Prof. Alicia de Andrés

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"Diluted and condensed wide gap semiconductors and oxides: the cases of Mn doped GaP and SnO2"

Diluted magnetic wide gap semiconductors and oxides with high ferromagnetic transition temperatures and spin polarized carriers are the paradigm for spintronics. However, so far, the theories describing the long range ferromagnetic correlations as well as the experimental results are still under debate. Now, in many cases, the formation of standard or exotic secondary phases inside the matrix is suspected to be responsible for the observed ferromagnetism. Nevertheless, these nanocomposite systems, where the nanocrystals buried in a semiconductor host may be ferromagnetic and metallic, are expected to originate new applications. Here we will focus on two different systems: III-V semiconductor, GaP, and oxide, SnO2, thin films, both doped with Mn. In GaP:Mn the formation of MnP nanocrystals with anomalous magnetic behaviour is detected and explained in terms of confinement effects. In SnO2:Mn, ferromagnetism is not detected in diluted films but occurs at high density Mn regions located at SnO2-MnO interfaces. The combination of the experimental results with simulations and ab-initio calculations, allowed us to understand the very different magnetic behaviours of these systems.

Dr. Anna BARANOWSKA-KORCZYC

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"Electrospun ZnO nanofibers – characterization and applications"

One-dimensional ZnO nanostructures such as nanowires and nanofibers have attracted growing interest in the recent years due to their optical and electronic properties. These unique features contribute to various applications in electronic and optoelectronic, including devices for sensing and biosensing. We constructed FETs (Field Effect Transistor) based on ZnO and core/shell ZnO/ZnS nanofibers. The first step was to form one-dimensional structures by electrospinning technique using a suspension of zinc acetate in polymer (PVA). Then the fibers were calcined (400 - 900ºC) in air to obtain ZnO nanofibers. Characterization was performed using TEM, EELS, XRD, AFM, SEM, EDX, PL and CL techniques. The nanofibers consisted of wurtzite ZnO crystals. Increased crystal sizes and intensity of the band gap emission were observed for higher temperatures of calcination. The nanofibers for FET sensors were calcined at 500ºC for 4 h. We observed the current increase when the nanofibers were immersed in liquids (water and ethanol). Additionally, the current increased three orders of magnitude when the nanofibers were exposed to the light (325 nm). Fabrication of biosensors require a surface passivation, for this reason we prepared core/shell ZnO/ZnS nanofibers and a FET based on these fibers. Moreover, we were looking for an alternative biosensor material that would be more stable in liquid environment. We synthesized GaN nanofibers. The research was supported by the European Union within European Regional Development Fund, through grant Innovative Economy (POIG 01.01.02- 00-008/08) and by the Ministry of Science and Higher Education (Poland) through Grant No. N518 424036

Prof. Jean-Michel CHAUVEAU

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"Growth and properties of nonpolar (Zn,Mg)O/ZnO heterostructures on ZnO bulk substrates"

ZnO-based quantum wells have attracted much attention due to their opportunity of combining band gap engineering, with large excitonic binding energies. So far studies on ZnO have mainly focused on films grown in (0001) orientation. The wurtzite ZnO layers exhibit built-in electric fields along the c-axis, affecting the electronic properties. Non-polar surfaces are of interest since the c-axis of the layer lies in the growth plane in this case. It is expected that QWs structures can be grown without any screening of the exciton binding energies. Wide band gap nonpolar QWs grown on sapphire usually exhibit a large density of stacking faults, reducing the emission efficiency. ZnO bulk substrates are commercially available in nonpolar orientations. Unfortunately, the as-received substrates require a dedicated annealing procedure to achieve atomically flat surfaces. In this presentation we show a drastic improvement of the structural properties when the QWs are grown on ZnO substrates: no residual strain, smooth interfaces, no extended defects, reduced surface roughness, reduced X-Ray FWHM. A strong enhancement of the photoluminescence (PL) properties is also demonstrated compared to heteroepitaxial QWs. We shall compare the different nonpolar orientations (m- or a-planes). The PL intensity of an m-plane QW is constant as a function of the temperature up to RT. Our results demonstrate the interest of homoepitaxial QWs for bright UV emission applications.

