and Nanotechnology Meeting organized at VŠB – Technical University of Ostrava campus. The conference is aimed to scientists, students and representatives from companies which deal with nanomaterials and nanotechnology.

Study and research at the VŠB- Technical University of Ostrava is closely related to the fact that Ostrava, the third largest city in the Czech Republic, is an important industrial part of Central Europe. Our University is the fourth largest university in the Czech Republic which provides bachelor, master, and doctoral studies at seven faculties and four University degree programs in full-time and combined forms.

Our Program Committee has tried to prepare an interesting and informative technical program outlining current progress and activities in many research areas of nanotechnology. Papers presented at Nano Ostrava 2017 will be reviewed and published in the following journals:
Journal of Nanoscience and Nanotechnology and Photonics and Nanostructures: Fundamentals and Applications.

I wish you to have beneficial conference and I hope that you will enjoy both scientific and cultural aspects of the conference programme as well as your stay in Ostrava.



Chairman, NanoOstrava2017

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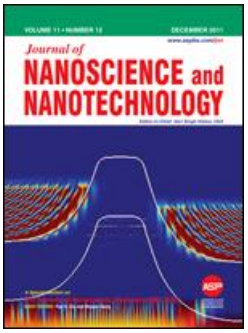
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CONFERENCE PAPERS

Conference full papers should present these substantial conditions: **high quality research**, original ideas, not published anywhere else. Deadline for submission of conference full papers is **June 20, 2017**.

Conference full papers will be published in following journals:

Journal of nanoscience and nanotechnology (JNN)

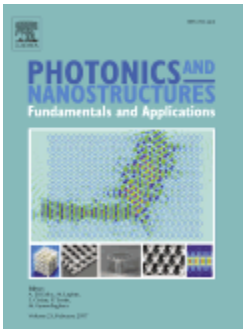


JNN is a multidisciplinary peer-reviewed journal covering fundamental and applied research in all disciplines of science, engineering and medicine. JNN publishes all aspects of nanoscale science and technology dealing with materials synthesis, processing, nanofabrication, nanoprobes, spectroscopy, properties, biological systems, nanostructures, theory and computation, nanoelectronics, nano-optics, nano-mechanics, nanodevices, nanobiotechnology, nanomedicine, nanotoxicology.

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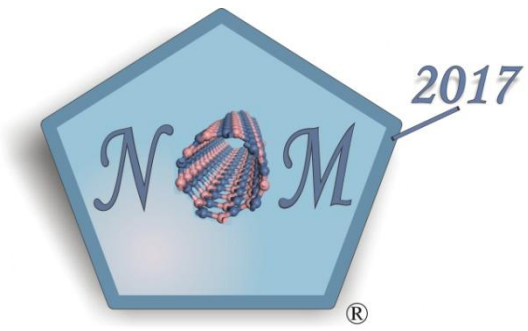
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TOPIC 1

Nanomaterials and nanoparticles

Chair: Pavla Čapková
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New methods of nanoparticles preparation
Polymeric nanocomposites and nanocomposites with special effects
Nanocarbons, nanoclays and functional nanooxides
Nanoceramics and nanoporous materials
Techniques for characterization in nanotechnology



Invited lecture (IL):

Nanocarbon based composites for Li-ion batteries: synthesis and application

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Advanced electrode design is crucial in the rapid development of electrochemical energy storage systems for emerging Li-ion batteries. Li-ion batteries (LIBs) are of particular interests due to their high energy density, high operating voltage, and long lifetime. The critical issue of fabricating high specific capacity, high rate capability, and long cycle life LIB device is the advanced nano architectured design and flexible electrode materials with good mechanical deformations. Recent developments in nanoscience and nanotechnology offer potential prospects to devise novel-nanostructured electrode materials for next-generation better-performing LIBs. Nanostructured materials are pivotal to these progresses due to their manageable surface-area, stunted mass and charge-diffusion span, and volume change acclimatization during charging/discharging. CNTs, CNFs and Graphene with their special structures provide excellent electrical and thermal conductivities, mechanical flexibility and significantly large surface-area, are considered ideal additives to enrich chemistry of electrodes. In this review, we summarized the recent progresses on developments of nanocarbon based and/or nanocarbon supported (CNT, CNF, Graphene etc.) negative and positive electrodes for high performance Li-ion batteries. The synthesis techniques of the 1-D, 2-D and 3-D electrodes has been discussed for special hierarchical structures and free standing electrodes. Special concentration has been made on the nano carbon supported silicon negative and layered and spinel type of positive electrodes. The effect of the synthesizing techniques on the electrochemical properties of the Li-ion batteries.

Oral presentations(OP):

The improving with graphene oxide of the electrical behavior of lanthanum ferrite nano electroceramics by hydrothermal route

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In the present study, graphene oxide was synthesized by Hummers method. The LFO/GO nanocomposites were synthesized with various GO contents by the hydrothermal method. The obtained doped and undoped samples were characterized by XRD, temperature dependent electrical resistance changes, dielectric measurements and ferroelectric measurements. X-ray diffraction results indicate that the LFO nano electroceramics are polycrystalline with an Orthorhombic structure. The crystallite size for 0, 20, 50 and 100 mg of graphene oxide doped Lanthanum ferrite samples were found to be 26.76, 20.64, 35.93 and 33.6, respectively. The electrical transport mechanisms of LFO/GO nanomaterials were investigated by the temperature dependent conductivity. The electrical conductivity results indicate that the electrical conduction mechanism is a thermally activated process and *dc* conductivity increases exponentially over the studied range of temperatures. The electrical conductivity changes with increasing temperature and graphene oxide dopants of all samples. Activation energy (E_A) values of the nanocomposites decrease with increasing graphene oxide content.The dielectric properties of LFO/GO nanocomposite (real and imaginer) with respect to frequency variation (1KHz–5MHz) was measured with the LCR analysis at room temperature. The relative permittivity (ε'), dielectric loss (ε'') and alternating current conductivity (σ_{ac}) values of the samples were estimated. It is show that (ε'), (ε'') and (σ_{ac}) increase with increasing frequency.The polarization-electric field (P-E) hysteresis loop of all LFO/GO nano electroceramics was measured at the room temperature. The loop shows proper saturation with enhanced saturation polarization (P_s), remnant polarization (P_r) and coercive electric field (E_c).
The obtained results suggest that the electrical properties of LFO/GO nano electroceramics can be changed by Graphene Oxide doping. This materials can be used for variety of technological applications in the field of dielectric and ferroelectric.

Keywords: Lanthanum Ferrite, Hydrothermal Method, Graphene Oxide, Dielectric properties, Ferroelectric

Acknowledgements: This work was supported by the Management Unit of Scientific Research Projects of Firat University (FUBAP) (Project Number: FF.16.29). Authors thank to Firat University for supporting.

NanoEnviCz - Nanomaterials and Nanotechnologies for Environment Protection and Sustainable Future

Pavla Čapková

Faculty of Science, University J.E. Purkyně, Ústí nad Labem, Czech Republic

The research infrastructure NanoEnviCz integrates Czech scientific institutions and universities renowned for complex interdisciplinary research into broad range of nanomaterials and nanotechnologies. The activity of the RI is focused on the research in the field of nanomaterials, surfaces and nanocomposites for environmental and related applications including 1) the controllable syntheses; 2) complex chemical, structural, morphological and surface characterization;

3) tuning their functional properties; 4) monitoring their potential toxicity and hazard; 5) developing their application in advanced technologies. The RI forms an efficient multipurpose platform both for the partners of the project as well as for the external users from academia, industry, and government organizations. The RI is designed as a platform providing complete services in the R&D and opening access to the unique equipment and the state of the art methodology for users both from academia and industry, inevitable for the accomplishment of priorities of the national strategies of support to R&D&I and for the competitiveness of the Czech science. The research service offered by University J.E. Purkyně under the project NanoEnviCz in the field: nanomaterials and nanotechnology for environmental, biomedical and other applications will be presented in more details.

Rare earth metal oxides – preparation and their biological activity

Kateřina Dědková[1, 2], Ľubomíra Kuzníková[1],Lubomír Pavelek[3], Jana Kupková[1, 2],Karla Čech Barabaszová[1], Rostislav Váňa[4], Jiří Burda[5], Jozef Vlček[5], Daniel Cvejn[1]and Jana Kukutschová[1, 2]

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The contribution summarizes a method of the preparation of three dilanthanide trioxides :Gd_2O_3, Sm_2O_3 and Er_2O_3 in a shape of nanocrystals. Thermal decomposition of a transient complex formed in situ from $Lx(NO_3)_3.H_2O$ and glycine was studied using TG/DTA analysis. The resulting 10 to 11 nm nanocrystals assembled to 8 μm agglomerates were characterized by X-ray powder diffraction analysis, the particle size and particle size distribution analysis. Morphology of the nanocrystals was examined by scanning and transmission electron microscopy. Biological activity expressed as antibacterial activity and acute aquatic toxicity was tested. The lowest determined MICs were as low as 5.6 mg ml^{-1} against *Escherichia coli* and *Pseudomonas aeruginosa*. Toxicity experiments against *Desmodesmus subspicatus* has shown toxicity peaking with EC_{50} = 0.47 g dm^{-3}.

Keywords: nanocrystals; lanthanides oxides; antibacterial activity; acute aquatic toxicity

Structure and mechanical properties of porous Ti-Ta-Nb biomedical alloy prepared by sintering process of high-energy ball milled nanocrystalline precursors

Grzegorz Dercz, Izabela Matuła, Maciej Zubko

Institute of Materials Science, University of Silesia in Katowice, Poland

The most desirable metallic material for implants seems to be titanium alloys, because this material is characterized by a good biocompatibility, a high corrosion resistance and the ability to self-passivation. Despite these advantages, there are some problems of titanium and its alloys in bone tissue application. First, the most common titanium-based alloys used in medicine have V and/or Al elements, which are harmful for human body. Second the mismatch of Young's modulus between titanium materials and bones can causes severe "stress shielding", which can lead to bone resorption and eventual loosening of the implants. To overcome this drawback, implant materials with porous structure have been introduced. The porous structure materials can permit the ingrowth of the new-bone tissues and the transport of the body fluids, what provide to prolong the life time of implant.

In the present work of porous Ti-30Ta-20Nb (wt.%) nanostructure biomaterial were fabricated by a combination of mechanical alloying in the planetary ball mill Fritch PULVERISETTE 7 premium line and annealing processes. After high-energy ball milling of a Ti-30Ta-20Nb alloy for 5, 20, 30 and 70 h powder mixture was pressed and annealed at 900°C for 12 hours with next aging at 450°C for 3 hours. The X-ray diffraction methods were applied for the structure characterization of the examined samples. The parameters of diffraction line profiles were determined by PRO-FIT Toraya procedure. The crystallite sizes and lattice distortions were analyzed using Williamson-Hall method. The Rietveld method was applied for the verification of the qualitative and quantitative phase composition of the studied material. The powder morphology and microstructure of sintered samples were analyzed by scanning electron microscopy (SEM) and transmission electron microscopy (TEM) techniques. Observation of the powder morphology after various stages of milling leads to the conclusion that with the increase of the milling time the size of the powder particles as well as the degree of aggregation change. Clear tendency of crystalline size reduction at every stage of the grinding process is clearly observed. The XRD results confirmed the formation of β phase during high-energy ball milling of the precursor mixture of Ti, Ta and Nb.

Acknowledgments: This work was supported by the Polish National Science Centre (Polish: Narodowe Centrum Nauki, abbr. NCN) under the research project no. UMO-2011/03/D/ST8/04884.

Polymeric nanocomposite thin films with modified clay minerals with antimicrobial properties

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Polymeric thin film enhanced with functional particles has good perspective for medical applications. They can be used as coating for subjects used in human as stents or prosthetics. Our study focuses on nanocomposites films prepared from polymers able to slowly degrade within lifetime of the subject. To selected vinyl polymers (polyvinyl acetate and polyvinyl alcohol) polyethylene oxide was added to compare the effect of another group. Main goal of the research was laboratory preparation of polymeric nanocomposite films containing modified clay particles. Clay particles were modified via intercalation process with ciclopyroxol amine and trolamine.
Both modified clays were used for all three polymeric matrices in 1wt.% total content. For polyvinyl acetate was used method of polymerization in situ, where monomer is polymerized using indicator of polymerization, ultrasound and temperature to obtain homogenous distribution of filler particles in matrix. Both polyvinyl alcohol and polyethylene oxide has been used as polymeric powder with molecular weight suitable for solution of polymers in water. The process included dissolving of polymers and compounding of filler particles. As refence polyethylene oxide nanocomposite was prepared employing melt extrusion methods. Seven polymeric nanocomposite film were characterized for important parameters as homogeneity of fillers in matrix, possible new interaction or bonds, morphology of the surface. X-ray diffraction method was used to determine intercalation of clay particles and following effect of polymer on filler. Comparing all characteristics of prepared materials, the decision on further applicability was made. As final antimicrobial testing for anaerobic strains and yeast was performed where all samples passed as antimicrobial with different level of activity.

Keywords: nanocomposite, polymeric film, biliary stent, antimicrobial properties
Acknowledgement: Authors want to acknowledge to project SP2017/86 for material support.

Dispersion and structure analysis of Ti- *m*ZrO_2 composite powder with nanocrystalline Ti phase for biomedical applications

Grzegorz Dercz, Izabela Matuła, Maciej Zubko, Natalia Kuczera

Institute of Materials Science, University of Silesia in Katowice, Poland

Titanium and titanium alloys are employed widely in biomedical applications but these alloys have unsatisfactory tribological properties because of their low hardness. Much better biomaterials for hard tissue replacement implants may be acquired by the preparation of titanium composites. Therefore, the connection of excellent biocompatibility and bioactivity of ZrO_2 ceramics with good properties of titanium is considered to be a promising approach for fabrication of more perfect hard tissue replacement implants. In this study the formation of Ti-ZrO_2 nanostructure composite biomaterial was described. Weighted amounts with the composition corresponding to Ti-x ZrO_2 (x=10, 30 and 50 wt.%) were high energy milled in the planetary ball mill PULVERISETTE 7 premium line by Fritch at 10, 30 and 50 h milling times. The structural evolution and morphological changes of powder particles during mechanical alloying were studied by X-ray diffractometer (XRD), scanning electron microscopy (SEM) and transmission electron microscopy (TEM) analysis. The Rietveld method was applied for the verification of the qualitative and quantitative phase composition of the studied material. The parameters of diffraction line profiles were determined by PRO-FIT Toraya procedure. The crystallite sizes and lattice distortions were analyzed by Williamson-Hall method. It was found that during high-energy milling a significant decrease of crystallite size is observed only for titanium phase. The crystallite size of this phase diminishes to 35 nm when the milling time rises to 50 h for Ti-x ZrO_2 (50 wt.%), while the crystallite size of ZrO_2 phase is still above 100 nm. The SEM and TEM images of the milled powders show that the size of the agglomerates of Ti nanocrystallites changes in a broad range and that ZrO_2 particles can be immersed in larger agglomerates or occur separately.

Acknowledgments: This work was supported by the Polish National Science Centre (Polish: Narodowe Centrum Nauki, abbr. NCN) under the research project no. UMO-2011/03/D/ST8/04884.

Mesoporous $ZnFe_2O_4$@TiO_2 nanofibers fabricated via Electrospinning and PECVD for enhancement of photocatalytic properties

Amr A. Nada[1,2], Stéphanie Roualdes,[1] Mikhael Bechelany[1]

[1]Institut Européen des Membranes, Université Montpellier 2, CC 047, Place Eugène Bataillon, 34095, Montpellier Cedex 5, France; [2]Dept. of Analysis and Evaluation, Egyptian Petroleum Research Institute, Cairo, Nasr city P.B. 11727, Egypt

The development of the dye industries was leading to the increasing of water contamination. This contamination supplies a serious threat to humanness. Therefore, many strategies have been developed to remove the organic dye from wastewater such as chemical flocculation, adsorption, ion exchange. However, the traditional remediation of dye wastewater has many side effects, including the secondary pollution and long processing cycle.

Recently, several investigations focused on the photocatalytic technology which is useful for degradation of organic dye into environmental friendly compounds (CO_2 and water) using semiconductors material such as TiO_2. TiO_2 has attracted attention as a photocatalyst due to its relatively low cost, high stability and low toxicity. However, the high recombination rate between the electron-hole of TiO_2 limits the efficiency of the photocatalytic reaction. In addition, TiO_2 has a wide band gap (3.2 eV) and it can only be excited by UV light. In order to shift the absorption edge

of TiO_2 to the visible range, $ZnFe_2O_4$@TiO_2 nanofibers were fabricated. These composite nanofibers were elaborated by combining the two techniques: electrospinning and plasma enhanced chemical vapour deposition (PECVD). The nanofibers morphology and performance were optimized using different zinc/iron ratios. Their morphological, structural, and optical properties were analysed using scanning electron microscopy (SEM), X-ray diffraction (XRD), energy-dispersive X-ray spectroscopy (EDX), BET surface area, Raman spectroscopy and UV-Visible spectrophotometry. The photocatalytic activity have been investigated by degradation of methylene blue (MB) under visible light. The results indicated that the combination of spinel structure with titanium dioxide improved the photodegradation efficiency up to 98%. Deposition of TiO_2 via PECVD on zinc ferrite surfaces enhanced the absorption in the visible region and improved the electron-hole separation.

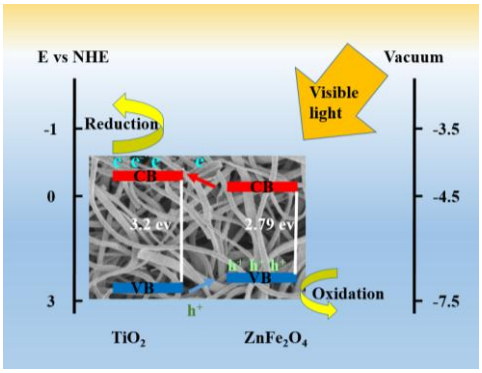


Figure 1. Schematic illustration of the band gap of $ZnFe_2O_4$@TiO_2 nanofibers.

Synthesis of silver/chitosan nanocomposites by biosynthesis using linden extract for antimicrobial coating

Sara Pakseresht[1] , Ahmed Waleed Majeed Alogaili[1], Hatem Akbulut[1], Daniela Placha[2], Diana Klushina[2], Zuzana Konvickova[2], Grazyna Simha Martynkova[2]

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Medical devices have an essential part in healthcare system in recent years, such as usage of heart valves, several types of stents and implants devices in patients. However, bacterial infection of medical devices causes critical issues for patients due to attachment of bacteria and formation of biofilm onto the medical devices. The most of infections are often caused by *Staphylococcus aureus*, *Pseudomonas aeruginosa* and *Escherichia coli*. Therefore, finding an effective antibacterial coating to prevent biofilm formation and infection is our goal. In this study, we developed silver/chitosan nanocomposites for antimicrobial coating system by chemical and green methods using sodium borohydride ($NaBH_4$) and linden extract, respectively. Silver is known as a strong inorganic antimicrobial agent to kill bacteria by inactivating enzymes and dysfunction bacterial cell membranes. By immobilizing silver nanoparticles on chitosan biopolymer can prevent agglomeration of nanoparticles, besides it can improve the biocompatibility. We characterized properties of our silver chitosan nanocomposites samples using particle size distribution, ultraviolet-visible spectroscopy, X-ray diffraction analysis and scanning electron microscopy. Effective antimicrobial film preventing biofilm formation on medical devices was designed.

Keywords: nanocomposite, chitosan, silver, biosynthesis.

Acknowledgement: Authors want to acknowledge to project SP2017/86 for material support.

Iron oxide nanoparticles functionalized with fullerene phosphonic acid derivative for catalytic applications

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Iron oxide nanoparticles (IONPs), consisting of magnetite (Fe_3O_4) have attracted considerable interest due to their superparamagnetic properties, biocompatibility and non-toxicity. Recent developments in the synthesis of IONPs by thermal decomposition of iron carboxylate salts have allowed preparation of magnetic nanoparticles with necessary size control, high monodispersity and desired surface morphology. Various molecules can be attached to the surface of IONPs using ligand exchange strategy with compounds bearing appropriate anchoring group. For this purpose phosphonic acids are widely used, which are known for forming strong linkages with iron oxide cores, necessary to form stable assemblies on nanoparticles. Coated IONPs intended for catalysis are of special interest due to their considerably larger active surface when comparing to bulk materials. Additionally, magnetic properties of iron oxide core allow targeting of catalyst and/or its removal using magnetic field. In presented research, functionalization of IONPs was achieved using fullerene diphosphonate obtained by Bingel reaction and its later hydrolysis to corresponding phosphonic acid analogue. Synthesized fullerene coated IONPs were investigated using transmission electron microscopy (TEM), X-ray photoelectron spectroscopy (XPS), Mössbauer spectroscopy and thermogravimetric analysis (TGA). Catalytic properties of resulting nanomaterial in selected organic transformations were investigated using High Pressure Liquid Chromatography (HPLC).

Synergies in New Nanobimetallic Unalloyed Materials for Catalysis

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Over the past few years, a number of techniques have been developed for the production of nanosized metallic particles and their distribution on different carriers. The methods recently used, which are based on the bottom-up and the top-down approaches, still have some disadvantages, including broad nanoparticle size distributions and a tendency to aggregate or to form clumps. During the lecture we will discuss general problems of nano bi- (poly) metallic synthesis and applications in catalysis, in particular synergy between metals. To minimize synthetic problems, we have recently developed a novel, innovative method for the formation of a bimetallic catalysts, in which a variety of synergic effects of unalloyed nano-metals were observed. We have prepared a variety of such catalysts that appeared to be highly efficient in a variety of reactions of Sonogashira coupling, glycerol oxidation or aldolization, ammonia cracking, CO_2 methanation [1-5] or deNOx process. Figure below shows bimetallic oxide passivated Ni-supported Ru nanoparticles in silica applied as a new catalyst for low-temperature carbon dioxide methanation [5]. We tested here potential synergies between nano-metals and nano-metal and metallic support. Various possible situations discovered here will be discussed during the lecture.

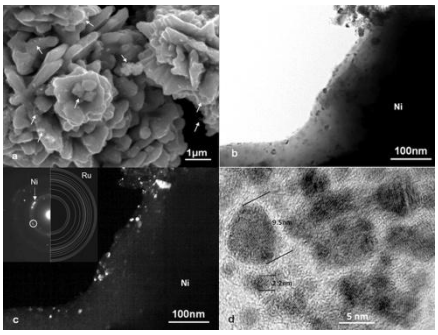


Figure 1. Structure of silica supported Ru NPs in 1.5% Ru/Ni catalyst. a) – SEM image, b – c) – bright and dark field of TEM images and d) – HRTEM image of Ru nanoparticles [5].

New materials provide interesting capabilities for the potential production of industrial catalysts. Low active metal content, a potential for the catalyst recovery and the scope of use illustrate the contribution of the method to nano-catalysis.

Acknowledgements: The research was co-financed by the NCBR grants: ORGANOMET No: PBS2/A5/40/2014 and TANGO1/266384/NCBR/2015.

