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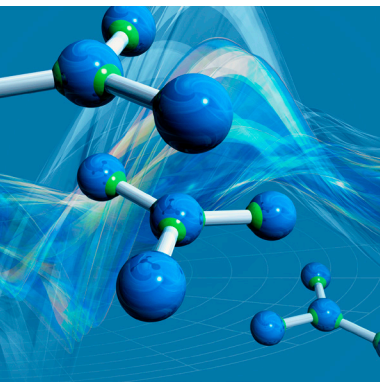
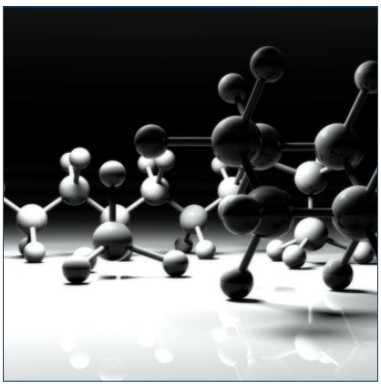
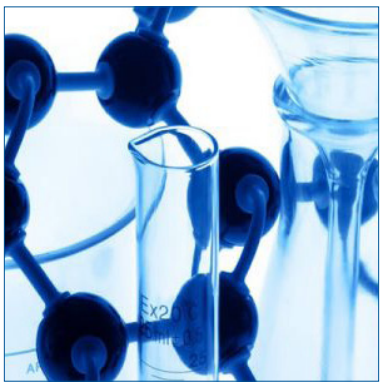
e-Poster

Materials Physics 2018



International Conference on

Materials Physics and Materials Science

November 22-23, 2018 | Paris, France

Additive SLS machine for PEEK

Alexey Nazarov

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The parts manufactured by the selective laser sintering (SLS) technology from some types of powders based on polyetheretherketone (PEEK) cause increased interest. They have high strength values, high heat resistance, as well as excellent biocompatibility and dielectric properties. A set of these properties in combination with the capabilities of the SLS method allows creating unique parts. These parts are increasingly used in the aerospace industry, medicine, and motorsport.

We present the original design of the SLS machine for PEEK, which has the following advantages:

i. The accuracy of the applied powder layer ±10μm

ii. The capability of automated control of the powder recoater alignment

iii. The possibility of changing the intensity distribution into the spot of laser radiation from “gauss” to “reverse gauss” or “top hat”, which can improve the quality of the components produced by the SLS method and others.

Speaker Biography

Alexey Nazarov has completed his PhD at the age of 26 years. He is the designer of SLS/SLM equipment, engineer of the Laboratory of Innovative Additive Technologies of MSTU “STANKIN”, Moscow.

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Notes:

Bioactive Ag^-, Zn^- and Cu^- incorporated calcium phosphate coatings: Microstructure, physicochemical and biological properties

Mariya B Sedelnikova
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Bio composites combining a metal base and a bioactive calcium phosphate coating are promising materials for traumatology, orthopaedics and dental implantology. A serious problem in biomedicine is bacterial infection of medical implants. It is necessary to develop biocoatings with high antibacterial activity, biosafety, and Osseo conductivity. The use of the microelements such as Ag-, Zn- and Cu- in trace amounts allows to produce a directional antimicrobial effect in the postoperative period and to minimize the risk of pathogenic microorganism evolution. Microarc oxidation is a relatively new surface treatment technique, being famous for its ability to form in-situ grown porous and homogeneous coatings on the surface of valve metals, such as Ti, Al, Mg, Nb, their alloys, etc.

In present research work the study of the CaP bio coatings with Ag, Zn and Cu incorporation produced by a (MAO) method on the titanium substrate were carried out. The coatings were formed in the anodic potentiostatic regime for 5–10min under the applied voltages of 200–450V. The Zn- and Cu-incorporated coatings were deposited in the electrolyte containing 30% aqueous solution of phosphoric acid, calcium carbonate and Zn- or Cu-substituted hydroxyapatite ($Ca_{9.9}Zn_{0.1}(PO_4)_6(OH)_2$ or $Ca_{9.9}Cu_{0.1}(PO_4)_6(OH)_2$). To synthesize the Ag-incorporated coatings the electrolyte containing Na_2HPO_4, NaOH, $AgNO_3$ and β-$Ca_3(PO_4)_2$ powder was used.