Prof. Marta CIEPLAK

Institute of Physics Polish Academy of Sciences, Al. Lotnikow 32/46, 02-668 Warsaw,
Poland

"Large enhancement of vortex pinning in superconductor-ferromagnet bilayers with tunable domain patterns"

Ferromagnet superconductor hybrids provide a fascinating example of systems in which there is a rich interplay between two seemingly incompatible collective phenomena. Particularly interesting is the impact of the ferromagnet on the dynamics of vortices in the superconductor. The magnetic domains control the location of the vortices. Exquisite control of the dynamics can be achieved by careful tuning of the geometry of the magnetic domains. The effect may be utilized to achieve high critical current density, which is a parameter important for the applications. In this talk I will present the results of recent experiments on superconductor(S)-ferromagnet(F) bilayers with a focus on understanding of the seemingly unpredictable dependence of the critical current density on the parameters of the experiment. In our experiments the S layer is made of niobium, the F layer is a Co/Pt multilayer with perpendicular magnetic anisotropy, and a thin insulating layer in-between eliminates proximity effect. We use various demagnetization and partial re-magnetization procedures to define different domain patterns in the F layer. We show that some domain patterns produce highly inhomogeneous flux penetration and strong vortex confinement at the sample edge, while for others there is remarkable enhancement of the critical current density in excess of

15. This is the highest value reported to date. We have measured, for the first time in a single tunable structure, the dependence of the activation energy for vortex pinning on the domain width, temperature, and magnetic field. In collaboration with L.Y. Zhu, X. M. Cheng and C. L. Chien (Johns Hopkins), Z. Adamus (Polish Acad. Sci.) and M. Konczykowski (Ecole Polytechnique). Supported by Polish MNiSW grant N202 058 32/1202, by EU grant POIG.01.01.02-00-108/09, by the NSF grant DMR05-20491, and by the French-Polish Program PICS 4916.

Prof. Marek EKIELSKI

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"3-D patterning of GaN using nanoimprint lithography"

GaN is becoming an increasingly important material system cross a diverse range of markets encompassing industrial and consumer applications, from high efficiency power switching, high power radio frequency, advanced optoelectronics, and sensors. The vast majority of advanced GaN-based devices require nanoscale patterning. Nanoimprint lithography (NIL) owing to its main advantages such as high resolution, high throughput and low cost is a powerful technique for nanoscale patterns fabrication and thus one of the preferred at the International Technology Roadmap for Semiconductors for the 32 and 22 nm nodes. Moreover, the technique is ideally suited for fabrication of periodic patterns such as optical nanostructures for LEDs and Photodetectors. Resistance to most chemicals makes GaN material very difficult for patterning. The most promising results in this respect have been obtained by applying Inductively Coupled Plasma (ICP) etching in chlorine-based gasses. In this talk principles of NIL and its application to sub-micrometers pattern generation in GaN will be presented. Special attention will be paid to (i) fabrication of silicon stamps for NIL by using e-beam lithography, and (ii) comparative study of ICP etching of bulk GaN material (AMMONO) and MOCVD grown epi-layers. Processing of the stamp is one of the most important parts of imprinting process. In this work the silicon stamps were made by a direct stamp fabrication method. For pattern definition e-beam writer with HSQ resist was used. The results concerning patterning of GaN using combined techniques such as NIL, e-beam, laser lithography and ICP etching will be presented. The research was partially supported by the EU within European Regional Development Fund, through grant Innovative Economy (POIG.01.01.02-00-108/09, "MIME").

