Book of Abstracts

Title page

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Welcome

Programme

Thursday, 22 September

REGISTRATION
Thursday morning, 22 September, 8:40

LECTURE

Welcome and introduction
Thursday morning, 22 September, 9:00

LECTURE

Scientific infrastructures: Karlsruhe - Warsaw
Thursday morning, 22 September, 9:10

9:10 Invited oral

Center for Advanced Materials and Technologies - CEZAMAT

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The CEZAMAT Centre for Advanced Materials and Technologies was created in order to develop interdisciplinary research into new materials and technologies and to disseminate knowledge about them. CEZAMAT provides a unique scientific and research platform for projects which combine the experiences of various universities and scientific institutions. The project envisages the creation of a central laboratory and 4 other laboratories which would be equipped with the state of the art equipment needed for the development of science and the implementation of technological solutions for the economy. The state of the art infrastructure of the CEZAMAT laboratories will be available to Polish and foreign scientific institutions and – in future – to commercial institutions and business as well.

The total cost of the project will amount to PLN 385.1 m. The CEZAMAT project is one of the largest scientific and research investments in Poland co-financed by EU funds under the Operational Programme “Innovative Economy”.

The main beneficiary and Coordinator of the project is Warsaw University of Technology. The Project Consortium comprises scientists from leading technical universities and institutes in Poland:

• Institute of Physical Chemistry Polish Academy of Sciences

• Institute of Physics Polish Academy of Sciences

• Institute of Fundamental Technological Research Polish Academy of Sciences

• Institute of Electronic Materials Technology

• Institute of High Pressure Polish Academy of Sciences

• Warsaw University of Technology

• University of Warsaw

• Military University of Technology

The Central Laboratory of CEZAMAT will be placed at the Southern Campus of Warsaw University of Technology in the ultra-modern eight-storey building. It will house research laboratories equipped with state of the art equipment allowing the fabrication, observation and measurement of materials and objects at the single atom level. The sensitivity of the research being conducted and the possibility of contamination is addressed by creation of cleanrooms to prevent the introduction, creation and accumulation of contaminants. The research conducted in this environment will involve nanotechnology, nanoelectronics, nanophotonics, microsystems and biotechnology.

The implementation of the CEZAMAT project at the Military University of Technology will enhance, the capacity of the advanced laser nanotechnologies laboratory. An advanced spectroscopic and magnetical properties characterization laboratory will be created at Warsaw University's Institute of Applied Physics, while the Institute of High Pressure at the Polish Academy of Sciences will house nitrides quantum structures and their advanced characterization techniques laboratory. In addition, the Institute of Electronic Materials Technology will equip a precision chromium masks and micro-optical diffraction structures fabrication laboratory.

Research platforms of central laboratory accompanied by 4 supporting laboratories will create an unique possibility to perform research at the following 4 levels: basic research, application oriented research, prototyping and application in the production. The CEZAMAT project aims to deliver new quality and attitude in conducting research - the supply driven attitude will be exchanged with the attitude driven by the external forces. Basic research level is intended to be driven by economy development forecasts, whereas the remaining three levels will be driven by concrete demand and cooperation with the economic environment interested in market implementation of solutions developed. The results of the work carried out by the CEZAMAT are foreseen to be utilized in many areas of industry – electronics, telecommunications, transport and healthcare.

9:25 Invited oral

Scientific infrastructures and large scale facilities in Poland; CEPT, CENT I and CENT III

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A new infrastructure for education, research and development is rising in Warsaw, at Campus Ochota. Three new centers will be presented: "The Centre of New Technologies University of Warsaw" (CENT I), "Biological and Chemical Research Center, University of Warsaw" (CENT III), and "Centre for Preclinical Research and Technology (CEPT)"

9:35 Invited oral

Scientific infrastructure and large scale facilities -KIT (KNMF&ANKA)

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Innovations in micro and nano technologies rely heavily on the availability of reliable cutting-edge equipment for structuring and characterization of a multitude of functional materials. However, the availability of multimaterial micro and nano technologies is often limited in industry and academic institutions, leading to a rather slow transfer of ideas into scientific results and finally economic products.
The Karlsruhe Institute of Technology (KIT) has responded to this innovation demand by establishing the Karlsruhe Nano Micro Facility (KNMF) in 2009 as a large scale user facility in addition to the synchrotron radiation source ANKA, which is operating as a user facility since 2003. KNMF and ANKA provide users from industry and academia all over the world a unique opportunity to manage their scientific challenges thanks to a comprehensive set of high-end technologies, extensive expert and application know-how, tailored process chains and individual support and advice during all stages. Currently, KNMF unifies more than 24 technology clusters with 39 scientists operating three laboratories:
1. The KNMF Laboratory for Micro- and Nanostructuring combines an innovative toolbox of constructive bottom-up and ablative top-down structuring and replication technologies.
2. The KNMF Laboratory for Microscopy and Spectroscopy provides state-of-the-art structural characterization from the micron to the atomic scale using a combination of microscopic and spectroscopic techniques.
3. The KNMF Laboratory for Synchrotron Characterization offers novel characterization possibilities using the synchrotron radiation source ANKA.
ANKA is operated and developed as a national source of synchrotron radiation and as a large-scale facility for scientific user operation. ANKA´s activities range from microfabrication, micro- and nanocharacterization, actinide and earth sciences, biological sciences, to synchrotron technology. Seventeen beam lines offer a wide range of analytical methods as well as for microfabrication techniques. These methods can be divided into the competence areas X-ray spectroscopy, X-ray diffraction & imaging, infrared spectroscopy and X-ray lithography.
Two ways of user access are offered. The model of open research offers users free of charge access. In this case, the user has to submit a proposal which will be evaluated by an international and independent peer review board. The model of proprietary research is based on full cost recovery. Here, proposals will not be peer-reviewed and the obtained results will not be published.

LECTURE

Mechanical properties of nanomaterials
Thursday morning, 22 September, 10:00

10:00 Invited oral

Reability of nanomaterials - Plasticity, fractures and fatigue of ultra thin matallic films

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Compliant substrates like polyimide enable the fabrication of flexible electronics for numerous applications such as flexible displays, organic LEDs or flexible solar cells. However, the reliability of such devices is often limited by the extensibility of the inorganic components. So far, little experimental work has been carried out to investigate the mechanical properties of thin metallic films on compliant substrates at high strains and cyclic loading. Here, we present experimental results for the yield strength, fracture toughness and fatigue behavior of ultra thin Cu and Ta/Cu film systems on polyimide substrates with 20 to 1000 nm film thickness. The film systems have been tested by a synchrotron-based tensile testing technique (up to 7% total strain) as well as cycling loading (100 Hz, strain amplitude of 0.5 to 1%) and have been characterized by SEM and FIB microscopy. The synchrotron experiments yield the stress-strain curves of the Cu films (as prepared and fatigued) whereas the cyclic tests give the fatigue lifetime. On the other hand, in-situ tensile tests in the SEM and stationary FIB investigations reveal the evolution of cracks and fatigue damage in the films. For the thinnest films the deformation behavior during the tensile tests and for cycling loading becomes more and more brittle and multiple cracking is observed. It is shown that the fracture toughness of the Cu films decreases with decreasing film thickness whereas the fatigue lifetime and the yield strength increase. The different size effects may be attributed to an increasing constraint and final lack of plastic deformation by full dislocations. This may be corroborated by the observation that the strain hardening is strongly reduced for the thinnest films. Finally, some results on the unexpectedly strong temperature dependence of different Au/SiNx film systems and the evolution and succession of specific deformation mechanisms in nanocrystalline AuCu films, which could be determined and separated by sophisticated peak shape analysis, will be shown in order to demonstrate the unique capabilities of the synchrotron-based testing technique.