The comparative investigation of the Ag-, Zn- and Cu-incorporated CaP coatings showed that the electrolyte composition influences considerably on the morphology, structure and properties of the coatings. In addition, the applied voltage effects significantly on the coating phase composition, thickness and roughness. Introduction of Ag, Zn and Cu microelements into the coatings provides the formation of their antibacterial properties.

Speaker Biography

Mariya B Sedelnikova has completed her PhD and received the degree of technical sciences at the age of 45 years from Tomsk Polytechnic University, Russia. She is the senior researcher of Institute of Strength Physics and Materials Science of SB RAS. She has over 100 publications.

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Modeling the Seebeck coefficient of GaAs in the limit of ballistic quantum transport

Karl Heinz Gresslehner
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Several methods have been developed to determine the Seebeck coefficient for thermoelectric materials. In this work we investigate the Seebeck coefficient for n-GaAs within the limit of ballistic quantum transport. The ballistic quantum transport is calculated by the contact block reduction (CBR) method which is a very efficient variant of the nonequilibrium Green's function formalism. A great advantage of the CBR method is, that we can calculate the Seebeck coefficient of inhomogeneous materials and structures including heterostructures, functionally graded thermoelectric materials and segmented materials self-consistently. The calculations were carried out for a bulk device geometry both for constant doping as well as graded doping with a linear carrier concentration gradient. The left side was taken as the cold and the right side as the hot side. The current is determined by calculating the two different electron distribution functions at the cold and hot contact.

Speaker Biography

Karl-Heinz Gresslehner have completed his PhD in the field of semiconductor physics in 1981 at the Johannes Kepler University, Linz. He was working more than 10 years in the industry and 24 years as a teacher at a school for higher technical education. Since 2016 he is a professor at the University of Applied Sciences in Upper Austria and is the head of the research group "Thermoelectricity".

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Characterization of commercial Bi_2Te_3 thermoelectric materials

Karl Heinz Gresslehner
University of Applied Sciences Upper Austria, Austria

In this work we present results of experimental investigations of commercially available n- and p-type Bi_2Te_3 alloys. The as delivered samples are slabs with a diameter of D~31mm and thicknesses of L = 1.5 – 2mm. They were analyzed by energy dispersive X-ray analysis (EDX) to estimate the elemental composition, by spectroscopic ellipsometry in the IR and UV-VIS to estimate the real and imaginary part of the refractive index and by IR-thermography to estimate the thermal diffusivity as well as a potential anisotropy. For SE analysis the samples were mechanically polished. By mass fractions the empirical formula of the compound is $Bi_2Te_{2.7}Se_{0.3}$. In the case p-type samples the empirical formula of the compound is $Bi_{0.4}6Sb_{1.54}$ Te_3. For IR thermography the samples were instantaneously heated on the front side by a pulsed diode laser with a peak wavelength of 808nm and an operating power between 12W and 33W. The pulse duration was in the range from 10msec to 100msec.

To estimate the absorbed energy of the incident laser pulse the temperature rise at the end of the heating phase on the front side was evaluated for several heating times. From theoretical point of view the temperature rise is proportional. Based on this the absorbed energy lies in the range of 3 to 10% of the incident energy. The temperature evolution was measured with an IR camera which is a cooled 1280 x 1024pixel FPA with a thermal resolution of typically 18mK and sensitive in the spectral range of 1.5-5µm. A frame rate of 333.33Hz was chosen and the spatial resolution was 4.33pixel / mm. From thermal imaging on the front side no anisotropy in the in-plane thermal diffusivity was detected.

To obtain the thermal diffusivity in z-direction temperature measurements were carried out at the rear side of the samples (z = L, transmission mode). The measured (red) and modelled (black) temperature rise above ambient for a pulse heating of 100msec of a n-type sample. The thermal diffusivity was evaluated with Parker's method, which was modified to consider the finite heat duration. With this, a thermal diffusivity of $1.01x10^{-6}$ m^2/s was obtained. This leads to a thermal conductivity of 1.2W/m.K for a density of 7700kg/m³ and a specific heat capacity of 154 J/kg.K. From SE measurement the imaginary part of the refractive index is $n'' \approx 4$ at = 808nm. From that the absorption coefficient was estimated at 6.2×10^{-5} cm^{-1} which leads to a penetration depth of the laser light of 16nm. Therefore, the absorption of the laser pulse takes place at the front side (z = 0) and can be modelled as a Dirac Delta function (z).