1. M. Korzec, P. Bartczak, A. Niemczyk, J. Szade, M. Kapkowski, P. Zenderowska, K. Balin, J. Lelątko, J. Polanski, *J. Catal.* **313** 1 (2014).
2. M. Kapkowski, P. Bartczak, M. Korzec, R. Sitko, J. Szade, K. Balin, J. Lelątko, J. Polanski, *J. Catal.* **319** 110 (2014).
3. J. Polanski, P. Bartczak, W. Ambrozkiewicz, R. Sitko, T. Siudyga, A. Mianowski, J. Szade, K. Balin, J. Lelątko, *PLoS ONE* **10(8)** 1 (2015).
4. M. Kapkowski, W. Ambrożkiewicz, T. Siudyga, R. Sitko, J. Szade, J. Klimontko, K. Balin, J. Lelątko, J. Polanski *Applied Catalysis B: Environmental* **202**, 335 (2017).
5. J. Polanski, T. Siudyga, P. Bartczak, M. Kapkowski, W. Ambrozkiewicz, A. Nobis, R. Sitko, R. Sitko, J. Klimontko, J. Szade, J. Lelątko, *Applied Cat. B: Environmental* **202,** 16 (2017) in print.

Nanofibrous Antimicrobial Nylon 6 Based Membranes; Fabrication and Evaluation

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One-step fabrication of nanofibrous membranes modified by quaternary ammonium salts and chlorhexidine was carried out using *Nanospider* technology. Evaluation of modified nanofibrous membranes includes XPS, XRD, elektrokinetic measurements, tensile tests and antibacterial assays. Chlorhexidine (CHX), 1-Dodecyltrimethylamonium bromide (DTAB) and benzyltrimethylamonium bromide (BTAB) were used as antibacterial agents. Experimental characterization has been combined with molecular modeling using empirical force field to analyze the interaction of nanofibers with modifying molecules for better understanding the effect of nanofibers modification on their properties. Interaction energy of isolated ligands with nylon surface is highest for CHX and lowest for BTAB. Antibacterial modification of PA6 led to significant changes of zeta potential (from -31mV for nylon 6 up to -49mV for PA6/BTAB), to changes in phase composition (decrease of α phase content and increase of γ phase content) and to significant increase of fiber diameter for PA6/BTAB. Antibacterial modification resulted in the straightening of nanofibers and to higher permeability of nanofiber textile for all investigated samples. Tensile tests showed the increase of Young modulus for all the modified nanotextile

samples comparing with pure nylon 6. All the modified samples exhibits antibacterial activity, however the nylon6/DTAB was the best of them.

Modification of microwave assisted preparation of Fe_xO_y nanoparticles

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Composites of Fe_xO_y/phyllosilicate have been prepared using simple microwave assisted synthesis from $FeSO_4.7H_2O$ and the magnetic and sorption properties of prepared composites have been tested recently. The presence of Fe_xO_y nanoparticles in composites both in form of magnetite (Fe_3O_4) and maghemite (γ-Fe_2O_3) have been proved. To improve the magnetic properties and the possibility of magnetic separation of magnetically modified sorbents based on phyllosilicates, the method of preparation was hereby modified. The goal was to prepare a composite with higher Fe_3O_4 content because the magnetite has higher saturation magnetization than maghemite. For this purpose, the iron nanoparticles were prepared using the $FeSO_4.7H_2O$ with the addition of oxalic acid during the iron oxides precipitation. The syntheses were carried out under various conditions (pH of precipitation, amount of added oxalic acid, time of microwave activity). The prepared nanoparticles were characterized by X-ray diffraction, chemical analyses, scanning and transmission electron microscopy, and magnetic properties measurement. The results showed that pH and addition of oxalic acid affected the amount of Fe_3O_4 nanoparticles and as the result, the magnetic properties were changed. In contrast to the spherical iron oxides nanoparticles prepared using the unmodified method, resulting nanoparticles were of cylindrical shape when the oxalic acid was present.

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Exfoliated graphite for polymeric nanocomposite coating

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Exfoliation of graphite is one of the ways of graphene preparation in scalable way and relatively non-defect graphene layers. Well known way of exfoliation in ultrasound gives though a low yield and partly defected several layers graphene. A very simple way of exfoliation showed Varrla et al.[1] that ordinary kitchen blender and dishwashing detergent can prepare particles of several layers of graphene. Adapting this method exfoliated particles were prepared unfortunately in low yield.

The experiment confirmed that exfoliation is very effective in case of more than one kind of organic surfactant in water medium. Comparing the exfoliated results in sense of particle size, morphology and crystallinity for 3 methods – ball milling, ultrasound activation in hydrogen peroxide and shear grinding with help of surfactants, the differences were found.

Characterization of structure using X-ray diffraction methods and Raman spectroscopy explained the changes in layers stacking. Morphology by scanning electron microscopy and atomic force microscopy gave clue to understand destruction of compactness of layers. And particle size analysis explained variation of particulate matter.

Selected well exfoliated samples of graphite were compounded in to polymeric matrix using insitu polymerization or compounding in dissolved polymer. Prepared polymeric nanocomposites included up to 0.025 wt.% of graphite filler. Transparency, homogeneity and integrity of nanocomposite were the main parameters of successfully prepared samples.
Additional test for electric conductivity were performed.

Keywords: nanocomposite, exfoliated graphite, shear force, polymeric nanocomposites

Acknowledgement: Authors want to acknowledge to project SP2017/86 for material support.

[1] KR Paton, E Varrla, C Backes, RJ Smith, U Khan, A O'Neill, C Boland, et al... Scalable production of large quantities of defect-free few-layer graphene by shear exfoliation in liquids, Nature materials 13 (6), 624-630.

Characterization of nano-hydroxyapatite/Graphene hybrit biocomposite produced by Hydrothermal method on Ti_6Al_7Nb alloy

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In this study, graphene/nano-hydroxyapatite (nHAp) hybrit nanocomposites on Ti_6Al_7Nb alloy surface were synthesized by hydrothermal method. The samples were prepared 25mmx25mm and 4,1 mm thickness. Prior the surface threatmens Ti_6Al_7Nb alloy substrates were ground by using 1200 grids SiC paper and cleaned ultrasonically in distiled water in order to remove the natural oxide layer present on their surface. The hydrothermal reactions were run at 100-250 °C. The synthesized nHAp-Graphene characterized by SEM, EDS, AFM, XRD and mechanical tests. The XRD peak confirms its crystalline nature and phase. The surface morphological studies were carried out using AFM and SEM. Analysis showed that the nHAp-Graphene composites were uniformly deposited on Ti_6Al_7Nb with enhanced nanoscale surface roughness. Crystal structure, mechanical properties and thermal stability of the nanocomposites was investigated in detail. Atomic force microscopy (AFM) and phase imaging studies revealed the intercalation of nHAp-Graphene improved elasticity compared to pristine nHAp. The mechanical properties of nHAp was improved with addition of graphene. The result shows nHAp-Graphene hybrit biocomposites has a great potential for biomedical sciences.

Poster presentations (PP):

Fabrication of Sulfur/carbon/clay mineral cathode material and its electrical performance

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The lithium-sulfur battery is a type of rechargeable battery, notable for its higher theoretical specific capacity (1675 $mAhg^{-1}$) and higher energy density. The properties of sulfur include abundant, low cost and nontoxic. However, there are some issues of using sulfur as a cathode such as its short cycle life, low effeciency, loss of capacity on repeated cycling due to the dissolution of polysulfides into the electrolyte and low electrical conductivity, therefore needing an extra mass for a conducting agent. In this study, we focus to find highly conductive sulfur cathode by using carbon and clay minerals to improve conductivity of sulfur by the strong interaction between sulfur and carbon matrix. Clay minerals have high physical and chemical adsorption characteristics and excellent ion exchange capability. Carbon and clay minerals are used for stabilizing sulfur cathodes and improve the conductivity. Carbon is advantageous for wrapping sulfur because of its good conductivity and the flexible structure and play an important role as a absorbent to maintain polysulfides and reduce their dissolution into the electrolyte during the discharge/charge process. The mixture of sulfur, carbon and clay minerals are heated at 230 °C for 2-4 hours and followed by measuring electrical performances.

Keywords: nanocomposite, sulfur, nanocarbons, conductivity, clay minerlas

Acknowledgement: Authors want to acknowledge to project SP2017/86 for material support.

Photocatalytic decomposition of N_2O over ceramics cordierite/CeO_2 nanoparticles

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The study is focused on the testing of the photocatalytic ability to decompose nitrous oxide (N_2O) over cordierite/CeO_2 nanoparticles ceramic catalysts (samples A/CeO_2 and B/CeO_2). The activity of ceramic materials was compared with the activity of industrially produced TiO_2 (Evonik P25 photocatalyst). Photocatalytic decomposition of N_2O over the ceramic samples A/CeO_2, B/CeO_2 and the TiO_2 was performed in annular batch reactor illuminated with 8 W Hg lamp (λ = 254 nm wavelength). Reaction kinetics was well described by pseudo 1st rate law. Photocatalytic activity of cordierite/CeO_2 was better in comparison with TiO_2 Evonic P25. The highest N_2O conversion (56 %) after 20 h of irradiation in inert gas was achieved over the sample B/CeO_2. The photocatalyst sample B/CeO_2 was examined for photocatalytic activity in the decomposition of N_2O in the three various gaseous feed mixtures. The gaseous feed mixtures were N_2O enriched with O2 (6.5 mol. %); N_2O enriched with H_2O (25 mol. %) and N_2O enriched with mixture of O_2 and H_2O (6.5 mol. % and 25 mol. %, respectively). It is assumed that the reduced conversion of N_2O (47 %) observed in the flow of the mixture of N_2O and H_2O could be affected by the sorption of water vapor on onto the photocatalyst "active sites" causing less penetration of light and thus reducing the efficiency of

photocatalytic decomposition of N_2O. The presence of oxygen in the N_2O mixture had little effect to photocatalytic decomposition of N_2O, conversion of N_2O decreased from 56 % in inert gas to 52 % in mixture with O_2.

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Physics, chemistry and synthesis of structurally modified yttrium manganite-based nano materials for multifunctional applications

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Yttrium manganite is a multiferroic material, which means that it exhibits both ferromagnetic and ferroelectric properties, so making it interesting for a variety of technological applications. In this work, yttrium manganite/Graphene Oxide nanocomposites were prepared by the hydrothermal process. The crystalline and morphological structure, physical and chemical properties of samples were investigated. XRD patterns of obtained nanopowders can be indexed to the $YMnO_3$ polycrystalline structure with the orthorombic structure according to (JCPDS 01-077-8272) with the lattice constants a=5,2580, b=5,8361, c=7,3571 nm and space group *Pbnm62*. The crystallite size of the yttrium manganite-based nano materials were calculated from the Debye–Scherrer formula. The chemical composition of nanocomposites was determined by EDX. The results obtained from EDX spectrum showed the peaks of Y, Mn, O and C. The average grain size values of the powders were found to be 459, 317, 396 and 501nm for YM0, YMO20, YMO50 and YMO100 samples, respectively. SEM results indicate that the BMO-GO samples have nanostructure. Fourier transform infrared spectroscopy (FTIR) of the nanocomposites was measured. The obtained FTIR bands intensities are changed with the increase in graphene oxide content. Thermogravimetric analysis (TGA) and differential thermal analysis (DTA) curves of YMO based nanocomposites depicts a weight loss up to 900 °C, which is due to the presence of trapped nitrates and entrapped water.
The obtained results suggest that the physical and chemical properties of yttrium manganite-based nanocomposites can be controlled and changed by Graphene Oxide doping.

Keywords: Nano electroceramics, yttrium manganite; Graphene Oxide; Hummers Method; Hydrothermal Process

Acknowledgements: This work was supported by the Management Unit of Scientific Research Projects of Firat University (FUBAP) (Project Number: FF.16.29). Authors thank to Firat University for supporting.

Synthesis of ZnS nanoparticles by precipitation in aerosol microdrops

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In this work we present synthesis of zinc sulphide (ZnS) nanoparticles by an aerosol method. Solution, containing the first precursor, was dispersed into the form of microdroplets by an ultrasonic nebulizer. Then microdroplets were introduced by airflow just above the level of a vigorously stirred solution containing the second precursor, which was in an excess. These microdroplets served as microreactors so the reaction took place only in limited volume containing exact amount of the first reactant given by its concentration. Therefore, when the size of microdroplets and the concentration of the first precursor are known and also when the reaction of precursors proceeds faster than their convective diffusion into the stirred solution, then the final size of synthesized particles can be predicted. The first precursor was an aqueous solution of zinc acetate and the second precursor was an aqueous solution of sodium sulphide. The ZnS nanoparticles were successfully synthesized with diameter around 50 nm. The main advantages of this method are a) controllable size of particles based on the calculated concentration of the first precursor, b) unlike another microemulsion methods, there is no need to use surfactants or immiscible solvents of precursors.

Occupational exposure assessment of nanomaterials within production of composite materials

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Composite material consists of two or more components where mechanical, physical and chemical properties are significantly different. The resulting properties of the composite are given by the combination of the properties of all the components contained. The resulting properties outweigh the properties of each used part. These types of materials are used in many areas, where it is a need to achieve low weight and high strength (e.g. in transport, construction, electrical engineering, leisure, etc.). In recent decades global production of composite materials has been increased, when micro and nano fillers are added. These nanomaterials have unique physical and chemical properties that allow a large number of useful applications but also carry toxicological properties that often differ from their parent material in a "bulk" form and may thus represent "new" potential sources of health risks.

The aim of the study was to monitor the level of exposure of the aerosol at the selected workplace of composite materials production. Work exposure was measured using DustTrak DRX 8533 (mass concentration), CPC 3007 (count concentration) and NanoScan SMPS 3910 (particle size range 10-350 nm). The detected values confirmed a significant increase in the concentration during the operation compare to the background. The measurement results were used as a basis for estimating and managing the risks arising from this exposure, so called the Control banding. Based on the results obtained risk management measures were recommended.

Toxicity of the zinc oxide and zinc oxide/vermiculite nanomaterials

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Nanomaterials and nanocomposite materials on the base of zinc oxide (ZnO) are being produced and applied in our daily lives at a rapid pace mainly as additives to the different polymer materials. The antibacterial behaviors of ZnO nanoparticles are intensively studied but related health and environmental toxicity assessments are lagging behind. The aim of this work was evaluated the toxic effect of self-synthesized samples (ZnO nanoparticles, ZnO/vermiculite nanocomposite particles) and one commercial sample of the ZnO nanoparticles, to induce oxidative stress via lipid peroxidation. This ability is one of the indicators of material toxicity. The toxicity results were compared with the results of titanium dioxide (TiO_2) nanoparticles as a validated toxic standard. The effect of the major nanoparticles properties as particle size, shape, specific surface area, phase and composition were evaluated. They have been used the dynamic laser diffraction, scanning electron microscopy, the Brunauer-Emmett-Teller method, and X-ray diffraction. The attention was also focused on the influence of the vermiculite (as matrix of nanocomposite samples) and temperature of the nanostructured materials preparation. All samples containing vermiculite are not able to induce peroxidation of lipids in comparison to TiO_2 nanoparticles. However samples of ZnO nanoparticles demonstred the ability to induce oxidative stress via lipid peroxidation, which decrease with the increasing temperature of preparation and for commercial ZnO was higher than for prepared ZnO nanoparticles.

Keywords: ZnO nanoparticles, ZnO/vermiculite nanocomposites, toxicity, lipid peroxidation

Acknowledgements: The work was supported by the project No. SP2017/45 - "Nanostructured composites materials".

Influence of microwave treatment on Ghassoul stability

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Moroccan clay, locally known as Ghassoul, with a significant portion of stevensite is a very good sorbent. For the facilitation of the sorbent separation, it is convenient to use its magnetically modified form. Recently, the composites of Fe_xO_y/Ghassoul have been prepared using simple microwave assisted synthesis and the effect of method preparation on composite composition has been proven. The aim of the presented work was to evaluate the effect of the microwave radiation during the preparation of the magnetic form on the structure and stability of Ghassoul which is to be applied as a sorbent of ions from water solutions. Water extracts were prepared by batch method using deionized water. The leachate was prepared for 1, 6 and 24 hours in varying ratios of solid and liquid phase from the original material and the material after interaction with microwave radiation. In the filtrate, pH was determined as well as concentrations of Al, Ca, K, Mg, Na, Si and Sr using Atomic emission spectrometry with inductively coupled plasma. The results imply that microwave treatment of the material changes the pH of the leachates to more acidic compared to the original material in which the pH increases. Even the microwave treatment of Ghassoul did not cause changes in Al, in contrast with Si which was leached considerably more in the case of the microwave-treated sample. Opposite result was observed in the case of Na. Leached amounts of Ca

are comparable in both the treatments, leached amounts of Mg and K are not affected by the treatment, leaching time and solid:liquid ratio.

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Synthesis and antimicrobial activity of LDPE/chlorhexidine_vermiculite nanocomposites

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Polymers can act as matrix for holding the antimicrobial components. The use of antimicrobial polymeric materials offers a guarantee of enhancing the efficiency of antimicrobial agents. Since clay minerals can absorb antimicrobial agents and polymer/clay nanocomposites exhibit better barrier properties, mechanical strength and heat resistance than traditional polymers and conventional composites, for those reasons polymer/clay nanocomposites have become a promising new research field. Besides they offer minimizing problems with residual toxicity of conventional antimicrobial agents and guarantee increasing and prolonging antimicrobial efficiency. The aim of this study was to obtain new material based on low density polyethylene (LDPE) with antimicrobial activity, due to the incorporation of chlorhexidine diacetate modified vermiculites. Primarily, antimicrobial properties of a series of polymer layered silicate nanocomposites were tested *in vitro* for *Staphylococcus aureus*, *Escherichia coli* and *Candida albicans* strains.

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Polyethylene/organo-inorgano vermiculites and their antibacterial properties

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The presented work is focused on the study of antibacterial activity of vermiculite (VT) nanofillers and polyethylene (PE)/VT composites surfaces. VT was treated with silver and copper nitrate aqueous solutions and samples were subsequently modified with organic compound (dodecylamine (DA)) via solid-solid melt intercalation. The PE/Ag,Cu-DA/VT composites were prepared via melt compounding technique. Structure changes of prepared powder VT nanofillers and PE/VT composites were studied by X-ray diffraction analysis. Antibacterial activity of VT nanofillers and PE composites surfaces was tested on Grampositive bacteria *Escherichia coli*. Efficiency of VT nanofillers was evaluated by determination of minimum inhibitory concentration (MIC) of samples needed to completely stopped the bacterial growth. The MIC values of samples was from 0.12 -

0.014% (w/v) after 24 h of tested time. Efficiency of PE composites surfaces was evaluated by counting the colony forming units (CFU) number of the viable bacteria. The CFU number of bacterial colonies on PE composites decreased about four orders opposite pure PE after 24 h of tested time.

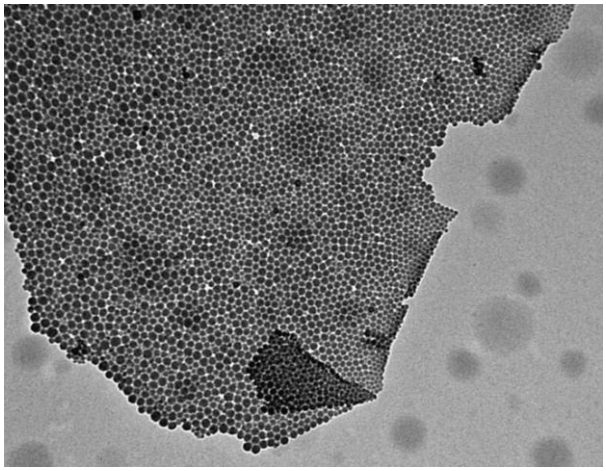
Acknowledgement: This work was supported by projects funded by Ministry of Education, Youth and Sports of the Czech Republic: No. LO1203 "Regional Materials Science and Technology Centre - Feasibility Program" and No. SP2017/78. The authors thank D. Kimmer, J. Chmelenský and J. Fenyk for helping with composite preparation.

Mathematical modelling of lamellar aggregation of dispersed globular nanoparticles nC_{60} on the interface upon sublimation of water molecules from rapid frozen dispersion

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The publication is focused on the problem of nanoparticles aggregation on the sublimation interface between vacuum and rapid frozen liquid dispersion. The main aims are simulation experiments of mathematical modeling of these processes. During lyophilization of rapid frozen liquid dispersion of nanoparticles a selforganization of nanoparticles occurs. The resulting structure depend on setting parameters. These are, according to current knowledge, the temperature, the depth of the vacuum and the nanoparticle fraction in the dispersion liquid. On the free sublimation interface, a streamlined flow of dispersion liquid molecules flows into the vacuum, which we have called the "sublimation wind". Lamellar nanoparticle aggregates are formed on the interface surface in this mode, which are gradually torn by the pressure of sublimation wind.
Aggregated materials with very high specific surface area may be formed by these processes. Mathematical modelling of nanoparticle dynamics on two-dimensional sublimation layer is employed to deepen the understanding of basic mechanisms of these aggregation processes. Simulation results are in good agreement with experimental results of lamellar nanostructure of bonded globular nanoparticles nC_{60}. Further refinements will allow an active control of the process and the quality of aggregated nanostructures.



Synthesis and characterization of erbium oxide nanocrystallites

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The present article describes a method of the preparation of erbium oxide nanocrystallites (nano Er_2O_3) via thermal decomposition of a transient complex formed in situ from $Er(NO_3)_3 \cdot 5H_2O$ and glycine. Decomposition of the complex occurred at about of (250 ± 10) °C. Ultra-fine light pink powder of erbium oxide nanoparticles was obtained due to this method. The resulting nanocrystallites were characterized by X-ray powder diffraction analysis, which showed the erbium oxide nanoparticles to be with the crystallite size of 10 nm. Morphology of the erbium oxide nanocrystallites was examined by scanning and transmission electron microscopy. Electron diffraction observed in transmission electron microscopy corresponds to the results obtained from X-ray powder analysis. The elemental composition of the product was confirmed by EDS analysis.

Keywords: Thermal decomposition, Nanocrystallites, Erbium oxide, XRD, TEM, SEM

Preparation and characterization of the nanostructured cerium dioxide sorbents

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This paper deals with nanostructured cerium dioxide sorbents which are successfully used for the removal of pollutants such as organophosphate pesticides or nervous agents VX and soman from the environment. Sorbents were obtained from two independent precursors. The first was prepared by homogeneous hydrolysis as the hydrated CeO_2 and the second one by precipitation in the form of $Ce(CO_3)_3$. Powders of cerium dioxide were obtained by additional calcination of precursors at temperatures from 500°C to 800°C. The both groups of samples were characterized by X-ray diffraction (XRD), transmission electron microscopy (TEM), scanning electron microscopy (SEM) and the Brunauer-Emmett-Teller (BET) method of surface study. Magnetic properties at room and low temperatures were tested by superconducting quantum interference device (SQUID) magnetometer. Results of measurements show increasing size of crystallites (from units to tens of nm) and decreasing specific surface area with increasing temperature of calcination. Magnetization curves consist of low ferromagnetic reversal detected at low magnetic fields followed by a paramagnetic response at higher fields. However, type of preparation method as well as calcination temperature has a significant influence on the degradation effects and magnetic properties of sorbents.

Photoactive and non-hazardous kaolinite/ZnO nanocomposite: Characterization and reproducibility of the preparation process

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Photoactive and non-hazardous kaolinite/ZnO nanocomposite with 50 wt.% of ZnO nanoparticles was prepared using simple hydrothermal method. The resulting solid phase was separated by decantation, and dried at 105 °C. Calcination of the nanocomposites at 600 °C led to the kaolinite – metakaolinite phase transformation, to further growth of ZnO crystallites, and to significant increase of photodegradation activity. Characterization and reproducibility of the preparation process were studied and confirmed using X-ray fluorescence spectroscopy, X-ray powder diffraction, Fourier transform infrared spectroscopy, scanning and transmission electron microscopies, and Rietveld quantitative phase analysis. Photodegradation activity was evaluated by the discoloration of Acid Orange 7 aqueous solution under UV irradiation. ZnO nanoparticles are anchored on the clay surface which prevents its releasing to the environment and kaolinite/ZnO nanocomposite is tested in order to develop the new eco-friendly formulation of the friction composite for the automotive brake linings in the framework of the H2020 MG-3.1-2014 LOWBRASYS - a LOW environmental impact brake system (No. 636592) LOWBRASYS project.