Prof. Encarnacion GARCIA VILLORA

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"UV-visible-infrared Faraday isolators based on single crystal fluorides and oxides"

Faraday isolators (FIs) are unidirectional optical components mainly used in optical fiber communications and laser machinery. They preserve the performance of laser sources by blocking all kind of back reflections generated in the system. The main commercial materials used as Faraday rotators (FRs) are doped yttrium-iron-garnets (YIG) for wavelengths beyond 1100 nm, and terbium-gallium-garnet (TGG) for wavelengths below. YIG crystals are highly developed and present excellent properties in their transparent region. Instead, the TGG crystal is difficult to grow and process, as well as cost expensive. Even more, the use of this

compound in the visible region below 700 nm is notably hindered by the increasing optical losses. Consequently, at present there is a need to find new FRs with improved magneto-optical properties in order to satisfy the increasing demands for current applications. Our research focus on the one side on composition engineered Tb-garnets, namely Tb3Sc2Al3O12 (TSLAG). These compounds are isotropic like TGG and present a higher rotation power, a higher transparency (especially in the visible), and a higher damage threshold. Therefore, TSLAG crystals are indicated for high power lasers operating in the visible-near infrared region. On the other side we are also developing FRs for the ultraviolet-visible wavelength region, which can be used for ultraviolet-visible excimer lasers and laser diodes. For this kind of applications we center on widely transparent fluoride crystals containing a high concentration of rare earth FR ions, like CeF3, PrF3, and Tb(1-x)(Ca,Sr)xFy among others. The magneto-optical properties and figures of merit of these oxides and fluorides will be discussed.

Prof. Ewa GOLDYS

Macquarie University, North Ryde 2109 NSW, Australia

"Smart dust" plasmonic nanoparticles: nanoscale optical cavities"

Plasmonic nanoparticles with silver cores and silica shells containing Eu fluorophores near the surface produced by wet chemistry method exhibit reduced fluorescence lifetimes compared with the same fluorophores in free space conditions. These can be interpreted within the Purcell framework which highlights that the surface plasmon polariton modes of the nanoparticle behave as energy-storing resonators. Surprisingly, the structures show high Purcell factors of over 60, comparable with those observed in high quality semiconductor micropillar cavities. Such high Purcell factors result from very low mode volumes (~ 10 000 nm3 and comparatively high cavity Q factors (~ 100). Structures such as those are capable of lasing, provided a gain medium is introduced into the shell. We present the method and predictions of the lasing wavelengths and lasing threshold. We also demonstrate a simple diagnostic method that can identify the proximity of a given nanoparticle to the lasing threshold. Furthermore, we show that these structures can enhance the electric field by a factor of over 1500 (at 99.9% of threshold gain) and beyond. We discuss the implication of such enhancement for biosensing with these "smart dust" nanoparticles.

Prof. D. Hommel

Institute of Solid State Physics, University of Bremen, Germany

Single photon sources are a key element for quantum information technology. Compared to other concepts self-organized quantum dots can be easily incorporated into semiconductor devices and electrically driven. Unfortunately such devices based on InGaAs lub InGaP have a temperature range limited to less than 100K. Wide-bandgap semiconductors like ZnSe and GaN with a high exciton binding energy are suited for room temperature emission. Recent results on CdSe and InGaN quantum dots (QDs) will be reported.

CdSe QDs in a ZnSe matrix grown by MBE showed antibunching up to 200K [1]. Improving the carrier confinement by introducing thin MgS barriers and replacing ZnSe by ZnSSe with about 30% suphur the emission of a single quantum dot could be detected up to

300K under optical and electrical pumping [2, 3]. We could show recently for the first time single photon emission from one CdSe/ZnSSe/MgS quantum dot up to room temperature [4]. For this photon correlation measurements were performed using a Hanbury-Brown_Twiss-Setup. Even under continuous wave excitation, a striking antibunching behavior is found up to T = 300 K. Second-order correlation measurements reveal a surprisingly low value of $g^{(2)}(\tau)$ = 0.15 for zero time delay even at room temperature, confirming the high potential of these quantum dots for future single photon emitting devices operating under ambient conditions.

InGaN dots have been grown by MOVPE on a sapphire substrate with n-GaN buffer and GaN cap layer. In contrast to GaN QDs the InGaN dots are formed by spinodal and bimodal decomposition [5]. Emission from single InGaN QDs was observed under electrical pumping up to 150K [6]. Such dots have been successfully integrated into fully monolithic microcavities and electroluminescence has been observed as well [7, 8].