Speaker Biography

Karl Heinz Gresslehner have completed his PhD in the field of semiconductor physics in 1981 at the Johannes Kepler University in Linz. He was working more than 10 years in the industry and 24 years as a teacher at a school for higher technical education (HTL). Since 2016 he is a professor at the University of Applied Sciences in Upper Austria and is the head of the research group Thermoelectricity.

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PTR-TOF-MS a new tool for volatilome investigation of autoimmune diseases

Julia Ricanyova
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A publication issued by the World Health Organization (WHO) in 2006 pointed out that: autoimmune diseases are multifactorial. Both intrinsic factors (e.g. genetics, hormones, age) and environmental factors (e.g. infections, diet, drugs, and environmental chemicals) may be responsible for them. Bacterial, viral and yeast infections are associated with many autoimmune diseases as well as chronic fatigue syndrome. When considering these biological ranges of selected volatile organic compounds (VOCs), personal factors such as race, age, gender, weight, food consumption, medication, illicit drugs, and even profession/class have to be taken into account for autoimmune diseases. Advances in multiplexed assay technology at the gene, protein, and cellular level have enabled the identification of potential biomarkers by PTR-TOF-MS. Analysis of VOCs or volatilome have been investigated from human exhaled breath. New tool PTR-TOF-MS provide deep insight into the status of various biochemical processes in the human body. Selected VOCs have been considered as potential biomarkers of immune-pathophysiological processes related to autoimmune diseases. PTR-TOF-MS of breathe VOCs analysis is noninvasive and fast biomonitoring with potential for the early detection of autoimmune diseases like rheumatoid arthritis, lupus and sjorgren´s syndrome. Typical scan and MID spectrums for an on-line real-time breath sampling of selected protonated ions related m/z were monitored. This poster gives an overview of the major VOCs measured in human exhaled breath, possible biochemical pathways of breath VOCs generation, diagnostic importance of their analysis, and analytical techniques used in the breath test.

Speaker Biography

Julia Ricanyova has completed her PhD at the age of 27 years from Nicolaus Copernicus University in Poland and P J Safarik University in Slovakia. She is the researcher of Chem MS Labs, Swiss. She has just 8 publications that have been cited over 100 times, attended more than 30 conferences, and her publication H-index is 5.

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Accepted Abstracts

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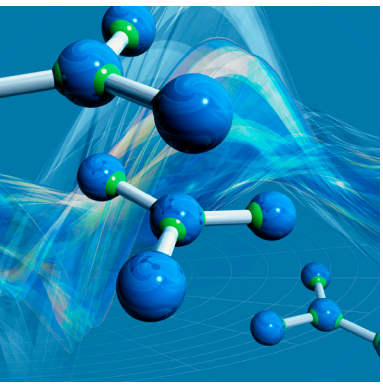
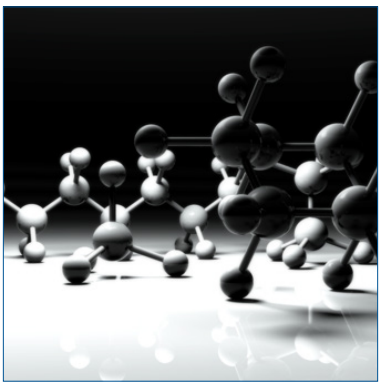
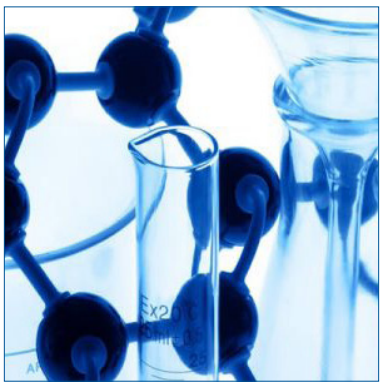

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Effect of sintering on formation and structure of nanocrystalline $La_{0.1}$ $C_{0.9}$ MnO_3 perovskite