The influence of calcination temperature on the optical and structural properties of TiO_2 thin films

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In this research, ceramic TiO_2 thin films were prepared on glass substrates using the sol-gel and spin coating methods from solution of TNBT/AcOH/EtOH/H_2O. The obtained coatings were subjected to drying at room temperature and then were calcined in the air at different temperatures in a range of 400–600°C. The optical and structural properties of TiO_2 films were determined for calcination temperatures. The surface morphology, crystal structure, chemical composition and thickness of layers were characterized by scanning electron microscope (SEM) with energy dispersive spectrometer (EDS) and atomic force microscopy (AFM). The optical properties and the energy band gap of prepared TiO_2 thin films were determined by spectral analysis of the absorbance in the function of the energy of radiation were obtained using a UV-Vis spectrophotometer.

The effect of Ce ions doped into $LiMn_2O_4$ – structural, morphological and electrochemical studies

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Lithium manganese oxide ($LiMn_2O_4$, LMO) of spinel structure has been extensively studied as a cathode material for lithium-ion batteries and supercapacitors. Application of LMO has several advantages like: low cost, easy preparation, non-toxicity, high potential (4V vs. Li/Li+), a satisfactory capacity, high-energy density, low self-discharge and high thermal and structural stability. Despite of these advantages, $LiMn_2O_4$ suffers from a serious capacity fading during charge-discharge cycles, which is unacceptable in commercial applications. This problem can be caused by several factors: manganese dissolution, electrolyte decomposition at high potentials, the Jahn-Teller distortion at the state of a deep discharge and lattice instability. One way to overcome this problem is doped by metallic ions into LMO structure.
In our work, lithium manganese oxide nanopowders doped with Ce ions were synthesized using modified sol-gel method and the effect of annealing atmosphere (air vs. nitrogen) on the structure, morphology, and phase composition was studied thoroughly. Additionally, electrochemical testing was conducted to evaluate the effect of annealing atmosphere on electrochemical performance. The results of these measurements will be presented at the Conference.

Physicochemical studies of $LiMn_2O_4$ modified using graphene oxide flakes

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Lithium manganese oxide of spinel structure is an attractive candidate for a positive electrode material in lithium ion batteries and supercapacitors. This is partially due to its non-toxicity, low cost and ease of preparation. $LiMn_2O_4$ (LMO) has high discharge potential (4.1 V vs. Li metal) compared to layered lithium cobalt ($LiCoO_2$) or lithium nickel ($LiNiO_2$) oxides and is environmentally friendly. However, $LiMn_2O_4$ electrodes suffer from a capacity fading during charge-discharge cycles, at higher voltages of around 4.1 V (vs. Li/Li+), especially at elevated temperature (50-60°C), which restricts their use in commercial Li-ion batteries. A surface coating or thin surface film such as metallic], carbon or ceramic oxides on LMO grains can prevent the direct contact between the electrolyte solution and the electrode material, as well as help to improve structural stability and suppress phase transitions.
In our work, we will demonstrate the new synthesis route to decorate the LMO grains using graphene oxide flakes. All the synthesized materials have been characterized by a number of methods: X-ray powder diffraction (XRD), X-ray photoelectron (XPS) and Raman spectroscopy, scanning and transmission electron microscopy (SEM, TEM). Also, the electrochemical tests were performed of LMO/n-GO composites.

Thermal treatment of organovermiculites used in sorption process

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Vermiculite is a well-known material from the group of the phyllosilicates nowadays used among others for sorbents preparation. They are known to be very efficient sorbents of organic compounds, especially polycyclic aromatic hydrocarbons, in their modified forms. There is a large amount of a research in the topic of organically modified vermiculites and their properties. One of ours studies revealed almost 100% efficiency in the column sorption of benzene, dichlorbenzene, toluene, naftalene and others. But there are only few studies about their treatment after utilization. Thus, the goal of this work is to propose ways of disposing them after the application.
One of the options is the thermal treatment in range of temperatures and our goal is determine structural changes in the process which could help us understand if there is a possibility of repeatable use or the treated material could be used in different application. The prepared and tested samples were investigated using X-ray diffraction (XRD) method, Fourier transform infrared (FTIR) spectrometry and phase carbon analysis.

Keywords: Vermiculite, Organovermiculite, Sorption, Thermal treatment

Acknowledgement: This work was funded by the MSMT project SP2016/65, SP2017/78 and the European Regional Development Fund in the IT4Innovations Centre of Excellence (CZ.1.05/1.1.00/02.0070).

Sulfur cathode material conductivity improving by nanocarbons admixture: technology and characterization

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Sulfur (S) is announced as future cathode material with a theoretical specific capacity of 1672mAh/g,~5 times higher than those of traditional cathode materials based on transition metal oxides or phosphates.
S based battery is partly limited by the problems of low electrical conductivity of sulfur, dissolution of polysulfides in electrolyte and volume expansion of sulfur during discharge.
The high effort to find materials to overtake these disadvantages is leading to conductive materials similar to S. The nanocarbons are well known for very good conductivity along the graphene layers. For this purpose, 3 types of nanocarbons were tested using mechanofusion milling process to create interaction of sulfur and carbon as two inorganic materials. Conductivity was tested and high improvement was proven. To solve problems with dissolution of polysulfides in electrolytes the intercalation of sulfur to clay interlayer space was designed. The efficiency of intercalation was studied using molecular modeling of such system. The models were confronted with measured analytical data.

Keywords: nanocomposite, sulfur, nanocarbons, conductivity, clay minerals

Acknowledgement: Authors want to acknowledge to project SP2017/86 for material support.

Stability of calcium deficient hydroxyapatite/clay mineral composite in solutions with different pH

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Hydroxyapatite is one of the building blocks of hard tissues of living organisms. Therefore the synthesis of hydroxyapatite particles on clay mineral substrate has important issue that is the stability of nanoparticles in solutions with pH range similar in human body. In this study, the stability (amount of CaII and PV released into the water) of calcium deficient hydroxyapatite (CDH)/clay mineral composites was investigated. The CDH composites with montmorillonite (Mt) and two vermiculites (Vt) (Brazil – VtBr and Bulgaria – VtBu) were compared with pure CDH. The stability was investigated for 24 h where CDH/clay mineral composites and pure CDH were placed into the water solutions with different pH values (pH = 5, 7, and 9). The presence of CaII and PV ions at solutions were determined using atomic absorption spectrometry. The CDH/clay mineral composites after stability testing were characterized by X-ray powder diffraction and infrared spectroscopy with Fourier transformation. The results showed that most stable is composite of VtBu/CDH. On the other hand the less stable is VtBr/CDH in comparison with pure CDH. The Mt/CDH composite is more stable than pure CDH, but less than VtBu/CDH. The X-ray powder diffraction and infrared spectroscopy with Fourier transformation results showed no significant changes in structure, which is perspective for medicine applications.

Keywords: Montmorillonite, Vermiculite, Calcium deficient hydroxyapatite, pH stability

Acknowledgement: The authors gratefully acknowledge the support by projects funded by Ministry of Education, Youth and Sport of Czech Republic (SP2017/86; National Programme of Sustainability NPU II project „IT4Innovations excellence in science - LQ1602“; Project No. LO1203 "Regional Materials Science and Technology Centre - Feasibility Program").

Characterization of nanostructured materials using TEM and SEM microscopy

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Methods of severe plastic deformation (SPD) are usually defined as metal forming processes in which a very large plastic strain is imposed on a bulk process in order to obtain an ultra-fine grained metal. The objective of the SPD processes is creation of an ultra-fine grained metal and manufacturing of lightweight parts by using high strength metal for the safety and reliability of micro-parts and for environmental harmony. In this keynote paper, the fabrication process of equal channel angular pressing (ECAP) was used to increase the mechanical properties of Al-Mg alloy. Because of extremely small grain sizes the microstructure was characterized using TEM and SEM microscopy. We found that through the size of subgrain achieved after ECAP process can reach few tens of micrometers.

Biodegradable polymeric materials for biliary stents

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The benign stenosis of biliary tracts belong to the problems of medicine nowadays. This disease is caused with cancer of the pancreas, gallbladder, bile ducts or inflammation gallbladder and biliary tract. The standard treatment is surgery but only 20% of patients are able to resect. Another solution of treatment of stenosis is the endoscopic placement of a biliary endoprosthesis – stents. Common used stents are made of metal or polymer but these stents are clogged over time and then they must be removed by surgery. Biodegradable polymeric materials are suitable for biliary stents because may offer advantages for treatment of benign and malignant biliary strictures. The greatest advantage of biodegradable stents is that they do not have to be removed from patient's body but the main problems of these stents are the clogging and intestinal bacteria. We have prepared polymeric films of polylactide acid with silver nanoparticles and vermiculite modified with hexadecyltrimethylamonium bromide (HDTMA) in various concentrations to get antibacterial properties of polylactide. The films were characterized by FTIR, optical microscope and microbial tests.

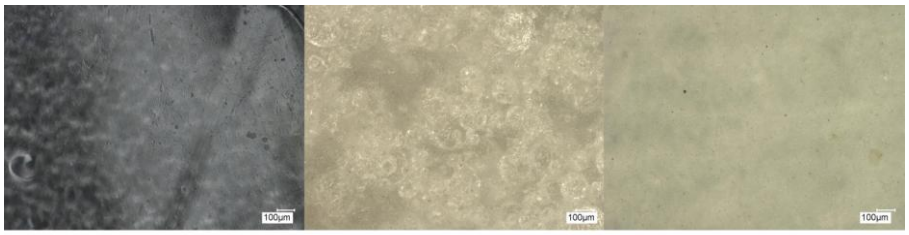


Figure 1. Images of light microscope, a) clear PLA, b) PLA+Ag, c) PLA+HDTMA.

Acknowledgement: This research was supported/partially supported by project Polymer nanocomposites with layered materials (SP2017/86) and MSMT project SP2017/78.

Hybrid nanocomposite based on ZnO/vermiculite

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Hybrid nanocomposites are nanostructured materials which combine organic and inorganic constituents in order to create or enhance new unique material properties and eliminate disadvantages of the individual components. The aim of this work were compared the fabrication routes of hybrid nanocomposites. In the first step, the inorganic nanocomposites based on zinc oxide/vermiculite were prepared using either sonochemical or mechanochemical method. Inorganic nanocomposites were then intercalated by chlorhexidine diacetate under different conditions using ultrasound. Novel hybrid nanocomposites were characterised by X-ray diffraction and Fourier transform infrared spectroscopy. The particle size, specific surface and total carbon concentration changes were analysed. Ultrasound method remarkably accelerates the intercalation process and increases intercalated drug amount within the material.

Keywords: sonochemistry, vermiculite, zinc oxide, chlorhexidine, antibacterial activity

Acknowledgement: The work was supported by the project No. SP2017/45 - “Nanostructured composites materials“.

Use of X-ray fluorescence spectrometry for analysis of very thin layer formed on an abrasive foil

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The aim of this work was to develop a method of sampling and analysis of thin layer on solid materials surface. The surface layers are sampled by abrasion on abrasive foil. The layers of materials captured on the foil are suitable for analysis by XRF method. The method was used for analysis of friction layers created on brake pads surfaces during brake process. Calibration models were developed using brake pads of known composition. Based on a linear relation between fluorescence radiation intensities and elements concentrations in such a thin layer it was possible to determine a modification of brake lining surfaces during friction process. The method of abrasion of material surface was found to be effective for qualitative and/or semi-quantitative analysis of a very thin layer. For quantitative analysis it is very important even distribution of homogeneous particles on the foil, which is problematic and present the main limitation of this methodology.

Keywords: Thin layer; XRF; Abrasive foil; Friction

Acknowledgement: The authors gratefully acknowledge the support of Nanotechnology Centre and Project No. CZ.1.05/2.1.00/01.0040 "Regional Materials Science and Technology Centre" within the frame of the operation programme "Research and Development for Innovations" financed by the Structural Funds and from the state budget of the Czech Republic.

Preparation and stability of magnetically modified kaolinite

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Clay mineral kaolinite is a low-cost, environmentally harmless and suitable substrate for composite preparation. Kaolinite modified by iron oxides nanoparticles seems to have a material for wastewater treatment. Moreover, due to the magnetical properties of kaolinite/Fe_xO_y composite, pollutants adsorbed onto the composite can be easily removed from the solution by a magnetic field. Not only the successful preparation of composite is important but also the testing of its stability. Natural kaolinite and kaolinite/Fe_xO_y composite were characterized using X-ray fluorescence spectroscopy, X-ray powder diffraction, infrared spectroscopy, and transmission electron microscopy. Testing the stability of kaolinite and kaolinite/Fe_xO_y composite was performed according to the European technical standard EN 12457-2 in deionized water and extraction agents with pH 2, pH 4, pH 9 and pH 11. The stability of composite was evaluated on the basis of elements determined in the leachates by atomic emission spectrometer with inductively coupled plasma and compared with elements released from original kaolinite to the leachates. The results of experiments

proved that the kaolinite is a suitable substrate for iron oxides nanoparticles. The content of iron and the magnetic properties of kaolinite/Fe_xO_y composites were not changed even after leaching test.

Stevensite-rich Moroccan clay intercalated by polypyrrole

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Regularly arranged chains strongly affect the electrical conductivity of conductive polymers (e.g., polypyrrole). One of the easiest ways to achieve this arrangement is the insertion of the polymer into the interlayer space of solid inorganic layered matrix, i.e., the intercalation process. Among various kinds of layered materials, the clay minerals, especially the smectite group, deserves particular attention. Negative charge of smectite layers helps the intercalation process resulting in higher conductivity of the polymer in clay/polymer intercalates. Characterization of stevensite-rich Moroccan clay (denoted as STE) and intercalation of polypyrrole (PPy) into STE in order to increase the conductivity were two main purposes of this work. Two forms of STE/PPy nanocomposites were studied: powder and pressed tablets. X-ray fluorescence spectroscopy, X-ray diffraction analysis, atomic force microscopy, thermogravimetry, Raman microspectroscopy, and scanning electron microscopy in conjuction with energy dispersive X-ray spectroscopy were used to study the composition and structure of the nanocomposites. Measurements of the electrical conductivity of pressed tablets revealed not only that the conductivity of PPy is enhanced but it was also found that the tablets pressed from STE/PPy nanocomposite are electrically anizotropic because the STE particles act as insulators in a direction parallel to the direction of the tablet pressing.

Raman Spectroscopic Study of Selected Clay Minerals

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The paper presents the results of Raman spectroscopic study of selected montmorillonites and kaolinites supplemented with infrared spectroscopy and thermal analysis. Raman spectroscopy is a highly informative method that allows to record spectra in the range from 4,000 to 50 cm^{-1} in a one-step measurement. In case of clay minerals Raman spectra exhibit unique bands near 700 and 200 cm^{-1} that are due to tetrahedral SiO_4 in layer silicates and vary depending on the mineral structure. The second region between 920 and 840 cm^{-1} corresponding to metal–OH bending vibrations provides information about the octahedral cations present. Similar to FT-IR, Raman spectroscopy is able to detect minor amount of carbonate, amorphous silica, fine-grained quartz and traces of organic material. The weakness of this method is the occurrence of fluorescence, which quite often accompanies the measurement of clay minerals and devalues the final spectral information. Because the incidence of fluorescence is very closely related to excitation wavelength, experimental measurements of clay minerals were carried out using lasers with different wavelengths (532 nm,

780 nm, 1064 nm). The aim of the paper is to show possibilities and limits of using Raman spectroscopy in clay sciences.

Evidence of tetrahedrally coordinated nickel cations in nanostructured $NiFe_2O_4$

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Nanostructured nickel ferrite ($NiFe_2O_4$) is prepared via high-energy ball milling of the bulk counterpart at ambient temperature. The structure of the as-prepared nanoferrite is characterized by Raman spectroscopy and 57Fe Mössbauer spectroscopy. Due to the ability of these spectroscopic techniques to probe the local environment of ions, valuable complementary insight into the nature of the local structural disorder of nanosized $NiFe_2O_4$ is provided. For the first time, evidence is given of the tetrahedrally coordinated nickel cations in the nanomaterial.

The thermal stability of polyaniline/phylosilicate nanocomposite materials

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This work deals with the determination of the thermal stability of prepared polyaniline/phylosilicate nanocomposite materials. The thermal stability of the studied nanocomposite samples was determinated according to the characteristic temperatures obtained from TG/DTG curves. Thermal stability was evaluated both from the point of view of the mineral type and the influence of the anilinium sulphate concentration. The thermal stability of all prepared nanocomposites has been improved compared to pure polyaniline. The highest thermal stability was found for samples contained kaolinite. The values of start temperature T_i increased from 30 to 130°C, the peak temperature T_p up to 40°C.

Keywords: nanocomposite, polyaniline/phyllosilicate, thermal analysis, thermal stability

Hydrothermal synthesis of nano-hydroxyapatite/Graphene hybrit biocomposite on Ti_6Al_4V alloy

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Nano-hydroxyapatite (nHap) is an attractive and biocompatible material due to its chemical similarity to bone and tooth. The nHAp has osteoconductivity and bioactive properties that promote regeneration and adherence to bone tissue, however, lack mechanical properties. Graphene added in to improve bioactivity and corrosion ressistance. Graphene has excellent physicochemical,

mechanical and biological properties and has been used in numerous biomedical areas, such as biosensing, drug delivery, biological imaging. In this study, graphene/nano-hydroxyapatite (nHAP) hybrit nanocomposites on Ti_6Al_4V alloy surface were synthesized by hydrothermal method. The hydrothermal reactions were run at 100-250 °C. The synthesized nHAp-Graphene showed the XRD peak confirms its crystalline nature. The surface morphological studies were carried out using TEM and SEM. Analysis showed that the nHAp-graphene composites were uniformly deposited on Ti_6Al_4V with enhanced nanoscale surface roughness. Crystal structure, mechanical properties and thermal stability of the nanocomposites was investigated in detail. The mechanical properties of nHAp was improved with addition of graphene. The result shows nHAp-Graphene hybrit biocomposites has a great potential for biomedical sciences.

Polyaniline/montmorillonite intercalate as a precursor for few-layer graphene: AFM and Raman spectroscopy study

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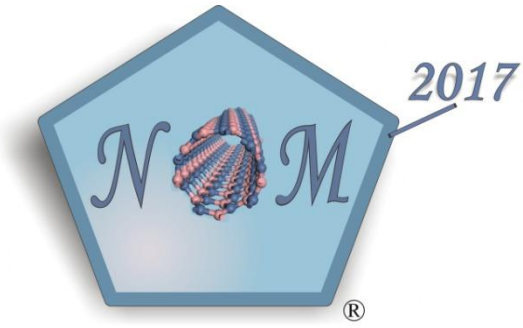
Aluminosilicate/graphene nanocomposites are group of synthetic conductive materials which combine rheological properties of nonconductive aluminosilicate and electrical properties of graphene. These materials are usually prepared with commercially available graphene and *in situ* preparation of graphene is quite uncommon in the nanocomposites. The original method for obtaining aluminosilicate nanocomposite containing *in situ* prepared graphene is based on high-temperature (1400 °C) induced changes of polyaniline (PANI) in the interlayer space of montmorillonite (MMT) under dynamic argon atmosphere. While the original method included only tablets compressed (p=400 MPa) from PANI/MMT intercalate, two different forms of PANI/MMT were studied in present work: tablets and thin layers. A cost of preparation was reduced, i.e., tablets and layers were calcined at lower temperature 1300 °C in static argon atmosphere. Few-layer graphene was formed from PANI chains in both cases. Types of carbon in calcined samples were specified by Raman microspectroscopy. Atomic force microscopy and conductive atomic force microscopy were used for the characterization of surface morphology and electrical properties of noncalcined and calcined samples. In case of tablets, differences between internal volume and surface were observed. Current distribution maps obtained by conductive atomic force microscopy showed an importance of MMT in graphene formation.

TOPIC 2

Advanced computational modeling of materials and nanostructures

Chair: Miroslav Pospíšil
Co-chair: Jonáš Tokarský

Ab-initio modeling of novel materials and nanostructures
Molecular modeling and simulations of layered nanostructures and nanocarbons
Molecular simulations of polymers and polymeric nanocomposites
Molecular simulations in design of drug carriers
Advances in computational methods and software tools for nanotechnology



Invited lecture (IL):

Towards sub-nanometer quantitative measurements of magnetic properties

Jan Rusz

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X-ray magnetic circular dichroism (XMCD) is a well established technique for measurement of magnetic properties. By measuring x-ray absorption spectra with circularly polarized x-rays the values of spin and orbital magnetic moments can be extracted using sum rules. Due to difficulties to focus x-rays to small spots, the spatial resolution of XMCD-based techniques remains around 10nm [1]. Since 2016 a transmission electron microscopy analogue of XMCD is under intense development. The technique named electron magnetic circular dichroism (EMCD; [2]) should in principle allow to measure magnetic moments with atomic lateral spatial resolution. We will review the present state of the art in EMCD, particularly focusing on recent advances in EMCD measurements with atomic size electron beams [3,4,5].

[1] P. Fischer, Front. Phys 2, 82 (2015).
[2] P. Schattschneider, S. Rubino, C. Hébert, J. Rusz, J. Kuneš, P. Novák, E. Carlino, M. Fabrizioli, G. Panaccione and G. Rossi, Nature 441, 486 (2006).
[3] J. C. Idrobo, J. Rusz, J. Spiegelberg, M. A. McGuire, C. T. Symons, R. Raju Vatsavai, C. Cantoni, and A. R. Lupini, Adv. Chem. Struct. Imaging 2, 5 (2016).
[4] J. Rusz, S. Muto, J. Spiegelberg, R. Adam, K. Tatsumi, D. E. Buergler, P. M. Oppeneer, and C. M. Schneider, Nat. Comm. 7, 12672 (2016).
[5] T. Thersleff, J. Rusz, B. Hjörvarsson, and K. Leifer, Phys. Rev. B 94, 134430 (2016).

Oral presentations(OP):

Laser induced ultrafast demagnetization and spin current generation

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Magnetization can be changed by means of a very strong laser light on the femtosecond timescale. This effect has a high application potential but it is also very interesting from the theoretical point of view due to reaching a previously unexplored nonequilibrium states of magnetic materials. We discuss here one effect related to the ultrafast demagnetization, laser induced generation of spin currents. In transition metals and their alloys a laser pulse can excite electrons from the spin polarized d band into the conduction s band with a higher electron mobility. The nonequilibrium hot charge carriers migrate away from the laser spot and reduce the local magnetic moment as described by the superdiffusive spin transport model [1], which takes into account scattering of hot electrons on atomic sites leading to nonequilibrium avalanches of excited electrons. We theoretically study the spin transfer torque and magnetization dynamics induced by femtosecond laser pulse in a spin valve consisting of two magnetic layers with perpendicular magnetizations separated by a nonmagnet, as suggested in a recent experiment [2]. Ultrafast generation of spin currents has many possible applications in spintronics where it allows spin manipulation at unprecedented speeds, and has already been used to generate spin polarized THz pulses [3].

