24th International Young Scientists Conference Optics and High Technology Material Science - SPO 2023 ”STAND WITH UKRAINE”

Report of Contributions

Contribution ID: **125** Type: **Invited Talk**

Multiferroics: controlling magnetism with electric fields

Friday, 17 November 2023 10:40 (30 minutes)

Multiferroic materials, which exhibit multiple ferroic orders simultaneously, have garnered significant scientific interest thanks to their potential for electric-field control of magnetism. These materials present unique domain formations and poling behavior under external fields. Here, we will showcase a remarkable reversible transfer of domain patterns between magnetization and electric-polarization spaces in $Dy_{0.7}Tb_{0.3}FeO_3$ (DTFO) – the ideal multiferroic material. A magnetic field can impress a ferromagnetic domain pattern onto an identical ferroelectric domain pattern, effectively erasing the original magnetic domain. The process can be reversed, completing a cycle of domain transfer. This attribute of DTFO extends our understanding of domain coupling in multiferroics and opens up new possibilities for their application.
Ref.: Hassanpour.... Weber, Science 377, 1109–1112 (2022)

Topics

Session A. Physics of condensed matter and spectroscopy

Contact Email address

Primary author: Dr WEBER, Mads C. (Le Mans University / Institute of Materials and Molecules Le Mans)

Presenter: Dr WEBER, Mads C. (Le Mans University / Institute of Materials and Molecules Le Mans)

Session Classification: Multiferroics and Magnetoelectric Coupling

Contribution ID: **126** Type: **Invited Talk**

Nanoscale Imaging of Ferroic Order with Soft X-ray Ptychography

Friday, 17 November 2023 11:10 (25 minutes)

Soft X-ray ptychography is a scanning coherent diffractive imaging technique employed at synchrotron facilities. It relies on collecting diffraction patterns from overlapping illumination spots of the sample. Spatial resolutions in the order of 5 nm are achievable and ferroic order can be visualised by dichroic contrast with circularly or linearly polarised soft X-rays at the 3d transition metal L-edges. An example for the success of the technique is the imaging of the multiferroic domain structure of bismuth ferrite, which will be the focus of the presentation.

Topics

Session A. Physics of condensed matter and spectroscopy

Contact Email address

Primary author: Dr BUTCHER, Tim A. (Paul Scherrer Institute, Switzerland)

Presenter: Dr BUTCHER, Tim A. (Paul Scherrer Institute, Switzerland)

Session Classification: Multiferroics and Magnetoelectric Coupling

Contribution ID: **127** Type: **Poster**

Change in microhardness of iron-copper nanocomposites depending on the content of multi-walled carbon nanotubes

Friday, 17 November 2023 15:00 (5 minutes)

The use of mechanochemical activation of metal powders and their mixtures in planetary mills opens wide prospects for the creation of new nanocomposite materials. Mechanochemical synthesis provides the possibility of obtaining a uniform distribution of the dispersed phase, of expanding the solubility limits of elements, of reducing the grain size to the nanoscale, and of obtaining new crystalline and quasi-crystalline phases. The paper investigated the dependence of the microhardness of samples of iron, copper (Fe-Cu) and iron, copper with multi-walled carbon nanotubes on the time of processing in a planetary ball mill and the influence of multi-walled carbon nanotubes on the microhardness of nanocomposites Fe-Cu with multi-walled carbon nanotubes. Microhardness in the work was studied on the multifunctional device "Micron-Gamma" by the method of continuous indentation. A detailed study of the dependence of the microhardness of Fe-Cu (4:1) and Fe-Cu (6:1) nanocomposite materials on the processing time in a planetary ball mill (20 min, 60 min, 120 min) was carried out at loads of 20, 50 and 100 grams. It has been established that the mechanochemical activation of a mixture of Fe and Cu powders in a planetary mill and their interaction, which changes the dispersion, morphology, and phase composition of the processed particles, open the prospects for the creation of composite materials with fundamentally new physical and mechanical characteristics necessary for the use of these nanocomposites as structural materials in instrument building and the aerospace industry.

Topics

Session A. Physics of condensed matter and spectroscopy

Primary authors: MELNICHENKO, Mykola (Taras Shevchenko National University of Kyiv); Prof. REVO , Sergiy (Taras Shevchenko National University of Kyiv); Prof. ZHUK, Yaroslav (Taras Shevchenko National University of Kyiv)

Presenter: MELNICHENKO, Mykola (Taras Shevchenko National University of Kyiv)

Session Classification: Poster session

Contribution ID: **128** Type: **Poster**

Influence of Environment on Vibrational Spectra of Hydrogen-Bonded Clusters

Friday, 17 November 2023 15:05 (5 minutes)

Quantum-chemical calculations (by DFT method in B3LYP/cc-pVTZ approximation) of optimal structure and vibrational spectra of water and methanol clusters in different media were carried out using Gaussian 09 software. Water clusters consisting of from one to six molecules in vacuum, water and argon media were considered. By comparison of the calculated IR absorption spectra of clusters in different media it is shown that the environment affects the spatial structure of hydrogen-bonded clusters of water molecules, and this influence is manifested in the shifting of the vibrational bands.
Similar calculation was made for methanol clusters (monomer, dimer, trimer) in vacuum, methanol, water and argon. Different shifts for different media were observed. It is shown that the influence of argon is greater than the influence of methanol.
The calculated IR absorption spectra of water and methanol clusters in different environments were compared with the corresponding spectra in vacuum, and so the spectral shifts for all IR bands were determined. The determined spectral shifts can be considered as matrix shifts observed during the experimental study of alcohol and water clusters in low-temperature argon matrices. In particular, it is shown that the presence of argon has a stronger effect on the structure of methanol clusters than their surrounding by methanol molecules, so the vibrational spectra of methanol in matrix isolation will be different from the vibrational spectra of methanol in a liquid or gaseous state.

Topics

Session A. Physics of condensed matter and spectroscopy

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Presenter: Ms ONUK, Marta (Taras Shevchenko National University of Kyiv)

Session Classification: Poster session

Contribution ID: **129** Type: **Invited Talk**

Probing the Electric-Field Induced Antiferroelectric-Ferroelectric Phase Transition in PbZrO3 with Second Harmonic Generation Imaging

Friday, 17 November 2023 11:35 (25 minutes)

The physics of electric-field-induced phase transitions in ferroelectric materials has attracted considerable attention for promising future use in a variety of new-generation electronic devices. Even more, control of the antiferroelectric-ferroelectric phase transition of antiferroelectric thin films is necessary for highly efficient data storage, sensing, and energy harvesting applications. Consequently, there is a need for the development of thorough characterization methods of thin antiferroelectric films. In this study, we present an innovative approach utilizing second harmonic generation (SHG) imaging to probe and image the field-induced antiferroelectric-ferroelectric phase transition in PbZrO3.
Second harmonic generation (SHG) imaging has emerged as a robust and non-invasive technique that enables the direct observation of structural and polarization changes in materials exhibiting ferroic order. Through the analysis of the symmetry in the second-order nonlinear optical response, SHG imaging provides exceptional insights into the domain structure and polarization states associated with specific ferroic phases. In this work, we study a high-quality single crystal of PbZrO3 with a thickness of 50 nm, grown using the PLD technique on a SrTiO3 substrate. By employing a state-of-the-art SHG microscope in the transmission geometry, we recorded the dynamics of the antiferroelectric-ferroelectric phase transition. The experimental setup involved illuminating the sample with 900 nm pulses and capturing an intensity map at 450 nm wavelength using a photon multiplied camera. The controlled in-plane electric field strength and direction allow for comprehensive investigations of the phase transition dynamics in PbZrO3.
Our preliminary findings provide valuable insights into the underlying mechanisms governing the phase transition conditions, where we image the dynamics of the field-induced transition between the polar and nonpolar phases in PbZrO3. These findings could be beneficial for the development of advanced materials with tailored functionalities, such as high-performance dynamic-random access memory and energy storage systems.