Mohamed Hegazy
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Nanocrystalline $La_{0.1}$ $C_{0.9}$ MnO_3 perovskite been synthesized employing co-precipitation technique. X-Ray Diffraction (XRD) and Fourier-transform Infrared spectroscopy (FTIR) analysis were used to explore the structural features and calculate lattice parameter values for all the compositions (as prepared, sintered at 200, 400, 600, 800 and 1000 0C for 3h). Formation of nanoparticles was revealed by transmission electron microscopy (TEM). The elemental analysis as obtained by EDAX is in close agreement with the expected composition from the stoichiometry of reactant solutions used. Increasing sintering temperature enhances the perovskite structure to 800 0C. The perovskite structure is distorted above this temperature. Crystallite size was determined by three method Scherrer, Williamson Hall, and Warren Averbach to be in ranging from 33 to 86nm.

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Mass spectrometry for authentication of food products

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Mass spectrometry is an important analytical tool to authenticate the geographical origin of various food products. This is particularly important in the present world-scenario of free trade agreement, terrorism, and to identify the fraudulent approaches for money profits. A number of mass spectrometric techniques, e.g. thermal ionization mass spectrometry (TIMS), inductively coupled plasma source mass spectrometry (ICPMS), stable isotope ratio mass spectrometry (SIRMS), etc. are being increasingly employed to fulfill the objective of geographical authentication. The precise and accurate data on the isotopic composition of some of the elements viz., B, Sr, Pb, C, O, etc.; concentrations of trace elements in the food product and the soil; and the chemometric analysis (e.g. principal component analysis PCA) of the data provide valuable tools. Though fully automated mass spectrometers are commercially available these days, yet the high precision and accuracy required for the isotope ratios demands a skilled analytical scientist with critical evaluation of the various parameters affecting the precision and accuracy of the analytical data. Examples will be shown of various parameters which need be carefully examined to get meaningful data. A number of studies are reported in literature on different food products. This presentation will summarize the internationally reported results on a few food products (rice, coffee, tea. etc.) and discuss the results obtained on tea leaves and rice grown within India. The talk will also highlight the future requirements to satisfy the various objectives of food authentication.

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Changing the magnetic properties of ZrO_2: Mn nanocrystals by adjusting hydrothermal synthesis and conditions

Witold Dobrowolski
Institute of Physics, Poland

The aim of the present work was to study the magnetic properties of ZrO_2(Mn) nanocrystals prepared by the microwave-assisted hydrothermal synthesis using $KMnO_4$ precursor. The structural characterization was performed by means of X-ray diffraction. The morphology of the samples was studied by use of STEM microscopy. The magnetic properties were studied by means of AC susceptibility. All the samples demonstrated the Curie-Weiss behaviour at higher temperatures with negative values of Curie-Weiss temperature. It was shown that the conditions of the synthesis, e.g. pH, can be adjusted to decrease the value of Curie-Weiss temperature and reduce antiferromagnetic interactions

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Hyphenated Mass Spectrometric techniques for smart materials architecture: Theranostic applications

Hossam E M Sayour
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Rapid early detection is crucial for transboundary/ emerging/ zoonotic disease outbreak prevention. Several international organizations such as WHO, OIE, FAO and EPA called upon the development of rapid, sensitive, low cost, and easy to use early diagnosis of pathogens as "rapid field tests" or "point of care diagnostics". Molecular recognition plays an important role in biological systems and is observed in between receptor-ligand, antigen-antibody, DNA-protein, sugar-lectin, RNA-ribosome, substrate-enzyme, etc. (The lock and the key theory, Pauling, 1940). My investigations show that the characteristics of the functional biomimetic system of "molecular architecture" for certain biological organisms and systems should be designed by computational approach. Molecular imprinted polymers (MIPs) have been applied as artificial antibodies, catalysts, sensors, drug assay tools, and affinity separations. Targets including epitopes or haptens, which are the major antigenic determinants of microorganisms like bacteria or viruses, lead to innovations in disease theragnosis. MALDI-TOF MS bio typing was highly successful in rapid identification of Brucella cultures through dendrodrogram analysis, despite the high phenotypic and genotypic similarity among members of the genus Brucella. From the species perspective, B. suis and B. ovis were more related to B. melitensis than to B. abortus, which had a separate cluster. Strain-specific mass spectral peaks were observed among almost all strains examined Tandem mass spectrometric experiments reveal individual polymer end groups; in contrast, the 1-D MS spectrum provides insight about the sum of chain end substituents present in the oligomer, which may also contain partial or complete monomer unit(s). Additionally, MS can be employed to analyze copolymer sequences and to differentiate polymer architectures. Hyphenated mass spectrometric techniques are machines driving these innovations to successful marketable products based on patents. Computational chemistry tools will aid this developmental approach upon conformational decisions of diagnostic biomarkers/ biomimetic smart polymers.