[1] M. Battiato, K. Carva, P. Oppeneer, Phys. Rev. Lett. 105, 027203 (2010).
[2] A.J. Schellekens et al., Nature Comm. 5, 4333 (2014).
[3] T. Kampfrath et al., Nature Nanotechnol. 8, 256 (2013).

Conformational assay of 2-acetylpyridine in low temperature matrices

Nihal Kuş

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Matrix isolation is a technique where gaseous atoms and molecules are trapped in an environment of solidified inert gases (most of times a rare gas) at low temperature (4-20 K). The method was initially used to study free radicals and other short-lived chemical reaction intermediates. Nowadays the method receives many other applications, including the investigation of rare, most of times high-energy, conformers prepared in situ by selective near-infrared excitation of matrix-isolated conformers existing prior to deposition in significant amounts in the gas phase, or the elucidation of intricated reaction mechanisms. By comparing results obtained for the isolated molecules using the matrix-isolation approach with results obtained for the neat condensed phases (solid, liquid), one may also have access to an estimation of the type and strength of intermolecular interactions present in these latter. In this study, the conformational space of 2-acetylpyridine (2AP) was investigated theoretically at the DFT/B3LYP/6-311++G(d,p) level and investigated experimentally by matrix isolation IR spectroscopy. The optimized structures of the two conformers of the compound (*cis* and *trans* forms) were obtained. In a cryogenic N_2 matrix (prepared from the room temperature vapor of 2AP) only the cis conformer was observed. The spectroscopic data allows to estimate the relative strength of the major intermolecular interactions (involving the CO group) in the different 2AP neat condensed phases.

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Ab-initio calculations help to interpret experiment: elastic and magnetic properties of the quasi-one dimensional magnetic system $Cu(en)(H_2O)_2SO_4$

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The density functional theory [1] was used to calculate elastic constants and magnetic interactions for the quasi-one-dimensional (1D) antiferromagnetic compound $Cu(en)(H_2O)_2SO_4$, with en=$C_2H_8N_2$. The bulk, shear, Young moduli, Poisson ratio, and elastic anisotropy were determined for the polycrystalline $Cu(en)(H_2O)_2SO_4$ by employing the Hill averaging [2] of the single crystal elastic constants. The $Cu(en)(H_2O)_2SO_4$ compound is predicted to be soft and ductile. We have also estimated the Debye temperature for the $Cu(en)(H_2O)_2SO_4$ single crystal by using the sound velocities obtained from the calculated elastic constants. Concerning the magnetic order the strengths of the magnetic interactions were determined on the basis of the Heisenberg model. The strongest magnetic interaction is identified within the bc-plane forming a zig-zag chain and confirms the 1D magnetic character as expected previously [3]. Finally, the effect accounting for the van der Waals interactions to better describe the H-O bonds was considered on the discussed quantities.

[1] P. Hohenberg and W. Kohn, Phys. Rev. 136, B864 (1964).
[2] R. Hill, Proc. Phys. Soc. A 65, 349 (1952).
[3] R. Sýkora and D. Legut, J. Appl. Phys. 115 17B305 (2014).

Ab-initio calculations of QMOKE in bcc Fe, Drude term modelling

Ondřej Stejskal[1], Robin Silber[1,2], Jaroslav Hamrle[3], Martin Veis[3], Jaromír Pištora[1]

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The part of the magnetooptic Kerr effect (MOKE) that is even in magnetization is called the quadratic MOKE (QMOKE). The permittivity tensor fully describes the magnetooptic response of a material. We performed ab-initio calculations of the permittivity tensor in bcc Fe by the WIEN2k code [1]. We also model the intraband contributions via the Drude term [2]. The results are then compared to the experimental spectra. Further we investigate in more detail the microscopic origin of the magnetooptic effect. We analyze the band structure and the joint band structure of the bcc Fe. The optical and magnetooptic transitions are then visualized as a surface in the Brillouin zone and the key transitions contributing to the linear magnetooptic response are identified. We show that the magnetooptic response originates only from limited number of k-points in the Brillouin zone.

[1] P. Blaha, K. Schwarz, G. Madsen, D. Kvasnicka and J. Luitz, WIEN2k, An Augmented Plane Wave Plus Local Orbitals Program for Calculating Crystal Properties, Vienna University of Technology, Austria (2001).
[2] Š. Višňovský, Optics in Magnetic Multilayers and Nanostructures,Taylor and Francis Group, Boca Raton, Florida 2006.

Poster presentations (PP):

Effect of blockiness and monomer sequence on self-assembly of gradient copolymer melt

Pavel Beránek[1], Zbyšek Posel[2,3]

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Recent advances in living polymerization allowed synthesis of copolymers with controlled monomer sequences. Among these sequence controlled structures, the gradient copolymers (GC) have promising properties for industrial applications. GC are composed of two different types of monomeric species with smoothly varying concentration along the chain. GC melts self-assemble into lamellae, gyroid, cylindrical and spherical nanostructures. Equilibrium nanostructure depends on blockiness (λ) and monomer sequence in GC chains. The most significant property of GC is wide window of stable gyroid nanostructure. We employed Dissipative particle dynamics (DPD), to model self-assembly of GC melt. Our GC chain consists of A, B segments connected by harmonic spring. Sequences of A, B in chain are controlled by gradient strength (C). We observe that all types of GC melts separates into three structures: lamellae, gyroid and cylindrical, with wide gyroid phase. Self-assembly of GC with high C resembles behavior of diblock copolymers, where narrow gyroid window is observed at volume fraction f_A=0.35. With decreasing C the gyroid window extends between f_A=0.20 and f_A=0.35. Further decreasing of C widens lamellae phase and GC behavior resembles linear GC where lamellae dominates among all other structures. Increasing λ then leads to lower order-disorder transition.

Photochemistry of p-(dimethylamino)benzaldehyde (DMABA) Isolated in Solid Argon

Nihal Kuş[1,2], Archna Sharma[1], Rui Fausto[1]

[1]University of Coimbra, Department of Chemistry; Coimbra, Portugal; [2]Anadolu University, Department of Physics; Eskisehir, Turkey

p-(Dimethylamino)benzaldehyde (DMABA) is a bifunctionalized arene bearing the aldehyde and *N*,*N*-dimethylamino substituents in para position, and has a wide range of uses, from analytical to biologically relevant applications, and in chemical synthesis. It has a donor-aromatic-acceptor structure exhibiting an appreciable degree of intramolecular charge-transfer, thus making this compound also an interesting target for research in the field of non-linear optical materials.
In this study, DMABA was investigated as an isolated species in a low temperature argon matrix (T = 10 K) by infrared spectroscopy, and also by quantum chemical (DFT) calculations. The main addressed subject was the investigation of the photochemistry of the matrix-isolated DMABA, upon broadband UV irradiation (λ > 298 nm), which led to the first observation of methane photochemical production from an N,N-dimethylamino-substituted arene. New structural and spectroscopic data on the resulting product of demethylation, 4-(methylideneamino) benzaldehyde (4MAB), was also obtained both theoretically and from the experimental matrix-isolation data.

Acknowledgements: These studies were funded by the Portuguese “Fundação para a Ciência e a Tecnologia” (FCT), project PTDC/QEQ-QFI/3284/2014. The Coimbra Chemistry Centre (CQC) is supported

by the FCT through the project PEst-OE/UID/QUI/00313/2013. N Kuş thanks FCT for the post-doctoral grant ref. SFRH/BPD/88372/2012.

Controlled transport of polymer in slit and cylindrical pores coated with polymer brushes: Insight from dissipative particle dynamics

Zbyšek Posel[1,3], Martin Svoboda[2,3], Martin Lísal[2,3]

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We use meso-scale dissipative particle dynamics method to simulate a controlled transport of linear polymer through slit and cylindrical pores coated with solvent-sensitive polymer brushes. The coated pores control polymer permeability by stretch-to-collapse transition of polymer brushes in response to changes in solvent quality. The flexible polymer is represented by coarse-grained beads connected by harmonic spring. The results show that polymer brushes collapse at bad solvent conditions, open the pore and promote polymers' permeability. At good solvent conditions the polymer brushes stretch, close the pore and suppress polymers' permeability. Therefore, we observe a significant reduction in the permeation rate of polymers in both pores. Moreover polymer's structural properties (radius of gyration, hydrodynamic radius and end-to-end distance) show that, due to the pore confinement, the polymers in the cylindrical pore have more pronounced orientation in flow direction than polymers in the slit pore.

Molecular simulations of layered double hydroxides intercalated with anti-inflammatory drugs

Miroslav Pospíšil, Milan Pšenička

Charles University, Faculty of Mathematics and Physics, Department of Chemical Physics and Optics; Prague, Czech Republic

Demand for new multifunctional nanomaterials suitable for using in health care is still increasing, due to that it is necessary to combine actual knowledge of the medical field and new approaches for the preparation of materials with desired properties. One of these unique materials are layered double hydroxides (LDH) that exhibit suitable properties like biocompatibility, which allow them to be suitable nanocarriers of natural bioactive organic compounds. It was found that LDH can increase the chemical stability of the resulting intercalated material and allow its subsequent release in the body, or can eliminate undesirable side effects like aging and decomposition. We focused on description of sustained release process of drugs (for example statins, mefenamic acid and sulindac) by molecular simulation methods. These drugs have anti-inflammatory and antinociceptive effects (anti conduction of painful stimuli). We present molecular models of LDH intercalated with those drugs, their arrangement and properties. The selected drugs were investigated by the simulation methods in the environment with different pH, simulating the environment of the human body with focus on description of controlled release of the pharmaceutically active molecules. Structure and properties of the optimized models were compared with available published experimental data.

Self-organization and self-assembly of gold nanoparticles highly grafted by poly(styrene) homopolymer or poly(styrene)-poly(vinylpyridine) symmetric diblock copolymer: dissipative particle dynamics study

Michal Řeřicha[1,3], Zbyšek Posel[2,3]

[1]J. E. Purkyně University in Ústí nad Labem, Faculty of Science, Department of Physics, Ústí nad Labem, Czech Republic; [2]J. E. Purkyně University in Ústí nad Labem, Faculty of Science, Department of Informatics, Ústí nad Labem, Czech Republic; [3]Institute of Chemical Process Fundamentals of the CAS v. v. i., Laboratory of Chemistry and Physics of Aerosols, Czech Republic

Long-range ordered structures formed by inorganic nanoparticles (NPs) grafted by homopolymer chains depend on grafting density, grafted chain conformation and particle radius. Increasing the degree of polymerization of grafted chains beyond threshold value leads to the reduction of the structural regularity. Using computer simulations and Dissipative Particle Dynamics (DPD) method, we studied self-organization of gold nanoparticles highly grafted by poly(styrene) homopolymer chains. We vary volume fraction of NPs and degree of polymerization of PS chains and demonstrate that high volume fraction of NPs grafted by short and moderately long PS chains form ordered array. Contrariwise, NPs grafted by long PS chains and/or low volume fraction of nanoparticles disarray. By using Voronoi analysis, we show that increase of volume fraction leads to reorganization of nanoparticles into more compact array.

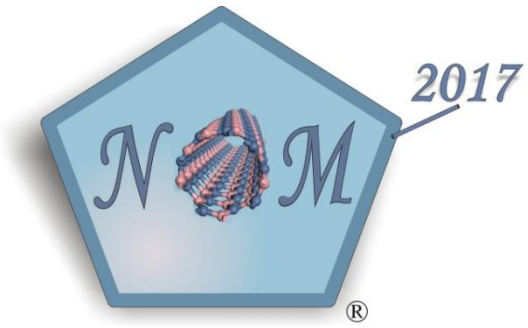
Self-assembly of gold nanoparticles highly grafted by symmetric poly(styrene)-poly(vinylpyridine) (PS-PVP) diblock copolymer is further described again as a function of NPs volume fraction and diblock degree of polymerization. We show that high volume fractions of NPs grafted by long PS-PVP chains self-assemble into nanostructure with NPs ordered in strings. Decreasing the volume fraction of NPs and degree of polymerization leads to disordering of the nanostructure. Both homopolymer and diblock copolymer grafted NPs are characterized by density distributions, chain statistics and by structure factor accessible also experimentally.

TOPIC 3

Terahertz technology and nanostructures in photonics and electronics

Chair: Mathias Vanwolleghem
Co-chair: Kamil Postava

Terahertz photonics and applications
Nanotechnology for electronic devices
Photonics, optoelectronics and magneto-optics



Invited lectures (IL):

Terahertz spectroscopy of spin-phonon excitations in multiferroics

Filip Kadlec

Institute of Physics, Academy of Sciences of the Czech Republic, Prague, Czech Republic

Magnetoelectric multiferroics are crystals where ferromagnetic and ferroelectric orders occur simultaneously. In many cases, interactions between the two orders are observed, which makes these materials attractive not only because of their fundamental properties but also in view of potential applications, such as memory elements, magnetic sensors or components for spintronics. Such coupling is, in general, observed on both static and dynamic scales. In the THz range, the dynamic coupling manifests itself often by characteristic excitations, so-called electromagnons, which can be viewed as periodic oscillations of both atomic positions and spin orientations. The talk will introduce examples of systems featuring electromagnons, results of their measurements in external magnetic field and discuss their main properties.

Photomixing THz Sources: Past, present and future

Emilien Peytavit

IEMN CNRS, THz Photonics, Villeneuve-dAscq, France

A large number of chemical species have absorption lines lying in the Terahertz frequency range, which is thus a very interesting spectral range for molecular spectroscopy applied to earth, planetary, environmental and space science. In spite of this great scientific interest, the THz range still remains one of the less used spectral bands. It is indeed called the THz gap because of the lack of low cost, compact and reliable sources and detectors as compared to its two adjacent frequency ranges, i.e. the microwave and the optical waves, which rely respectively on the efficiency of the photonics and electronics technology.

Significant improvements of the detectors performances have been done in the last years, motivated by the emergence of new applications such as security or medical imaging, DNA study or even painting analysis. Background limited THz detectors are now available. On the other hand, the generation of THz wave remains a challenge and a room-temperature powerful, and compact THz source is still needed.

One of the most promising THz continuous-wave (CW) sources working at room temperature is based on the photodetection of the beating frequency generated by two spatially overlapped infrared lasers. It is the so called photomixing THz source, which is intrinsically wideband and is potentially compact when semiconductor laser diodes and amplifiers are used.

I will present here the past and present developments of this technology. I will focus my discussion on the ultrafast photodetectors suitable for this application, i.e. uni-travelling carrier photodiodes and ultrafast photoconductors using sub-picosecond lifetime semiconductors. I will then show that the current limits in terms of output powers, i.e. around 1 mW at 300 GHz and 10 μW at 1 THz, can be overcome by using new design of traveling waves photomixers. These latters could lead to the development of broadly tunable solid state sources working at room temperature and providing mW-level output power.

Recent progress on Terahertz quantum cascade laser based frequency combs

Markus Rösch

ETH Zurich, Institute for Quantum Electronics, Zürich,Switzerland

In the last years it has been shown that it is possible to achieve octave-spanning lasers using terhertz quantum cascade lasers (THz QCL), fully exploiting the concept of heterogeneous cascading in quantum cascade active regions [1]. Another recent breakthrough has been the first demonstrations of frequency comb (FC) operation with THz QCLs by either compensating the dispersion present in the laser with a double-chirped mirror or with broadband lasers that feature an intrinsically low dispersion [1, 2]. Using the latter one, ensures a simple fabrication resulting in a good reproducibility of the fabricated devices. The fabrication is identical to standard metal-metal waveguide Fabry-Pérot THz QCLs [1, 3].

FC operation is especially interesting for broadband high accuracy spectroscopy applications. A well know technique for FC spectroscopy - also with mid-infrared QCLs - is the so-called dual-comb spectroscopy [4, 5]. Dual-comb spectroscopy requires two FCs that beat on a fast detector generating a multi-heterodyne beating of the two FCs. Lately we were able to demonstrate that the QCL itself can replace such a fast detector resulting in a self-detected on-chip dual-comb source [6]. We could demonstrate a dual-comb operation over a spectral bandwidth of up to 630 GHz. The generated multi-heterodyne beating signal can be further used to fully prove the FC nature of the laser and determine a frequency accuracy of 1.3×10^{-12} [6]. Such a dual-comb source provides a complete toolbox for realizing compact, high power (in the order of several mW) THz dual-comb spectrometers for high accuracy spectroscopy.

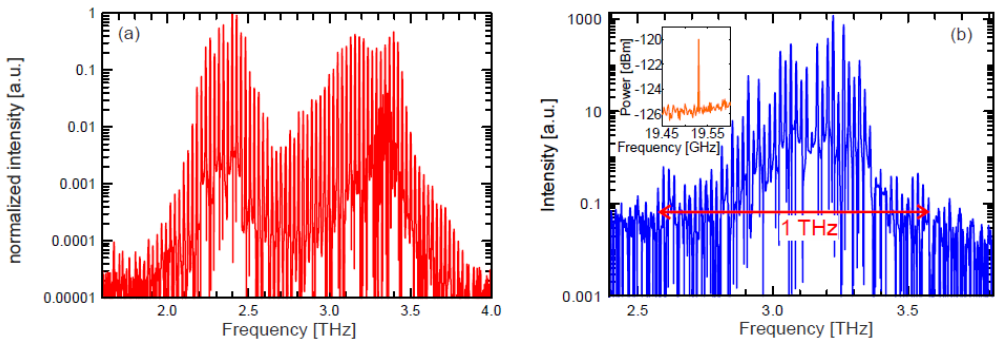


Figure 1. (a) Optical spectrum of a 1.5 mm x 150 µm wet-etched laser in pulsed operation (20 % duty cycle) at 20 Kelvin. (b) Optical spectrum of a 2 mm x 60 µm dry-etched laser in CW operation at 16 Kelvin acting as a FC as indicated by a narrow intermode beatnote (inset).

To further improve the spectral coverage of THz QCL based FCs, we designed a new laser based on 4 different active regions with central frequencies of 2.3, 2.6, 2.9, 3.5 THz integrated in a single laser cavity. This results in lasers with almost 2 THz spectral bandwidth (see Figure 1(a)) with a 1.32 THz wide flat top within a 20 dB range [7]. The reported bandwidth spans over more than a full octave in frequency. With respect to previous designs [1], the laser features a significantly larger dynamic range as well as higher output power up to 10mW peak power in pulsed operation. Dry-etched lasers with side-absorbers for lateral mode suppression similar as in [8] were fabricated for continuous wave (CW) operation. These lasers show up to 1 THz spectral bandwidth when operating as frequency combs (see Figure 1(b)) [7]. The narrow intermode beatnote (inset of Figure 1) was used to identify the FC operation [1, 2]. The FC nature of these lasers was proved again by an on-chip dual-comb experiment. To summarize, THz QCL FCs, especially in a dual-comb

configuration, will open new possibilities for spectroscopy at terahertz frequencies combining the powerful quantum cascade laser with the concept of frequency combs. Therefore high accuracy spectroscopy combined with high terahertz power in compact setups should be realizable within the near future.

[1] M. Rösch et al., Nature Photonics 9, 42-47 (2015)
[2] D. Burghoff et al., Nature Photonics 8, 462-467 (2014)
[3] B. S. Williams et al., Appl. Phys. Lett. 83, 2124-2126 (2003)
[4] S. Schiller, Optics letters 27, 766 (2002)
[5] G. Villares et al., Nature Communications 5, 5192 (2014)
[6] M. Rösch et al., Appl. Phys. Lett. 108, 171104 (2016)
[7] M. Rösch et al., ArXiv 1612.07594 (2017)
[8] D. Bachmann, M. Rösch et al., Optica 3, 10871094 (2016)

The thinner, the better: nanometer-thick efficient spintronic emitters of terahertz radiation

T. Seifert, L. Braun, M. Wolf, T. Kampfrath

Fritz Haber Institute, Berlin, Germany

Terahertz spectroscopy is a powerful tool to probe numerous low-energy excitations. However, there is still a need of broadband, gap-free and efficient sources of terahertz radiation driven by a compact femtosecond oscillator.
To address this issue, we employ laser pulses (duration 10 fs, center wavelength 800 nm, repetition rate 80 MHz, pulse energy 2.5 nJ) from a laser oscillator to launch spin currents in ultrathin magnetic heterostructures. As detailed in Fig. 1, the dynamics of these ultrafast currents are monitored by taking advantage of the inverse spin Hall effect [1] and broadband terahertz emission spectroscopy [2].
In particular, we study THz emission from nanometer-thick multilayers consisting of ferromagnetic and nonmagnetic metallic layers. Our emission data provide a quick and easy estimate of the strength of the spin Hall effect. Importantly, this spintronic route permits the development of new, efficient and scalable emitters of THz electromagnetic pulses that fully cover the range from 1 to 30 THz without gap [3]. This THz source outperforms standard emitters such as zinc telluride in terms of bandwidth while having comparable or even better conversion efficiency.
The results shown here were obtained in close collaborations with the research groups of L.M. Hayden, M. Kläui, Y. Mokrousov, M. Münzenberg, P.M. Oppeneer, I. Radu and D. Turchinovich.

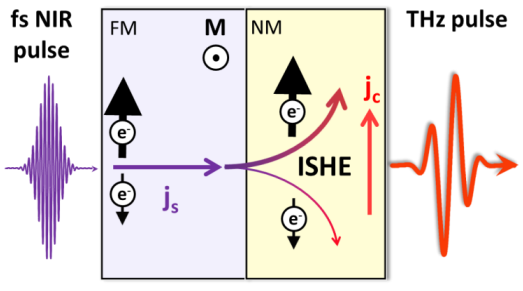


Figure 1. Terahertz emission from a nanometer-thick magnetic heterostructure. The sample, with in-plane magnetization M, is pumped with a femtosecond near-infrared (fs NIR) laser pulse, thereby launching an ultrafast spin current js from the ferromagnetic (FM) to the nonferromagnetic (NM) layer. This spin current is converted into a transverse charge current jc by means of the inverse spin Hall effect (ISHE) in the NM layer. The sub-picosecond transverse charge current jc leads to the emission of a broadband terahertz transient that is detected by electrooptic sampling.

1 S.A. Wolf et al., Science 294.5546, 1488-1495 (2001).
2 T. Kampfrath et al., Nature Nanotechnology 8, 256 (2013).
3 T. Seifert et al., Nature Photonics 10, 483-488 (2016).

THz Isolator Using Nonreciprocal Magnetoplasmonic InAs Mirror

O. Stepanenko[1], T. Horak[1], J. Chochol[2], K.Postava[2], J.-F. Lampin[1], and M. Vanwolleghem[1]

[1]IEMN CNRS, University Lille 1, Villeneuve-dAscq, Franceů; [2]Nanotechnology Center, VSB Technical University of Ostrava, Ostrava Poruba, Czech Republic

Isolation is a highly important passive functionality in optics, which helps to block any destabilizing feedback radiation. Creating an isolator demands breaking Lorentz reciprocity of Maxwell's equations [1], which can be achieved using gyrotropic phenomena. As an example, Faraday rotation is one of the well-known nonreciprocal (NR) magnetooptical (MO) effects, which is commonly used for fabrication of the optical isolators. However, the Faraday rotators at mid-IR and THz ranges have serious drawbacks, such as a high applied magnetic field (~1 Tesla) necessary to achieve a reasonable polarization rotation, propagation losses, and bulky dimensions.
In present work we demonstrate a NR magnetoplasmonic InAs mirror for THz and mid-IR isolation. We use transverse magneto-optical Kerr effect (TMOKE), which is based on the reflection of the p-polarized light from the transversally magnetized surface. Therefore, we avoid the problem with propagation losses through MO material. The low effective mass of free carriers of the InAs ($m^*=0.024m_e$) allows achieving cyclotron frequencies ($\omega_c=eB/m^*$) with reasonable magnetic inductions. In order to enhance the TMOKE efficiency, we use 1D plasmonic gratings on the surface of the NR InAs mirror.
The Comsol calculations of the reflectivity of undoped InAs NR mirror with chemically etched grating (Fig.1a) show the isolation ratio around 20 dB at normal temperature and applied magnetic field of 1 Tesla (Fig.1b). Experimental reflectivity characterizations of NR n-type InAs mirror with plasmonic gratings are ongoing and results will be presented on the conference.