The sample under study showed μ-PL of a single quantum dot at 2.915eV up to 130K. A surprisingly strong linear polarization of 96% was observed. Single photon emission was observed up to 50K. The correlation function of the antibunching $g^{(2)}$ was 0.21 for 10K and 0.33 for 50K respectively. Micro-electroluminescence measurements of the same sample with an additional p-GaN cladding are performed at present.

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Prof. Grzegorz KARCZEWSKI

Institute of Physics Polish Academy of Sciences, Al. Lotnikow 32/46, 02-668 Warsaw, Poland

"CdTe-based solar cells"

In order to enhance the quantum efficiency of CdTe-based SCs from the today's record of 16.5% towards the theoretical limit of 27%, i.e., to make a significant progress beyond the state-of-the-art, we work on optimization of solar cells based on p-n CdTe homojunctions. The essence of this work is to eliminate the CdS/CdTe heterojunction by replacing it by CdTe homojunction to reduce the carrier scattering on defects and impurities and, thus, to increase

the photocurrent. The second alteration of the architecture of CdTe-based solar cells relies on adopting on graded composition p-type CdZnTe absorber. Composition of the absorbers is adjusted to the solar light spectrum at the earth surface. An extra advantage of employing the graded CdZnTe absorber arises from the fact that a pure, highly p-type doped ZnTe layer will be placed at the top of the device providing both, the transparent window and the good contact layer. The significant progress in doping of wide-gap II-VI materials made in last years opens the new perspectives for such homojunction devices. The molecular beam epitaxy (MBE) technique enables controlling of the doping process in Cd(Zn)Te in the wide range: 10^{15} – 10^{19} cm^{-3} for the n-type doping and 10^{15} – 10^{18} cm^{-3} for the p-type doping. The donors (Iodine) are supplied from a ZnI2 effusion cell, the acceptors (Nitrogen) from an N-plasma cell.

Dr. Iwona KOWALIK

Institute of Physics Polish Academy of Sciences, Al. Lotnikow 32/46, 02-668 Warsaw, Poland

"Soft x-ray spectroscopy and microscopy on functionalized Diluted Magnetic Semiconductor films"

We present results of magnetic investigations at room temperature on (Ga,Fe)N films by means of soft x-ray based element specific and spin sensitive spectroscopy. The studied samples were grown by MOVPE and studied previously by SQUID magnetometry, transmission electron microscopy, synchrotron radiation based x-ray diffraction techniques, as well as by EXAFS and XANES. In order to establish a relationship between the nanocrystal structure and their magnetic properties we carried out measurements of XMCD, XLMD and XMCD-PEEM on the Fe L-edge and XMCD on the N-K edge. Here we complement these results by means element specific dichroic spectro-miscroscopy using synchrotron radiation soft x-rays as the excitation source. XAS micrographs taken by X-PEEM at the Fe L-edges indicate that Fe is incorporated both on Ga substitutional sites in the GaN lattice as well as self-assembled FexN nanocrystals with sizes up to 80 nm. The XAS micrographs confirm that the Fe atoms are embedded in different local environments. By means of XMCD-PEEM we identify magnetic Fe-rich nanocrystals and study their magnetic domain structure. XMCD contrast from nanocrystals with a lateral size of 40 nm is clearly visualized. The obtained set of findings allows to identify both ferromagnetic and non-ferromagnetic nanocrystals. The present set of data illustrates the complementarity of X-PEEM and XMCD-PEEM with low noise XAS and XMCD measurements without spatial resolution.

Dr. Tomasz KRAJEWSKI

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"Schottky junctions based on the ALD-ZnO thin films for electronic applications"

Most of the advanced electronic applications of zinc oxide (ZnO) is based on the Schottky junction revealing sufficiently high rectification ratio. Construction of a good quality Schottky contacts to ZnO still remains a scientific challenge due to the reported high n-type conductivity of ZnO. The predicted electron concentration in ZnO to form a Schottky junction