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Notes:

Synthesis of transition metal doped $BiVO_4$ nano photoanodes from single source precursors

Haijiao Lu
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As global energy demands, and related environmental concerns grow, there is an urgent requirement to harness alternative energy sources, such as solar energy. One attractive opportunity is to utilise sunlight to split water, forming H_2 which may be used directly as a fuel or as a reagent for the preparation of liquid fuels. $BiVO_4$ exhibits a valence band edge at a suitable position for water oxidation (2.4eV vs reversible hydrogen electrode (RHE)), and a conduction band edge located close to RHE. The band gap of $BiVO_4$ allows absorption of a significant portion of visible light, giving a theoretical Solar-to-Hydrogen (STH) efficiency of 9%. $BiVO_4$ exhibits good photostability, non-toxicity and is composed of earth abundant, non-costly elements. It occurs in three polymorphs, with the monoclinic scheelite structure as the most effective as a photoanode. However, the low carrier diffusion length (70-100nm) reduces the efficiency of photo-absorption due to accumulation and recombination of charge carriers. Efforts to remediate this issue include doping, Nano structuring, heterojunction formation. Recent reports state the necessity for simple scalable routes to deposit thin films of $BiVO_4$ onto conductive surfaces for the preparation of larger photoanodes. Simple solution preparation routes such as spray pyrolysis or drop casting/spin coating are particularly attractive due to their simplicity and potential for scale up. Current methodologies commonly use inorganic salts and/or metal organic precursors. A challenge when using a mixture of precursors is the even distribution of molecular precursors and prevention of phase separation upon the film prior to annealing. Here we report a one step, straightforward synthesis with polyoxometalates as suitable single-source precursors for nanoporous thin films of Co/Ni/Cu/Zn doped-$BiVO_4$, which show good photoactivity and can be produced on a large scale due to the simplicity of deposition.

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RegenerAge System: Therapeutic effects of combinatorial biologics (mRNA and allogenic MSCs) with a spinal cord stimulation system on a patient with spinal cord section

Joel I Osorio
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Bioquantine a mRNA extract from Xenopus laevis frog oocytes (purified from intra- and extra-oocyte liquid phases of electroporated oocytes), showed potential as a treatment for a wide range of conditions in animal models, including Spinal Cord Injury (SCI) and Traumatic Brain Injuries (TBI) among others. The current study observed beneficial changes with Bioquantine administration in a patient with a severe SCI. Pluripotent stem cells have therapeutic and regenerative potential in clinical situations CNS disorders. One method of reprogramming somatic cells into pluripotent stem cells is to expose them to extracts prepared from Xenopus laevis oocytes. Due to ethical reasons and legal restrictions we selected a No Option patient, deciding to include in our protocol the Restore Sensor Sure Scan to complete it. Based on the electrical stimulation for rehabilitation and regeneration after spinal cord injury published by Hamid and MacEwan, we designed an improved delivery method for the in-situ application of MSCs and Bioquantine in combination with the Restore Sensor Sure Scan. To the present day the patient who suffered a complete section of spinal cord at T12-L1 shows an improvement in sensitivity, strength in striated muscle and smooth muscle connection, 14 months after the first Bioquantine and MSCs treatment and 9 months after the placement of Restore Sensor at the level of the lesion, showing an evident improvement on his therapy of physical rehabilitation (legs movement) on crawling forward and backwards and standing on his feet for the first time and showing a progressively important functionality on both limbs.