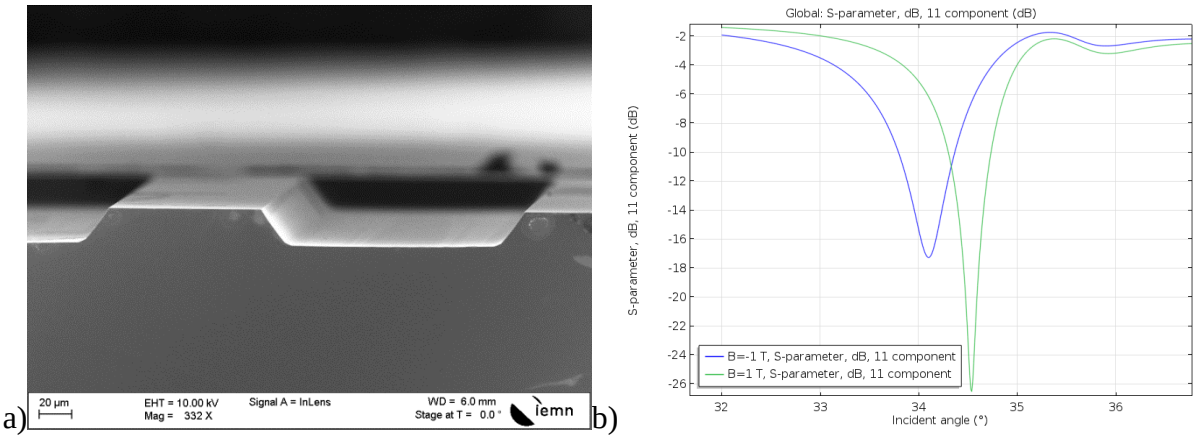


Figure 1. (a) - InAs grating with 250 µm periodand 20 µm depth. The grating was fabricated using H_3PO_4:H_2O_2 etching solution.(b) – Calculated reflectivity at 761 GHz (HCOOH THz laser line) as a function of the incident angle.

[1] D. Jalas et al., Nature Photonics, vol. 7, pp. 579–582, July 2013.
[2] L. Halagačka et al., Op. Ex., vol. 21, pp. 21741-21755, 2013.

Oral presentations(OP):

Mueller matrix ellipsometric study of multilayer spin-lasers structures with local optical anisotropy

Tibor Fördös[1,3], Henri Jaffrès[2], Kamil Postava[3,4], Jaromír Pištora[3], and Henri-Jean Drouhin[1]

[1]Laboratoire des Solides Irradiés, École Polytechnique / Université Paris-Saclay, France; [2]Unité Mixte de Physique CNRS/Thales and Université Paris-Sud, France; [3]Nanotechnology Centre, VŠB-Technical University of Ostrava, Czech Republic; [4]Department of Physics, VŠB-Technical University of Ostrava, Czech Republic

Spin-polarized laser structures such as spin-polarized vertical-cavity surface-emitting lasers (spin-VCSEL) are recently widely studied semiconductor devices in which the radiative recombination of spin-polarized carriers results in emission of circularly polarized photons. Nevertheless, additional anisotropies in the cavity, e.g. interfacial and surface anisotropies generally leads in preferential linearly-polarized laser emission and lead to a coupling between modes. Such anisotropic effects originate from i) reduction from T_d to C_{2v} symmetry group at the III-V semiconductor interface and ii) locally present strains at surfaces and in the quantum wells. We present Mueller matrix ellipsometric study of InGaAs/GaAsP laser structures in the spectral range from 0.73 to 6.4 eV and modeling in order to disentangle surface and QWs contributions to the linear optical birefringence of the structures. The method of measurement and calculation of rotational spectra has been used for extraction of optical permittivity tensors of surface strained layers and quantum wells (QWs). Such spectral dependence of optical constant tensors are crucial for future modelling of spin-laser eigenmodes, resonance conditions, and also for understanding of sources of structure anisotropies.

Enhanced terahertz absorption in graphene composite integrated with double circular metal ring array

Guo-Qiang HE[1], Johan Stiens[1,2]

[1]Department of Electronics and Informatics, Vrije Universiteit Brussel, Brussels, B-1050, Belgium; [2]SSET Department, IMEC, Kapeldreef 75, Leuven, B-3001, Belgium

Graphene-based terahertz devices, such as modulators, detectors, absorbers, occupy important positions in terahertz application due to graphene's effectively tunable terahertz absorption. The features of these terahertz devices are greatly related to graphene's absorption properties of terahertz wave. However, the bare graphene shows limited absorption to terahertz waves. We demonstrate a new graphene composite with a double circular metal ring array deposited on graphene to enhance the absorption. The graphene composite consists of a double circular metal ring array, graphene, silicon dioxide and silicon substrate. The double circular metal ring array locally enhances the electromagnetic field on graphene and further increases graphene's absorption. It shows that the peak absorption of the proposed graphene composite is increased to 78% when graphene chemical potential is 0.5 eV at room temperature, which is 2.7 times larger than that of the graphene composite without the double circular metal ring array. The enhanced terahertz absorption can improve features of graphene-based terahertz devices.

Compact THz nonreciprocal components using hexagonal ferrite ceramics

T. Horák[1,2], G. Ducournau[1], O. Stepanenko[1], K. Postava[2] , J.-F. Lampin[1], and M. Vanwolleghem[1]

[1]Univ. Lille, CNRS, Centrale Lille, ISEN, Univ. Valenciennes, UMR 8520 - IEMN, F-59000 Lille, France;
[2]IT4Innovations, National Supercomputing Center, Department of Physics and Nanotechnology Center, Technical University of Ostrava, Ostrava, Czech Republic

A key element to protect coherent sources and achieve desired power stability and spectral purity for certain applications is an isolator, which in THz range has still no effective solution. Our concept of a novel THz isolating device builds on the recently demonstrated proof-of-principle design based on an oneway reflecting surface for NIR and visible wavelengths. This combines gyrotropy with a surface plasmon resonance [1]. A first crucial requirement to realize this is a sufficiently strong THz gyrotropic material. In the last decade new fabrication and material processing methods have enabled a new type of ferrite material with hexagonal magnetoplumbite structure (e.g. $SrFe_{12}O_{19}$). Gyrotropy in this material is the result of gyromagnetic effects occurring when the saturation magnetization precesses nonreciprocally (NR) at Larmor frequency $\omega_0 = \mu_0 \gamma H_{int}$ around internal magnetic field Hint. As a result the permeability acquires a tensorial form and its unequal off-diagonal elements are responsible for NR behavior. The internal field in hexaferrites is particularly strong (up to 20kOe), resulting in a Larmor frequency in the mm-wave range.
A first important step for the development of the device is complete material characterization of the used hexaferrites. In a first instance the diagonal permittivity and permeability elements have been characterized using both standard Time-Domain Spectrometry (TDS) and time-windowed Vector Network Analyzer (VNA) characterization. In a second step, the off-diagonal tensorial contributions are characterized in a Faraday configuration by measuring the magnetized samples with magnetization coaligned with the beam path. This was done both on the VNA setup and TDS (Fig. 1Left). The obtained strong THz gyrotropy of hexaferrites proves their unique potential for THz isolator applications, as will be shown by first designs of a NR magnetoplasmonic mirror using the fitted material parameters. Our design combines strong gyromagnetic properties of hexaferrites in THz range with surface plasmon resonances formed due to the presence of a metallic grating at the hexaferrite surface. Close to these SPP resonances there can appear frequency ranges where the device acts as a one-way mirror (Fig. 1Center). Figure 1Right shows first fabricated samples with 6 different filling factors of grating for test measurement.

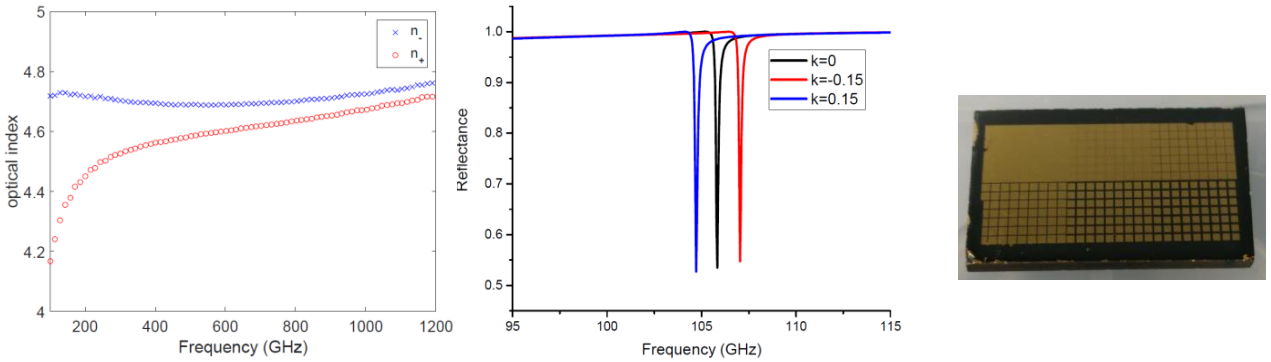


Figure 1. Left: Difference in optical indices of hexaferrite for left and right circularly polarized light measured by TDS proving strong material gyrotropy. Center: simulation results showing a shift of reflection dip according the direction of substrate magnetization (or incidence). Right: Picture of the first fabricated samples for test measurement.

[1] L. Halagačka et al., Opt. Ex., vol. 21, pp. 21741-21755, 2013.

Experimental demonstration and dispersion analysis of a Terahertz SPR sensor based on InSb and InAs

Jan Chochol[1,2], Kamil Postava[3], Michael Čada[2], Jaromír Pištora[1]

[1]VSB-Technical University of Ostrava, Nanotechnology Centre, Ostrava-Poruba, Czech Republic; [2]Dalhousie University, Department of Electrical and Computer Engineering, Halifax, NS, Canada; [3]VSB-Technical University of Ostrava, Department of Physics, Ostrava-Poruba, Czech Republic

We experimentally demonstrate surface plasmon resonance (SPR) in the terahertz range in InSb and InAs. The surface plasmon is excited on the interface between a thin polymer film and the semiconductor using a silicon prism in Otto configuration. The experimental data show good agreement with the model. A dispersion analysis of the sensor is presented for configurations with different sensitivity to different materials. Furthermore, the low effective mass of InSb and InAs permits tuning of the SPR by more than 100 GHz for the field of 0.25T by external magnetic field in the transversal configuration. This behavior is experimentally verified, modeled and analyzed for the enhancement of the sensor's functionality.

Terahertz optical properties measurement using time-domain spectroscopy including Gouy shift compensation

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[1]Department of Physics, Technical University of Ostrava, Ostrava, Czech Republic; [2]Nanotechnology Centre, Technical University of Ostrava, Ostrava, Czech Republic

The paper describes compensation of an influence of the Gouy phase on measurement in terahertz spectral range. Our work demonstrates crucial error of obtained optical parameters of thick plate during transmission measurement by spectrometer. It is related to TPS Spectra 3000 from Teraview company. We demonstrate that the influence of the Gouy phase is huge. We provide method of elimination the influence of the Gouy phase and we have also compared it with numerical method from Ref. [P. Kužel, H. Němec, F. Kadlec, and C. Kadlec, "Gouy shift correction for highly accurate refractive index retrieval in time-domain terahertz spectroscopy," Opt. Express 18, 15338-15348 (2010)].

Analysis of phonon spectra of L-tartaric acid in terahertz and infrared spectral range

Martin Mičica[1,2,3], Dominik Legut[1,2], Mathias Vanwolleghem[3], Kamil Postava[2], Jaromír Pištora[1,2] and Jean-François Lampin[3]

[1]Nanotechnology Centre, VŠB – Technical University of Ostrava; [2]IT4Innovations National Supercomputing Center, VŠB – Technical University of Ostrava; [3]Institut d'Electronique, de Microélectronique et de Nanotechnologie, Lille 1 University

Our study is focused on the experimental and theoretical investigations of the highly anisotropic atomic vibrations of L-tartaric acid $C_4H_6O_6$ (LTA). Single crystals of LTA were prepared from saturated solution by slow evaporation method on high resistivity silicon with thickness lower than 30 μm. THz Time Domain Spectroscopy and Fourier Transform Infrared Spectroscopy for different orientations of the crystals with respect to the beam polarisation in the range of 0.1 - 100 THz (approx. 3 - 3500 cm^{-1}) were performed. Results obtained LTA single crystals show high anisotropy in principal axes compared to LTA powder sample. The ab initio calculations of the atomic vibrations employ the Density Functional Theory [1] using the VASP code [2] to identify the vibrations up to 120 THz. The partial phonon density of the states assign the vibrating frequencies

for C, O, and H atoms. The lattice frequencies at center of the Brillouin zone with possible detection by the IR or Raman spectroscopies were assigned.

[1] P. Hohenberg and W. Kohn, Phys. Rev. 136, B864 (1964).
[2] G. Kresse and J. Furthmueller, Phys. Rev. B 54, 11169 (1996).

Spectroscopy of the quadratic magnetooptic tensor of materials with the cubic structure

Robin Silber[1,2], Ondřej Stejskal[1], Jan Dušek[3], Lukáš Beran[3], Jaromír Pištora[1], Günter Reiss[2], Martin Veis[3], Timo Kuschel[2] and Jaroslav Hamrle[1,3]

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The magnetooptic Kerr effect (MOKE) is a well known and very useful tool in the field of ferromagnetic material characterization [1]. Most of the MOKE techniques rely solely on effects linear in magnetization (M). Nevertheless, there is also its part being even in M, the quadratic MOKE (QMOKE). Handling and understanding the underlying origin of QMOKE could be key to utilize this method for research of antiferromagnetic materials in the future. Here, we present a technique of QMOKE spectroscopy based on the 8-directional method [2] applied on the Fe thin films grown on MgO substrate. From measured QMOKE spectra, further two complex spectra of quadratic magnetooptic (MO) tensor [3] are yielded, using standard Yeh's 4×4 matrix formalism. Those quadratic MO parameters are further discussed and compared with ab-initio calculations.

[1] T. Kuschel et al., J. Phys. D: Appl. Phys. 44, 265003 (2011).
[2] K. Postava et al., J. Appl. Phys. 91, 7293 (2002).
[3] Š. Višňovský, Czech. J. Phys. B 36, 1424 (1986).

Plasmonic nanostructures with waveguiding effect

Jaromír Pištora[1,2], Jaroslav Vlček[3], Petr Otipka[3]

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The mutual interaction of surface plasmon polaritons (SPPs) with an optical guided mode excited in planar waveguide (WG) is discussed. The model study is made for planar layered structure consisting from coupling prism, Au film and high-index interlayer for SPP's generation, air gap, and dielectric waveguide composed from ferromagnetic garnet on SGGG substrate. The dependence of coupling resonances on the gap thickness and the interlayer refractive index is analyzed to obtain optimal field intensity enhancement for future design of plasmonic and magneto-plasmonic sensing elements.

Poster presentations (PP):

Theoretical investigation of light-polarization dynamics in spin-polarized lasers

Mariusz Drong[1,2], Tibor Fördös[1,3], Kamil Postava[1,2], Jaromír Pištora[1]

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Thanks to rapid advancements in the promising field of spintronics it is now possible to construct and investigate devices such as spin-polarized VCSELs. It is possible to control the light-polarization of emitted photons by optimizing spin-polarization of injected electric current. However, they consist of complicated multi-layered generally anisotropic resonant cavities. The novel approach based on Yeh's matrix formalism was developed by T. Fördös to describe light-polarization of spin-polarized VCSELs in steady-state [1, 2]. In order to model dynamical properties of spin-VCSELs we combine optical Bloch equations for 4-level system with transfer-matrix formalism.

[1] Postava, K., Fördös, T., Jaffrès, H., Halagačka, L., Drouhin, H.J., Pištora, J. Modeling of anisotropic grating structureswith active dipole layers Proc. SPIE 9516, 95160O, (2015).
[2] T.Fördös, K. Postava, H.Jaffrès, and J. Pištora, Matrix approach formodeling of spin-polarized light-emitting diodes and lasers, Journal of Optics, 16 (6), 065008 (2014).

New materials for magneto-optics

Radek Ješko[1], Ondřej Stejskal[1], Robin Silber[1,2], Stanislav Cichoň[3], Matúš Mihálik[4], Jaroslav Hamrle[5]

[1]Nanotechnology Centre / VSB-Technical University of Ostrava; Ostrava, Czech; [2]CSMD, Physics Department / Bielefeld University; Bielefeld, Germany, [3]Institute of Physics of the Czech Academy of Sciences; Prague, Czech Republic; [4]Institute of Experimental Physics / Slovak Academy of Sciences; Košice, Slovak Republic; [5]Institute of Physics of Charles University; Prague, Czech Republic

In this study, authors summarize results of optical and magneto-optical measurements on different kind of materials. Mainly bulk $Co_2FeAl_{0.5}Si_{0.5}$ Heusler compound, which shows large Kerr rotation up to 0.5° in spectral range from 1.2 to 6 eV with applied 1.2 T magnetic field. Next samples are Heusler compounds Rh_2MnAl and Rh_2MnBi deposited on MgO, which shows magneto-optic effect, but so far, the samples rough surface structure is not suited for quality optical measurements. Different studied kind of materials are bulk Perovskites $PrMn_{1-x}Fe_xO_3$ and $NdMn_{1-x}FeO_3$. Those have crystalline or polycrystalline structure and should have magnetic ordering, however the magneto-optical measurements acquired zero signal for rotation and ellipticity at room temperature. For $Co_2FeAl_{0.5}Si_{0.5}$ sample, ab-initio calculations were conducted to compare the results. Agreement is quite nice in optical spectra, but comparison of off-diagonal part of permittivity tensor is not so satisfying. At the time of the conference, authors will also present ab-initio comparisons for Rh_2MnAl and Rh_2MnBi.

Modeling of surface plasmons on circular waveguides

Barbora Kacerovská[1], Jan Chochol[1,2]

[1]VSB-Technical University of Ostrava, Nanotechnology Centre, Ostrava-Poruba, Czech Republic; [2]Dalhousie University, Department of Electrical and Computer Engineering, Halifax, NS, Canada

We present numerical analysis of circular plasmonic waveguides with the use of the commercial software COMSOL Multiphysics®. Various types of materials for the waveguide (noble metals and semiconductors) were studied. We focus on the difference between weakly guided modes, which are also known as Zenneck modes, and classic surface plasmon modes. The influence of an external magnetic field on the surface plasmon on the semiconductor circular waveguide is also discussed.

Design of MO-SPR sensor element with photonic crystal

Petr Otipka[1], Jaroslav Vlček[1], Michal Lesňák[2]

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Magneto-plasmonic response in planar multilayer with prism coupling composed from Fe/Au bi-layer supplied by photonic crystal (Ta_2O_5 / SiO_2) is studied. Modeled structure is intended as a sensor unit combining magneto-optical (MO) and surface-plasmon-resonance (SPR) effects. The sensitivity of MO-SPR system by small variations of analyte refractive index is tested to obtain optimal resolution ability. The non-reciprocal MO-SPR response is studied by means of the function $\rho(\phi) = (R_p^{(+)} - R_p^{(-)})/(R_p^{(+)} + R_p^{(-)})$, where the reflectance Rp depends on the incidence angle ϕ and external magnetic field oriantation by a fixed wavelength. The detection ability is characterized by the angular shift $\Delta\phi_0$ between the null-points of the function ρ that corresponds to the change Δn_a of analyte refractive index. Besides the key role of metallic layers thicknesses the number and size of Ta_2O_5/SiO_2 bi-layers of photonic crystal are discussed.

The quadratic magnetooptic tensor of cubic materials without inversion symmetry

Robin Silber[1,2], Jan-Oliver Dreessen[2], Jaromír Pištora[1], Günter Reiss[2], Martin Veis[3], Jaroslav Hamrle[1,3] and Timo Kuschel[2]

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The permittivity tensor of a magnetized crystal could be described by a Taylor series: $\varepsilon_{ij} = \varepsilon_{ij}^{(0)} + \varepsilon_{ij}^{(1)} + \varepsilon_{ij}^{(2)} + \ldots$, where the superscript denotes the order in magnetization (M). The shape of $\varepsilon_{ij}^{(2)}$ is determined by so-called quadratic magnetooptic (MO) tensor G_{ijkl} [1]. This quadratic MO tensor for cubic materials with and without inversion symmetry differ in the parameter $\Delta\Gamma = (G_{12} - G_{21})$ [2], being zero for cubic materials with inversion symmetry as $G_{12} = G_{21}$. The $\Delta\Gamma$ parameter was predicted by symmetry arguments of the structure, but no experimental determination method exists so far. Here, we propose a new measurement procedure of magnetooptic Kerr effect (MOKE), allowing us to separate contribution of $\Delta\Gamma$ to overall MOKE signal.

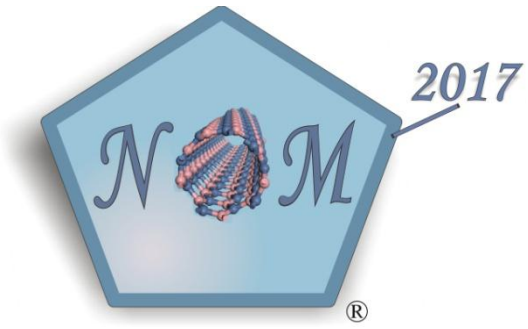
[1] Š. Višňovský, Czech. J. Phys. B 36, 1424 (1986).
[2] J. Hamrlová et al., Phys. Status Solidi B 250, 2194 (2013).

TOPIC 4

Photovoltaic nanomaterials and physical nanoscience

Chair: Martin Foldyna
Co-chair: Kamil Postava

New materials and concepts for solar cells
Nanotechnology for energy generation and storage
Characterization of nanostructures and physical nanoscience



Invited lectures (IL):

What is new in photovoltaics on macro- and micro- scales

Antonín Fejfar, M. Hývl, Z. Hájková, A. Vetushka, M. Ledinský

Laboratory of Nanostructures and Nanomaterials / Institute of Physics, Czech Academy of Sciences, Prague, Czech Republic

The story how photovoltaic cell evolved from a curiosity to an omnipresent device, being produced on truly macroscopic scale (> 75 GWp power capacity per year, with over 300 GWp installed worldwide) contains dramatic moments and fascinating insights. Short review of the most important moments will be presented.
The present photovoltaics is totally dominated by cells based on silicon wafers. Any alternative photovoltaic technology has to challenge both the high efficiency and price levels of the silicon wafers. One such technology might be radial junction solar cells based on silicon nanowires [1]. Their self-organized, optically thick and geometrically thin structure offers advantages with potential to reach high efficiency with very low material consumption. They also offer a challenge of how to measure the conversion efficiency in the individual junctions, each producing power on picowatt level. We apply the tip of the scanning probe microscope as an electrical contact for probing electronic properties of individual junctions [2]. We correlate various microscopic techniques using the fiducial marks prepared by nanoindentation, enabling us to locate the same nanoobjects repeatedly or even before and after technological steps.