10:25 Invited oral

Mechanical properties of nanometals

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The paper deals with mechanical properties of nanocrystalline materials (MNK) with special consideration of bulk nanocrystalline metals. The study based on literature reports and author's own experiments. The definition of MNK was analyzed. It was suggested to use the dominating deformation mechanism as a criterion of the materials classification.

Fundamental deformation mechanisms were described with special attention to characteristic features of MNK deformation. Influence of nanostructure on mechanical properties was described, i.e. on modulus of elasticity, ductility, hardness, yield and tensile strength, fracture toughness and fatigue strength. Methods of structure modification to achieve improvement of strength, ductility and fracture toughness were proposed. The following were suggested as the most promising methods: modification of materials structure by means of alloying or by severe plastic deformation connected with heat treatment of the materials; production of a hybrid microstructures; improvement of the materials' ability of dislocation emission and mechanical twinning by alloying causing so that unstable stacking fault energy and unstable twinning energy decreases.

10:50 Invited oral

Scale up of nanometals production

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Nano-crystalline metals and alloys can be fabricated by various processing methods, which can be classified into: bottom-up (nanostructure is built up atom by atom, molecule by molecule) and top-down (coarse grained structures refined into nano-scaled ones employing, among others, severe plastic deformation).

In the present work, two different methods for producing relatively large products of nanometals are presented, namely (i) SPD induced grain refinement, (ii) plastic consolidation of nano-powders. SPD grain refinement has been implemented by equal channel angular pressing, ECAP, and hydrostatic extrusion, HE. Plastic consolidation of powder and ribbons was conducted by warm extrusion. The materials used in the experiments were 5XXX series aluminium alloys.

It will be demonstrated that by applying various fabrication routes for a given chemical composition, diverse nano-structures can be obtained, which differ in terms of grain size and shape, grain boundary character and dislocation density. As a result, the alloys also differ significantly in the mechanical properties and thermal stability. The findings are discussed in terms of the possibilities for optimizing properties of the bulk-nano-metals.

11:15 Invited oral

Mechanical properties of nanomaterials

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After a general introduction to the topic most recent results on the fundamentals of plastic deformation of fully dense nanocrystalline materials and metallic glasses will be presented. The first model system investigated is Pd (fcc) and several single-phase Pd alloys while it is found that "pure" nanocrystalline Pd-samples are inherently unstable against grain growth.
The experiments focus on mechanical tests using new testing equipment for miniaturized specimens with different stress state conditions. The aim is to obtain a significantly improved database of materials behaviour for these alloys at a grain size around 10 nm, since this has previously been explored only sporadically, and to elucidate and describe the microscopic mechanisms that mediate the deformation with maximum stress at fracture up to 1.8 GPa.
These results are in compression whereas under tensile conditions all materials in the nanocrystalline state seem to be inherently brittle. Under compressive conditions these nanocrystalline Pd-Au alloys represent the strongest noble metals ever made. Since the key mechanism of plasticity bears some similarities to shear band formation in bulk metallic glasses this opens a way in the design of new materials.

COFFEE

Thursday morning, 22 September, 11:40

LECTURE

Nanomaterials and nanostructures for electronic applications
Thursday afternoon, 22 September, 12:00

12:00 Invited oral

Devices from sorted carbon nanotubes

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We have combined sorting and assembling techniques to fabricate devices from single-walled carbon nanotubes (CNTs) with well defined properties [1]. On such devices we have recently performed a range of experiments. I will report on hydrogen sensing with chirality-sorted CNTs [2], electroluminescence from metallic CNTs [3], and CNTs as molecular leads for molecular electronics [4]. I will also present voltage-contrast scanning electron microscopy as a tool for rapid device screening [5].

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ACS Nano 4, 2748 (2010);
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Adv. Mat. 23, 1734 (2011)
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[5] Marquardt et al.,
Nature Nanotechnology 5, 863 (2010)
[6] Vijayaraghavan et al.,
Nano Res. 1, 321 (2008); Carbon 48, 494 (2010)

12:25 Invited oral

Graphene epitaxy by chemical vapor deposition on SiC.

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Graphene is an atomically flat sheet of carbon atoms arranged in a two-dimensional honeycomb lattice. Each carbon atom is covalently bound to its nearest neighbors by sp^2 s and by resonant p bonds. The p resonant bonds leads to unusual band structure, in which carriers behave as relativistic Dirac fermions. These offer possibility to create devices that have no analog in silicon based electronics. On the other hand sp^2 s bonds are responsible for extraordinary mechanical properties of this material.

Review of electronic, mechanical and optical properties of graphene will be presented. In addition, methods of growth of a large area of epitaxial graphene by Chemical Vapor Deposition on SiC will be described. It will be shown that the epitaxial graphene grown on SiC and metals have significant potential for electronic applications and lead to wide range of unique devices.

12:50 Invited oral

Organic Molecules for Molecular Electronics: from single molecules to new integration strategies

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Molecules are the smallest objects still providing the structural diversity required to tune their properties in order to design their functions. Furthermore, the challenge to assemble these minute nanoscale building blocks has been addressed by organic chemists since more than a century. Considering the ongoing feature size reduction in semiconductor electronics, the increasing interest in molecules as potential functional units in electronic circuits is not surprising.[1] With the development of the experimental tools required to investigate these objects even on the single molecule level by experimental physicists and physical chemists, an outstanding platform to tackle the interdisciplinary challenge of “single molecule electronics” was created and resulted immediately in an inspiring and fruitful cooperation between scientists from these disciplines.

The ability of single molecules integrated in an electronic circuit to modulate the trans¬port current was investigated by comparing structural variations. Following this approach, entire series of molecules varying in a single structural parameter like e.g. biphenyl cyclophanes with a controlled interphenyl ring torsion angle were synthesized [2-4] and investigated [5,6]. The observed correlation of the transport current with the cos2 of the torsion angle further corroborated the single molecule as the origin of the current variation. First examples of single molecule devises have been developed successfully like e.g. a single molecule rectifier [7]. Current investigations are geared towards molecular systems combining optical and electronic signals. In a re¬cent single molecule electroluminescence experiment based on a tailor-made molecular rod in a carbon nanotube junction [8], the optical response from the junction pro¬vides the unambiguous proof of the molecular nature of the junction [9].

To reduce the mismatch between the top-down fabricated electrodes and the bottom-up assembled molecules, a supramolecular approach based on organic / inorganic hybrid materials [10-12] to increase the size of the molecular object which has to be integrated will be presented.