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The spin generated from ferromagnetism and anti-ferromagnetism conditions as the origin of the catalytic activity of oxygen reduction reaction

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Platinum and Pt alloys are known to be the best catalyst for oxygen reduction reaction (ORR). In the presence of precious and expensive Pt and Pt alloys the ORR is still not very efficient (sluggish). This means that it is very important to find alternative non-precious metal which is cheaper and more efficient than precious platinum. The ORR is the cathode-anode reaction in fuel cells that runs hydrogen powered vehicles and in water splitting reaction to hydrogen and oxygen. Hydrogen is considered the optimum future green fuel. It is well known that alloying Pt with Fe, Co or Ni increase the rate oxygen reduction reaction (ORR). However, the origin of this effect still remains elusive. The purpose of this abstract is to show that under the effect of spin Seebeck effect (induced thermal gradients) the increase of the spin current of the conduction electrons of the platinum when joined with ferromagnetic materials (Fe, Co or Ni) may be responsible for such catalytic activity. Thus, this suggest that antiferromagnets materials exposed to thermal gradients such as for example PtMn or Cr which can generate extremely higher spin current can be a possible replacement for Pt.

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High voltage nano-electrospray ionization Mass Spectrometry for aqueous solution

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Nano electrospray (nESI) has widely been used in the field of chemistry, biology, medicine, pharmaceutical industry, clinical assessment and forensic science. nESI can be done without corona discharge if the sample is prepared in organic solvent. The corona discharge is typically observed in negative ion mode at nESI emitter tip under high aqueous solvent conditions, resulting in low ion intensity. The corona discharge can be quenched using a 10 GΩ resistor between a pulled glass capillary and high voltage power supply. In order to elucidate the scenario of the adduct of Na^+ and enhanced the signal intensity of peptides and proteins, a high-voltage is applied to nanocapillary and compared with conventional nESI in this study. Different proteins and peptides could be selected and assessed using Bruker-HCT ion trap mass spectrometer. The performance of high voltage-nESI could be superior to low voltage or conventional nESI in terms of ion intensity and the effect of Na^+ adduct for the analysis of biomolecule in aqueous solution.

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Numerical evaluation of the effect of the used activator on the development of the microporous structure of the carbonaceous materials

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AGH University of Science and Technology, Poland

The porous structure and functional properties of carbonaceous materials are dependent on the structure of the original raw material. As a consequence, the choice of suitable material is no less important than the selection of adequate production method and the determination of optimum process conditions. Therefore, a search for new raw materials that would be useful in the production of carbonaceous materials has been under way, and particular attention has been paid in this regard to biomass waste from food and timber industries and agriculture. The work presents numerical evaluation of the effect of the used activator and the raw material on the development of the microporous structure of the carbonaceous materials. On the basis of the research and analyses, a significant effect of the type of the activating agent used as well as the raw material on the formation of the porous structure and, consequently, on the adsorptive properties of the produced activated carbons were observed. The new proposed method provides a wider spectrum of information on the analyzed porous structure of the activated carbons and the processes occurring on their surface, what provides a unique tool enabling a precise characterization of the structure of the carbonaceous microporous materials, and this in turn makes it possible to optimize the processes of their manufacture.

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Exploitation of *Enterobacter spp.* in microbial degradation of acrylamide: an environmental bioremedial approach

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A widespread use of acrylamide, probably a neurotoxicant and carcinogen, in various industrial processes has led to environmental contamination. Fortunately, some microorganisms are able to derive energy from acrylamide. In the present work, we reported the isolation and characterization of a novel acrylamide-degrading bacterium from domestic wastewater in Chonburi, Thailand. The strain grew well in the presence of acrylamide as 0.5% (W/V), at pH 6.0 to 9.0 and 25°C. Identification based on biochemical characteristics and 16S rRNA gene sequence identified the strain as *Enterobacter spp.* Degradation of acrylamide to acrylic acid started in the late logarithmic growth phase as a biomass-dependent pattern. Specificity of cell-free supernatant towards amides completely degraded butyramide and urea and 86% of lactamide. Moderate degradation took place in other amides with that by formamide > benzamide >acetamide > cyanoacetamide > propionamide. No degradation was detected in the reactions of N,N-methylene bisacrylamide, sodium azide, thioacetamide, and iodoacetamide. These results highlighted the potential of this bacterium in the cleanup of acrylamide/amide in the environment.