Topics

Session A. Physics of condensed matter and spectroscopy

Contact Email address

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Presenter: Dr LEVCHUK, Artem (CEA-Saclay)

Session Classification: Multiferroics and Magnetoelectric Coupling

Contribution ID: **130** Type: **Poster**

Determination of optical constants for heterostructures with inner layer of Cu (Ag) by ellipsometric method

Friday, 17 November 2023 15:10 (5 minutes)

The heterostructures of $Cr_1Ag_{45}TiO_2$, $Cr_{1.2}Cu_{40}TiO_7$, and $Cr_{1.2}Cu_{43}$, prepared by chemical vapour deposition method were investigated using ellipsometric measurement method in order to calculate optical constants by two models namely Tautz-Lorentz and the effective medium model at the vicinity of the principal angle of the light incidence. Each sample contains a buffer layer of chromium that was deposited on quartz glass. Besides thin upper layer of TiO_2 was deposited on sample by high-frequency magnetron sputtering.

As a result of optical measurements, within the range from $190nm$ to $25\mu m$ and carried out by Semilab SE-2000 device, two ellipsometric parameters ψ (an azimuth of the restored linear polarization) and Δ (a phase shift between the p- and s-components of the polarization vector) were obtained, then the values were compared for the given heterostructures including a thin layer of copper and silver. Thereby it was found that upper layer of TiO_2 deposited on surface does not significantly affect the absorption of these structures in the selected wavelength range. Eventually it was demonstrated 8% difference between the values of the reflection coefficient for the Tautz-Lorentz model and the values for the effective medium model. In addition it was found that heterostructure which contains only a pure layer of copper without upper layer of TiO_2 gives the largest difference for the values of the reflection coefficient when compare these two models (approximately n- 10%, κ-15%, σ- 4%, R-10%) and may indicate the formation of such oxide film on sample surface.

Topics

Session A. Physics of condensed matter and spectroscopy

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Presenter: Mr HYRMAN , Igor (Taras Shevchenko National University of Kyiv)

Session Classification: Poster session

Contribution ID: **131** Type: **Poster**

Luminescence from ZnO Nanomaterial due to Defect Centers

Friday, 17 November 2023 15:15 (5 minutes)

The potential of Zinc oxide (ZnO) nanophosphor material as a host for optoelectronic applications was investigated in this study. ZnO nanoparticles were synthesized using the co-precipitation method, followed by sintering at a maximum temperature of 700℃ in air. The sintering process was carried out in a custom-made temperature-controlled muffle furnace with a precision of ±1℃, reaching a maximum temperature of 1200℃. All sintered powder samples underwent characterization using XRD, SEM, FTIR, UV-VIS, and photoluminescence (PL) techniques. XRD analysis confirmed the formation of nano-material with a hexagonal wurtzite phase. SEM images revealed the spherical shape of the prepared particles, which tended to agglomerate at higher temperatures. FTIR spectroscopy indicated absorption at 430 cm^(-1), corresponding to the Zn-O (metal-oxygen) bond, confirming the formation of ZnO. UV-VIS analysis exhibited strong band-edge absorption in the UV region, particularly around 370 nm. Photoluminescence studies, conducted with various excitations of UV light, demonstrated broad emission in the visible region attributed to defect centers in ZnO. This investigation explores the potential of ZnO to serve as an effective host material. The anticipation is that, when doped with a suitable metal, ZnO will exhibit broad emission ranging from 400 to 700 nm, making it a promising candidate for a white light source in optoelectronic applications.

Topics

Session B. Laser physics and modern optoelectronics

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Presenter: LIMBU, Abhay (Lovely Professional University)

Session Classification: Poster session

Contribution ID: **132** Type: **Oral**

Photophysics of the fluorescent guanine analog tzG

Friday, 17 November 2023 12:15 (15 minutes)

The development of environmental sensitive fluorescent nucleoside analogues (FNA) to site-selectively characterize the structure and dynamics of nucleic acids is of high demand [1]. One of the perspective FNA is isothiazologuanosine (tzG) [2], an isomorphic and isofunctional FNA of guanosine (G). tzG can faithfully substitute G in non-canonical nucleic acid structures. tzG spectroscopic response to different environmental changes is critical to fully understand its photophysics and correctly interpret its spectroscopic signatures when it is inserted into nucleic acids.

In this work, we performed the fluorescence spectroscopy measurements of free tzG in different solvents and quantum mechanical (QM) calculations to characterize the mechanisms underlying tzG photophysics. In aprotic solvents, mainly tzG-H1 keto-amino tautomer is present and possesses short fluorescence decay (τ ~ 2 ns) and low quantum yield (ϕ ~ 0.10). In buffer, tzG-H1 and tzG-H3 keto-amino tautomers coexist in ground-state equilibrium and tzG-H1 is the main emitting species (ϕ = 0.36, τ = 8.84 ns). The two tautomers were also observed in methanol, but with a 30% decrease in ϕ and τ values for the major H1 tautomer and decreased population of tzG-H3 tautomer. QM calculations revealed the main non-radiative pathway of tzG-H1 caused by NS bond loosening, which is responsible for the solvent-sensitive ϕ and τ values. The study lays the ground for rationally using tzG as a sensitive FNA.

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[2] Rovira, A. R. et al., J. Am. Chem. Soc. 2015, 137 (46), 14602–14605.

Topics

Session D. Biomedical optics and sensors technology

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Presenter: TKACH, Olha (Laboratoire de Bioimagerie et Pathologies, UMR 7021 CNRS Universit´e de Strasbourg, Facult´e de pharmacie)

Session Classification: Emergent biosensing technologies

Contribution ID: **133** Type: **Oral**

Engineering thermoresponsive polymer coating on plasmonic nanostructures for drug delivery applications

Friday, 17 November 2023 12:30 (15 minutes)

Drug delivery is a method of administering a drug to achieve a therapeutic effect in humans or animals [1]. Over the past two decades, many ways to create controlled drug delivery systems have emerged, among which systems based on plasmonic metals, particularly gold, stand out. Due to their bioinertness, ability to be heated under laser irradiation at different wavelengths depending on size and morphology, surface functionalization capabilities and ability to accumulate in tumors, gold nanoshells have become one of the best solutions for use in the fight against cancer cells.
The main idea of our investigation is to create a drug delivery system based on gold nanoshells covered by thermoresponsive polymer poly(N-isopropylacrylamide) (pNIPAM). When a near-infrared laser irradiates the nanostructure, gold heats up and polymer changes its structure from hydrophilic to hydrophobic, thus opening pores and releasing the loaded drugs outside. Using a specialized iniferter with SH- group for binding with metal makes RAFT polymerization much easier and with fewer stages.
By performing spectrophotometric measurements, it was found that application of iniferter to colloidal citrate-coated gold nanoshells leads to their aggregation and blocks pNIPAM synthesis. Alternatively, the creation of a thermoresponsive polymer layer simultaneously with the synthesis of seed silver nanoparticles was successful. As a result of performed studies, it was demonstrated that a thermosensitive polymer coating should be synthesized in a way to avoid the replacement of a stabilizing layer on plasmonic nanostructures, which would also reduce the complexity of the fabrication protocol.

