23rd International Young Scientists Conference Optics and High Technology Material Science - SPO 2022 ONLINE ”STAND WITH UKRAINE”

Thursday 24 November 2022 - Saturday 26 November 2022

Taras Shevchenko National University of Kyiv and Shizuoka University

Book of Abstracts

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Poster session / 53

Electron Acceleration by Cross Focused Cosh Gaussian Laser Beams in Thermal Quantum Plasmas

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Theoretical study on electron acceleration by intense laser beams
in thermal quantum plasmas has been presented. In order to enhance the interaction of accelerated electrons with the laser beam the irradiance over the beam cross
section has been modeled by Cosh Gaussian (ChG) profile. Effect of self focusing of the laser beam on energy gained by the electrons has been investigated in detail. Following moment theory and hydrodynamic fluid model of plasma coupled differential equations governing the evolution of beam width of the laser beam and energy of the accelerated electrons have been obtained. It has been observed that the uniformity of the irradiance over the beam cross section enhances the energy of the accelerated electrons considerably.

Topics:

Session B. Laser physics and modern optoelectronics

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Quantum coherence and Nonlinear Optics / 54

Population dynamics in ionized nitrogen molecule: evidence of laser without inversion

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A nitrogen gas pumped by near-infrared femtosecond pulses gives rise to a coherent emission at 391.4 nm due to transitions between ionic levels. For the first time, we experimentally analyze the temporal evolution of the populations of N_2^+ levels involved in this lasing process. To visualize this dynamics, we measure the transmission of a high harmonics source through N_2^+.

Topics:

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Poster session / **55**

NANOINDENTATION OF NANOSIZED FILMS

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Further progress in the field of creating functional and multifunctional nanostructured materials and coatings is associated, both with the development of industrial technologies for their production and with the certification of methods for measuring the mechanical properties of nanomaterials. Determination of mechanical properties plays a primary role in the design of new nanomaterials, making it possible to predict possible mechanisms of their destruction, controlled by the structural state of the surface layers. In this work, using a micro-nano modifier "Micro-nano mod", the surface morphology of nanosized films of gold and indium was studied, and the methodological features of their nanoindentation were shown. Analysis of the morphology of the surface of nanosized films on glass obtained by magnetron sputtering demonstrates the presence of a pronounced island structure with dimensions of 70- 400 nm for indium film and 50-200 nm for the gold film. It was found that for nanoindentation of indium nanofilms on glass it is necessary to apply an indentation load of not more than 0.9 cN. Latter will allow correctly determining the size of the impression and standardizing the determination of the actual hardness of indium nanofilms on glass. It is shown that when indenting the gold nanofilm with a load of 1.5 cN, the shape of the Berkovich indenter impression is not triangular. The fundamental possibility of creating nano-objects as the nanotracks-wires by means of the tunnel current on the surface of indium nanofilm is shown.

Topics:

Session A. Physics of condensed matter and spectroscopy

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Biophotonics and sensor technologies / **56**

Optical Properties of Films of Thiochrome Dye with Tryptophan Amino Acid

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Despite the significant achievements of biophysical science, many mechanisms of interaction between biological molecules and external agents (medicines) are not explained. There are many different approaches to the study of the interaction of proteins with drugs. One of them is a study of the spectral properties of π-conjugated amino acids (tyrosine, tryptophan, phenylalanine), which absorb and emit in the UV-Vis region, and provide information about the conformational states of biopolymers in the initial state and when changing the external environment. More significant studies can be detected by adding fluorescent dyes that have high-intensity absorption and photoluminescence. In the presence of third agents, such as drugs, fluorescent dyes can change their structure, electronic properties, etc.

Thiochrome ($CH_{14}N_4N_4OS$) is a natural dye formed by the oxidation of thiamine (vitamin B).

Thiochrome in the study plays the role of the detector of complex formation. It has freely solubility in water, is not toxic to biological systems, and has intense fluorescence at 443 nm. The dye contains two aromatic rings. Also, tryptophan has an aromatic ring. Both molecules, with the help of aromatic rings, can create the non-covalent, π-π stacking bond.
Spectral studies make it possible to determine the availability of complex formation of a tiochrome with a tryptophan. And the distribution of charge, electronic and oscillatory structure, forms of molecular orbitals of individual molecules, and their complexes can be characterized by quantum-chemical calculations: semi-empirical and DFT method. The purpose of this work is to study the spectra of absorption of composite films of tryptophan with the thiochrome and to establish the mechanisms of their interaction in the formation of complexes in the case of π-π stacking.