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13:15 Invited oral

Liquid Crystal Nanoparticles

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At first glance, obtaining liquid crystal from spherical metal nanopartiles (NPs) seems to be difficult task, as the key factor gathering formation of mesophase is molecular shape anisotropy. However, recetly few examples were reported of NPs, made of metallic core and grafted with soft organic layer, forming smectic and columnar structures in which metal cores and organic parts self-segregate in

[1,2]. Properly grafted gold nanoparticles can even show temperature induced liquid crystalline polymorphism with unique phase sequence: from smectic to columnar structure. The transition is entropy driven; with increasing temperature ligands attached to nanoparticle surface require more space to fluctuate, in result smectic layer become deformed ('peristaltic mode') and voids between metal particles filled with organic molecules form hexagonal structure.

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13:40 Invited oral

Printed electronics based on inorganic nanomaterials

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The notion of printable electronics encompasses any printing technologies or processes to create electronic devices, circuits and systems. Printed electronics will complement rather than compete with silicon-based electronics. It aims at completely different application markets where solution-processable, simple and laterally structured circuitry, such as radio-frequency identification tags (RFID) tags on plastic foils, flexible displays, artificial skins, electronic textiles, electronic toys, energy storage devices etc. will be manufactured with high throughput. From the advent of the idea of solution-processed devices organic semiconductors became the immediate choice due to their easy solution processability. The first thin film transistor (TFT) based on an organic semiconductor (polythiophene) was published in the mid 1980's and showed a mobility value of 10-5 cm2/Vs. Since then, in spite of rapid developments of organic field-effect transistors (OFET's) over the last decades, measured by the steep rise in the device carrier mobility, the values are still inferior to those of amorphous silicon. For most of the organic semiconductors progress has stalled around values of 10-1 cm2/Vs. This has been accompanied by another limitation pertinent to their applicability, i.e., the stability of the organic materials in air. Moreover, most of the available organic semiconductors are p-type, while n-type semiconductors are scarce.

In this context inorganic oxide semiconductors can be a natural choice as most of the inexpensive, non-toxic, high quality oxide semiconductors are electron conductors. Moreover, the performance of inorganic devices in terms of good efficiency, reliability, high mobility, electronic properties and cost effectiveness is much superior to that of organic devices. There have been only scattered efforts on the development of solution-processed inorganic semiconductor field effect transistors (FET). The progress in inorganic semiconductor devices has been hampered notably due to processing limitations such as low temperature and solution processibility. At this point, we believe that the negligence in inorganic-based printed electronics due to mere processing limitations is premature. The novel approach developed at KIT shows that printed and room temperature processed high quality oxide FET with a transistor mobility better than of amorphous silicon can be produced when electrochemical gating is utilized.

LUNCH

Thursday afternoon, 22 September, 14:05

LECTURE

continuation of previous session
Thursday afternoon, 22 September, 14:30

14:30 Invited oral

Silver nano-inks for printable electronics

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The techniques of the assembly in present miniaturized electronics are based on structures and contacts with micrometer sizes scale. Executing such structures requires the special, precise techniques of printing, assembly and special materials to the realization of these tasks.

Among many new or modified methods for making electronic devices (e.g. Screen, R2R, and others similar), one from recent, there is the method of the technique pulse printers (*Ink-jet printing)*. To the realization of this type of the technology, except the using of suitable devices, necessary is applying special materials called the inks. Such a ink has to fulfill several basic conditions, and namely:

- be characterize approximate features to so-called proper solutions (or "true fluid"),
- should has very low viscosity value,
- realize special physical functions e.g. the electrical conductive properties.

The simultaneous realization of all introduced conditions requires the use special prepared components e.g. the fillers with possibly small, especially the nanometer sizes. The electrically conductive inks for printing microstructures contain the fillers with nano size noble metals (mostly the silver) with the highest and stable electric conductivity. However the use of nano size silver possible will be with the base condition, that the nano particles will do not undergo the agglomeration i.e. to creating larger structures.

Basic questions connected with the method of printing the electrically conductive structures by Ink-jet techniques will be presented with some information about inks properties especially with point of view of low temperature sintering possibilities.

LECTURE

Nanomaterials and nanostructures for energy storage
Thursday afternoon, 22 September, 14:55

14:55 Invited oral

Materials for lithium ion batteries

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In recent years most of the researches on novel electrode materials for Li-ion rechargeable batteries have been concentrated on phosphoolivines and oxides of the spinel structure. There is a significant interest in structural properties of these materials because electrode capacity and battery performance depend mostly on the rate of lithium diffusion and electron transport. Phosphates – olivines have excellent structural stability (strong bonds: P-O), good cycle life, thermal and chemical stability and are safe [1]. Lithium iron phosphates $LiFePO_4$ have good lithium intercalation properties, high specific stored energy, and excellent charge/discharge reversibility. LiMnPO4 has a redox potential of 4,1 V versus Li^+/Li which is considered to be the maximum limit accessible to the most liquid electrolytes.

Also, lithium manganese oxide ($LiMn_2O_4$) spinel has been extensively studied as a cathode material for Li-ion batteries. Application of $LiMn_2O_4$ has several advantages like: low cost, easy preparation, non-toxicity, high potential (4V vs. lithium metal), a satisfactory capacity, high-energy density, low self-discharge and high thermal stability. In spite 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. There are various strategies to improve structural stability of $LiMn_2O_4$. One of them is a partial substitution of manganese ions by other divalent or trivalent metal elements e.g. Fe, Co, Ni, Al. Another way is to use nonstoichiometric lithium manganese spinel like – $Li_{1+x}Mn_{2-x}O_4$. Recently, a new class of anode materials – lithium titanium oxide ($Li_4Ti_5O_{12}$) of the spinel structure is investigated. This compound is very suitable for $LiMn_2O4$ used as cathode.

We succeeded in obtaining nanocrystalline compounds of olivine and spinel structures by modified sol-gel method. Examples are: olivins – $LiFePO_4$, $LiMnPO_4$ [2] and spinels: $LiMn_2O_4$ (stoichiometric, nonstoichiometric and substituted) [3,4] and $Li_4Ti_5O_{12}$.The details of sol-gel synthesis will be presented at the Symposium. All mentioned above compounds are safe (resistant to uncontrolled oxidation) and environment friendly.

As-synthesized samples were characterized by X-ray powder diffraction (XRD), scanning electron microscopy (SEM) and simultaneous thermal analysis (differential scanning calorimetry DSC and thermogravimetry TGA). All obtained materials were single phase and with nano size of crystallites. Application of nanocrystalline electrode materials has many additional advantages: high surface area, new active reactions, decrease the path length for Li ion transport, reduce the specific surface current rate, improved stability, enhanced specific capacity. The modified sol-gel synthesis turned out to be a very effective way for production of the electrode materials for lithium ion batteries.