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Enhanced conformability of protective equipment with a negative Poisson's ratio

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Auxetic materials have a negative Poisson's ratio (NPR), when subject to deformation they exhibit interesting characteristics, that have shown potential for protective sportswear; these materials laterally expand under stretch and laterally shrink under compression. The conformability of auxetic foam is owed to its excellent shape fitting ability on a curved surface through the formation of synclastic curvature under pure bending as well as biaxial expansion. These qualities could enhance the current standard of protective equipment, as a key challenge for designers of impact protective clothing is to create garments that allow people to work and play effectively. Foam components are embedded within personal protective equipment (PPE) for sports apparel, where protective material is positioned at regions of the body frequently exposed to injury of the soft tissue through collision, fall or hard impact. Current protective materials can inhibit movement, breathability and wicking, whilst moulded pads are prone to saddling. Research has not yet determined whether the impact performance of auxetic materials is hindered under a state of synclastic curvature or biaxial expansion. One of the main benefits of using auxetic equipment for apparel is in exploiting its ability to conform to curved body regions such as the shoulder and extend with stretch fabrics and body movements rather than restrict them. Under a state of synclastic curvature and biaxial expansion, the structure of an auxetic material is subject to unhinge or unravel. Therefore, it is critical to assess the impact attenuation under synclastic curvature and biaxial expansion of a selection of auxetic materials versus conventional alternatives, including foams and 3D prints. The outcomes of this research will contribute to knowledge of the potential application of auxetic materials in sports apparel.

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Attenuation performance of OPEFB-PCL composites incorporating NZF filler for microwave absorbing applications at X-band region

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The insulating properties of Ni–Zn ferrites can be improved by the addition of various types of insulating materials such as polymers, fiber, etc. In this connection, ferrite–polymer composites have been subjected to wide research, because they have many applications: microwave devices and telecommunication applications, electromagnetic interference shielding and microwave absorption. Dielectric and magnetic properties of such composites will depend on the size, shape and amount of filler addition. Nickel Zinc Ferrite ($Ni_{0.5}Zn_{0.5}Fe_2O_4$) or (NZF) material were prepared by using conventional solid-state reaction technique. This study highlights the development of microwave absorbing material from NZF by the addition of fiber and polycaprolactone. Thermal Hake blending machine was adopted to blend the powder structure of $Ni_{0.5}Zn_{0.5}Fe_2O_4$-PCL-OPEFB which resulted to a homogeneous. These composites were characterized by Fourier transform infrared spectrometer and scanning electron microscopy (SEM). The thermal degradation behaviour for composites was analyses by thermogravimetric analysis (TGA) and (DTG). The complex permeability was measured over a wide frequency range from 8GHz to 12GHz at room temperature. From our studies, it is observed that the values of permeability increased with an increase in NZF content. The permeability measured by material measurement software (Agilent 85071) with vector network analyser. A rectangular waveguide device connected with a microwave vector network analyser (VNA) is used to measure the reflection and transmission parameters of composites (|S21| and |S11|) respectively, in different percentage of NZF filler. The results showed that the reflection/transmission ratio can be modified for all composite samples of 1mm limited thickness. It is observed that both the values of reflection and transmission change with filler change in composites.

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Disclosure of the hydrogen generation and accumulation in steel and graphite irradiated in inert environment

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In traditional power engineering hydrogen may be one of the first primary source of equipment damage. This problem has high actuality for both nuclear and thermonuclear power engineering. Study of radiation hydrogen embrittlement of the steel raises the question concerning the unknown source of hydrogen in reactors. Later unexpectedly high hydrogen concentrations were detected in irradiated graphite. So, alloying of steel and graphite by hydrogen in nuclear reactor takes place. It is necessary to look for this source of hydrogen especially because hydrogen flakes were detected in reactor vessels of Belgian NPPs. As a possible initial hypothesis about the enigmatical source of hydrogen one can propose protons generation during beta-decay of free neutrons in as much as protons detected by researchers at nuclear reactors as witness of beta-decay of free neutrons.

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Polycrystalline Gallium Nitride thin film and bulk for highly efficient devices: A new process and approach

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Interest in polycrystalline gallium nitride (GaN) material is driven by rapid development of IIIV nitrides-based devices despite of its inevitable notorious formation of grain boundaries. As compared to its single crystal counterpart, polycrystalline GaN can be produced in variety of size through simple and cost-effective means. By producing the material in bulk, it could serve as a native substrate for GaN based devices of various sizes.