Topics:

Session D. Biomedical optics and sensors technology

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Poster session / **57**

Self Focusing of Rippled Elliptical q-Gaussian Laser Beam in Plasma with Axial Density Ramp

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Theoretical investigation on self focusing of an elliptical -Gaussian laser beam carrying an intensity ripple over its cross section, in plasma with axial density ramp has been presented. The optical nonlinearity of plasma has been modeled by the relativistic mass nonlinearity of plasma electrons in the field of laser beam. Using Variational theory approach, semi analytical solutions of the wave equations for the fields of main beam and that of ripple have been obtained. Emphasis has been put on the evolutions of the beam widths of main beam and that of ripple.

Topics:

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Optoelectronics and detection technologies II / **58**

Visualization of X-ray beam using Augmented Reality(AR) technology

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Currently, X-rays are used in a variety of places by taking advantage of their penetrating effect, such as X-ray imaging and CT inspection in the medical field, and non-destructive testing field, and security field such as baggage inspections at airports. On the other hand, when taking image with X-rays, due to the fact that X-rays are invisible light, it takes much time on alignment, the operation status of the radiation source and detector is unclear, and the observer couldn't get the location where X-ray beam hits. These factors cause lack of efficiency when taking images with X-ray. So, visualization of X-ray beam is considered necessary.
As basic research, the visualization of the center line of X-ray beam as a pencil beam by using Hololens2 in X-ray imaging environment is aimed.
This study proposed the following methods. A storage-type flat panel detector is used to measure X-ray's trajectory , and it is output to the real world as AR image with Hololens 2. Using an X-ray source radiation is narrowed down by a collimator and a storage-type flat panel detector changing the distance between X-ray source and the detector, and detection is performed while accurately acquiring three-dimensional position information of the detector. Based on the data, X-ray trajectory was displayed in AR. As a result, it became possible to superimpose on X-ray imaging device in the real space, demonstrating the effectiveness of AR in X-ray imaging.

Topics:

Session C. Applied optics and engineering

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Applied Optics / **59**

Evaluation of the photoelectric effect of X-rays for Gallium Nitride

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Ge detectors are widely used as X-ray/γ-ray detectors, but they cannot operate at room temperature due to narrow bandgap, must be cooled with liquid nitrogen. As a better material, CdTe, which can operate at room temperature and has a large attenuation coefficient, is becoming more widely used. However, compared to Ge, the manufacturing process has not been optimized and the manufacturing cost is high.

We propose the use of Gallium Nitride (GaN) as a new semiconductor detector material. GaN is a wide bandgap semiconductor that has been used in many products in the fields of power devices and optical devices. GaN is in great demand in those markets. Therefore, the manufacturing process is optimized, and it is expected to low manufacturing cost.
GaN has a large attenuation coefficient, exceeds that of CdTe in the energy range of 10-26 keV. Despite such excellent characteristic, sufficient experimental data on GaN as a radiation detector have not been obtained.

To demonstrate that GaN can be used as a radiation detector, we measured the photoelectric effect when GaN pn diodes were irradiated with X-rays. A pn diode structure was fabricated by epitaxial growth of 2μm p-type GaN on a 350μm thick n-type GaN substrate.

As a result of the experiment, it was shown that the current increased in proportion to the intensity of the irradiated X-ray. However, the current change is very small, about 10 nA, indicating that the structure needs to be modified for practical use.

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Optoelectronics and detection technologies / 60

Investigation of annealing effects for CdTe pn diodes fabricated by laser-induced doping method

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CdTe has been used as radiation detectors at room temperature. Impurity doping of CdTe has been considered difficult because it requires high temperature heat treatment and characteristics are degraded. However, the laser doping method that we have recently developed is overcoming this problem. When doping semiconductors, not all dopants act as donors or acceptors, and some of them become defects in the crystal. In response to the presence of such inactive dopants, for example, ion implantation undergoes an annealing process to promote the activation of the dopants. On the other hand, when CdTe is annealed above 150℃, the characteristics of diodes and detectors are degraded, such as increased reverse current and decreased hole mobility. Therefore, annealing has been considered difficult for CdTe. The I-V characteristics of CdTe pn diodes doped by laser-induced backside doping do not degrade when heat-treated above 150℃, and in fact I-V properties are improved. Therefore, it was assumed that annealing of CdTe might be possible because the characteristic degradation due to annealing that has been reported could not be measured. In this study, the CdTe pn diodes fabricated by the laser doping method was annealed and investigated the annealing effect. The annealing process was carried out from 100℃ to 400℃. The spectral properties of CdTe diodes during long time measurement can indicate In diffusion in Schottky detector due to annealing. The result of PL measurement can indicate dopants activate due to anneal above 300℃. Details will be discussed on the day.