is not higher than $10^{16} – 10^{17}$ cm^{-3}. This assures the low value of the diode's reverse current, whereas high carrier mobility is needed for its high enough driving current. However, the discrepancy between the Schottky barrier height and metal workfunction arises due to the presence of the interface states in the junction. This strongly affects the oxide/metal interface and deteriorates the rectification ratio. This work demonstrates the ZnO-based Schottky junctions with silver, in which zinc oxide films were grown at low temperature by Atomic Layer Deposition method using either diethylzinc or dimethylzinc and deionized water as precursors. Our layers were deposited at the temperature range between 60°C and 200°C. We compare the electrical characteristics of ZnO-based diodes obtained in different conditions, i.e. after post-growth annealing, for ZnO doped with nitrogen and diodes with thin dielectric film (HfO2) introduced between ZnO and the Ag Schottky contact. We show that the factors mentioned above strongly affect the diodes' rectification ratio. Some modelling based on the thermionic emission theory will also be presented. The research was partially supported by the European Union within European Regional Development Fund, through grant Innovative Economy (POIG.01.01.02-00-008/08) and by grant of the National Science Center of Poland (1669/B/H03/2011/40).

Prof. Alexander KUKHTA

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"Organic based nanocomposites and nanostructures and applications"

Thin film nanostructures based on π-conjugated organic compounds and π-conjugated based on their combination with inorganic nanoparticles attract wide attention of researchers owing to both the unique properties and the possibility of manifold practical applications. In such nanostructures the optical and electrophysical properties depend essentially on molecular structure and solid state organization. In this talk a short review on the studies of some optical and electrophysical properties and applications of organic and organic-inorganic thin film nanostructures made in the B.I.Stepanov Institute of Physics of the National academy of sciences of Belarus jointly with other researchers are presented. The effect of the substrate nature, the molecule structure, and the deposition rate on optical and luminescent properties, morphology and photostability, is shown using dibenzoxazolylbiphenyl derivatives as typical example. It was revealed the reversible molecular reorganization resulting to the formation of partially ordered structures with luminescence polarization and radiating ability depending on the film temperature below the glass transition. The presence of oxygen was found to cause the essential luminescence quenching. The effect of adsorbed oxygen on electrophysical properties of some organic thin film nanostructures was also found. The different kind additives are widely used to change polymer properties. The examples of additives are conductor (metal) or semiconductor (organic and inorganic) nanoparticles with a shell from organic material. We found that insertion of aromatic thiol into the shell of silver and gold nanoparticles in thin films based on polyepoxypropylcarbazole matrix results in the conductivity increase several orders of magnitude depending on temperature. IR spectroscopy data are the evidence of the formation of bond between SH functional group and nanoparticle surface. The strong conductivity dependence on oxygen concentration has been observed for polythiophene-Au nanoparticles nanocomposite. Cathodoluminescence of the composite based on polyfluorene and CdS nanoparticles was observed. New electroactive materials based on dibenzoxazolylbiphenyl derivatives as well as doped and grafted polymers, conducting and cathodoluminescent nanocomposites, nitrogen dioxide sensor, etc. are proposed.

Dr. Grzegorz LUKA

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"ZnO and ZnO:Al films grown by atomic layer deposition for organic electronics"

We present the growth and properties of ZnO and aluminum-doped ZnO (ZnO:Al) films obtained by the atomic layer deposition (ALD) method using zinc and aluminum organic precursors, i.e. diethylzinc (DEZ) and trimethylaluminum (TMA), respectively. We analyze the possible source of high conductivity in the undoped ZnO films. For ZnO:Al films, we show that the aluminum distribution within the layers is uniform and no foreign Al phases are observed, even in films with the Al content as high as 8 at.%. Finally, we present the application of ZnO films in two organic-based structures. The first one is a photodiode with ZnO/nickel-phthalocyanine (NiPc) p-n junction. The presence of ZnO layer in the structure not only improves its characteristics comparing to the same structure without ZnO, but also improves the time stability of the device. The second obtained structure is an organic light emitting diode with conductive undoped ZnO film as transparent anode and tris(8-hydroxyquinolinato)aluminium (Alq3) as an emitting layer. The device achieves higher current efficiency comparing to the same structure but with ITO as anode layer. This work was partially supported by the European Union within the European Regional Development Fund, through the Innovative Economy grant (POIG.01.01.02-00-108/09).