This work will present a new way of producing polycrystalline GaN thin film using a combined technique of e-beam evaporator with a successive ammonia annealing. The role of patterned substrate with different profile and the effect of annealing parameters on the surface and crystalline quality of the thin film will be discussed. The results from these experiments have been used as the input to produce a freestanding flat bulk polycrystalline GaN with a thickness of 50µm using the same producers as above and followed by a wet chemical etching for the substrate removal. The surface of the freestanding bulk sample is 2 times smoother than commercial ones. Our group has also successfully demonstrated a freestanding patterned polycrystalline GaN for the first time.

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High purity diamond single crystals and their possible applications in hi-tech areas

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During the past decade, the technologies of perfect diamond single crystals, including semiconductor ones, have been developing rapidly. However, despite the 50ct and above success rate in the single crystal growth processes, the prospects of diamond single crystals application in modern electronics and other high-tech areas remain undiscovered. There are the following main methods for obtaining diamond crystals: growth at high pressures and temperatures (HPHT) and gas-phase synthesis (CVD). Both methods have a number of advantages and disadvantages. In HPHT processes, it is possible to obtain structurally perfect crystals, but the diamond size is limited by the dimensions of the high-pressure cell. In the case of CVD, the growth volume can be much larger, and it is easier to apply doping in the synthesis of semiconductor crystals, but still, it is not yet possible to produce dislocation-free diamonds.

Currently, there are several main hi-tech directions where we can anticipate successful use of diamonds.This is primarily passive electronics: diamond heat sinks. This is associated with a sharp decrease in the cost of the diamond itself, an increase in its size and in its thermal conductivity.On the other hand, we can now establish some new directions that have emerged on the basis of the successes in the perfect diamond single crystals synthesis:

- X-ray optics, including the creation of X-ray lasers on free electrons
- Extreme electronics, Schottky diodes and a β-decay diamond battery; sensors of nuclear radiation, high-temperature sensors
- acoustoelectronics, including resonators with a frequency of up to 40GHz
- quantum crystals, quantum computers, controlled formation of NV and other centers in diamond
- single-crystal diamond tools, including those combined with laser radiation, as well as for application in micro- and nanoscale

The research carried out at FSBI TISNCM in these and other fields showed high potential for the use of perfect diamonds. Thus, in 2012 a free-electron X-ray laser using diamond optics was launched in the US for the first time in the world; later beam dividers, high-resolution spectrometers, focusing lenses and other devices were created thereupon.In 2017, a β-decay diamond battery was tested, and an output power of 50μWt/cm^3 was obtained.In 2014, p-type diamond single crystals were synthesized, and their crystallization and electronic structures were studied showing that their physical properties are due to the formation of B-C layers.These and a number of other experimental results open up new horizons for using high-purity diamond single crystals, including semiconductor crystals, in the hi-tech industry comprising electronics, nuclear and medical equipment.

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Obtaining of graphene/polymer composites by hydrosilylation reaction for SLA printer

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Three-dimensional (3D) printing is often considered synonymous with additive manufacturing. Several types of 3D printers are known where we usually used polymers are. Stereolithography (SLA) employs a single beam laser to polymerize or crosslink a photopolymer resin. By drawing on the liquid photopolymer resin with a light beam, thin layers of polymer are stacked layer by layer. Elastomer based on polydimethysiloxanes (PDMS) are important class of materials, because of properties such as chemical inertness, flexibility, optical transparence, also they have a very low surface tension (20.4mN/m) and glass transition temperatures (146K). it is possible to print a support material that holds the PDMS prepolymer in place until it can be cured by UV light using a photoactive cross-linking agent. It is possible to graft photoactive group on PDMS backbone and obtain new UV curable polymer. The aim of presented work is obtaining of photopolymers based on PDMS. For purpose, we have conducted hydrosilylation reaction of polymethylhydrosiloxane (PMHS) with allyl acrylate and vinyltriethoxysilane in the presence Karstedt's catalyst in Toluene. Obtained polymer is liquid which are well soluble in organic solvents with specific viscosity $\eta sp \approx 0.4$. The end of reaction was tested by FTIR, where peak at 1260 cm^{-1} disappears which belongs to Si-H bonds. After this the polymer distilled in vacuum, cross-linking agent was adding about 1% and curried by UV during 1h.

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