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Optoelectronics and detection technologies II / 61

Representation of the internal structure of an object imaged by 3D X-ray CT using mixed reality

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Demand for X-ray inspection has been increasing in recent years, and research in advanced fields is progressing, including the development of high-definition X-ray CT. On the other hand, since the human eye can only spatially grasp the surface information of a three-dimensional object, the three-dimensional information captured by X-ray CT is confirmed as images from three directions: sagittal, axial, and coronal sections. On the other hand, the representation of three-dimensional X-ray CT imaging data by Virtual Reality (VR), Augmented Reality (AR), and Mixed Reality (MR) has been studied, but these methods are limited to the representation of the superficial structure of the object. In this study, the objective was to spatially represent the internal structure of an object imaged using mixed reality. By combining a spatial reality display with motion capture, overlaying a DICOM 2D image on a cross-section of a "surface-rendered" model of the object, the observer can view the cross-section in the desired direction and position as if he/she were grasping, moving, and rotating the contents of the object with his/her hands. The result is that the proposed method is able to display the cross section of a box containing internal information. As a result, the proposed method is shown to be effective as a useful 3D method for 3D X-rays, which are voxel data containing internal structure.

Topics:

Session C. Applied optics and engineering

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Biophotonics and sensor technologies / **62**

Protocells and Surface-adhered Biomembrane Networks

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Reservoirs of lipid molecules, specifically onion shell vesicles, spread on high energy surfaces, e.g. SiO2, to form a stack of molecular films (double bilayer). Eventually, the spreading lipid exhausts the reservoir, and rising tension ruptures the films. Köksal et al. discovered that this disruptive process generates a network of nanotubes, which redistributes lipid material in order to alleviate local tension (Marangoni flow), and vesicles grow from the tubes. We have shown that local heating accelerate the growth and transformation of containers,
and initiates their fusion. Similar processes might have occurred in warm environments on the Early Earth. Our current work aims to utilize this system and control soft matter transformations with IR light to design and construct reconfigurable chemical reaction networks (CRNs) on engineered surfaces

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Biophotonics and sensor technologies / 63

Fluorescence lifetime DNA-PAINT for multiplexed super-resolution imaging of cells

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DNA point accumulation for imaging in nanoscale topography (DNA-PAINT)[1] is a powerful super-resolution technique highly suitable for multi-target (multiplexing) bio-imaging. However, multiplexed imaging of cells is still challenging due to the dense and sticky environment inside a cell. Here, we combine fluorescence lifetime imaging microscopy (FLIM) with DNA-PAINT and use the lifetime information as a multiplexing parameter for target identification. In contrast to Exchange-PAINT, fluorescence lifetime PAINT (FL-PAINT)[2] can image multiple targets simultaneously and does not requires any fluid exchange, thus leaving the sample undisturbed and making the use of flow chambers/microfluidic systems unnecessary. We demonstrate the potential of FL-PAINT by simultaneous imaging of up to three targets in a cell using both wide-field FLIM and 3D time-resolved Confocal Laser Scanning Microscopy (CLSM). FL-PAINT can be readily combined with other existing techniques of multiplexed imaging and is therefore a perfect candidate for high-throughput multi-target bio-imaging.

[1] Jungmann, R.; Avendaño, M.S.; Woehrstein, J.B.; Dai, M.; Shih, W.M.; Yin, P., Nat. Methods, 11, 313 (2014).
[2] Oleksiievets, N., Sargsyan, Y., Thiele, J.C. et al. Fluorescence lifetime DNA-PAINT for multiplexed super-resolution imaging of cells. Commun Biol 5, 38 (2022).