Prof. Matthew PHILLIPS

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"Cathodoluminescence spectral imaging of zinc oxide and III - nitride nanostructures and devices"

CL spectral imaging, where an entire spectrum is measured at each pixel, significantly expands the capabilities of CL microanalysis by enabling correlative statistical analysis of the whole CL spectral map data set. In this work, CL spectral imaging has been used to study electron beam induced irradiation effects in InGaN/GaN multiple quantum wells (MQW) devices and deep level defects in ZnO nanorods. Electron irradiation (8- 15 kV) of the InGaN MQW LED structure at 300K produced pronounced changes in a Lorentzian MQW emission at 2.64 eV (FWHM = 0.12 eV). Curve fitting of time-resolved full spectrum data indicates that following an initial increase, the MQW intensity at 2.64 eV falls as a new Gaussian emission rises at 2.70 eV (FWHM = 0.23 eV). A spatially resolved composite pesudo-colour map of the peak shift can be produced by assigning different colours to specific region of interest bands across the MQW emission. These data show that the peak shift is constant across all of the electron beam exposed area while blue shifted MQW regions present in the pristine sample remain unaffected. The origin of this peak shift will be discussed. Similar spatially-resolved intensity ratio imaging of the cross-section of ZnO nanorods have been measured using the deep level emission (DLE) bands and near band edge (NBE) emission. This analysis reveals that the DLE and NBE are anti-correlated and the green DLE is mainly localised at the surface of the nanorod along the growth axis.

Prof. Czeslaw SKIERBISZEWSKI

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True blue and green laser diodes (LDs) are one of the key challenges for epitaxy of nitrides due to variety of its potential applications like e.g. TV projectors, medicine diagnostics, environmental protection. Very recently, green LDs at 500 - 530 nm have been demonstrated in nitride-based structures grown by Metal Organic Vapour Phase Epitaxy (MOVPE) either on polar, semipolar and nonpolar substrate orientations. On the other hand, the progress in understanding the new growth mechanism for nitrides in Plasma Assisted Molecular Beam Epitaxy (PAMBE) has led to the demonstration of blue-violet laser diodes [1], which in turn has renewed interest in this technology. For ammonia free PAMBE, the growth mechanism is entirely different from that in MOVPE, and allows the growth of device-quality nitride structures at temperatures lower by 300°C versus those used in MOVPE [2,3]. Therefore it is highly interesting whether PAMBE can be useful for high In content structures required for true blue and green emitters.

In this work we demonstrate LDs grown by PAMBE in the range 410nm - 460nm. We also present optically pumped lasing from Single Quantum Well (SQW) InGaN laser structures in the range 470 – 500 nm. The LDs were grown on different c-plane bulk GaN substrates with treading dislocations ranging from 10^3 cm^{-2} to 10^7 cm^{-2}. We will discuss the InGaN growth conditions in PAMBE which led us to obtain efficient SQWs for lasing from violet to green optical spectral region. We will discuss the influence of (a) claddings thickness (b) waveguide design and (c) electron blocking layer height on the performance of LDs.

Our results show that further optimization of the LDs design and growth parameters should allow extending PAMBE-grown LDs lasing wavelength to the green spectral region.

Keywords: GaN, laser diodes, molecular beam epitaxy, InGaN growth.

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Prof. Andrzej SOBOLEWSKI

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"PROTON TRANSFER REACTION AS A MECHANISM FOR CONTROLLING ELECTRICAL TRANSPORT IN SINGLE MOLECULE JUNCTION"

Electrical transport in molecular junction, where single molecule is bound to metal or semiconductor electrodes, has been of great interest recently. Molecular junction represents a prototype system to investigate nonequilibrium physics at the nanoscale and, furthermore, may provide the building blocks for future nanoelectronic devices in the field of molecular electronics. An important aspect in this respect is the possibility to influence and control the

conductance of a molecular junction by external parameters. Recent theoretical studies show that in molecule which subjects to intramolecular proton transfer reaction [1], the various tautomeric forms ("enol" and "keto", for instance) can realize different conductance states of a molecular junction [2]. The reversibility of such reaction has recently been proven experimentally [3]. In the presentation, the results of theoretical investigations of proton transfer reaction in a molecular junction triggered by static or optical external fields will be discussed as a mechanism to control electrical transport. [1] A.L. Sobolewski, Phys. Chem. Chem. Phys, 10 (2008) 1243. [2] C. Benesch, M. F. Rode, M. Cızek, R. Hartle, O. Rubio-Pons, M. Thoss, and A. L. Sobolewski, J. Phys. Chem. C, 113 (2009) 10315. [3] L. Lapinski, M. J. Nowak, J. Nowacki, M. F. Rode, A. L. Sobolewski, ChemPhysChem., 10 (2009) 2290