[1] Misra et al IEEE Journal of Photovoltaics. 5 (2015) 40–45.
[2] Fejfar et al., Sol. Energy Mat. Sol. Cells 135 (2015) 106–112.

Silicon nanowire solar cells: the state of the art and future prospects

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Nowadays photovoltaic (PV) market is dominated by crystalline silicon wafer based solar cells with a cost-saving reduction of the wafer thickness reported every year. With the constant reduction of the silicon wafer thickness, PV industry is searching for new approaches which can provide at least as good light trapping as random pyramids, but without the removal of substantial amount of the material. Both requirements can be satisfied by radial junction solar cells based on controlled length silicon nanowire (SiNW) arrays. The solar cells presented in this work have been fabricated around crystalline SiNW arrays by two methods: a metal assisted chemical etching (MACE) of crystalline silicon material (top-down) and a plasma-enhanced vapor-liquid-solid (VLS) growth (bottom-up).
Heterojunction with intrinsic thin layer (HIT) on c-Si NW arrays prepared by the top-down approach either by using standard MACE process alone [1] or coupled with nanosphere lithography (NSL) can be used to achieve ordered NW arrays of controlled diameters. Optical properties of NSL grown NW arrays have been studied and optimized using an in-house developed model based on rigorous coupled wave analysis (RCWA) and compared with experimental data. The c-Si NW surface passivation by hydrogenated amorphous Si (a-Si:H) has been optimized to maximize the performance of SiNW HIT devices, which has reached over 12 % efficiency for randomly organized vertical arrays.

Radial junctions provide an attractive solution also for solar cells with ultra-thin absorbers, as they combine advantages of a very good light trapping with an excellent carrier collection. Such high efficiency solar cells can be prepared by plasma-enhanced VLS growth in plasma enhanced chemical vapor deposition (PECVD) reactor using low-melting point metals, thus allowing the fabrication at a low temperature (below 450 °C) during a single pump down process [2]. In this case, PIN structures were formed on p-type randomly oriented crystalline silicon nanowire arrays, with 100 nm thick a-Si:H absorber layer plus a 10 nm thick n-type a-Si:H, microcrystalline Si or their oxides, respectively. Our PIN radial junction solar cells with a-Si:H absorber have reached energy conversion efficiencies over 9 % for 0.126 cm^2 device areas [3].

[1] A.S. Togonal, L. He, P. Roca i Cabarrocas, Rusli, Langmuir 30, 10290 (2014).
[2] S. Misra, L. Yu, W. Chen, M. Foldyna, P. Roca i Cabarrocas, Topical Review, Journal of Physics D: Applied Physics 47, 393001 (2014).
[3] S. Misra, L. Yu, M. Foldyna, P. Roca i Cabarrocas, IEEE Journal of Photovoltaics 5, 40 (2015).

Oral presentations(OP):

In-situ spectroscopic ellipsometry of low-temperature epitaxial silicon growth

Lukas Halagacka[1, 2], Martin Foldyna[1, 2], Ronan Leal[1, 2, 3], Pere Roca i Cabarrocas[1, 2]

[1]IPVF (Institut Photovoltaïque d'Ile-de-France), Antony, France; [2]LPICM, CNRS, Ecole Polytechnique, Université Paris-Saclay, Palaiseau, France; [3]Total SA, Paris La Défense Cedex, France

Low-temperature growth of doped epitaxial silicon layers is a promising way to reduce the cost of p-n junction formation in c-Si solar cells. In this work, we study process of highly doped epitaxial silicon layer growth using in-situ spectroscopic ellipsometry. The film was deposited by plasma-enhanced chemical vapor deposition (PECVD) on crystalline silicon substrate at a substrate temperature of 200 °C. In the deposition process, SiF_4 was used as a precursor, B_2H_6 as doping gas, and a hydrogen/argon mixture as carrier gas. Spectroscopic ellipsometer Woollam M200DI with spectral range from 190 nm to 1700 nm was used for in-situ spectroscopic measurements. Since the temperature during process is 200 °C, the optical functions of silicon differ from these at room temperature and have to be also adjusted. Parameters of the silicon model were fitted on in-situ ellipsometric data together with the thickness of the epitaxial layer. As a result we were able to determine the dynamics of epitaxial layer growth, namely initial layer formation time and epitaxial growth rate. This study opens new perspectives in understanding and monitoring the epitaxial silicon deposition processes as the model fitting can be applied directly during the growth.

Solution processed semiconductor solar cell based on “green” materials

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Nanosize semiconductors have been used as active sensitizers for the application of quantum dot-sensitized solar cells (QDSSC) and perovskite solar cells (PSC). These solar cells have gained momentum in the past few years due to the excellent optical properties of the semiconductor sensitizers and high efficiency of the solar cells. Generally, QDSSC works on the same principle as the dye sensitized solar cell where quantum dot (QD) sensitizers such as semicondutor CdS or CdSe are used instead of the usual inorganic dye sensitizers. To date, QDSSCs have reached a power conversion efficiency of over 11%. On the other hand, PSCs use perovskite structure compounds as the sensitizers where they exhibit good absorption and charge transport. Further progress on the solar cell architecture has yielded a power conversion efficiency of over 20% for solid state PSC. In order to elevate the application of emerging solar cell technologies in the mainstream photovoltaic market, a low-cost, stable and non-toxic material are crucial for the development of solar cell module. Non-toxic QD sensitizers are usually termed as lead-free or cadmium-free materials. In this work, “green” sensitizers are reviewed. Among the “green” materials that have been adopted as sensitizers in QDSSC and PSC included Sn- and Bi-based compounds. Although the performance of “green” QDSSCs such as Ag_2S and Bi_2S_3 QDSSCs are not as high as that of CdS or CdSe based QDSSCs, their performance can be enhanced with post-thermal annealing, carbon doping and the application of passivation layer. The effect of post-thermal annealing and graphene doping will be reviewed in the context of particle size while the role of passivation layer will be discussed.

Keywords: Quantum dot-sensitized solar cell, Ag_2S, Bi_2S_3, post-thermal annealing, passivation layer, graphene.

Tracing the growth of random silicon nanowires for radial junction solar cells using in-situ ellipsometric techniques

Zuzana Mrazkova[1,2], Martin Foldyna[1], Soumyadeep Misra[1], Kamil Postava[2], Mutaz Al-Ghzaiwat[1], Jaromír Pištora[2], and Pere Roca i Cabarrocas[1]

[1]LPICM-CNRS, École Polytechnique, Université Paris-Saclay, 91128 Palaiseau, France; [2]Nanotechnology Centre, VSB-Technical University of Ostrava, 708 33 Ostrava-Poruba, Czech Republic

We have studied samples of randomly oriented silicon nanowires grown by plasma-assisted vapor-liquid-solid method [1]. We have applied Mueller matrix spectroscopic ellipsometry in-situ (with spectral range from 450 to 850 nm) for fast, non-destructive and non-invasive characterization of the material during the deposition in a plasma-enhanced chemical vapor deposition reactor. We have investigated the process from a Sn droplet formation by H_2 plasma treatment all the way through the silicon nanowire growth.

We have designed a multi-layer optical model [2] which reproduces the experimental data very accurately (see Fig. 1). Model structure is based on the analysis of scanning electron microscopy images of random nanowire arrays. Having successive spectra measured during the whole process enables us to evolve the model during later deposition stages. The results show that ellipsometry data is highly sensitive to the material composition and highlight crucial stages of the deposition which have impact on the nanowire growth. The observed linear dependence of the silicon material increase with the deposition time enables us to trace the fabrication process in-situ and to control variable deposition conditions. Our method is suitable for quality control of the vapor-liquid-solid growth of silicon nanowires which is crucial for radial junction solar cells.

[1] S. Misra, L. Yu, M. Foldyna, and P. Roca i Cabarrocas, IEEE Journal of Photovoltaics, 5, 40 (2015).
[2] Z. Mrazkova, M. Foldyna, S. Misra, M. Al-Ghzaiwat, K. Postava, J. Pištora, P. Roca i Cabarrocas, Applied Surface Science (2017), in press, doi: 10.1016/j.apsusc.2016.12.199.

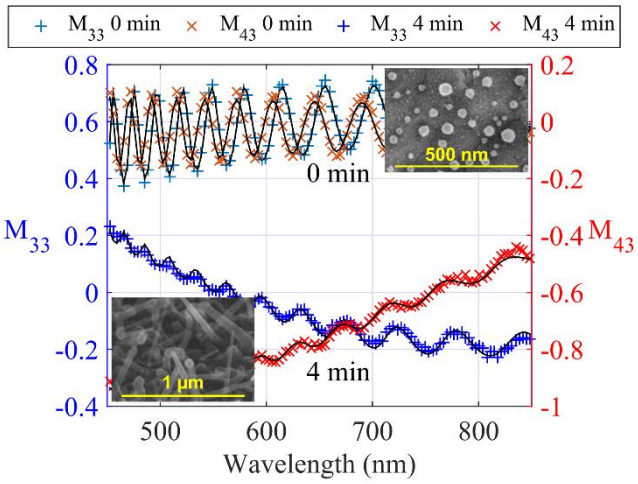


Figure 1. Measured and modeled ellipsometric data taken during the silicon nanowire growth.

Diffraction efficiency of lithographic blazed grating

Kamil Postava[1,3], Libor Kotačka[2], Lukáš Halagačka[1,3], Jan Chochol[3],and Jaromír Pištora[3]

[1]Department of Physics, VŠB – Technical University of Ostrava, Ostrava, Czech Republic; [2]Innovia Security Pty Ltd, Craigieburn, Australia; [3]Nanotechnology Centre, VŠB – Technical University of Ostrava, Ostrava, Czech Republic

In this paper we model realistic blazed gratings used in optical security holograms. The blazing is used to maximize holograms diffraction efficiency and to manipulate with optical phase. We focus on aluminium coated reflection gratings. The Rigorous Coupled Wave Analysis (RCWA) is applied to model diffraction from the gratings and compared with models based on scalar diffraction integral. The blazed grating is modelled in the form of step-like approximations and the grating fuctionality is optimized as a function of the blazed angle, grating period, and number of steps.

Poster presentations (PP):

SEM and XRD studies of nanostructure indium doped ZnO films by MW-CBD

Saliha Ilican[1], Kamuran Gorgun[2], Seval Aksoy[3], Yasemin Caglar[1], Mujdat Caglar[1]

[1]Anadolu University, Department of Physics, Eskisehir, Turkey; [2]Eskisehir Osmangazi University, Department of Chemistry; Eskisehir, Turkey; [3]Sinop University, Department of Physics, Sinop, Turkey

Zinc oxide (ZnO) is widely used in solar cells, gas sensors, photo-detectors due to its wonderful physicochemical properties, cost effectiveness, high transmittance and wide optical band gap. In recent years, synthesis and applications of nanostructured ZnO materials such as nanowires, nanorods and nanotubes have been widely studied due to their optoelectronic properties. Growth modes, structural, morphological, electrical and optical properties can be modified with deposition parameters or doping. Nanostructure ZnO films can be prepared not only by expensive vacuum-requisite methods but also by solution-based methods such as electrochemical deposition, sol gel, microwave assisted chemical bath deposition method (MW-CBD). Among them MW-CBD, known as a rapid synthesis technique, has become an attractive method for the preparation of the films due to several advantages compared to other techniques, low temperature, short deposition time and the use of the interaction of the MW electromagnetic field with the substrate. The MW-CBD method was used to prepare nanostructure indium (In) doped ZnO films onto p-Si substrates. Zinc nitrate hexahydrate and indium nitrate hydrate were the precursor materials and doping source materials. Scanning electron microscopy (SEM) and X-ray diffractometer were used to analyze the microstructures and crystalline structures of these films, respectively.

Acknowledgements: This work was supported by Anadolu University Commission of Scientific Research Projects under Grant No. 1402F055 and 1605F449.

Optical Band Gap Engineering of Electrodeposited MgZnO

Saliha Ilican[1], Seval Aksoy[2], Yasemin Caglar[1], Mujdat Caglar[1]

[1]Anadolu University, Department of Physics; Eskisehir, Turkey; [2]Sinop University, Department of Physics; Sinop, Turkey

Nanostructured metal oxides have been widely studied due to their unique properties and promising applications. Zinc oxide (ZnO), an important II–VI semiconductor with a band gap of 3.3 eV, a large exciton binding energy of 60 meV, high transmittance and electrical conductivity has received extensive attention for its potential applications to photo-detectors, solar cells, field-effect transistors and gas sensors. An important step to extend the applications of ZnO-based optoelectronic materials is the realization of band gap engineering to design device heterostructures with barrier layers and quantum wells. Especially, ZnO can be alloyed with another high optical band gap compound like magnesium oxide (MgO) to increase its band gap. In this study, MgZnO films were prepared by using electrodeposition method onto p-Si substrates. Electrodepositions were carried out in a conventional three electrode cell for the working electrode (p-Si), reference electrode (Ag/AgCl, sat.) and counter electrode (platin wire). The structural, morphological and optical properties of the films were investigated using X-ray diffractometer, field emission scanning electron microscope and UV-Vis spectrophotometer, respectively. The surfaces coated uniformly with nanorods, which is changing diameter, orientation and density, were observed in the FESEM micrographs. On the other hand, the diffuse reflectance spectra of these films were measured and

the optical band gap values were determined using Kubelka-Munk theory. The structural, morphological and optical properties of the resultant MgZnO films were substantially changed as the dependence of Mg content in ZnO. These semiconducting composite oxides with tunable optical properties have potential applications in electronics and optoelectronics.

Spectroscopic ellipsometry of $Cu(tn)Cl_2$ molecular crystal

Daniel Vala[1], Kamil Postava[1], Dominik Legut[1], Urszula D. Wdowik[2], Alžběta Orendáčová[3], R. Tarasenko[3], and Jaromír Pištora[1]

[1]Nanotechnology Centre and IT4Innovations, Technical University of Ostrava, Ostrava, Czech Republic; [2]Institute of Technology, Pedagogical University, Cracow, Poland; [3]Centre of Low Temperature Physics, P. J. Šafárik University, Košice, Slovakia

Two-dimensional (2D) quantum antiferromagnets have attracted a significant amount of theoretical and experimental attention due to the unconventional magnetic properties. Optical properties of the $Cu(tn)Cl_2$ (tn denotes 1,3-diaminopropane - $C_3H_{10}N_2$) single crystal [1] were obtained using spectroscopic ellipsometry in the range from 0.7 to 6.5 eV (wavelength range from 190 nm to 1700 nm). The measurement was obtained from small crystal using focusing optics and sample 360 degree rotation by Mueller matrix spectroscopic ellipsometer. The crystal possesses orthorhombic symmetry. The ab-initio calculations employing the density functional theory [2] were used to obtain the electronic structure. The total and partial density of states were determined as well as the optical gap.

[1] A. Orendáčová, et. al., Phys. Rev. B 80, 144418 (2009).
[2] P. Hohenberg and W. Kohn, Phys. Rev. 136, B864 (1964).

Study of the interaction of light with textured silicon wafers for photovoltaic applications

Michal Vrána[1], Zuzana Mrazkova[1,2], Kamil Postava[1], Martin Foldyna[2], and Jaromír Pištora[1]

[1]Nanotechnology Centre, VSB-Technical University of Ostrava, 708 33 Ostrava-Poruba, Czech Republic; [2]LPICM-CNRS, École Polytechnique, Université Paris-Saclay, 91128 Palaiseau, France

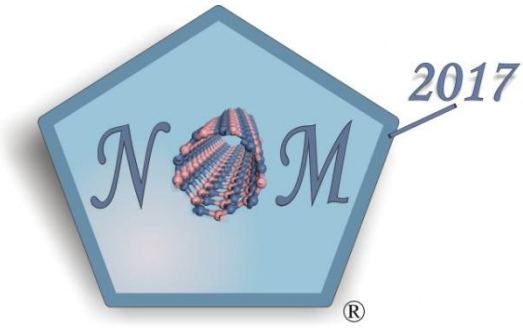
Surface textures are usually used to improve the light-trapping in photovoltaic devices by reducing the surface reflectance. Furthermore, the optical path is increased due to the scattering inside the active material and light absorption is enhanced.
We study the light interaction with pyramidal texture widely used in photovoltaic industry. We use a 2D simplification (roof-like structures) to model the light propagation after its normal incidence on the textured wafer. Our aim is to identify main paths of the light propagation and to assign them weights according to their importance. Fresnel equations and matrix formalism were used to describe the reflectance on pyramid facets with antireflective coatings. Spectral absorbance during the propagation through the bulk silicon is based on Beer-Lambert law.
This work will allow us to identify impact of pyramid texture parameters (such as pyramid height distribution or number of pyramids per unit area) on the optical performance, while identifying minimal amount of material which has to be removed to achieve a good performance.

TOPIC 5

Bionanotechnology – ”green” principles for nano

Chair: Marek Kolenčík
Co-chair: Gabriela Kratošová

Biosynthesis of nanoparticles and their applications
Bio-inspiration for progressive and sustainable nanostructured materials
Biologically inspired nanodevices
Biomineralization – magnetosoms, biosilica, self-assembly structures



Invited lecture (IL):

Structural coloration of Blue butterflies: from sexual signaling to chemically selective sensing

G. Piszter, K. Kertész, Zs. Bálint, and L. P. Biró

Nanostructures Department, Institute of Technical Physics and Materials Science, Centre for Energy Research, Hungarian Academy of Sciences, POB 49, H-1515 Budapest, Hungary

The photonic nanoarchitectures of biological origin, and in particular those occurring in the wing scales of several butterfly species, are more and more in the focus of attention both as sources of bioinspiration and as cheaply produced sensor material for chemically selective vapor sensors. These photonic nanoarchitectures are nanocomposites of chitin and air, with structural elements typically 100 nm size. Beyond the normal biologic variability, generally found in any characteristics of living beings, the structure and color of these nanoarchitectures are remarkably constant in time over a tested period of 100 years. This is the consequence of role of sexual signaling color played by the blue coloration of the dorsal wings of the males. We investigated nine closely related Lycaenid butterfly species living in the same type of habitat and we found that their coloration and the nanoarchitectures generating the color are species specific.

Due to the air filled nanovoids, these structures are well suited for the substance selective detection of the vapors of different volatiles. The capillary condensation of the volatile vapors into the nanovoids of the photonic nanoarchitecture produces the shift of the refractive index contrast between the constituent elements of the structure and by this the spectral shift of the structural color.

Oral presentations(OP):

Catalytic decomposition of p-NP by bionanogold anchored on waste diatomaceous earth

Veronika Holišová[1], Zuzana Konvičková[1], Gabriela Kratošová[1], Marek Kolenčík[2], Teppei Niide[3], Ivo Šafařík[4], Mitsuo Umetsu[3], Daniela Plachá[1]

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This research is focused on the green synthesis of gold nanoparticles (AuNPs) using waste diatomaceous earth (WDE). Recently, in the green biosynthesis of metal nanoparticles bio-waste materials are preferred increasingly than some other biomasses (algae, bacteria, plant extracts, etc.), which may be difficult to obtain. In the pilot experiment we verified bio-reduction potential of WDE for formation, stabilization and anchoring of AuNPs on the WDE surface. WDE from the beer filtration contains different biomolecules and metabolites originating from beer processing, e.g. yeasts, diatom silica debris, etc. possibly responsible for the bio-reduction of Au ions and stabilization of AuNPs. After the biosynthesis, the biosilica-nanogold composite was obtained and modified by ferrofluid (FF). Un-modified and magnetically modified bionanocomposites were characterized by scanning electron microscopy, X-ray diffraction analysis, transmission electron microscopy, Brunauer-Emmett-Teller and vibrating sample magnetometer. Composites were then tested in the catalytic reduction of 4-nitrophenol (p-NP) and UV-Vis spectroscopy was employed to observe reaction kinetic. The catalytic activity of biosilica-nanogold composite was successfully confirmed. The combined composite with AuNPs and FF showed the most effective decomposition of p-NP during 10 minutes. Combination of metals may have synergistic effect in catalysis and show effective decomposition of organic pollutants in environmental engineering.

Diatom bionanocomposites: interfacial phenomena and their antibacterial activity

Zuzana Konvičková[1], Adam Schröfel[2], Marek Kolenčík[3], Kateřina Dědková[1,4], Pavlína Peikertová[1,5], Martin Žídek[6], Jana Seidlerová[1] and Gabriela Kratošová[1]

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The mesoporous biosilica with unique 3D hierarchy in/organic functional groups is attractive material in terms of interfacial phenomena. *Diadesmis gallica* biosilica surface acts as a bio-template for AgCl and Au nanoparticle (NP) *in vitro* biosynthesis. Moreover it exhibits antibacterial action human pathogenic bacteria in temporal time-dose-dependency.
TEM and XRD describes a biosilica “local sphere” which affects formation, stabilization and encapsulation of Au (9-27 nm) and AgCl (3-51 nm) NPs in one simple step. FTIR analysis reveals various functional groups, including Si-OH and polyamides. Both composites have analogical spherical-shape with determined aggregation, ICP-AES analysis determined more effective 5.29 wt. % Au NPs formation than 1 wt.% AgCl NPs. MIC analysis confirms that bionanocomposite with AgCl by concentration 0.014 mg/mL has the most effective antibacterial system for gram-positive

and gram-negative bacteria strains. Although dual effect of Au/AgCl NP bionanocomposite has almost analogical influence on gram-positive bacteria.
The fundamental antimicrobial experiments as well as other advantageous material properties have shown a promising potential in many medicinal applications such as water purification (disinfection) systems, purification membranes, and antimicrobial coatings.

Biosynthesis of inorganic nanoparticles: state-of-the-art and future perspectives

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Employment of living organisms/biomass in nanomaterials synthesis is relatively recent phenomenon. Bacteria, fungi, yeasts, algae, plant extracts and even nutritional bio-products and waste biomass were tested in biotechnological approaches to reduce and stabilize inorganic nanoparticles. These biotechnological protocols designated as biosynthesis of nanoparticles are nowadays equivalent partner to chemical synthesis, however regarded as "eco" and meeting conditions of green chemistry. Nanoparticles gained by these methods are usually referred as bionanoparticles. Although chemical and physical methods are dominating the synthesis of nanoparticles, biosynthesis has gained its stable position in nanotechnology today. Physicochemical characteristics of bionanoparticles may be dependent on factors such as pH, concentration, type and growth phase of biomass, type of metal precursor and concentration, temperature, reaction time, irradiation, stirring, etc., which leaves a plenty of room for an optimization. The long-term goal is to design and apply green, inexpensive and sustainable protocols of functional nanoparticles and nanocomposites processing. Although bionanoparticles of different chemical compositions and shapes have already been prepared, studies of their real applications mostly in catalysis or disinfection have appeared in last years. In the future, it will be extremely important to understand and explain precisely mechanisms of biosynthetic methods that, as nature itself, are very diverse.