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15:20 Invited oral

Conversion Materials for Energy Storage

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The contribution will start with an introduction to the problem of energy storage.
Chemical methods offer the highest energy density for storing energy; they are the most interesting option for high energy and high power applications such as automobiles and for seasonal storage of electric energy from renewables.
For storage of hydrogen or lithium, today´s systems are based on intercalation materials. However, as the energy density shall be improved by a factor of two (H storage materials) or five (battery materials), a paradigm change is necessary in the materials development in order to be able to reach these goals. From the current knowledge, only systems based on the conversion principle offer such high energy densities.
Conversion materials are based on solid state chemical reactions where several reaction partners may be involved depending on whether the material is charged or discharged. The systems undergo a massive reconstruction of their structures, which is different in intercalation based systems. Several successful examples from H storage materials and battery research will be presented and discussed, and current directions of research in these fields will be outlined.

15:45 Invited oral

Structure and properties of nanoglasses

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Interface or grain boundary effects in materials have been widely investigated since the discovery of nanocrystalline materials. Another interesting class of materials are nanoglasses or na¬nostructured amorphous solids. These materials can be produced by synthesis of amor¬phous nanoparticles in an inert-gas-condensation (IGC) process and subsequent compaction in UHV. The resulting solid material is characterised by its increased density of structural defects and free atomic volume in the interfaces between the former particles. Nanoglasses have been reported in a variety of binary alloys [1, 2]. Recent molecular dynamics simulations showed that the short-range order in the interface of Cu64Zr36 nanoglasses is significantly different from that found in the starting amorphous nanoparticles [3]. A combined study of small-angle X-ray scattering and positron annihilation lifetime spectroscopy on Sc75Fe25 nanoglasses has yielded evidence of a relative reduction of the atomic density in the interface by more than 10% [4].

These important structural modifications may give rise to new mechanical, transport or mag¬ne¬tic properties. Indeed we have evidence that in Fe90Sc10 nanoglasses, the magnetic state of the system is strongly affected. Mössbauer spectroscopy and magnetometric characterization reveal an increase of the Curie temperature by more than 200 K and an enhancement of the magnetic hyperfine field compared to the regular amorphous system, unexplainable by any compositional changes alone [5].

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DISCUSSION

Thursday afternoon, 22 September, 16:25

POSTER

Thursday afternoon, 22 September, 16:35

16:35 Poster 1

Tailoring microstucture and mechanical properties of 6063 aluminium alloy for lightweight structural parts of chairs

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In this work, an attempt has been made to improve mechanical properties of 6063 aluminium alloy via combination of heat treatment (precipitation hardening) and severe plastic deformation by hydrostatic extrusion (grain size refinement). Samples were extruded in hardened (T66) and supersaturated states. The samples extruded directly after quenching were additionally subjected to aging process. The influence of aging parameters such as time and temperature on mechanical properties evolution of extruded material was determined.

6063 aluminium alloy was chosen as the best material for lightweight structures, where mass reduction is important, using Ashby`s maps and market analysis. Traditionally 6063 AA is formed by hot extrusion. In this work, the alloy was hydrostatically extruded at ambient temperature in order to obtain ultrafine grained structure. Microstructural changes after every stage of extrusion was observed with optical microscope. Microstructure of ultrafine grained alloy was investigated using transmission electron microscopy. The average grain diameter and grain boundary misorientation angles (using Kikuchi`s lines) were measured. Mechanical properties were examined in microhardness test and tensile test.

The results have shown that the highest mechanical strength was obtained for a sample extruded in hardened T66 condition but its ductility was poor. Ageing at 100°C for 26 hours of samples extruded previously solution treatment and quenched results in an increase of mechanical properties (compared to extrusions without ageing) but yield strength is still lower than measured for material extruded in hardened condition. On the other hand, this sample exhibits substantially improved ductility which make it attractive for lightweight applications.

16:35 Poster 2

Modification of epoxy resin properties by adding multi wall carbon nanotubes

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Epoxy resin is the most often used resin in aircraft industry, due to good properties such as low density, low shrinkage during curing process, high mechanical properties, and low absorption of water.

The biggest disadvantage of epoxy resin is low electrical conductivity. Carbon nanotubes have high electrical conductivity and high mechanical properties. They have high surface area and even small amount of CNT can significantly change properties of the material. Development of epoxy/nanotubes composites can be meaningful if we think about new application in aircraft like lightning strike protection, electromagnetic interference shielding. Application of conductive nanocomposites will reduce the weight of airplane and in the result will diminish of fuel consumption.

The aim of this work was to obtain epoxy/nanotubes composites with good dispersion of nanofiller and better electrical conductivity. Weight fraction of multi wall carbon nanotubes was varied from 0.05% to 5%. Nanotubes were non-modified with 1.5μm length and 9nm diameter. Nanotubes were dispersed in epoxy resin by three roll mill Exakt machine. Scanning electron microscopy was done for composite microstructure observations. Electrical conductivity was measured by Van der Pauw method. Impact tests were done with Impact Hammer RESIL 5,5 by the Charpy method.

Nanotubes were uniformly dispersed in to epoxy resin. With the increase of MWCNT in epoxy matrix significant increase in electrical conductivity is observed. Impact resistance increases with the increase of MWCNT amount. For higher weight fractions of MWCNTs the decrease of properties is observed. It could be caused by defects which occur in composites with higher weight fraction of nanotubes.

This work has been supported by the European Union in the framework of European Social Fund through the Warsaw University of Technology Development Programme.

16:35 Poster 3

Pinned and unpinned epitaxial and sublimated graphene on SiC

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The Chemical Vapor Deposition (CVD) of epitaxial graphene has been up until recently almost exclusively carried out on metal substrates. This particular type of growth has been known since late nineties, and has recently received a lot of attention. However, the CVD growth of graphene on SiC is an emerging technique, hence it needs to be verified whether it leads to an improvement of graphene fabrication technology.

Raman spectroscopy is one of the standard optical methods providing valuable information about properties of graphene structures. In this communication we focus on temperature induced shift of Raman 2D band in sublimated and CVD graphene structures grown on SiC. It was found that temperature behavior of the 2D band shift, defined as the Thermal Shift Rate (TSR), depends on the growth method, substrate polarity as well as of the thickness of the multilayer graphene structure.

The highest TSR amplitudes were found in graphene structures fabricated by Si sublimation on Si-face of the SiC substrates. For the single graphene layer TSR–0.17cm^{-1}/K. It indicates that the first layer is strongly pinned to the SiC substrate. At the same time the mean positions of the 2D line for Si sublimated samples reaches 2742cm^{-1}, which is extremely blue shifted in comparison with freestanding graphene. This means that graphene layers grown by this method are strongly stained.

The results for CVD grown layers on Si face of SiC are different. The mean position for the 2D line becomes close to 2700 cm^{-1}which indicates much smaller strain. The values of TSR are also smaller. The CVD growth creates a weakly pinned first graphene layer. Succeeding layers have properties similar to freestanding samples and are almost unstrained. The smallest TSR amplitudes were observed in the CVD graphene structures grown on C-face of the SiC substrate, for which value of –0.032cm^{-1}/K was measured, which is comparable with the freestanding graphene TSR = –0.034cm^{-1}/K

The obtained results are discussed in terms of graphene pinning to the SiC substrate. Moreover the mechanisms responsible for the observed difference in pinning between sublimated and CVD grown layers are presented.