Dr. Wojciech SLYSZ

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"Ultrathin NbN films for superconducting detectors"

NbN films are applied in newly developed superconducting single-photon detectors (SSPDs) and hot electron bolometer mixers desirable in fields of optical communication, quantum optics and quantum cryptography. The detectors operate due to photon-induced resistive hot spot in electron current flowing through ultrathin superconducting stripe. Typically, the stripe is made of NbN film, which is deposited on sapphire or MgO single-crystal wafers. However, currently proposed new superconducting receivers directly integrated with advanced optoelectronic structures, such as distributed Bragg reflectors, optical waveguides or plasmonic nano-antennas, require some new optoelectronics-compatible substrates. Our research on fabrication of the SSPDs includes ultrathin NbN layers deposited on single-crystals and also on SiO2 and Si3N4 films grown on Si wafers. The films reactively RF sputtered from the Nb target in a nitrogen/argon plasma were fully characterized including structure, electrical transport, optical transmission and reflection, refraction and extinction coefficients. The NbN absorption coefficient dependence on the film thickness gave an estimate of the intrinsic quantum efficiency near 20 % at 1550 nm operation of the detector. High epitaxial quality of the NbN films were confirmed by TEM study. Transport measurements showed that even the 6 nm thick NbN films is characterized by the superconducting critical temperature Tc above 10 K. The highest Tc of 14 K was revealed on the thicker NbN films. A progress in development of SSPDs specifically designed for high-speed quantum communications will be discussed. The work was financially supported by the European Regional Development Fund through grant Innovative Economy (POIG.01.01.02-00-108/09).

Dr Michal SZOT

Institute of Physics Polish Academy of Sciences, Al. Lotnikow 32/46, 02-668 Warsaw, Poland

"PbTe/CdTe heterostructures for optical and thermoelectrical applications"

The PbTe/CdTe heterosystem is very attractive since it can be used in very efficient light sources in the form of rock-salt PbTe quantum wells or dots as well as can be implemented in thermoelectric devices as nanocomposite material composed of zinc-blende CdTe anti-dots in

PbTe thermoelectric matrix. These semiconductors exhibit excellent matching of their lattice parameters but posses different crystal structures what results in atomically sharp interfaces. In this talk growth procedures and experimental examination of structural, optical and electric properties of low dimensional epitaxial PbTe/CdTe structures as well as Pb(1-x)Cd(x)Te bulk monocrystals obtained by physical vapor transport method will be present. Applied two steps growth procedure allows control the size (from 5 to 30 nm) and distribution of PbTe dots and CdTe anti-dots in epitaxial heterostructures. It will be shown that doping with Eu or Cd ions enables significant tuning of luminescence energy from PbTe quantum wells and bulk samples, respectively. Both, n- and p-type conductivity of layered nanocomposite with CdTe anti-dots can be obtained by stoichiometry control. The thermoelectric power of PbTe/CdTe nanocomposite with the smallest CdTe anti-dots shows at 300 K increase up to 25 % as compared to reference bulk n-PbTe crystals. Work supported in part by the EU within the European Regional Development Fund, through the Innovative Economy grant (POIG.01.01.02-00-108/09).