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Topics

Session D. Biomedical optics and sensors technology

Primary author: MARIIA, Khutko (V.E. Lashkaryov Institute of Semiconductor Physics, National Academy of Sciences of Ukraine)

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Presenter: MARIIA, Khutko (V.E. Lashkaryov Institute of Semiconductor Physics, National Academy of Sciences of Ukraine)

Session Classification: Emergent biosensing technologies

Contribution ID: **134** Type: **Oral**

The Impact of Millimeter Waves on the Fluorescence of Aqueous Rhodamine 6G Solution

Friday, 17 November 2023 12:45 (15 minutes)

This report presents the results of recording the non-thermal effect of millimeter waves on the fluorescence of an aqueous solution of rhodamine 6G. At low concentrations of dye molecules, normal temperature quenching of fluorescence is observed: its intensity decreases with increasing temperature. However, solutions with high dye concentrations show the opposite effect: with increasing temperature, the fluorescence intensity also increases. This is due to the temperature decomposition of dimers with low quantum yield into monomers with high quantum yield. We chose the optimal solution concentration at which these two effects are mutually compensated. In this case, the temperature coefficient is close to zero in the range of 20-30 C.
The effect of millimeter waves on the fluorescence of a solution of rhodamine 6g placed in a thin capillary inside a rectangular waveguide was studied. An infrared laser was used to heat the solution, the radiation of which, through a small hole in the wall of the waveguide, hit the specially blackened surface of the capillary. Blue laser light was passed through a hole in the opposite wall, exciting fluorescence. The fluorescence signal was recorded by a matrix spectrometer from the open end of the waveguide. It has been established that at a dye concentration close to the optimal one, reactions of the opposite sign are observed when exposed to an IR laser (thermal effect) and millimeter waves (non-thermal effect). In addition, the effects showed different dynamics: the impact of millimeter radiation was characterized by a significantly longer time constant compared to heating with an IR laser.
There are two possible mechanisms for the observed non-thermal effect: (1) a direct effect of millimeter waves on the activation energy, shifting the equilibrium towards monomers, and (2) an indirect effect on the reaction rate due to a change in the structure of water.

Topics

Session D. Biomedical optics and sensors technology

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Session Classification: Emergent biosensing technologies

Contribution ID: **135** Type: **Poster**

The Heavy Atom Effect on Spectro-Optical Properties of Pi-electron Containing Molecular Complex Based on Tryptanthrin

Friday, 17 November 2023 15:20 (5 minutes)

The Heavy Atom Effect on Spectro-Optical Properties of Pi-electron Containing Molecular Complex Based on Tryptanthrin

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Tryptanthrin is a naturally occurring indoloquinazoline alkaloid (Indolo[2,1-b]quinazoline-6,12-dione; C15H8N2O2), the well-known pi-electron-containing compound. It was found in the cells of many plants, microorganisms and in some mammals [1]. Tryptanthrin possesses broad "spectrum" of biological and pharmacological activities due to its feature of easy binding to telomeric G4 DNA and stabilizing it [2,3]. Specifically, platinum complex based on 8-iodo-tryptanthrine possesses the higher anticancer activity than other tryptanthrin derivatives. Our investigations are focused on comparison of spectro-optical properties of the molecular complexes based on tryptanthrin (Try-Pt) and 8-iodo-tryptanthrin (ITry-Pt).
Optical absorption, fluorescence and phosphorescence of Try-Pt and ITry-Pt complexes were investigated. The first excited energy levels positions of these complexes were obtained. The iodine atom effect on spectro-optical properties of tryptanthrin pi-electron system were manifested: the short-wavelength shift of optical absorption spectrum of ITry-Pt in comparison with the corresponding spectrum of Try-Pt, the significant decrease of fluorescence intensity of ITry-Pt in contrast to the corresponding fluorescence intensity of Try-Pt, the short-wavelength shift of fluorescence and phosphorescence spectra of ITry-Pt relative to the corresponding spectra of Try-Pt.

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Topics

Session D. Biomedical optics and sensors technology

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Presenter: TKACH, Nazarii (Taras Shevchenko National University of Kyiv)

Session Classification: Poster session

Contribution ID: **136** Type: **Invited Talk**

Overcoming of “Boltzmann tyranny” in MOSTET with the “cold metal” source

Friday, 17 November 2023 09:30 (30 minutes)

The subthreshold swing S is a fundamental characteristic of MOSFET transistors [1]. It shows how many times the gate voltage Vg must be increased in the subthreshold range in order to achieve an increase in the drain current Id by an order of magnitude: $S \equiv \ln(10)\frac{dV_g}{d\ln(Id)}$.At room temperature in a high-quality transistor with a large value of sub-gate capacitance, the threshold value of this parameter is equal to $S \equiv \ln(10)\frac{kT}{e} \approx 60$ mV/decade, where e is the electron charge, k is the Boltzmann constant, and T is the temperature in Kelvins.

The importance of this parameter lies in the fact that its smallest threshold value determines the minimum possible operating voltage of the transistor supply (on the figure the curve with $S_2 < S_1$ corresponds to lower $V_{dd}^{(2)} < V_{dd}^{(1)}$). Therefore, a decrease in S below the fundamental limit, called in many sources as ‘Boltzmann tyranny,’ would theoretically open up great prospects for further reducing power consumption and scaling transistors.
For this purpose, in particular, it was previously proposed [2-4] to use the effect of negative capacitance in a ferroelectric that forms the gate dielectric layer. However, the futility of such attempts has been proven on the basis of fundamental thermodynamic principles and numerical calculations of real systems in [5].
Therefore, another, much more physical way to overcome the fundamental limit was proposed: to use a cold metal source for electron injection into the MOSFET channel, where, due to the small width of the valence band, the electrons injected into the channel no longer have a “hot” Boltzmann “tail” in their energy distribution. Transistors with a monolayer sub-10-nanometer MoS2 channel and drain and source on the basis of NbS2 and TaS2 with a subthreshold swing below the fundamental limit have already been realized experimentally [6, 7]. However, a visual analytical model that would allow us to estimate the magnitude of the expected effect has not yet been created.
Within the framework of the Landauer-Datta-Lundstrom formalism [8], we have derived in [9] an analytical expression for the subthreshold swing S, which implies that S is generally somewhat smaller than the fundamental limit, and the degree of its decrease is determined by the ratio of the energy kT (26 meV at room temperature) to the value of the energy interval between ΔE, the top of the valence band of the source material, and the value of the surface potential in the transistor channel. Under the limit $\Delta E \gg kT$, this expression leads to a standard value $S(300\,\mathrm{K}) = 60$ mV/decade. The formula can be used to estimate the magnitude of the effect under study in real state-of-the-art electronics systems.

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Topics

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Presenter: Prof. STRIKHA, Maksym (Taras Shevchenko National University of Kyiv, V.Lashkariov Institute of Semiconductor Physics, NAS Ukraine.)

Session Classification: Plenary

Contribution ID: **137** Type: **Oral**

Comparative Evaluation of X-ray Backscattered Energy Spectrum for Subsurface Material Characterization

Saturday, 18 November 2023 12:15 (15 minutes)

X-ray backscattering emerges as a pivotal technique in the realm of subsurface exploration, offering a non-invasive approach to material characterization beneath the soil. This method is significant due to its ability to provide detailed insights into the composition and structure of buried materials without direct physical contact, a feature crucial in fields like geology and environmental science.
Central to this research is the integration of wavelet technology with X-ray backscattered energy spectrum analysis. This synergy enhances the method's effectiveness in delineating the unique spectral signatures of different subsurface materials, such as metals, and ceramics. Wavelet technology, known for its proficiency in signal processing, significantly improves the resolution and accuracy of X-ray backscattering data. It effectively addresses challenges like signal attenuation and noise, enabling a more precise and detailed analysis.
Looking forward, the use of X-ray backscattering, augmented by wavelet technology, is set to become a key technique in subsurface material characterization. Its capacity to provide high-resolution data paves the way for breakthroughs in understanding subsurface structures. Looking ahead, the utilization of X-ray backscattering is poised to become a cornerstone in subsurface material characterization, revolutionizing our approach to exploring and interpreting the hidden layers beneath our feet.