16:35 Poster 4

Effect of nanostructure on low temperature glow discharge nitriding of an austenitic stainless steel

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In this work, the effect of nano-grain structure refinement in 316LVM austenitic stainless steel on the layers formed in glow-discharge low-temperature nitriding process was investigated. The material used in this work was 316LVM ASS in the following microstructural states: coarse grained (after annealing), plastic deformed (after conventional extrusion), nanocrystalline (after hydrostatic extrusion). All samples were subjected to glow-discharge low-temperature nitriding process at a temperature of 350 °C.

The results show significant influence of the structure nanorefinement on the nature of layers formed in low-temperature nitriding process, in particular on the surface topography, thickness, phase composition and the content of nitrogen. The effect of nanoscale structure on diffusion and surface layers formation is discussed.

16:35 Poster 5

Wet chemical methods of manufacturing alumina nanopowders

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Four wet chemical methods of manufacturing isometric nanoparticles of corundum was compared. This was: calcination of asrecived precipitate, calcination of hydrothermaly crystallized precursor, the citrate-nitrate method and calcination of AACH precursor - AACH method. In the first three methods the starting material was aluminum nitrate, in fourth method it was aluminum ammonium sulfate from which was precipitated AACH (aluminum ammonium carbonate hydroxide). Powders were crystallized at temperatures which limited corundum crystallites growth and maximize participation of alpha-Al_2O_3 phase. Intensive milling was used during calcination as well as the end of calcination. The DSC/TG method was used to characterize precursors of alumina oxide during calcination. Phase composition and specific surface area were determined by X-ray diffraction and BET methods, according to method of manufacturing and temperature of calcination. Particle size distribution was designated by laser method (DLS) and morphology of obtained powders was observed by Transmission Electron Microscopy (TEM). It was found that the milling precursors operation decreased the temperature of crystallizing alpha-phase. Crystallites shape which was closest to the spherical was obtained using the citrate-nitrate and AACH method.

16:35 Poster 6

Funkcjonalne opakowania firmy Arso-Polański Sp. zo.o. z warstwą kompozytu polimerowego na bazie nanoZnO. Mikrofalowa solwotermalna synteza nanotlenku cynku.

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Arso-Polański to firma zajmująca się produkcją jednostkowych opakowań kartonowych. Oferuje wykonanie opakowań z tektury litej w technologii druku offsetowego, wykrawania i klejenia. Firma Arso-Polański zajmuje się również projektowaniem konstrukcji opakowań. Dotychczasowa działalność w zakresie konstrukcji zaowocowała uzyskaniem przez firmę praw ochronnych na kilkanaście wzorów użytkowych.

W celu rozwoju firmy została nawiązana współpraca z Laboratorium Nanostruktur dla Fotoniki i Nanomedycyny IWC PAN, które jest ekspertem w syntezach nanocząstek z małym rozkładem wielkości przy użyciu technologii solwotermalnej syntezy mikrofalowej (MSS). Technologia MSS pozwala na dokładne kontrolowanie parametrów syntezy nanocząstek takich jak: czas reakcji, temperatura i ciśnienie. Proces solwotermalny z ogrzewaniem mikrofalowym pozwala otrzymywać nanocząstki w znacznie krótszym czasie niż w konwencjonalnym procesie „mokrej chemii". Nanocząstki w trakcie syntezy mogą być funkcjonalizowane związkami organicznymi np. polimerami w celu otrzymania nanotlenku cynku o specyficznych właściwościach. Nanokrystaliczny tlenek cynku o kontrolowanym rozkładzie wielkości cząstek jest otrzymywany za pomocą reaktora mikrofalowego MSS w procesie opisanym poniższym równaniem:.

$$Zn(OH)2 \rightarrow ZnO$$

Synteza nanotlenku cynku przebiega w roztworze wodnym w czasie 25 minut. Powierzchnia właściwa domieszkowanego ZnO wynosi 4,9 do 5,3 m2/g, a wielkość krystalitów znajduje się w zakresie od 5 do 15 nm.

Produkty firmy Arso-Polański poprzez zastosowanie warstw polimerowych ze zdyspergowanymi nanocząsteczkami wprowadzą na rynek innowacyjne opakowania które będą cechowały się wysoką odpornością na działania mechaniczne a ze względu na właściwości antybakteryjne i antygrzybiczne przedłużą termin ważności artykułów spożywczych. Ponadto opakowania będą doskonałym zabezpieczeniem produktów przed szkodliwym działaniem UV. Ponadto Arso-Polański wraz z Instytutem Ochrony Środowiska będzie opracowywać cykl życia nowego produktu poprzez ocenę aspektów środowiskowych i potencjalnych wpływów związanych z wyrobem podczas wszystkich etapów jego życia.

16:35 Poster 8

Synthesis and studies on $LiMn_2O_4$/Carbon nanocomposites as a cathode materials for lithium ion batteries

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Lithium based material such as lithium manganese oxide ($LiMn_2O_4$) of spinel structure is very promising as a cathode material for secondary Li-ion batteries. This compound has several advantages like: low cost and easy preparation, non-toxicity, high discharge potential (4V vs. lithium metal), a satisfactory capacity, high-energy density, low self-discharge and high thermal stability. In spite of these advantages, $LiMn_2O_4$ suffers from a capacity fading during charge-discharge cycles, which limits the application in commercial lithium-ion batteries. To reduce this undesired phenomenon many strategies have been applied, as described in our earlier works [1, 2]. Another, less serious drawback of lithium manganese oxide is its modest electronic conductivity. There are several ways of enhance it: i) by doping with high valence ions, ii) introducing metal particles or conducting polymers onto $LiMn_2O_4$ internal surfaces and iii) the most popular – mixing as-synthesized material with carbon species.

In our studies we used various forms of carbon in order to prepare $LiMn_2O_4$ composites of good electrochemical performance and electronic conductivity.

In this work we prepared series of $LiMn_2O_4$/C composites. Firstly, using a modified sol-gel method we obtained xerogels of $LiMn_2O_4$ from lithium and manganese salts and citric acid as a main chelating agent. The gels were dried at 150ºC and ground in an agate mortar. Then they were heated at 450 – 700ºC for a few hours in air, resulting in pure lithium manganese oxide nanocrystalline powders. In the second step we prepared $LiMn_2O_4$/C composite using different carbon sources: graphene flakes and acetylene black. $LiMn_2O_4$ powders and carbon species were either blended in an agate mortar or ball-milled, next pelletized in die set under high pressure.

The crystal structures of all samples were characterized by X-ray powder diffraction (XRD) and Raman spectroscopy. The particle size and morphology were observed by scanning electron microscopy (SEM). Impedance spectroscopy (IS) was used to determine the electrical conductivity vs. temperature. Moreover, the galvanostatic charge-discharge tests were carried out to examine the electrochemical performance of $LiMn_2O_4$/Carbon composites.

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NANONET Foundation

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The NANONET Foundation was created to promote nanotechnology and nanoscience as well as bring together scientists, academics and industry.

Our team consists of people for whom nanotechnology is passion. They are undergraduate students, PhD students, young scientists or others who volunteer to promote science and help build a society based on knowledge.