Dr. Lukasz WACHNICKI

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”Zinc oxide deposited on gallium nitride by Atomic Layer Deposition”

Atomic Layer Deposition method was invented by Suntola in 1980 and was originally used to obtain monocrystalline films on monocrystalline substrates. At present ALD is used to produce high quality polycrystalline and monocrystalline semiconductor and high-k oxide films. The main advantage of this method is possibility of low temperature growth at surfaces with highly developed morphology. Zinc oxide is very prospective material because of a large variety of potential applications. For example, it can be used in light-emitting diodes and transistors and transparent conductive oxide in solar cells. Especially in combination with others materials, such as e.g. gallium nitride zinc oxide allows obtaining several new devices. In this work we report on properties of zinc oxide deposited on different GaN substrates from a monocrystalline layer to nanorods. We demonstrate ability ALD to produce the core-shell structures. We also show deposition of ZnO nanostructures by the ALD method. Optical and structural characterization of these structures was performed by photoluminescence, scanning electron microscope and atomic force microscope. The research was supported by the European Union within European Regional Development Fund, through grant Innovative Economy (POIG.01.01.02-00-008/08).

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“Oxide nanomaterials for photoelectrochemical applications”

High expectations concerning new and attractive applications in the field of photoelectrochemistry stimulate the research in the nanotechnology and nanostructured materials. Nanosized metal oxides based on TiO2 offer much promise for an efficient conversion of solar energy into hydrogen in the process of water photolysis. Hydrogen is considered as a prospective energy carrier to replace the traditional fossil fuels. Modified

TiO2 is particularly well suited to act as a photoanode in photoelectrochemical cells, PEC. The presentation will cover the recent work, see for example [1,2], performed on oxide nanomaterials prepared in the form of powders, ceramics and thin films with the purpose to use them in PEC devices. Special emphasis will be put on the correlation between the nanostructure and the physical properties of the materials under study. The results of measurements aiming at the structural and chemical characterization of nanomaterials such as SEM (Scanning Electron Microscopy), TEM (Transmission Electron Microscopy), AFM (Atomic Force Microscopy), BET (Brunauer-Emmett-Teller) nitrogen adsorption isotherms, XRD (X-ray diffraction), RBS (Rutherford backscattering) will be reviewed. Spectroscopic methods including XPS (X-ray Photoelectron Spectroscopy) and optical spectrophotometry provide the insight into the electronic structure. The results of electrical measurements of the dc conductivity and impedance spectra will be presented. Finally, the most important issues related to the applications will be discussed in detail. Configuration of experiments for hydrogen generation will be shown. The fundamental factors such as a flat band potential and forbidden band gap, affecting the functional behavior will be pointed out. Acknowledgement The financial support of the Polish Ministry of Science and Higher Education (2009-2012) within the project NN515 080 637 is highly acknowledged. References [1] A. Trenczek-Zajac, M. Radecka, K. Zakrzewska, A. Brudnik, E. Kusior, S. Bourgeois, M.C. Marco de Lucas and L.Imhoff, Structural and electrical properties of magnetron sputtered Ti(ON) thin films: the case of TiN doped in situ with oxygen, J. Power Sources 194, (2009) 93-103 [2] M. Radecka, M.Rekas, E.Kusior, K.Zakrzewska, A.Heel, K.A.Michalow, and T.Graule, TiO2-based nanopowders and thin films for photocatalytical applications, J. Nanosci. Nanotechnol., 10 (2010) 1032-1042

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“Mn-doped YAlO3 crystals and ceramics as a material for thermoluminescent detectors of ionizing radiation”

Yttrium orthoaluminate (YAlO3), called also yttrium aluminum perovskite (YAP), is widely known as a host material for solid-state lasers and scintillators. Thermoluminescent (TL) properties of the manganese-doped YAlO3 crystals above room temperature have been intensively studied by us previously due to an application potential of the material for TL dosimetry of ionizing radiation. A relatively high sensitivity to ionizing radiation, a linear dose response at least up to 1 kGy and the optical emission in visible are the most attractive properties of the material. In spite of the relatively high effective atomic number, this material is a good candidate for middle- and high-dose dosimetry of ionizing radiation, especially when tissue equivalence is not needed. This contribution presents main dosimetric properties of TL detectors based on YAP:Mn crystals. Origin of the deep trap centers responsible for thermoluminescence of YAP crystals above room temperature will be discussed as well a role of manganese ions in the recombination processes will be described. Besides, an influence of the technological conditions of the material fabrication (in the form of single crystals or ceramics) on the thermoluminescent response of the material will be defined.