Topics

Session A. Physics of condensed matter and spectroscopy

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Presenter: Mr SAJJASHETTY VINAYAKA (Shizuoka University)

Session Classification: Session at Shizuoka University

Contribution ID: **138** Type: **Oral**

Image-domain Material Decomposition in Spectral CT with Photon-counting Detectors

Saturday, 18 November 2023 12:00 (15 minutes)

In recent years, the concern over the insecure supply of minor metals such as tantalum in Japan has prompted recycling from waste materials such as printed circuit boards.Techniques have been developed to strip metal parts from printed circuit boards, but it is difficult to completely separate parts containing a wide variety of metals, and some loss is incurred.Therefore, we propose a method to detect minute rare metals on printed circuit boards by material discrimination using X-ray CT with a photon-counting detector.For the actual measurement, the Monte Carlo simulator PHITS3.33 was used to simulate the attenuation of X-rays due to the metallic thin film.Simulations were performed by placing 0.1-μm-thick gold and 4-μm-thick gold and nickel on a copper plate and calculating the behavior of the photons when irradiated with X-rays.Simulation results confirmed the attenuation of X-rays by gold and nickel, indicating that imaging is feasible.However, many issues were found in the resolution, imaging time, and other aspects of practical application.

Topics

Session C. Applied optics and engineering

Primary author: HAYASHI, Kohei (Shizuoka University)

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Presenter: HAYASHI, Kohei (Shizuoka University)

Session Classification: Session at Shizuoka University

Contribution ID: **139** Type: **Oral**

Development of GaN Semiconductor X-ray and Gamma-Ray Detectors

Saturday, 18 November 2023 11:45 (15 minutes)

CdTe is an excellent material for semiconductor X-ray detectors that can be operated at room temperature, but its K-edge around 30 keV results in a low line attenuation coefficient in the lower energy region. We propose gallium nitride (GaN) as a new semiconductor detector material, which has a higher linear attenuation coefficient than CdTe in the low energy region of about 10 to 26 keV and can be operated at room temperature. Despite these promising properties, sufficient experimental data as a radiation detector has not been obtained. In this study, we first calculated the probability of X-ray detection with respect to the thickness of the depletion layer of the detector. As a result, we fabricated a vertical pn diode and pin diode detector, because it is difficult to realize it in a horizontal structure. Then, to confirm that a diode structure was formed, we performed I-V measurements, which confirmed the diode structure. On the other hand, it is difficult to detect γ-rays with the detector fabricated at the present stage because the required thickness of the depletion layer is not sufficient. Therefore, we evaluated radiation characteristics by detecting α-rays, which have lower penetrating power than γ-rays. Since α-rays could be detected, we believe that γ-rays can be detected if the thickness of the depletion layer can be increased. Details will be discussed on the day.

Topics

Session A. Physics of condensed matter and spectroscopy

Primary author: Mr HIDA, Kosuke (Shizuoka University)

Co-authors: Mr INABA, Kagemitsu (Shizuoka University); Mr TOYODA, Kohei; Dr NISHIZAWA, Junichi (Shizuoka Univ.); TAKAGI, Katsuyuki (Shizuoka University); TABATA, Kento; KASE, Hiroki; AOKI, Toru (Shizuoka University)

Presenter: Mr HIDA, Kosuke (Shizuoka University)

Session Classification: Session at Shizuoka University

Contribution ID: **140** Type: **Invited Talk**

Spatial Representation of Multi-energy 3D X-ray Imaging Using Mixed Reality

Saturday, 18 November 2023 08:00 (30 minutes)

Recent advancements in multi-energy X-ray computed tomography (CT) have garnered significant attention in non-destructive testing (NDT), allowing the segmentation of materials based on variations in X-ray absorption spectra across different energy bands. This study explores integrating multi-energy X-ray CT data with mixed reality (MR) technology to provide a spatial representation of internal structures, enhancing the observer's ability to inspect and understand complex interior details. The method involved capturing CT images of a lithium-ion battery using dual-energy X-ray CT, spanning energy bands from 10 KeV to 150 KeV. The images were processed and visualized in MR, enabling the observer to interact with and manipulate three-dimensional representations of the battery's internal structures. The system allowed for seamless switching and merging of energy bands, highlighting specific components like integrated circuit pins and cable connections at different energy levels. This approach, combining multi-energy X-ray imaging with MR, effectively organizes and presents the increased volume of data obtained, making it a potent tool for precise and intuitive examination of internal structures in NDT. The study demonstrates the potential of MR in enhancing the interpretation and visualization of complex imaging data, providing a significant advancement in the field of NDT and material analysis.

Topics

Session C. Applied optics and engineering

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Co-authors: Dr NISHIZAWA, Junichi (Shizuoka Univ.); TABATA, Kento; TAKAGI, Katsuyuki (Shizuoka University); AOKI, Toru (Shizuoka University)

Presenter: Mr KASE, Hiroki (Research Institue od Electronics, Shizuoka University)

Session Classification: Session at Shizuoka University

Contribution ID: **141** Type: **Invited Talk**

Raman spectroscopy capabilities for characterization of semiconductors nanostructures

Friday, 17 November 2023 10:00 (30 minutes)

Raman spectroscopy is a fast, sensitive, and non-destructive technique for characterization of structure, phonon spectrum and even some electronic properties of semiconductors and isolators. In exploring semiconductor nanostructures and heterostructures, this technique benefits from possibility to tune the excitation wavelength to selectively excite parts of the material with different composition, size or other factors of heterogeneity. The full compatibility with optical and near-field microscopy allows sub-μm spatial resolution to be achieved for mapping of elemental composition, strain, and temperature, including in situ and operando applications. An extension to the nm-resolution has already been implemented by combining Raman spectroscopy with scanning probe microscopy techniques. This talk gives briefly the basics of the Raman spectroscopy methods and exemplify its capabilities and limitations in application to characterization of different kinds of semiconductor nanostructures.

Topics

Session A. Physics of condensed matter and spectroscopy

Primary author: Prof. DZHAGAN, Volodymyr (V. Lashkaryov Institute of Semiconductors Physics, National Academy of Sciences of Ukraine, 03038 Kyiv, Ukraine)

Presenter: Prof. DZHAGAN, Volodymyr (V. Lashkaryov Institute of Semiconductors Physics, National Academy of Sciences of Ukraine, 03038 Kyiv, Ukraine)

Session Classification: Plenary

Contribution ID: **142** Type: **Oral**

Processing of spectral data by self-similar difference equations.

Friday, 17 November 2023 13:30 (15 minutes)

The application of self-similarity principle is shown in the example of utilizing a system of self-similar difference equations for processing spectral data, in particular the processing luminescence spectrum of quantum dots (Gaussian peak) as well as the kinetics of luminescence decay.
For the spectrum of quantum dots, the relationship between the parameters of the Gaussian function and the parameters of the hierarchical system of equations is shown.
To describe the kinetics of luminescence, the dynamics of the decay coefficient (in the transition region) is shown. For this purpose, a system of two nested difference equations is used, the main equation of which, contains two variable parameters, one of which can be considered as the decay value.
The calculated dependence decay on time is presented and divided into areas with different asymptotics.
The method introduces a mechanism for transition between different functional (continuous) descriptions, based on an elementary mapping of the proposed hierarchical system. This mechanism can be used to solve the interface problem when constructing multiscaling models and phase transition models.