Humic Acid Coated Zinc Oxide Nanoparticles – Improvement of Aqueous Stability and Solubility Properties

Martin Šebesta[1,4], Martin Urík[1,4], Marek Bujdoš[1,4], Marek Kolenčík[2,4], Ivo Vávra[3], Edmund Dobročka[3], Gabriela Kratošová[5], Peter Matúš[1,4]

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Natural chemical compounds that are already present in the soils present an excellent environmentally friendly option for nanoparticle coating. Humic acid-nanoparticle interactions are well studied and humic acids are a fitting choice for creation of environmentally benign nanoagrochemicals. Humic acid coated zinc oxide nanoparticles have a potential to be an effective nanofertilizer for zinc deficient soils. To test the difference in solubility and aqueous stability of nanoparticles, zinc oxide nanoparticles were created by sol-gel synthesis with (HA-ZnO-NP) and without (p-ZnO-NP) humic acid coating. Both HA-ZnO-NP and p-ZnO-NP are nanocrystals of mineral zincite with wurtzite hexagonal crystal structure. p-ZnO-NP in transmission electron microscope images display triangular and oval shapes with size of oval crystals below 100 nm and

size of triangular crystals between 100 and 250 nm. HA-ZnO-NP primarily exhibit triangular shape with size around 75 nm. HA-ZnO-NP dissolve comparably less than p-ZnO-NP in distilled water and are more stable in the suspension. These results are the first step towards validation of HA-ZnO-NP potential to be used as micronutrient nanofertilizers.

Acknowledgements: The work was supported by VEGA 1/0203/14 and 1/0836/15, by Grant UK/84/2017 and UK/85/2017 and by SSS, member of the Association of Slovak Scientific and Technological Societies with following logo:



Poster presentations (PP):

The stability of Au and mixed Au/ZrO_2 nanoparticles prepared using a simple extract of a horsetail

Veronika Holišová[1], Zuzana Konvičková[1], Gabriela Kratošová[1], Marek Kolenčík[2], Teppei Niide[3], Mitsuo Umetsu[3], Daniela Plachá[1]

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Due to easy availability, handling and non-toxicity, horsetail extract was chosen as a reducing and stabilizing agent for Au and Au/ZrO_2 nanoparticles (NPs) phytosynthesis. This process can be considered as "green chemistry" approach because no additional synthetic or toxic compounds are used as reducing agents and no further stabilizers are necessary. The main goal of this study is 35-day monitoring of stability of gold (AuNPs) and mixed gold-zirconium oxide nanoparticles (Au/ZrO_2NPs) synthesized using extract of *Equisetum arvense*. These NPs have a promising potential in catalysis.
Shapes, size and crystallinity of biotechnologically prepared NPs were characterized using scanning transmission electron microcopy. Absorption spectrum of bioNPs was observed using UV-Vis spectroscopy in long term multiple measurements. Hydrodynamic diameters and zeta potential of Au and Au/ZrO_2 NPs were also controlled at the same time interval.
Initial tests have shown satisfactory stability of both crystalline nanogold (in the range of -13.4 to -17 mV) and mixed Au/ZrO_2NPs (in the range of -14.1 to -17.5 mV) during 35 days. Average NPs sizes were 24 nm for AuNPs and 40 nm for Au/ZrO_2NPs. Long-term stability of solutions containing non-aggregating functional NPs is an important characteristic with regard to potential applications e.g. in catalytic degradation of pollutants.

Biosynthesis of gold nanoparticles mediated with flowers pollen and biosilica using green chemistry principles

Marek Kolenčík[1],Martin Šebesta[2,3], Martin Urík[2,3], Ivo Vávra[4], Gabriela Kratošová[5], Peter Štrba[6], Nora Poláková[1], Vladimír Šimanský[1]

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The aim of this work is using the flowers pollen suspension with or without diatomacea and gold precursor to form gold nanoparticles (AuNPs) via green chemistry protocol. Recently, nanoparticle protocol synthesis applied by physical and chemical methods usually takes many disadvantages and energetic, economic, and global negative impact. In the contrary using biological entities (biological synthesis inorganic nanoparticles) underline quick, effective, economical point of view which indeed deeply highlighted green chemistry principles. In our results Transmission and Secondary electron microscopy (TEM and SEM) and along with UV-vis spectra reveal the formation of colloidal AuNPs associated with flowers pollen and biosilica. For both experiments have almost analogical particle size distribution, and spherical morphology, colloidal stability and dispersity. The most probability functionalized flowers pollen and biosilica surface (volume-to-ratio surface

area) associated with Si-OH, siloxane groups, pollen biomolecules, and etc. play a key role for initialization of nucleation, and stabilization of AuNPs. Using biological protocol, simple designed in vitro experiment, static cultivation, and atmospheric condition (temperature and pressure) support interdisciplinary field of expertise such as colloidal, interfacial, and material chemistry, diatom nanotechnology and bionanotechnology research.

Acknowledgements: The work was supported by grants No. VEGA 1/0203/14, VEGA 1/0164/17, KEGA 014SPU-4/2016 and SSS, member of the Association of Slovak Scientific and Technological Societies with following logo:

Modelling of transport of engineered nanoparticles of gold through agricultural soil

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Gold nanoparticles are employed in many new fields including bioimaging, biodetectors, tumor detection, gene therapy, etc., and new uses are still discovered. In soil science, gold nanoparticles (Au-NP) can be used as an easy to measure model engineered nanoparticles, that can help us to understand the processes that govern the transport of engineered nanoparticles through soils. Thus, transport of engineered Au-NP through columns packed with sandy loam agricultural soil was tested with UV-vis spectrophotometry. Modelling program MNMs 2015 was used and model accounting for two active attachment/detachment sites was found to best simulate the breakthroughs, with processes of linear attachment and detachment, and blocking governing the transport of Au-NP through the soil. Au-NP strongly attach to the soil with only part of them being slowly released from the soil column. UV-vis spectrophotometry can be used only for high concentration of applied Au as there is a high background of natural colloidal particles and the release of Au-NPs is limited.

Acknowledgements: Part of this work was supported by the COST Action ES1205 “ENTER - The transfer of engineered nanomaterials from wastewater treatment & stormwater to rivers“.

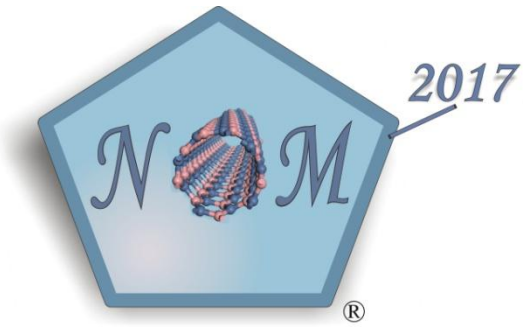
The work was supported by VEGA 1/0203/14 and 1/0836/15, by Grant UK/84/2017 and by SSS, member of the Association of Slovak Scientific and Technological Societies with following logo:

TOPIC 6

Nanotechnologies for medicine

Chair: Josef Jampílek
Co-chair: Daniela Plachá

Nanomaterials for drug delivery
Biocompatible nanomaterials
Pharmaceutical nanotechnology
Interaction of nanoparticles and living systems



Invited lecture (IL):

Antibody-targeted delivery of nanoparticles utilizing bispecific antibodies for applications in oncology

Stephen M Mahler

Australian Research Council Centre for Biopharmaceutical Innovation, Australian Institute for Bioengineering and Nanotechnology, University of Queensland, Brisbane, Australia

Incorporating drugs such as small molecules, siRNA and proteins into nanoparticles seeks to achieve greater therapeutic efficacy and reduced systemic toxicity. However, despite extensive research into nanomedicine, there are a limited number of passively-targeted products approved for use including liposomal nanoparticles Myocet, Doxil, Daunoxome and Depocyt, Abraxane (albumin-based nanoparticle) and Genexol-PM (micelle).

There are a number of barriers to successful nanoparticle-mediated drug delivery, including the reticular endothelial system, efficient extravasation, crossing the anatomical and physical barriers between endothelial and tumour cells, penetrating the tumour structure, endocytosis uptake and intracellular release of therapeutic agents[1]. Active targeting of nanoparticles using antibodies or peptides can improve nanoparticle delivery by enhancing uptake into targeted tumour cells[1]. While targeting has little or no impact on systemic delivery challenges, actively-targeted nanoparticles offer the advantage of having increased tumour cell uptake through receptor-mediated endocytosis and, compared to passively-targeted nanoparticles.

We are investigating a range of different strategies to empower nanoparticles with targeting antibody fragments that are highly specific to tumour cell receptor targets such as epidermal growth factor receptor (EGFR) and other tumour-associated targets[2]. The targeting of nanoparticles through the use of bispecific antibodies is described[3,4].

1. Goodall, Stephen, Jones, Martina L. and Mahler, Stephen (2014) Monoclonal antibody-targeted polymeric nanoparticles for cancer therapy - future prospects. Journal of Chemical Technology and Biotechnology, 90: 1169-1176. doi:10.1002/jctb.4555.

2. Jones ML, Alfaleh MA, Kumble S, Zhang S, Osborne GW, Yeh M, Arora N, Hou JJC, Howard CB, Chin DY and Mahler SM (2016) Targeting membrane proteins for antibody discovery using phage display. Scientific Reports, DOI: 10.1038/srep26240.

3. Taylor K, Howard CB, Jones ML, Sedliarou I, Munro TP and Mahler SM. (2015) Engineering bispecific antibodies – design impacts on stability and function. mAbs. 7, 53-65.

4. Howard CB, Fletcher N, Houston Z, Fuchs AV, Boase NRB, Simpson JD, Ruder T, Jones ML, de Bakker CJ, Mahler SM and Thurecht KJ (2016) Overcoming instability of antibody-nanomaterial conjugates: Next generation targeted nanomedicines using bispecific antibodies. Advanced Healthcare Materials.DOI:10.1002/adhm.201600263.

Oral presentations(OP):

Ecotoxicity of nanomaterials to soil organisms – ecotoxicity testing in agar-based media

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Composition of the exposure media and the spiking procedure always affects the behavior of nanomaterials in exposure media. Especially agglomeration and aggregation significantly affect resulting ecotoxicity. Therefore, our effort was focused on development of testing procedure employing such media, which should supposedly suppress the rate of agglomeration and ensure homogeneous distribution of tested nanoparticles in the entire medium volume. Therefore, we decided to replace soil for an agar. Among other advantage of using agar as an exposure medium belongs the possibility of secondary characterization of nanomaterials contrary to soil environment. In pilot experiments ecotoxicity of zinc oxide nanoparticles to the soil annelid *Enchytraeus crypticus* and to the freshwater oligochaete *Lumbriculus varieagatus* was tested. In agar medium, we observed higher toxicity compared to soil due to the absence of soil components, which can affect the bioavailability of nanomaterials and their ecotoxicity. In an attempt to mimic the conditions to which nanomaterials are exposed after application into the soil, in subsequent experiments further soil components were added to the agar, namely humic acids and kaolin, both individually and in mixtures.

Nanoparticles and other nanoforms for drug targeting to CNS

Josef Jampílek

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Based on various statistics, psychiatric diseases have become more frequent in the population, and especially disorders such as depressions, anxieties and different types of schizophrenia occur with increasing frequency in younger age. It can be stated that these brain disorders represent an enormous disease burden in terms of human suffering and economic costs. Thus, new/innovative neurological and psychiatric drugs without various side effects are needed. These drugs have to circumvent the blood-brain barrier and allow active central nervous system (CNS) drugs to reach their target. An application of nanoparticles (NPs) as drug carriers can be considered as one of the possible strategies of direct drug delivery to the CNS. The applications of nanomaterials as drug carriers have a number of advantages, especially the increased bioavailability and thus better therapeutic efficiency of medicaments as well as decreased toxicity, and thus not only modern drugs but also relatively old drugs have been reformulated into nano-based drug delivery systems, which are supposed to serve a revolution in the treatment of CNS diseases. This contribution is focused on the effects and CNS targeting of nanoscale formulations containing drugs such as antipsychotics, anxiolytics and antidepressants.

Keywords: Blood–brain barrier, Nanoformulations, Central nervous system, Targeted delivery, Antipsychotics, Anxiolytics, Antidepressants

Acknowledgements: This study was supported by the Slovak Research and Development Agency, Grant No. APVV-0516-12.

Thermally triggered drug release via thermosensitive nanoparticles

Witold Musiał

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The efficacy and safety of therapeutic approach using various pharmacologically active substances relies on several factors evaluated in specific branch of pharmacology – namely in pharmacokinetics. Pharmacokinetics uses i.a.: maximal drug concentration in central compartment, onset time of the maximal concentration, biological half-time, and some others, which finally describe the bioavailability of the drug. The fate of the drug, in the terms of pharmacokinetical factors may be modified via attachment to some carriers. Consequently the drug activity may be prolonged, retarded or targeted to a specific organ, increasing the efficacy and safety of pharmacotherapy. Classical release experiments, performed in pharmacopoeial and non-pharmacopoeial conditions, enable reflection of dissolution processes of the drugs present in living organisms, and thus are preliminary for further experiments dealing with the development of the drug form.
Interesting potential drug carriers are obtained on the basis of thermosensitive polymers. One of extensively studied polymer is *N*-isopropylacrylamide, which is used in various co-polymerization processes. The resulting co-polymers, due to the characteristic volume phase transition temperature, may act as thermosensitive drug carriers. The contemporary studies include evaluation of release kinetics of drugs from numerous pharmacological groups including: antibacterial agents, cardiovascular agents, anticancer agents, local anesthetics, steroidal and non-steroidal antiinflammatory drugs. The new thermosensitive polymers, and respective methods for drug release from the polymeric matrices are still developed, however the verification of the data in animal and human objects, as well as in vivo – in vitro correlations always is performed via extensive biological studies.

Development of water soluble curcumin grafted magnetic nanoparticles for its enhancing bioavailability, fluorescence, and magnetic resonance imaging activity

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Cancer is the most leading cause of death throughout the world due to the mortality and effective chemotherapeutic alternatives. Chemo-fluorescent drug curcumin is safety and effective anti-cancer agent, its lacks in bioavailability due to its poor solubility in water. Herein, we develop a novel formulation, magneto-fluorescent, and effective chemotherapeutic curcumin grafted with magnetic nanoparticles (CUR@MNPs) were synthesized by a pestling method and to improve its solubility, bioavailability and anticancer activity. CUR@MNPs was further characterized by fluorescence spectra, infrared (IR), ultraviolet-visible (UV) spectra, x-ray diffraction (XRD), scanning electron microscopy (SEM), transmission electron microscope (TEM), vibrating sample magnetometer (VSM) and MR Phantom imaging for NPs contrast enhancement. The results showed well grafted curcumin with spherical iron oxide particles with an average size of 30−50 nm and magnetic behavior for MR imaging. Cytotoxicity potential and Cellular uptake of Cur@MNPs were assessed by MTT assay, flow cytometry, Prussian blue staining (for iron detection), MR Phantom imaging and fluorescence microscopy, respectively, using A549 lung adenocarcinoma cells. Conclusion: CUR@MNPs exhibits potent anticancer activity along with imaging and magnetic targeting

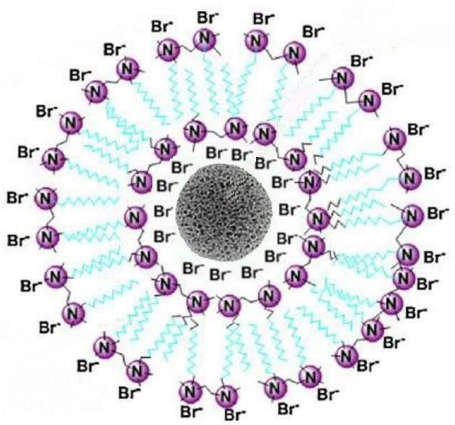
capabilities. With this background, we can functionalize with targeted molecules and they will serve as a novel platform for multiple biomedical application.

Silver nanoparticles stabilized by bisaminium gemini surfactants

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Silver nanoparticles continue to attract attention of researchers and various industry branches. From the point of view of pharmaceutical applications, they represent a new generation of agents with a potent biological effect. Their antimicrobial, antivirotic and fungistatic effect, even against multi-resistant pathogens, has been confirmed. The main problems related to silver nanoparticles are the low application concentration and poor particle stability in aqueous solutions over longer period of time which results in the limitation of their potential applications. A promising solution to this issue turned out to be a stabilisation of silver nanoparticles by cationic bisaminium gemini surfactants. Bisaminium gemini molecules are composed of two hydrophilic aminium headgroups, two alkyl tails and a polymethylene chain called spacer which interconnects the tail parts at the level of the headgroups. The superior physical and aggregation properties of gemini surfactants have been thoroughly studied and investigated over past decades. As the results indicate, cationic bisaminium gemini surfactants *N,N'*-bis(dodecane-1-yl)-*N,N,N',N'*-tetramethylalcane-alpha,omega-diyl-alpha,omega-diaminium dibromides with the polymethylene spacer length ranging from 2 to 12 CH_2 groups show a significant stabilising effect on silver nanoparticles. A possible arrangement of bisaminium gemini molecules on the surface of a silver nanoparticle is shown in the following scheme.



Gemini surfactant counterions (bromides) are adsorbed to the silver nanoparticle surface. Ion pairing of Br^- counterions and surface-active gemini dications provides an attractive electrostatic interaction between them which results in the formation of the first, inner layer of gemini molecules around the nanoparticle. Water-repelling character of hydrocarbon gemini chains avoids contact with aqueous environment and a second, outer layer of gemini molecules is formed. As a result, silver nanoparticles are surrounded by an organic bilayer composed of gemini molecules. As the measurements of particle size, zeta potential and scanning electron micrographs indicate, these structures show a stable particle size and have a high positive zeta potential value on the particle surface. This provides superior stability of silver colloids at high concentrations, without phase separation even experiencing a long term of storage. Moreover, biological activity tests proved

outstanding antimicrobial activity of gemini-coated silver nanoparticles against various strains which exceeded that of pure solutions of bisaminium gemini surfactants.

Keywords: Silver nanoparticle, Gemini surfactant, Micelle, Hydrodynamic diameter, Polymethylene spacer, Precipitation

Acknowledgements: This study was supported by the research grant of the Slovak Grant Agency VEGA 1/0298/16 and by the Slovak Research and Development Agency grant APVV-0516-12.

Preparation of submicron particles of ibuprofen using supercritical fluid

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Most of drugs are only slightly soluble in the circulatory system of the human body. This fact decreases the efficiency of their utilization, thus new ways how to increase a drugs' solubility are investigated. One way is to reduce their particle size. Conventional techniques such as crushing or grinding usually do not guarantee a narrow particle size distribution, which is required in pharmaceuticals. Application of supercritical fluids, especially of supercritical CO_2 ($scCO_2$) is very convenient method for the preparation of submicron particles or nanoparticles of pharmaceuticals. The method enables the preparation of particles in a narrow size distribution and at the same time they do not leave any unwanted residues of solvents or other chemicals. The aim of this work is the micronization of ibuprofen particles using the supercritical fluid and their characterization. The micronization of the particles was done with using of commercially available device Spe-ed SFE-4, characterization of prepared particles were performed by methods of XRD, FTIR, PSD, SEM and solubility tests. Preparation temperature and pressures were 35 and 40°C and 200, 250 and 300 bars. Mean particles size was decreased from 196 μm to 3.5-7.5 μm. The mixture of polymorphic particles were prepared and determined by the XRD and FTIR methods. The solubility test confirmed the better solubility of the prepared particles despite the submicron size of particles was not reached.

Keywords: supercritical fluid, particle size distribution, ibuprofen, micronization, supercritical CO_2

Acknowledgements: This work was funded by the MSMT project SP2017/78 and the European Regional Development Fund in the IT4Innovations Centre of Excellence (CZ.1.05/1.1.00/02.0070)

Influence of nano-ZnO exposition to plants on L-ascorbic acid levels: nanoparticle induced oxidative stress

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With the continuously growing production of nanomaterials, their presence in the environment increases. The effects of nanoparticle exposure on plants are yet not fully understood. This study aimed to provide new insights into the stress induced by the exposure of plants to nanoparticles via the determination of the content of L-ascorbic acid, known antioxidant, in the thalli of the bryophyte species *Pleurozium schreberi* (Brid.) Mitt. Bryophyte samples, collected from pristine

environment, were exposed to 0.1 $g.L^{-1}$ suspensions of nano-ZnO for five weeks. Prior to the exposure, the samples were subjected to the combination of treatments – washing or not washing as well as drying or irrigation. In order to assess the level of oxidative stress caused by the exposure to the ZnO nanoparticles under various pre-treatment conditions, the content of the L-ascorbic acid in the samples was determined by titration with dichlorophenolindophenol. Effect of both nano-ZnO exposure and pre-treatment was observed; nano-ZnO exposure significantly reduced the content of L-ascorbic acid in the bryophyte samples indicating it being consumed in the repair processes following the exposure-related physiological stress.

Poster presentations (PP):

Detection of micron and submicron particles in human bronchogenic carcinomas

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Metal based particles were detected in pulmonary tumor tissue samples and reference lung tissue samples (lung tissue without carcinoma) by Raman microspectroscopy and scanning electron microscopy. Many of these particles were in the size below 1 μm. Using scanning electron microscopy, particles based on iron were found in the majority of samples. Siderite was determined as the form of the iron in several samples by Raman microspectroscopy. The hypothesis that significant statistical dependence exists between the presence of metals in the lung tissue and lung cancer incidence was not proved. However, statistical dependence between smokers and the lung cancer incidence was determined as well as insignificant correlation between the presence of titanium based particles and lung cancer incidence. Titanium-based compounds were identified as TiO2 in the form of anatase and rutile. Both the reference and the carcinoma samples exhibited magnetic properties as confirmed by vibration magnetometry measurements.

Influence of hydrophilic co-monomer on the drug release from thermosensitive NIPA derivatives

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To improve therapy, especially with short acting drugs, various sustained release formulations are investigated. A promising group of this kind of drug delivery systems are the “intelligent polymers”, which release the active compound in response to external stimuli. Poly *N*-(isopropyl)acrylamide (PNIPAAm) is characterized by volume phase transition temperature ca. 32°C, and is presumed as an interesting releasing factor for polymeric matrices applied for controlled drug delivery. The purpose of the experiment was to synthesize PNIPAAm derivatives and evaluate theirs usability and physicochemical properties for topical drug delivery systems. Six different preparations were obtained via surfactant free precipitation polymerization. The influence of the cross-linking agents, hydrophilic segments and two different initiators on physiochemical properties of obtained polymers were investigated. The preparations obtained with 2,2'-azobis-(2-methylpropionamidine), and with polyethylene glycol dimethacrylate as a crosslinker presented the lowest drug release level, ca. 2,4% in 37°C. The preparation with methylene-bis-acrylamide as a crosslinker released higher amounts than aforementioned material and the formulation with hydrophilic segments of N-hydroxyethyl acrylamide presented the highest drug release.

Variability of properties of thermosensitive nanoparticles synthesized for controlled drug delivery

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The aim of the work was to synthesize, analyze and characterize thermally sensitive polymers (NB, NBP, NBT) and evaluate the influence of cationic initiator 2,2'-Azobis[2-methylpropionamidine] dihydrochloride (AMP) on the physicochemical properties of co-polymers of N-isopropylacrylamide (NIPA) nanospheres. The synthesis was performed using surfactant free precipitation polymerization (SFPP) at 70 °C. *N,N'*-methylenebisacrylamide (MBA) was used as crosslinker. Hydrodynamic diameter (HD), zeta potential (ZP) and polydispersity index (PDI) were measured in aqueous dispersions of the synthesized polymers by dynamic light scattering (DLS) method in temperature range 18°C - 42°C. Measured values of HD and PZ at 18°C were found to be for NB: 720 nm and 20 mV, for NBP: 970 nm and 17mV, for NBT: 160 nm and -0.1 mV, respectively The volume phase transition temperatures (VPTT) was found between 22 and 41 °C. PDI values for NB and NBP were around 0.2 in measurement temperature range and for NBT below VPTT polydispersity index was about 0.7 and over VPTT about 0.4. The composition and morphology of the synthesized co-polymeric nanospheres were confirmed by IR, NMR and SEM. The investigations allow to confirm the high potential of synthesized NB, NBP, NBT polymers as thermosensitive drug carriers.