Nanonet started as a Polish-language portal dedicated to nanotechnology — nanonet.pl (2006) — and is currently the leading Polish-language Internet site in this field. It is a young, rapidly growing, scientific, technical and industrial non-profit portal whose aim is to promote and support nanotechnology ventures at home and abroad.

From the beginning our purpose has been to improve standards of living by promoting science and its impact on improvement of society and entrepreneurship by means of:

·Informing readers about nanotechnology events at home and abroad

·Creating a materials research site

·Uploading photos and images related to nanotechnology

·Creating a database including information about courses and studies

·Informing the public about benefits and risks of nanotechnology

·Posting employment offers and PhD course information

·Sponsoring scientific conferences, fairs and other events

The www.nanonet.plportal consists of the following sections:

The Information Section includes advertisements or practical information about nanotechnology in Poland and abroad – jobs, internships, practice and PhD courses.

The nanoEducation Section presents Polish universities with nanotechnology studies. It also involves information about nanotechnology courses, workshops, Internet lectures and experiments.

The nanoLibrary Section consists of nanotechnology articles, essays and news.

The nanoMaterials and nanoTechnology Section provides up-to-date information on nanoscale processes, materials, diagnostic devices and other information about applications of nanotechnology in medicine, optics, electronics and other sciences.

The nanoBusiness Section contains information about projects, patents, inventions or products created through nanotechnology, as well as on legal and ethical issues.

Our Foundation also proudly presents its other portals:

The Virtual Cooperative Broker's Board nanoBroker (www.nanobroker.org), a platform dedicated to exchanging information between science and business. The platform operates in English, German and Polish, with the partners from home and abroad. These include Nanoinitiative Bayern, Nano-Cluster Bodensee, WCB EIT +, Cluster Chemii, and ADSOL coordinated by Jacek Doskocz. The aim of the Virtual Cooperative Broker's Board nanoBroker is to create a multilevel platform to exchange information between research institutions, industry and organizations. It provides information such as descriptions of institutions, research groups, organizations, projects, patents and events.

Nanotechnology in multimedia – nanoGallery (www.nanogallery.eu) – is an English language server on nanotechnology, managed by Anna Mączka. It contains videos, papers and photos showing the world of nanotechnology impossible to see with the naked eye. The main purpose of this portal is to attract public attention to nanotechnology and to show its possible applications in various aspects of our lives. Everyone will find something interesting here, whether an expert or a novice.

The nanoDialog Portal (www.nanodialog.eu) contains information about ethical, legal and social aspects of nanotechnology (ELSA). We publish ELSA information thanks to our partnerships with scientists and attorneys from leading universities and companies, especially from the USA. Piotr Homa manages this portal.

Our achievements include:

NEL – the Internet course dedicated to advanced technologies. The NANONET Foundation received "The Innovative Service" prize for the NEL project at the"VII Świętokrzyska Giełda Kooperacyjna Nowych Technologii" in 2008. The prize was awarded for

lectures published from January-June 2008 on www.nanonet.pl in the section dedicated to e-learning. The lectures related to two categories:

·**Nanotechnology** lectures given by the specialists from various Polish universities; and,

·**Nano application lectures** given by experts from nanotechnology companies and a distance learning school.

Participation in the e-lectures was free; the only prerequisite was logging into the portal.

The Virtual Conference – "Advanced technologies are the Polish future in the EU. The Virtual Conference for Polish PhD and undergraduate students" took place from 23 – 28 November, 2009. The project was run within a grants competition to promote the use of European funds by Poland for five years of Polish membership in the European Union, as announced by the Ministry of Regional Development and European Integration Committee Office. The project was co-financed by the European Union's Regional Operating Programme – Technical Support. The conference was aimed at undergraduate students and PhD students working create a new reality. Our goal was to give them a chance to present their study results, achievements and ideas. Additionally, the NANONET Foundation is the initiator and member of the NanoCons consortium, whose aim is to provide nanotechnology solutions, and of PLUSUJ.PL, an organization promoting science and technology in the society.

The Foundation exists thanks to volunteers and sponsors whom we would like to thank.

The NANONET team makes every effort to continuously promote knowledge about nanotechnology and an innovative economy.

The NANONET Foundation team

NANONET Foundation is created by people whose passion is nanotechnology.

16:35 Poster 10

Mechanical and electrical properties of functionalized carbon nanotubes and graphene layers

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We present results of extensive theoretical studies of functionalized carbon nanotubes (CNTs) and graphene layers (GLs). Our studies are based on the *ab initio* calculations in the framework of the density functional theory (DFT) and provide valuable quantitative predictions that are of importance for design of novel composite materials and functional devices. We have performed calculations fort metallic (9,0) and semiconductor (10,0) and (11,0) single-wall CNTs and epitaxial GLs, functionalized with simple organic molecules, such as -OH, -COOH, -NH, $-NH_2$ and $-CH_3$. We have determined the changes in the geometry, adsorption and binding energies, the Young's modulus, and the band structure as a function of the density of the adsorbed molecules. The theoretical elastic moduli of CNTs and GLs agree very well with experimental values. We observe characteristic effects such as rehybridization of the bonds induced by fragments attached to graphene and nanotubes and deformation of systems that results further in decrease of the Young's modulus. However, the functionalized carbon systems remain strong enough to be used as reinforcement in composite materials. We have also determined the critical density of molecules that could be adsorbed on the surface of CNTs and GLs. We show that the functionalization of the single graphene layer can open its electronic gap, which could be utilized in graphene devices. Our calculations reveal that the –NH radicals exhibit the strongest cohesion to GLs and CNTs. Further, we determine the critical density of the -NH fragments that leads to the closing of the band gap in functionalized CNT. We also show how to engineer the magnitude of the band gap by functionalizing graphene with $-NH_2$, -NH, -COOH and $–CH_3$ groups of various concentrations.

16:35 Poster 11

Effect of addition of nanosilica on the properties of ureaurethane nanocomposites

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Polyurethanes (PURM) are ranked fifth in the world's production of plastics. The reason for their great demand are their functional qualities such as high strength, low wear resistance and resistance to aggressive liquids, oils, greases as well as atmospheric conditions. That's why they are chosen for the application in i.e. elements (tires) of mining transport equipment, where units of these devices are exposed to work under very high pressures, dust and variable temperatures ranging between -40°C and +50°C. Since the elements work under very high stress, safety aspects are vital during technical operation and fast wear.

The purpose of the studies was to produce nanocomposites in a one-stage process with nanosilica in the form of sol and powder for the manufacture of wheels. Nanosilica was fabricated at the Industrial Chemistry Research Institute in Warsaw. Matrix of these materials was produced using polyureaurethane dicyandiamide, as an extension.

The testing of the obtained materials included density, hardness, wear resistance and resilience. The analysis was performed by observing brittle structures and their fractures through scanning electron microscopy (SEM). Thermal analysis of nanocomposites was carried out using differential scanning calorimetry (DSC) and thermogravimetry (TGA). Tensile properties were examined during the static tensile test.

The addition of nanosilica to PURM changed and improved the structure of material properties of the resulting nanocomposite.

However, further research is needed in order to find the optimal composition and synthesis conditions of the obtained nanocomposites assuring optimal properties of the material.