Topics

Session A. Physics of condensed matter and spectroscopy

Primary authors: PAVLOV, Evgen (University of Derby); Prof. YASHCHUK, Valeriy (Taras Shevchenko National University of Kyiv)

Presenter: PAVLOV, Evgen (University of Derby)

Session Classification: Spectroscopy techniques and applications

Contribution ID: **143** Type: **Oral**

Simulation of X-ray scattering of material surrounded by soil

Saturday, 18 November 2023 11:30 (15 minutes)

Backscattered X-ray imaging is a non-destructive inspection technique that uses X-rays scattered back from an object. Compared to X-ray transmission imaging, backscatter X-ray imaging has the advantage that the source and detector can be placed on the same side of the object and is used for inspection of thick objects and structures. However, due to the high attenuation of X-rays by soil, it is difficult to distinguish between objects with different detection levels.X-rays generated underground have their intensity and energy attenuated by interacting with underground materials such as objects, but the degree of attenuation depends on the atomic number of the material. Furthermore, backscattered X-rays are mainly generated by Compton scattering. The cross section of Compton scattering is proportional to the atomic number, and the energy change after Compton scattering depends on the scattering angle, which is a factor that changes the energy of scattered X-rays. In this study, we used simulations to evaluate the improvement in spatial resolution in backscattered X-ray imaging using the energy information of backscattered X-rays.The particle and heavy ion transport code PHITS was used in the simulations. The subject was placed in the ground at a depth of 2 cm and irradiated with a pencil beam measuring 5 mm on each side. To detect scattered X-rays, the detector was placed at three angles (30, 45, and 60 degrees). By changing the X-ray irradiation position, we detected backscattered X-rays near the edges of the object and evaluated the spatial resolution.

Topics

Session C. Applied optics and engineering

Primary authors: Mr IKEDA, Takehiro (Shizuoka University); HOTTA, Takumi; KASE, Hiroki; Dr NISHIZAWA, Junichi (Shizuoka Univ.); TAKAGI, Katsuyuki (Shizuoka University); TABATA, Kento; AOKI, Toru (Shizuoka University)

Presenter: Mr IKEDA, Takehiro (Shizuoka University)

Session Classification: Session at Shizuoka University

Contribution ID: **144** Type: **Poster**

Interaction of nanosystems based on chlorine e6 with model phospholipid membranes

Friday, 17 November 2023 15:25 (5 minutes)

The study of the interaction of nanoparticles and complexes with phospholipid membranes is an important stage of research, since they can be of potential importance for biological applications. Phospholipid membranes serve as an important model for studying the reaction to the introduction of the objects under study, as they are characterized by their simplified structure.

In our study, we investigated the interaction of model membranes with nanosystems including chitosan using differential scanning calorimetry. We analyzed the interaction of individual nanoparticles, such as hafnium oxide, chlorine e6, and silver nanoparticles, as well as complexes formed on their basis.

The results of our studies have shown that the investigated nanosystems interact well with phospholipid model membranes and cause a decrease in the temperature of phase transitions in these membranes.

This work was supported by the National Research Foundation of Ukraine (project 2020.02 / 0367).

Topics

Session D. Biomedical optics and sensors technology

Primary authors: Dr SAMILOV, Oleksandr (Institute for scintillation materials of National academy of Sciences of Ukraine); Dr ROPAKOVA, Iryna (Institute for scintillation materials of National academy of sciences of Ukraine)

Presenter: Dr SAMILOV, Oleksandr (Institute for scintillation materials of National academy of Sciences of Ukraine)

Session Classification: Poster session

Contribution ID: **145** Type: **Oral**

SERS-substrates with controllable localization of analyte in the plasmonic “hot-spots”

Friday, 17 November 2023 13:45 (15 minutes)

Surface-Enhanced Raman Spectroscopy (SERS) has been increasingly gaining popularity as a promising spectroscopic tool for detection and identification of trace amounts of various molecular species [1]. The level of sensitivity claimed by many groups various types of substrates and analytes in the impressive pico- to femto-molar concentration range. However, the no wide commercialization of the SERS-based sensing technologies took place so far. The major reason is that a good performance of the sensing substrate should come at affordable fabrication costs. At the same time, the best performance is usually reported for SERS substrates fabricated by rather sophisticated routes. In addition, one of the important issues is reproducibility of the enhancement produced by the substrate. One of the conditions of achieving reproducible results is homogeneous distribution of the analyte over the substrate surface. On the other hand, the condition of obtaining high enhancement is localization of as much as possible analyte in the so-called “hot spots” – nanometer-scale space regions of high concentration of electric field between metal nanostructures.
In this work we reported an original type of very affordable substrates developed to enable self-localization of the analyte (deposited from solution) in the hot spots that are regularly arranged over the substrate surface. The basis of the substrate are self-assembled layers of highly monodisperse SiO2 nanospheres, synthesized via facile and scalable route in aqueous solution. The coverage of this nanosphere layer with thin layer of gold or silver by thermal evaporation or some other methods creates numerous hot-spots in the places between silica particles. The efficiency of the developed substrates is demonstrated for several different types of analytes, in particular common dye molecules, small biomolecules such as aminoacids, as well as large biomolecules such as proteins and antibodies.
The work was funded by NRFU projects no. 2020.02/0204.

[1] P. Dey. Aiming for Maximized and Reproducible Enhancements in the Obstacle Race of SERS. ACS Measurement Science. 10.1021/acsmeasuresciau.3c00037

Topics

Primary authors: Dr MAZUR, Nazar (Department of Optics and Spectroscopy, V. Lashkaryov Institute of Semiconductors Physics, National Academy of Sciences of Ukraine, Kyiv, Ukraine.); Dr KAPUSH, Olga (Department of Optics and Spectroscopy, V. Lashkaryov Institute of Semiconductors Physics, National Academy of Sciences of Ukraine, Kyiv, Ukraine.); Dr ISAEVA, Oksana (Department of Optics and Spectroscopy, V. Lashkaryov Institute of Semiconductors Physics, National Academy of Sciences of Ukraine, Kyiv, Ukraine.); Dr PIRKO, Yaroslav (Department of Cell Biology and Biotechnology, Institute of Food Biotechnology and Genomics, National Academy of Sciences of Ukraine, 04123 Kyiv, Ukraine); Dr HRESHCHUK, Oleksandr (Department of Optics and Spectroscopy, V. Lashkaryov Institute of Semiconductors Physics, National Academy of Sciences of Ukraine, Kyiv, Ukraine.); Prof. YEMETS , Alla (Department of Cell Biology and Biotechnology, Institute of Food Biotechnology and Genomics, National Academy of Sciences of Ukraine, 04123 Kyiv, Ukraine); Dr BUZIASHVILI, Anastasiia (Department of Cell Biology and Biotechnology, Institute of Food Biotechnology and Genomics, National Academy of Sciences of Ukraine, 04123 Kyiv, Ukraine); Prof. YUKHYMCHUK, Volodymyr

(Department of Optics and Spectroscopy, V. Lashkaryov Institute of Semiconductors Physics, National Academy of Sciences of Ukraine, Kyiv, Ukraine.); Prof. DZHAGAN , Volodymyr (Department of Optics and Spectroscopy, V. Lashkaryov Institute of Semiconductors Physics, National Academy of Sciences of Ukraine, Kyiv, Ukraine.)

Presenter: Dr MAZUR, Nazar (Department of Optics and Spectroscopy, V. Lashkaryov Institute of Semiconductors Physics, National Academy of Sciences of Ukraine, Kyiv, Ukraine.)