Ecotoxicity of nanomaterials to soil organisms – optimization of agar-based exposure media composition

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It has long been known that results of toxicity studies tend to be significantly affected by the behavior of nanomaterials in exposure media. Therefore, effort of our work was focused on development of testing procedure applicable in common laboratory practice providing data, which are not distorted due to this phenomena. Use of agar instead of soil provides an advantage, especially when it comes to analysis/characterization of nanoparticle in the exposure media, reducing agglomeration and exclusion interactions with soil constituents in order to focus on the impact of nanoparticles. In our study we tested ecotoxicity of zinc oxide nanoparticles (mean particle size diameter 10 nm) to the annelid *Enchytraeus crypticus* in pure and modified agar. We used and compare four different environments and studied the influence of the components to the properties and ecotoxicity of nanoparticles. The results clearly showed that the soil constituents in modified agar, namely kaolin a humic acids or their mixture, influenced the behavior and resulting ecotoxicity of nanoparticles.

Potential carriers of drugs – derivatives of graphene oxide

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Functionalized chemically novel graphene oxide (GO) can be used as drug carriers. Modifications of graphene oxide can be performed in two ways, namely covalent and noncovalent. In the case of covalent functionalization, GO surface is modified by the formation of chemical bonding, while in the noncovalent mode, by van der Waals forces, hydrogen bonding and π–π stacking interactions [1,2]. It is noteworthy that covalent modification seems to be more useful, since modifications prepared by a noncovalent method are more unstable. Covalent modification allows obtaining compounds of desired properties, which are more stable and can be used many times. Synthesis of GO-IDA and GO-Gly is based on the nucleophilic substitution of iminodiacetic acid (IDA) or glycine (Gly) to graphene oxide nanoparticles. In the first step, IDA or Gly was transformed into IDA or Gly methyl ester hydrochloride in order to protect the C-terminal of the amino acid [3]. The obtained product, activated in situ, was used for the formation of amido binding between IDA or Gly and GO.

Keywords: Graphene Oxide, Nanoparticles, Drug Carriers, Iminodiacetic Acid, Glycine

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[1] Georgakilas V., Otyepka M., Bourlinos A.B., Chandra V., Kim N., Kemp K.C., Hobza P., Zboril R., Kim K.S., *Chem. Rev*. **2012**, 112, 6156.
[2] Rao C.N.R., Sood A.K., Subrahmanyam K.S., Govindaraj A., *Angew. Chem., Int. Ed*. **2009**, 48, 7752.
[3] Pytlakowska K., Kozik V., Matussek,M., Pilch M., Hachuła B., Kocot K., *RSC Adv*. **2016**, 6, 42836.

Computational design, preparation, characterization, *in vivo* and *in vitro* studies of Phe-Tyr dipeptide loaded PLGA nanoparticles for the treatment of hypertension

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Phe-Tyr dipeptide which was investigated in Wakame food with greatest ACE-inhibitory activity is used as a pharmaceutical drug for the treatment of hypertension, cardiovascular diseases and diabetic nephropathy. To improve the bioavailability of Phe-Tyr, a delivery system based on poly (lactic-co-glycolic acid) (PLGA) nanoparticles loaded with Phe-Tyr (Phe-Tyr-PLGA NPs) for treating hypertension and cardiovascular diseases was prepared in this study. In the experiments, poly(lactic-co-glycolic acid) (PLGA) and Phe-Try dipeptide-loaded PLGA nanoparticles were prepared using the double emulsion (w/o/w) method. The characterization of the nanoparticles were performed with a UV spectrometer, the Zeta-sizer system, FTIR spectroscopy, and a SEM. Cell toxicity of nanoparticles at different concentrations was assayed with XTT methods on L929 fibroblast cells. The optimum size of the Phe-Try dipeptide-loaded PLGA nanoparticle was

obtained with a 213,8 nm average particle size, and a 0,061 polydispersity index. This study obtained and characterized spherical morphology, determined that the nanoparticles have low toxicity at lower concentration and toxicity augmented with increasing concentration of dipeptide. To analysis of the effect of solvents on structure of Phe-Tyr, Molecular dynamics simulation was performed with GROMACS program. Molecular orbital calculations was carried out to obtain structural and electronic properties of dipeptide. Moreover, molecular docking calculations were also employed to model and predict polymer-drug interactions.

Development of new materials suitable for 3D printing with antimicrobial properties

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The silver nanoparticles have been the most used nanomaterial which have been integrated to industrially processed materials (including clothes, medical devices) or have been tested for various medical purposes. Contemporary nanomaterials are modified by different ways in order to preserve their physical-chemical stability and primarily boost their working potential. Therefore, it is appropriate to modify the nanomaterials by antibiotics, antivirotics or eventually by other therapeutics for enhancing of their synergic effects on target organisms. Technology in 3D printing goes to the general interest; furthermore it could be called as a starter of the new industrial revolution. The new applications of 3D printing are developed almost every day and obviously this new technology spread out to various industrial sectors and even to a nanomedicine.
We developed and in detail described various silver types of nanoparticles (size 30 – 80 nm). It is assumed that the modification of nanoparticle surface properties (sodium citrate, gallic acid, various preparation time and pH) or preparation of hybrid material will evince important antimicrobial properties (S. aureus, E. coli, inhibitory effect in the range of 5 – 10 mm). Suitable materials/3D printed products were tested from perspective of their antimicrobial properties.

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Microstructure and electrochemical behavior of TiO_2 nanotubes coated on titanium based substrate before and after thermal treatment

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Titanium and its alloys have suitable biomechanical and biocompatible properties and constitute an excellent choice for the long-term replacement of hard tissue, such as hip and knee joints. The surfaces of titanium based materials are protected from the corrosion by their self-organized oxide layers. The surface modification of the implant materials improves the promotion of the osseointegration. The relatively recent technology for improving implant surface properties is the TiO_2 nanotubes forming on the titanium based materials that represents great potential in promoting

cell adhesion, proliferation and differentiation. Moreover, nanotubes can promote the possibility of loading the tubes with antibacterial agents and thereby controlling the bacterial infection. This work is focused on the comparative study of the properties of nanotube layers produced by anodization on the surfaces of pure titanium and TiAlV alloy. The nanotubes are formed on the titanium substrates by simultaneous surface oxidation and controlled dissolving of oxide film due the fluorine ions. The SEM, X ray and AFM analyses were performed to determine the properties of the anodizing layers before and after heat treatment. The corrosion tests before and after heat treatment of anodizing surfaces were realized on both titanium based materials.

Alpha lipoic acid-loaded liposome formulation enhance the activity of liposomal epirubicin toward metastatic pancreatic cancer cell line

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Pancreatic cancer is a leading cause of cancer deaths worldwide. Combination therapies of natural bioactive substances and anthracycline agents have been highlighted as effective treatment. for pancreatic cancer. However, such an approach remains very limited. Liposomes can serve as promising carriers for targeting delivery and controlled release of anti-cancer drugs. The work presented aimed to develop novel liposomal formulation of alpha lipoic acid and established anti-cancer therapeutics, namely, epirubicin, which were examined for their efficacy in combination against metastatic pancreatic cancer cell-line. Liposomal formulations of alpha lipoic acid was successfully prepared using passive method and epirubicin was prepared by using active loading method with ammonium ascorbate as described elsewhere (1).

All loading methods showed desired characteristics in terms of mean liposome size, polydispersity and zeta potential. The encapsulation efficiency was higher than 95% for all formulations.

The main aim of the present study was to investigate potent anticancer activity of liposomal formulations on tested pancreatic cancer cell line. The in vitro study proved cytotoxicity of alpha lipoic acid and epirubicin loaded liposomal formulations on tested metastatic pancreatic cancer cell line.

The other aim of the present study was to investigate the combined effects of liposomal formulations on metastatic pancreatic cancer cells. Synergism between two different liposomal formulations in vitro was determined by using the combination index analysis (CI). The results of the MTT assay indicated that the combined treatment of alpha lipoic acid-loaded liposomes and epirubicin-loaded liposomes by ammonium ascorbate significantly decreased the cell viability, as compared with those that were treated with the individual drugs (CI < 1). Therefore, the combination of the liposomal formulations generated synergistic effects on the pancreatic cell-line indicating that the combination of these drugs in liposomal form may be a highly effective therapeutic strategy for the treatment of pancreatic cancer and requires further mechanistic and biomarker investigations in clinical trials.

Keywords: Alpha lipoic acid, Epirubicin, Liposomes, Pancreatic cancer cell line, Combination effect

1. Lipka D, Gubernator J, Filipczak N, Barnert S, Süss R, Legut M, et al. Vitamin C-driven epirubicin loading into liposomes. Int J Nanomedicine. 2013 Sep 23;8:3573–3585.

Determination of oxidative potential caused by brake wear debris in non-cellular systems

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Wear debris from automotive brake systems represents a major source of non-exhaust emissions from road traffic and it´s production increases with number of cars worldwide. However, impact of brake wear debris on the environment and organisms is still not clear. One of the most probable ways by which these particles may affect living organisms is oxidative stress. Production of reactive oxidative species may cause damage of basic cells components, lipids, proteins etc. Aim of this study is to perform characterization of airborne and nonairborne fractions of brake wear debris generated during standard dynamometer tests and evaluation of it´s potential to induce oxidative stress via lipid peroxidation and carbonylation of proteins in non-cellular system. Elemental and phase composition was determined by scanning electron microscopy, Raman microspectroscopy, and X-ray diffraction analysis. Carbon in amorphous form and graphite, iron in form of oxides and copper were identified as major components in both studied fractions. Characteristic size of studied wear particles detected by laser diffraction particle sizer in airborne fraction was 12 μm and 80 μm in nonairborne fraction. Both airborne and nonairborne samples showed ability to induce oxidative stress which follows from determination of lipid peroxidation and carbonylated proteins.

Zinc-modified nanotransporter of anticancer drugs for targeted therapy of breast cancer

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Modern anticancer therapy aims to increase the effectiveness of the tumor treatment. The aim of this work was to propose a new nanotransporter for targeted delivery of anthracycline antibiotics, which is specific for its bioavailability, increased uptake of the drug from the bloodstream at the site of tumor tissue as well as low toxicity to non-target tissue. Chitosan nanoparticles have attracted more attention in drug delivery due to their stability, low toxicity and easy preparation. Deacetylated chitosan skeleton composed of glucosamine units has a high density of charged amino groups which allow strong electrostatic interactions with biomolecules, transition metals (Zn, Se), and peptides. Over the years, it has been demonstrated that elevated levels of the metallothionein (MT) are observed in tumor tissue, including breast tumors. This fact allowed the creation of a targeted nanotransporter CHIT-Zn-DOXO.

In the experiment, chitosan nanotransporter was designed and subsequently studied by biophysical methods. We found that chitosan nanoparticle sizes varies from 10 to 20 nm in dependence on the charge. The results showed that the nanoparticles formed from chitosan closes doxorubicin in its structure. On the surface of the nanoparticle Zn^{2+} is bound. Free -SH groups of MT bind preferentially to the structure of CHIT-Zn-DOXO. To study the interaction of various nanoparticles an experimental model based on the interaction of the magnetic iron oxide nanoparticles Fe_2O_3-

AuNPs was designed. Due to Fe_2O_3-AuNPs gold covering is possible their use for targeted binding with free –SH groups of metallothionein. The produced nanoparticle Fe_2O_3-AuNPs-MT allows binding with chitosan nanoparticles to form a complex of CHIT-Zn-DOXO-Fe_2O_3-AuNPs-MT.

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Nanoparticles for enhancement of water solubility of glibenclamide

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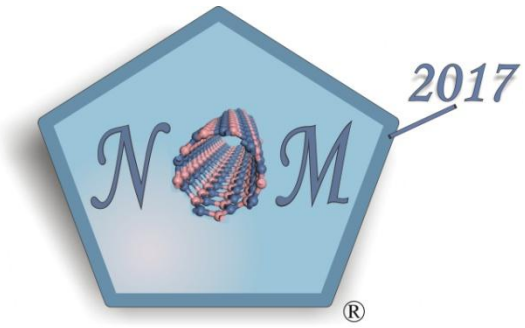
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Glibenclamide, 5-chloro-N-(2-{4-[(cyclohexylcarbamoyl)sulfamoyl]phenyl}ethyl)-2-methoxybenzamide, is a sulfonylurea per oral antidiabetic drug reducing glycaemia by increasing insulin release from beta cells of the pancreas. Glibenclamide belongs to Class II of the Biopharmaceutical Classification System, i.e. it is drug with good permeability but poor water solubility. Thus, this study is aimed at preparation of glibenclamide nanoparticles (NPs) for improvement of water solubility. NPs were prepared via a precipitation technique using a non-polar solvent, dichloromethane, because NPs prepared this way were more stable than NPs generated using polar solvents. Glibenclamide in dichloromethane solution (10% w/w) was added to a water solution of carboxymethyl dextrane sodium salt (3% w/w), and dichloromethane was subsequently evaporated. NPs were characterized by dynamic light scattering, zeta potential and scanning electron microscopy. The composition of samples was evaluated by Fourier transform mid-infrared spectroscopy. The solubility of glibenclamide NPs in a phosphate buffer at 37 °C was tested using high performance liquid chromatography. The solubility of glibenclamide NPs was compared to the solubility of bulk glibenclamide.

Keywords: Glibenclamide, Nanoparticles, Solubility, Antisolvent, Precipitation

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Integrated differential phase contrast (iDPC) STEM: low Z investigations and imaging beam sensitive materials with high S/N ratio

Anil Yalcin

Thermo Fisher Scientific (formerly FEI); Eindhoven, The Netherlands

With Cs correction in scanning transmission electron microscopy (STEM), one can use wider convergence angles, which brings much smaller probe size and provides a resolution in picometer range. In fact, STEM encompasses several conventional imaging possibilities in which different sets of elastically scattered electrons are collected by different detectors (BF, ABF and ADF) for image formation.

The biggest challenge in conventional STEM techniques is to fully image and interpret a lattice consisting of both high and low Z elements (i.e. GaN). In HAADF-STEM, since electrons scattered over >50 mrad are collected and the elastic scattering cross-section is directly proportional to the atomic number square (Z^2), images show only the high Z elements. Contrary to HAADF-STEM, low Z elements can be imaged with (A)BF-STEM, though atomic positions in the images are difficult to interpret as the atoms can exhibit bright or dark contrast [1,2].

Novel integrated differential phase contrast (iDPC) STEM imaging is instrumental in showing both low Z and high Z elements in a given lattice without contrast reversals [3], which is typically an issue for ABF-STEM [1,2]. iDPC-STEM is based on center of mass (COM) STEM imaging in which the electric field projected on the electron beam by the specimen leads to the COM displacement of CBED disc [4]. This displacement can be depicted as a 2D vector on the detector plane and the x- and y- components of this vector can individually be detected by segmented detector. These two images correspond to conventional DPC-STEM images. As the integration of the electric field corresponds to the phase shift, integration of DPC-STEM images brings the final iDPC-STEM image. Experimentally, the Ga and N atomic positions in GaN lattice has been clearly shown by iDPC-STEM imaging [3].

Another significant advantage of iDPC-STEM is the fact that beam sensitive materials such as zeolites and graphene can be imaged in low dose with high S/N ratio. For beam sensitive materials with small scattering cross section, S/N ratio becomes a limiting factor in resolution. iDPC-STEM technique employing segmented detector is shown to exhibit improved S/N ratio on graphene compared to conventional STEM imaging methods [3], therefore making iDPC-STEM a must-have for beam sensitive materials research.

In materials science, we are seeing an increasing particular interest in structures that are comprised of low Z elements and beam sensitive materials requiring low dose imaging techniques. With a wide Z-range detection capability without contrast reversals as well as enhanced S/N ratio in low dose applications, iDPC-STEM will be the key for subangstrom imaging method in these research areas.

[1] Bosch, E.G.T. *et al. Ultramicroscopy*, 2015, 156, 59-72.
[2] Findlay, S.D. *et al. Ultramicroscopy*, 2010, 110, 903-923.
[3] Lazić, I. *et al. Ultramicroscopy*, 2016, 160, 265-280.
[4] Müller, K. *et al. Nat. Commun.*, 2014, 5, 5653.



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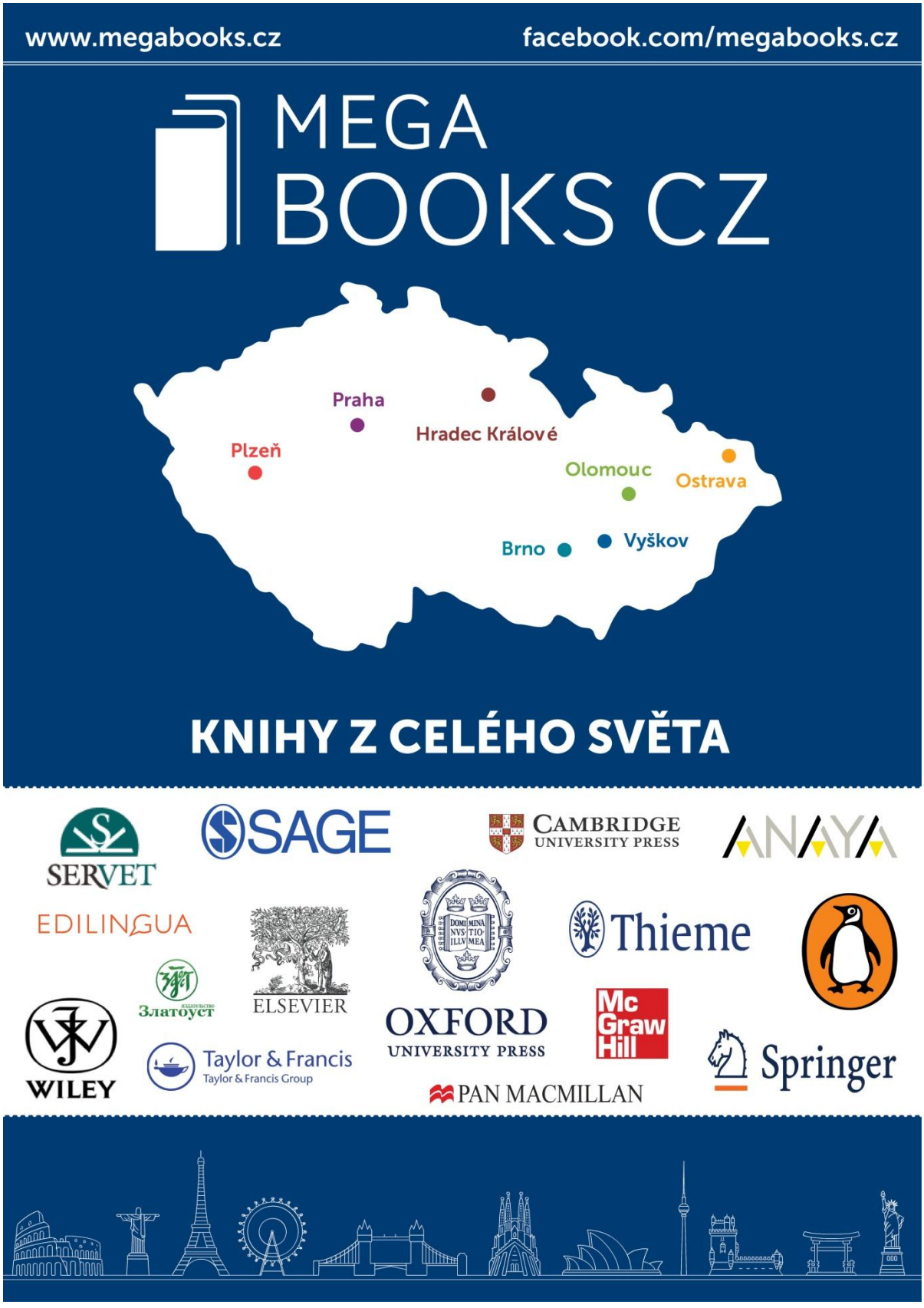
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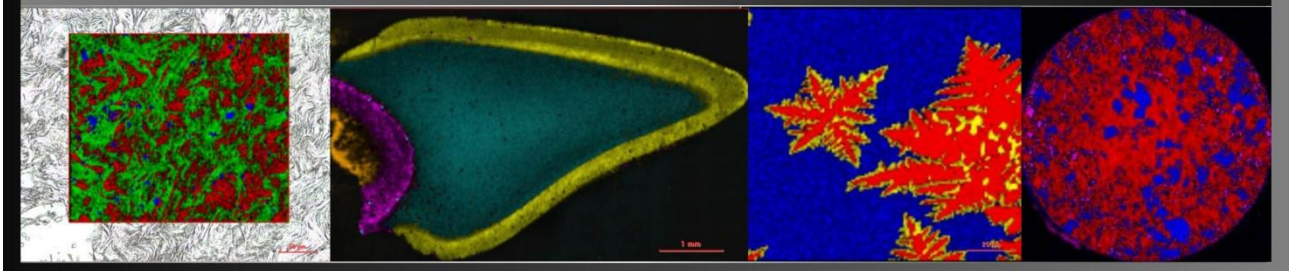

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Uživateli prověřený Ramanův mikroskop DXR je nyní v nové verzi DXR2xi dostupný s vysoce výkonným EMCCD detektorem a mikroskopickým stolkem s možností mikroposuvu 0,1 mikrometru pro tzv. „Chemical Imaging“ vzorků. Novinkou je zejména bezkonkurenční rychlost získávání dat; během několika minut lze získat miliony Ramanových spekter a 3D mapy vzorků s rozlišením 0,5 mikrometru. Ramanovy mikroskopy DXR2 a DXR2xi lze nyní také spojit s AFM mikroskopem, a získávat tak během měření rovněž informace o strukturálních a topografických vlastnostech povrchu materiálu, a to v jednotkách nanometrů. Samozřejmostí je také možnost SERS, TERS a SPM.



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LUMOS | HYPERION

- FT-IR mikroskopy pro chemické mapování
- univerzální nástavec pro transmisi, reflexi i ATR

SENTERRA II

- pokročilý disperzní Raman pro vědu i výzkum
- až 5 excitačních laserů

FT-NIR a Ramanovy spektrometry

TANGO | MPA | MATRIX

- FT-NIR pro procesní i laboratorní využití
- sofistikovaná kontrola kvality i identifikace



MultiRam | RAM II | BRAVO

- FT-Ramany pro R&D
- BRAVO ruční disperzní Raman



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- měření tenkých vrstev spektroskopickou elipsometrií
- DLS analýza velikosti částic, zeta potenciálu a molekulové hmotnosti
- povrchová a objemová prvková analýza GD-OES, N/O/H a C/S analyzátory
- Ramanova mikroskopie a mikroluminiscence
- fluorescenční spektroskopie a TCSPC
- SPR

AIST-NT Inc., USA
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- OMNISEC, Viscotec – multidetektorové GPC/SEC systémy a detektory
- Viscosizer – automatizovaná ultra-nízkoobjemová
- Taylorova disperzní analýza

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- UHR rastrovací elektronové mikroskopy
- HR-TEM mikroskopy s vysokým rozlišením
- stolní elektronové mikroskopy s EDX analýzou

Leica Mikrosysteme Vertrieb GmbH, Rakousko
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- kryogenní příprava a vysokotlaké metody
- nanášení vrstev C a pokovení
- korelační mikroskopie světelná a elektronová

SÜSS MicroTec AG, Německo
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