16:35 Poster 12

Solvothermal synthesis of nonstoichiometric hydroxyapatite nanoparticles

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Today, the most common approach for regrow of bone in case of large bone gaps is to use autografts. In this case two or more operations are needed, with increased risk, suffering and costs for the patient. There is also an emerging market for hydroxyapatite (HAp) and calcium phosphate (TCP) in the form of paste or granulates used to fill small bone gaps. For large bone gaps bone regrowth scaffolds are being developed, but still exist unsolved problems like: low regrowth rate, poor mechanical properties of the scaffolds, high risk of inflammatory processes and slow or no resorbtion. Therefore the main objectives of the current regeneration medicine projects is to develop the technology for a bioactive scaffold with improved comparing to the state of the art control of shape, mechanical properties, bioactivity and resorbability. One of the ways to achieve these goals is to produce nonstoichiometric nanoparticles of hydroxyapatite with grain size lower than 10 nm and shape close to the natural HAp which will be used as material for bioactive, mechanically strong scaffolds.

The Institute of High Pressure Physics of the Polish Academy of Sciences (IHPP) is an expert in synthesis of doped nanoparticles with narrow size distribution, at relatively low temperatures by using Microwave Solvothermal Synthesis (MSS) technology. The MSS technology permits synthesis of nanoparticles with precise control of the reaction time, temperature and pressure. IHPP and the Faculty of Materials Science, Warsaw University of Technology, created a joint Center for Bionanomaterials and started cooperation to develop materials for bone regrowth scaffolds. Thanks to unique worldwide reactors for microwave solvothermal synthesis of nanoparticles, IHPP is able to synthesize unique HAp nanoparticles using the standard reaction:

$$Ca(OH)_2 + H_3PO_4 \rightarrow HAp + H_2O$$

The reaction is carried out in water solution in time lower than 5 minutes. The specific surface is almost 240m^2/g, the average grain size lower than 10 nm with shape in the form of platelets mimicking the natural bone particles.

16:35 Poster 13

Numerical analysis of plasmonic superprism.

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We analyse the optical properties of nano-elements consisting of plasmonic superresolving metamaterials [1,2]. This contribution is focused on layered metal-dielectric prism-shaped structures with layer thickness in the order of 10nm [3].

The effective uniaxial permittivity tensor of the metamaterial contains an extremely large component value in the direction perpendicular to layer surfaces and components that assure impedance matching in the parallel directions. The extreme anisotropy of the metamaterial enables diffraction-free propagation through the device. Moreover, a broad range of spatial frequencies is propagated through the structure resulting in a resolution that overcomes the Rayleigh diffraction limit.

We present rigorous FDTD electromagnetic simulations, assuming a Drude dispersion model for silver and a non-dispersive model for the dielectric. We study beam focusing and coupling efficiency as a function of apex angle [4].

The presented results prove the possibility of using plasmonic prisms for energy focusing in a sub-wavelength-sized region. Other possible application areas range from optical interconnects, novel lithographic elements with improved resolution up to components of optical cloaks.

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16:35 Poster 14

Hydrothermal Synthesis of Zinc Oxide Nanopowders

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In this paper are presented results of investigation on the influence of hydrothermal synthesis of nano – zinc oxide on their morphology and properties. First step of the study it was synthesis of nano zinc oxide by hydrothermal method using five methods of heating. There was used the ERTEC reactor in the following conditions: • as reactor with microwaves emission (1) • without microwave emission after reactor head preparation for using the electrical immersion heater(2) • without microwave emission after reactor head preparation for using the volume heater, Joule's type (3) • reactor where high energy electrical impulses where used to initialize process (4) • reactor –autoclave CORETEST with teflon filling were used (5) Results of performed experiments give possibility to observed that in this same conditions of temperature and pressure, pure phases of nano –zinc oxide was synthesized in autoclave CORETEST and microwave reactor ERTEC. In reactor ERTEC the shortest time of process was needed. That is the reason why all other synthesis with metal ions were performed in ERTEC reactor, microwaves shortened greatly the time of synthesis. In each reactor for synthesis were placed aqua-solution zinc salts with metal ions. The characterization of nano-powders were examined including: morphology, grain size distributions, specific surface area (BET), crystal size (XRD), true density and chemical contest.

16:35 Poster 15

Modification of flexible polyurethane foams by addition of carbon nanotubes

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Flexible polyurethane foams have many applications, mainly in furniture and automotive industry. The main advantage of these materials is their low density and possibility to control some parameters e.g. hardness, density or flexibility. The main disadvantage of flexible polyurethane foams is high flammability and high value of toxic fumes which evolved during combustion. This contributes to the high number of deaths during the fires. For this reason some researches are conducted in order to obtain flexible polyurethane foams with lower flammability and lower amount of toxic fumes.

In these studies carbon nanotubes were used to modify properties of flexible polyurethane foams. The amount of the filler added to the polyurethane matrix was 0.25% wt. The characterization of the foams has been carried out using thermogravimetric analysis (TGA) and dynamic mechanical analysis (DMA). Also density, hardness, flexibility, irreversible strain and linear flammability tests were done. It has been found that using carbon nanotubes could be an effective way to reduce flammability and improve thermal stability of flexible polyurethane foams.

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Novel aminostibenes - potentially new materials for both photoconductive imaging and switching techniques.

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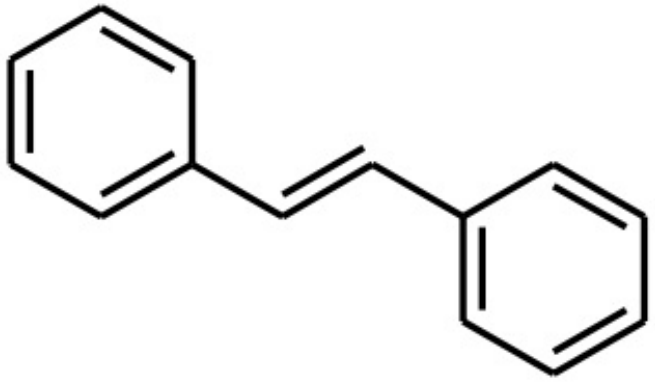
Stilbenes and their derivatives form a multidisciplinary field that combines many important branches of chemistry, biology, and physics[1-3]. This field, for the time being, is under active investigation. Unique features of this class of compounds, including a combination of fluorescence, phosphorescence and photochrome properties, have long been a matter of great interest to researchers. Also due to their miscellaneous photophysical and photochemical properties, stilbene compounds can be used for many applications in materials science. Data on the photochemistry of stilbene compounds and their role in materials science eg . materials for lasers, nonlinear optical systems, photoconductive materials, and imaging and switching techniques, were reviewed [3-6].

Specifically, recent years have seen the accumulation of new facts and ideas in the following areas: (1) stilbenes have proved to be convenient models (''proving ground'') for experimental and theoretical investigations of detailed mechanisms of photochemical and photophysical processes including photochromism and multiphonone phenomena; (2) stilbenes are used as dyes, brighteners, whiteners of paper and textile, and photobleachers; (3) stilbene derivatives have been used as molecular probes and labels for investigation of dynamic properties of proteins and biomembranes; (4) stilbene and its combination with polymers and inorganic materials have been made a basis for numerous optical and measuring instruments, devices, and apparatuses for dye lasers, organic solid lasers, and scintillators, phosphorus, neutron, and radiation detectors, electrophotographic photoconductor and image-forming apparatus, and photochromic, light-transmitting, dichroic, electroluminescent nonlinear optic, and organic–inorganic hybrid multichromophoric optical limiting materials.