Session Classification: Spectroscopy techniques and applications

Contribution ID: **147** Type: **Oral**

Raman spectroscopy study on Cu2ZnSnS4-based nanocrystals and nanocomposites

Friday, 17 November 2023 14:15 (15 minutes)

The quaternary semiconductor Cu2ZnSnS4 (CZTS) and related compounds is a promising material for photovoltaic applications, thermoelectric and other applications related with alternative energy conversion and storage [1]. Significant research efforts have been made to obtain CZTS with superior structural quality, as well as the development of more efficient characterisation techniques for the detection of structural imperfections and impurity phases [2].
Here, we investigate the CZTS nanocrystals (NCs) obtained by a low-temperature "green" aqueous colloidal synthesis in the form of liquid "inks". Because most device applications require thin films with well defined parameters, we investigated CZTS NC films formed by drop-casting, spin- and spray-coating, with subsequent thermal or photonic annealing as simple, fast, and scalable fabrication methods. We demonstrate the possibilities of structural characterisation of such NCs, their heterostructures and NC/polymer composites by Raman spectroscopy. [2,3]

Topics

Session A. Physics of condensed matter and spectroscopy

Primary authors: KARNAUKHOV, Anatolii (V.Ye. Lashkaryov Institute of Semiconductor Physics of the NASU); VALAKH, Mykhailo (V. Lashkaryov Institute of Semiconductors Physics, National Academy of Sciences of Ukraine, Kyiv, Ukraine.); MAZUR, Nazar; SELYSHCHEV, Oleksandr (Semiconductor Physics, Chemnitz University of Technology, 09107 Chemnitz, Germany.); KAPUSH, Olga (Department of Optics and Spectroscopy, V. Lashkaryov Institute of Semiconductors Physics, National Academy of Sciences of Ukraine, Kyiv, Ukraine.); DZHAGAN, Volodymyr (V. Lashkaryov Institute of Semiconductors Physics, National Academy of Sciences of Ukraine, 03038 Kyiv, Ukraine); YUKHYMCHUK, Volodymyr; HAVRYLIUK, Yevhenii (Dr.)

Presenter: KARNAUKHOV, Anatolii (V.Ye. Lashkaryov Institute of Semiconductor Physics of the NASU)

Session Classification: Spectroscopy techniques and applications

Contribution ID: **148** Type: **Oral**

Spectroscopic Investigation of BSA Protein and Thiochrome Dye Interaction

Friday, 17 November 2023 13:00 (15 minutes)

In this study, we investigated the relationship of BSA (Bovine Serum Albumin) protein with thiochrome dye through several spectroscopic techniques, including absorption, IR, and Raman spectroscopy. Since BSA is a multifunctional plasma protein that carries a huge number of compounds, in this study we have chosen a dye that has good spectral properties and can detect conformational changes in proteins in diseases, or when adding some kind of medicine, for example.
As a result of our studies, we analyzed the absorption films and obtained a shift of the composite film (BSA and thiochrome) of the second peak at 220 nm to the right, which may indicate potential conformational changes.
When the IR absorption spectra and the difference IR spectra of the BSA film and the composite film were studied, there were almost no changes in amides I and II, but a significant change in the amide A peak at 3402 cm-1 was observed. The observed decrease in intensity indicates N-H bond stretching.
The Raman spectra showed us small shifts of the amide I and amide II bands upon addition of the dye, as well as a change in the characteristic absorption peaks of the tryptophan residue in the protein at 1657 cm-1 (W3), a signal at 1340 and 1360 cm-1 (W7), and 757 cm-1 (W18), which shifted to the right. These changes in the tryptophan peaks are indicative of resonance in the vibration, a change in tryptophan conformation, and symmetrical vibrations of the benzene and pyrrole rings.

Topics

Session D. Biomedical optics and sensors technology

Primary author: Ms RYZHKOVA, Anastasiia (Taras Shevchenko National University of Kyiv, Faculty of Physics)

Co-author: Dr PAVLENKO, Olena (Taras Shevchenko National University of Kyiv)

Presenter: Ms RYZHKOVA, Anastasiia (Taras Shevchenko National University of Kyiv, Faculty of Physics)

Session Classification: Emergent biosensing technologies

Contribution ID: **149** Type: **Invited Talk**

Long-term stability of diode-type CdTe X-/gamma-ray detector with high current density

Saturday, 18 November 2023 08:30 (30 minutes)

Polarization poses a significant challenge in cadmium telluride (CdTe) detectors, preventing the simultaneous achievement of high energy resolution and long-term stability at room temperature. The mechanism driving bias-induced polarization is presumed to involve an increase in the number of ionized acceptors resulting from hole detrapping. Simultaneously, the accumulation of negative charges is suppressed as the hole density in the bulk increases. Consequently, polarization effects occur in diode-type detectors with low current densities but not in ohmic-type detectors with high current densities. In this study, we fabricated a diode-type detector with a high current density, which is between the ohmic and diode types, and evaluated its long-term stability. The detector had dimensions of 3×3×0.75 mm3, comprising a central electrode of 0.5×0.5 mm2 surrounded by a guard-ring electrode. By finely patterning the anode, we increased the current density, achieving a current density comparable to that of the ohmic type while enabling the application of a higher bias voltage.

Topics

Session A. Physics of condensed matter and spectroscopy

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Co-authors: TAKAGI, toshiyuki; Dr NISHIZAWA, Junichi (Shizuoka Univ.); Mr MORII, Hisashi (ANSeeN Inc.); KASE, Hiroki; AOKI, Toru (Shizuoka University)

Presenter: Dr TAKAGI, Katsuyuki (Shizuoka University)

Session Classification: Session at Shizuoka University

Contribution ID: **150** Type: **Oral**

GaN Semiconductor X-ray Detectors

Saturday, 18 November 2023 10:15 (15 minutes)

CdTe is an excellent material for semiconductor X-ray detectors that can be operated at room temperature, but its K-edge around 30keV results in a low attenuation coefficient in the lower energy region. We propose gallium nitride (GaN) as a new semiconductor detector material that has a higher attenuation coefficient than CdTe in the low energy region of approximately 10 to 26keV and can be operated at room temperature.

Despite these promising properties, sufficient experimental data as a radiation detector have not been obtained. In this study, we first calculated the probability of X-ray detection with respect to the thickness of the sensitive layer of the detector. As a result, we fabricated a vertical pn diode and pin diode detector because it is difficult to realize a horizontal structure. I-V measurements were performed to verify whether the diode structure was formed, and the diode structure was confirmed. This confirmed that GaN has the potential to be used as a semiconductor detector. Next, X-ray response measurements were performed to verify the sensitivity of the detector to X-rays. As a result, the detection current increased with the X-ray dose rate. Therefore, we believe that imaging using X-rays is feasible.

Topics

Session A. Physics of condensed matter and spectroscopy

Primary author: KAGEMITSU, Inaba

Co-authors: HIDA, Kosuke (Shizuoka University); Mr TOYODA, Kohei; Dr NISHIZAWA, Junichi (Shizuoka Univ.); TAKAGI, Katsuyuki (Shizuoka University); TABATA, Kento; AOKI, Toru (Shizuoka University)

Presenter: KAGEMITSU, Inaba

Session Classification: Session at Shizuoka University

Contribution ID: **151** Type: **Oral**

Improving the accuracy of X-ray beam visualization using augmented reality (AR)

Saturday, 18 November 2023 10:30 (15 minutes)

Demand for nondestructive testing using X-ray imaging is increasing, and it is used in a variety of situations to identify defects and damage in precision equipment. In X-ray imaging, it is difficult to accurately position the X-ray source, object, and detector on the irradiation axis because the trajectory of the X-rays is impossible to see with the human eye. In this research, we propose a system for visualizing radiation trajectories using augmented reality (AR) technology and aim to improve its accuracy. The trajectory of the X-ray irradiation was calculated by capturing transmission images while fixing the radiation irradiation direction and aperture method and changing the distance between the X-ray source and the detector. In addition, changed the way to display the radiation trajectory with AR device. Previously, the way was that using a single AR marker, and once the AR marker is recognized, its position is estimated and the AR object is displayed. The accuracy of trajectory expression can be improved by setting up multiple markers and displaying AR only while recognizing the AR marker with the camera on the AR device, or by displaying a virtual plane where the radiation trajectory intersects with the detector. This made it possible to increase the accuracy of trajectory expression.

Topics

Session C. Applied optics and engineering

Primary author: KAWAKAMI, Takumi (Shizuoka University)

Co-authors: AOKI, Toru (Shizuoka University); KASE, Hiroki; TAKAGI, Katsuyuki (Shizuoka University)

Presenter: KAWAKAMI, Takumi (Shizuoka University)

Session Classification: Session at Shizuoka University

Contribution ID: **152** Type: **Oral**

Thermal Diffusion Doping for CdTe Semiconductor Radiation Detectors

Saturday, 18 November 2023 11:15 (15 minutes)

CdTe used as a semiconductor detector has the advantages of high sensitivity to high energy and the ability to operate at room temperature. However, its charge collection efficiency is lower than that of Si and Ge. To ensure sufficient charge collection efficiency, it is desirable to use a structure that allows the application of high voltages. Therefore, when used as a CdTe detector, it is desirable to diode the detector at the p-n junction, which has the features of leakage current suppression by rectifying action, damage resistance, and heat resistance.
In this study, we aim to fabricate a p-n junction CdTe detector by thermal diffusion doping using an electron beam to develop a radiation image detector with high spatial resolution. To this end, we first verified whether a n+ layer can be formed inside the p- type CdTe. Thermal diffusion doping with an electron beam was performed using an EBAS (Electron Beam Assist Source) system. After depositing In onto CdTe, thermal diffusion doping was performed using the EBAS system. The carrier density of the doped layer was measured to confirm the formation of a n+ layer inside CdTe. The value of carrier density was determined using the Van der Pauw method of Hall effect measurement. The results show that the carrier density is sufficient for the n+ layer inside CdTe.

Topics

Session A. Physics of condensed matter and spectroscopy

Primary author: NAKAMURA, Ibuki (Shizuoka university)

Co-authors: Dr NISHIZAWA, Junichi (Shizuoka Univ.); TAKAGI, Katsuyuki (Shizuoka University); KASE, Hiroki; AOKI, Toru (Shizuoka University)

Presenter: NAKAMURA, Ibuki (Shizuoka university)

Session Classification: Session at Shizuoka University

Contribution ID: **153** Type: **Oral**

Formation of TlBr thin film for semiconductor radiation detector

Saturday, 18 November 2023 10:45 (15 minutes)

TlBr (thallium bromide) is one of the materials used in semiconductor detectors.
Due to its characteristics, it is generally being researched as a semiconductor detector for high-energy X-rays that can operate at room temperature, but it suffers from low carrier mobility and a reduction in energy resolution due to signal rise time. Therefore, we will consider fabricating a semiconductor detector using thin film TlBr. By making the film thin, it is possible to compensate for the low carrier mobility. Making it a thin film allows high-energy X-rays to easily pass through it, but TlBr has a characteristic of having a high mass attenuation coefficient in the low energy band, so we are considering creating a semiconductor detector for low energy use.
This time, in order to investigate the relationship between changes in substrate temperature and crystallinity when depositing a thin film of TlBr, we prepared two samples, one without heating the substrate and one with heating the substrate to 150℃, and each X-ray diffraction measurements were performed. As a result, it was confirmed that crystal orientation improved when the substrate temperature was increased.

Topics

Session A. Physics of condensed matter and spectroscopy

Primary author: HAYAKAWA, Shoma (Shizuoka University)

Co-authors: TABATA, kento; Mr TOYODA, Kohei; KASE, Hiroki; NISIZAWA, Junichi; TAKAGI, Katsuyuki; Prof. AOKI, Toru

Presenter: HAYAKAWA, Shoma (Shizuoka University)

Session Classification: Session at Shizuoka University

Contribution ID: **154** Type: **Oral**

Image Correction of Reconstructed Photon Counting CT Images Using Shot Noise

Saturday, 18 November 2023 11:00 (15 minutes)

X-ray CT is used in a wide range of fields, including diagnostics in the medical field and nondestructive testing in the industrial field. Among them, direct-conversion photon counting detectors are less susceptible to scattered light and have high spatial resolution. Although photon counting detectors can capture images in each energy band, it is necessary to select the corresponding energy band for observation when imaging an object that is a combination of a substance that reacts to low energy bands and a substance that reacts to high energy bands. The purpose of this study is to correct high-contrast images over a wide energy range by correcting and automatically combining multiple energy band images pixel by pixel. The correction process utilizes the shot noise found in photon-counting detectors. The original projection image data is divided into multiple energy bands, and the value that is the largest among the photon counts stored in pixels at the same location is used as the reference shot noise. Then, updating the number of photons by keeping the shot noise constant in all energy bands is repeated for all pixels in the image. The corrected projection data was reconstructed and compared to the uncorrected reconstruction to confirm the effectiveness of this method.

Topics

Session C. Applied optics and engineering

Primary author: KATAYAMA, Yutaro

Co-authors: KASE, Hiroki; Dr NISHIZAWA, Junichi (Shizuoka Univ.); TAKAGI, Katsuyuki (Shizuoka University); AOKI, Toru (Shizuoka University)

Presenter: KATAYAMA, Yutaro

Session Classification: Session at Shizuoka University

Contribution ID: **155** Type: **Oral**

Photoluminescence of polymer-incorporated ZnO nanocrystals

Friday, 17 November 2023 14:00 (15 minutes)

Incorporation of colloidal NCs in polymer matrices is a way to tailor NC properties and to protect NCs from degradation under the influence of ambient. Investigation of luminescent NCs in optically transparent polymers is important in view of perspective applications in photonics, while composites of NCs and conductive polymers can be promising for photovoltaics, electroluminescence, and photodetectors [1]. In our work, we investigated the effects of embedding the ex-situ synthesized colloidal ZnO NCs in different water-soluble polymers, such as polyvinyl alcohol (PVA), polyvinylpyrrolidone (PVP), polyethylene glycol (PEG), gelatine, and PEDOT:PSS [2]. In addition to monitoring the spectral and intensity changes in the NC PL spectrum, caused by polymer, we propose possible recombination mechanisms of the NC PL and the ways of their interaction with and polymer. Gelatine caused unexpectedly quenching of both PL excitonic (EPL) and DPL. The common major effect of PVP, PEG, and PVA is suppression of defect- related PL band (DPL), although at low NC loading the effect of these polymers is more different from each other than at high loading. The effect of PEDOT:PSS is relatively weak, as for conductive polymer, although distinct indications of structural and electronic changes in the polymer are found in Raman and XPS spectra.

1. Anni, M. Polymer-II-VI Nanocrystals Blends : Basic Physics and Device Applications to Lasers and LEDs // Nanomaterials.-2019.-9.P. 1036.
2. V. Dzhagan, O. Stroyuk, O. Raievska, O. Isaieva, O. Kapush, O. Selyshchev, V. Yukhymchuk, M. Valakh, and Dietrich R. T. Zahn. Photoinduced Enhancement of Photoluminescence of Colloidal II-VI Nanocrystals in Polymer Matrices // Nanomaterials. -2020.-10. P.2565.