In this poster we will report results of NMR examination, theoretical studies and properties of novel aminostilbene. These compounds may be applicable for obtaining new materials for both photoconductive imaging and switching techniques.



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Influence of SiC substrate orientation on epitaxial graphene quality studied by Raman spectroscopy

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High temperature annealing, which induces sublimation of Si atoms from SiC substrates at high temperatures is one of the commonly used methods of graphene layers fabrication. It was shown that sublimation process can be successfully performed in standard CVD reactors used for SiC epitaxial growth. The final result of the process depends on the annealing temperature and time as well as any other parameters like the pressure of the noble gas (usualy argon) in the CVD reactor. In contrast to the fact that the influence of the argon pressure in the reactor on the growth rate of the graphene structures is well established [1], the role of the substrate orientation on the effectiveness of the process of SiC sublimation is still not well known. In the case of epitaxy use of slightly misoriented substrates favors two dimensional growth modes, which is crucial in the case of flat and homogeneous epilayer growth. Thus the use of on-axis silicon carbide samples can't be the optimal choice for this method. It could be argued that misorientation of the substrate could have positive influence on out-diffusion of silicon atoms during SiC decomposition. In this communication the influence of SiC substrate orientation on epitaxial graphene is studied by Raman spectroscopy, which provides interesting information about strain state and homogeneity of the graphene structures. Here we focus our attention on the most prominent bands, so called the G and the 2D bands. The investigated samples were fabricated in the hot-wall CVD reactor Epigress VP508 at the temperature of 16000C. Two different argon pressures of 50 mbar and 100 mbar in the reactor were maintained during the growth process on the 4H-SiC substrates with different misorientation of 0, 4, and 8 degrees. Micro-Raman scattering experiments were performed in back scattering geometry, using the 532nm line of a continuous wave Nd-YAG laser. The laser spot size on the sample was about 2mm in diameter. In order to collect information about strain and concentration homogeneity micro-Raman maps consisting of 530 points on a 2.3x2.2mm2 sample area were performed. It was found that the average position of the 2D band, and thus biaxial strain present in graphene structures is not very sensitive to argon pressure on substrates with different misorientation. On the other hand, the 2D band average frequency increases with the misorientation angle. This is direct evidence that the average strain built in the graphene structures increases significantly with the misorientation angle. Similar behavior was found in the case of the 2D band broadening, for which the width is of about 30 cm-1 higher for 8o misoriented substrate, as compared to the on-axis samples. The observed broadening depends also on the pressure of argon during the epitaxial process.

The obtained results strongly suggest that the quality of graphene layers seems to decrease with misorientation of substrate. This provides additional information about mechanisms important in the growth of epitaxial layers by SiC sublimation. [1] A. Drabińska, K. Grodecki, W. Strupiński, R. Bożek, K. P. Korona, A. Wysmołek, R. Stępniewski, and J. M. Baranowski, Phys. Rev. B 81, 245410 (2010)

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Influence of heat treatment on luminescence of ZrO_2 + Eu nanopowders

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Investigations of the heat treatment influence on the luminescence of nanocrystalline ZrO_2 + 10 mol.% Eu were performed. Nanopowder with average crystallite size of 5 nm and Specific Surface Area (SSA) of 160 m^2/g was synthesized using hydrothermal-microwave synthesis method. Material was heated in air at temperature in range 400-850^oC during one hour. The microstructure and luminescence characteristics were done. We ascertained that grain growth and decrease of SSA occurred in the samples annealed at temperature higher than 400^oC. The most significant changes were observed for material heated at 850^oC when average crystallite size increased to 12 nm and SSA decreased to 35 m^2/g. We established that microstructure of the powders influenced their optical properties; the higher was annealing temperature, the lower was intensity of europium luminescence.

This work was supported by the project Eranet– MATERA- OXYN-

ANOSEN.

16:35 Poster 19

Nanosafety - chalange of nowadays

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Abstract

The influence of nanomaterials, especially nanoparticles, on environment and human health is steel an open question. It is supposed that contact with nanopowders by inhalation, skin exposure or swallowing may be dangerous and can cause hazardous health damages like mutations as well as high level of free radicals. That is why so big attention is paid to elaboration and application of very strict rules of handling and dealing with nanoparticles. For instance precaution principles concern special equipment like masks with fiber filters, gloves, glasses, special overalls and shoes. Working conditions have to guarantee personal safety by using of ventilating hoods, filters, nanopowders storage in colloidal suspension.

It should be stressed that materials characterization it is an essential step for nanoparticles final recognision as well as for elaboration of nano-safety principles. In Labotatory of Nanostructure for Photonic and Medicine of Institute of High Pressure Physics PAS, wide and professional characterization of nanopowders is performed using novel equipment which were bought thanks to participation in large EU projects like CEPT. Due to our experience in work with nanomaterials and great potential in materials characterization we participate in the international projects concerning nano-safety problems. At present we participate in European projects; NanoFate (nanoparticles fate in environment) and NanoForce (legal regulations like REACH, concerning rules of safety dealing with chemical substances and human health protection).

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Solvothermal synthesis of doped nano zinc oxide for the project NanoFATE.

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NanoFATE has been conceived to fill knowledge and methodological gaps currently impeding sound assessment of environmental risks posed by engineered nanoparticles (ENPs). Our vision is to assess environmental ENP fate and risk in example high-volume products for which recycling is not an option, namely; fuel additive, personal care and antibacterial products. Two market ENPs from each product (CeO2, ZnO, Ag of varying size, surface and core chemistries) will be followed through their post-production life cycles i.e. from environmental entry as “spent product”, through waste treatment to their final fates and potential toxic effects. This will test the applicability of current fate and risk assessment methods and identify improvements required for assessment of ENPs at an early stage.

Laboratory of Nanostructures for Photonics and Nanomedicine IHPP PAS is an expert in the synthesis of doped nanoparticles with small size distribution using microwave technology solvothermal synthesis (MSS). MSS technology allows precise control parameters of nanoparticle synthesis such as reaction time, temperature and pressure. Laboratory Nanostructures for Photonics and Nanomedicine IHPP PAS is responsible for providing the doped zinc oxide for project NanoFATE. We obtain the zinc oxide doped with cobalt ions with controlled content of dopant and particle size distribution in solvothermal synthesis which can be expressed as follows:

$$(CH_3CO_2)_2Zn + y(CH_3CO_2)_2Co \rightarrow Zn_{(1-x)}Co_xO$$

Synthesis of nano-zinc oxide doped with cobalt take place in solution of ethylene glycol during 25 minutes. Specific surface doped ZnO is 30-50 m^2/g and crystallites size are in a range from 20 to 50 nm.

DINNER
Thursday afternoon, 22 September, 16:50

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