Topics

Session A. Physics of condensed matter and spectroscopy

Primary authors: ISAIEVA, Oksana (V. Lashkaryov Institute of Semiconductors Physics, National Academy of Sciences of Ukraine, Kyiv, Ukraine.); Prof. DZHAGAN, Volodymyr (V. Lashkaryov Institute of Semiconductors Physics, National Academy of Sciences of Ukraine, Kyiv, Ukraine.); SELYSHCHEV, Oleksandr (Semiconductor Physics, Chemnitz University of Technology, 09107 Chemnitz, Germany.); TOMA, Maria (Babes-Bolyai University, Physics Faculty, M. Kogalniceanu 1, 400084, Cluj-Napoca, Romania.); GULE, Yevhen (V. Lashkaryov Institute of Semiconductors Physics, National Academy of Sciences of Ukraine, Kyiv, Ukraine.); Prof. YUKHYMCHUK, Volodymyr (V. Lashkaryov Institute of Semiconductors Physics, National Academy of Sciences of Ukraine, Kyiv, Ukraine.); HRESHCHUK, Oleksandr (V. Lashkaryov Institute of Semiconductors Physics, National Academy of Sciences of Ukraine, Kyiv, Ukraine); Prof. ZAHN, Dietrich RT (Semiconductor Physics, Chemnitz University of Technology, 09107 Chemnitz, Germany.)

Presenter: ISAIEVA, Oksana (V. Lashkaryov Institute of Semiconductors Physics, National Academy of Sciences of Ukraine, Kyiv, Ukraine.)

Session Classification: Spectroscopy techniques and applications

Contribution ID: **156** Type: **Oral**

Annealing Effect of Thallim Bromide Thin Film

Saturday, 18 November 2023 10:00 (15 minutes)

Thallium Bromide (TlBr) is a compound semiconductor with a wide band gap(2.68 eV). TlBr can be formed into thin films by vacuum evaporation, and large areas can be produced without a tiling process. TlBr is potentially suitable for FPD applications.

TlBr thin films deposited by vacuum evaporation was evaluated. In direct conversion semiconductor detectors, the quality of the semiconductor crystals is important. Polycrystals are less efficient at collecting the charge generated by photons due to grain boundaries, so larger grain sizes are preferred. Ideally, single crystals are best. Therefore, we conducted experiments to improve the crystal orientation by post-processing. Crystal orientation was evaluated by X-ray diffraction. The results showed that post-deposition heat treatment improved the crystal orientation. The results also showed that the crystalline orientation deteriorated when the cooling rate after heating was too fast. It was suggested that the recrystallization process during the transition from the liquid phase to the solid phase is affected by the cooling rate. It was found that the cooling rate must be controlled for post-deposition heat treatment to improve the crystal orientation. The results of this study will accelerate the application of thin film TlBr to detectors.

Topics

Session A. Physics of condensed matter and spectroscopy

Primary author: TOYODA, Kohei (Shizuoka University)

Co-authors: TABATA, Kento; HAYAKAWA, Shoma (Shizuoka University); Dr NISHIZAWA, Junichi (Shizuoka Univ.); TAKAGI, Katsuyuki (Shizuoka University); AOKI, Toru (Shizuoka University)

Presenter: TOYODA, Kohei (Shizuoka University)

Session Classification: Session at Shizuoka University

Contribution ID: **157** Type: **Oral**

Third Harmonic Generation through Stimulated Raman Scattering in Magnetized Plasma with Hermite cosh Gaussian Laser Beam

Friday, 17 November 2023 14:45 (15 minutes)

Stimulated Raman backward scattering of a laser beam propagating in a homogeneous plasma is investigated in the presence of static magnetic field. The laser decays into an upper hybrid wave and a down-shifted sideband wave as it travels through plasma. A non-linear ponderomotive force acts on the plasma electrons which drives the excited upper hybrid wave. The upper hybrid wave couples with the incident wave to drive the sideband. Non-linear current density and ponderomotive force is obtained by using Fluid Model. Dispersion relation of the scattered sideband wave and growth rate instability is obtained. This growth rate suppress when the static magnetic field is increased.

Topics

Session B. Laser physics and modern optoelectronics

Contact Email address

Primary author: AZAD, Taruna (Lovely Professional University, India)

Co-authors: Dr KAMBOJ, Oriza (Lovely Professional University,); Dr NITI, Kant (University of Allahabad, Prayagraj, India)

Presenters: AZAD, Taruna (Lovely Professional University, India); Dr KAMBOJ, Oriza (Lovely Professional University,)

Session Classification: Spectroscopy techniques and applications

Contribution ID: **158** Type: **Oral**

”Stimulated Raman scattering of laser dyes in a closed scattering shell”

Friday, 17 November 2023 14:30 (15 minutes)

The theses will be submitted later

Topics

Primary author: HAIDUK, Tetiana (Taras Shevchenko National University of Kyiv)

Co-author: Dr YASHCHUK, Vasil (Taras Shevchenko National University of Kyiv)

Presenter: HAIDUK, Tetiana (Taras Shevchenko National University of Kyiv)

Session Classification: Spectroscopy techniques and applications

Contribution ID: **159** Type: **not specified**

Opening Remarks

Friday, 17 November 2023 09:00 (10 minutes)

Presenter: Prof. KONDRATENKO, Serhiy (Taras Shevchenko National University of Kyiv, Faculty of Physics, Chair of Optics)

Session Classification: Opening

Contribution ID: **160** Type: **not specified**

Beyond Two Decades of the SPO Conference

Friday, 17 November 2023 09:10 (10 minutes)

Topics

Contact Email address

Presenter: Prof. POPERENKO, Leonid (Taras Shevchenko National University of Kyiv, Faculty of Physics, Chair of Optics)

Session Classification: Opening

Contribution ID: **161** Type: **not specified**

Decades of Collaboration: Shizuoka University and Taras Shevchenko National University of Kyiv

Friday, 17 November 2023 09:20 (10 minutes)

Topics

Contact Email address

Presenter: Prof. AOKI, Toru (Shizuoka University)

Session Classification: Opening

Contribution ID: **162** Type: **Oral**

Identification of buried objects using energy distribution of backscattered X-rays

Saturday, 18 November 2023 12:30 (15 minutes)

In recent years, as it has become possible to detect buried objects using X-rays, there is a need to detect landmines buried underground and to inspect the aging of reinforcing bars in aging buildings. This research uses a method called backscatter X-ray inspection, which irradiates an object with X-rays and detects what is reflected. Backscattered X-ray inspection can detect objects regardless of their size or distance, making it possible to perform X-ray inspections when the distance or size of objects such as underground objects is unknown.

The purpose of this research is to identify buried objects based on the differences in backscattered X-ray spectra emitted depending on the material, shape, and distance of the object. This time, we analyzed backscattered X-rays, including complex scattering and absorption within materials, and verified angle-dependent changes in scattered X-ray spectra depending on the material of buried objects. In this study, we evaluated the scattering angle of X-rays from 0° to 90° when X-rays are applied to an object through measurement and verification. From the experimental results, we were able to detect scattered X-rays and characteristic X-rays that are characteristic of each material and detect angle-dependent changes. However, the incident X-rays and backscatter X-rays were scattered in a complicated manner, and the detected It was difficult to determine the material and shape of the subject from the image.

Topics

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Primary author: Mr SUZUKI, Tatsuya

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Presenter: Mr SUZUKI, Tatsuya

Session Classification: Session at Shizuoka University