Topics:

Session D. Biomedical optics and sensors technology

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Optoelectronics and detection technologies II / 64

Approximate Bayesian Estimation And Maximum Likelihood Estimation of Type I Half Logistic Rayleigh Distribution And Its Application

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Type I Half-Logistic Rayleigh distribution is a new development distribution. The main objective of this study is to estimate parameter under Bayesian approach using Lindley's method with two different loss functions and maximum likelihood estimation (MLE). The two loss functions used are squared error loss function (SELF) and linear exponential (LINEX) loss function. Reliability and hazard function are also estimated by using both estimations. For Bayesian estimation, extension of Jeffrey's prior is used. The performance of the proposed estimators, reliability and hazard function are compared using their corresponding root mean squared error (RMSE) by using simulation methods. Different sample sizes are used in all estimations. As a result, estimation of parameters, reliability and hazard function of Bayesian approach under SELF performs better than LINEX and MLE. In conclusion, the estimated parameters, reliability and hazard function of Type I Half-Logistic Rayleigh distribution under SELF is comparatively the best with higher sample size with respect to LINEX loss function and MLE.

Topics:

Session C. Applied optics and engineering

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Light-matter interactions / **65**

Terahertz transmission spectroscopy of femtosecond laser filaments

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We investigate the relaxation dynamics of a plasma channel, called *filament*, produced in air by an intense femtosecond laser pulse. A single-cycle terahertz pulse, generated by a secondary air-plasma, probes the filament at its near-critical plasma density.
We investigate essential parameters of the plasma filament, especially the electron density, in the particular regime of high repetition rate (>kHz) lasers. In the latter, the fast accumulation of laser pulses drastically modifies the formation of filaments and their characterization with standard techniques. The results are compared with measurements of optical interferometry performed at lower laser repetition rate.
Through this experiment, we more generally demonstrate the reliability of our THz source for investigating ultrafast phenomena with similar pump-probe schemes.

Topics:

Session B. Laser physics and modern optoelectronics

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Optoelectronics and detection technologies II / **66**

Denoising for Reconstructed Image of Spectral X-ray CT Using Weighted Linear Local Regression

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X-ray CT is a technique to visualize the distribution of the X-ray attenuation coefficient inside an object and has a wide range of applications, such as nondestructive testing, medical examination, and intraoperative assessment. In general, the attenuation of X-rays depends on the energy of the X-ray photon and the material they penetrate; the X-ray spectrum will be different when it penetrates different materials.
However, Energy-integrating detectors used in conventional X-ray CT cannot obtain the spectral information of X-rays because they measure X-rays as intensity integrated with respect to energy. As a result, it can be difficult to distinguish between different materials with similar integrated values of X-rays after transmission.
In contrast, spectral X-ray CT, which has recently been studied and developed, uses a photon-counting detector (PCD) that can obtain discrete information on the X-ray spectrum, and thus spectral X-ray CT is a promising technique for the discrimination of multiple materials.
Nevertheless, in spectral X-ray CT, the tube current during measurement is limited to prevent pile-ups, and the measured data is divided for each energy threshold, which causes an increase in Poisson noise in each energy image.
In this study, we propose a method for denoising spectral X-ray CT reconstructed images by applying weighted linear local regression. In this method, the pixel value of each energy region is calculated by linear regression using the pixel values from other energy regions.
By reference to the structural features of the object common to the images, image-specific Poisson noise is expected to be reduced.

Topics:

Session C. Applied optics and engineering

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Optoelectronics and detection technologies / 67

Fabrication of thallium bromide thin film using vacuum evaporation method

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Thallium bromide is a compound semiconductor with high atomic number and density and wide bandgap. Therefore, thallium bromide has potential as a direct conversion type radiation detector that can operate at room temperature.

One application for semiconductor detectors is for low-energy X-ray applications such as mammography and pathology, where the high stopping power of thallium bromide allows for a thinner detector. Thinner detectors can also compensate for thallium bromide's disadvantage of low carrier mobility. However, the method of fabrication differs greatly between bulk crystals fabricated by the conventional CZ method and thin films fabricated by vacuum evaporation. In addition, since the melting point of bromine is lower than that of thallium, it is necessary to confirm that the bromine is correctly vacuum evaporated as a compound. Therefore, it is necessary to verify the crystal structure and electrical characteristics required for a radiation detector.
Therefore, the purpose of this study is to fabricate a thin film of thallium bromide and verify its crystallinity, elemental analysis, and current-voltage characteristics.
In this study, a total of two types of samples were prepared by vacuum evaporation of thallium bromide on SiO2 and silicon substrates. The crystallinity of the samples was analyzed by X-ray diffraction. Thallium electrodes were deposited on the thin film samples, and current-voltage characteristics were measured.

Topics:

Session C. Applied optics and engineering

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Optoelectronics and detection technologies / 68

Electrical Characterization of Thallium Bromide Crystals

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X-ray imaging technology has applications in medicine, nondestructive testing at industrial sites, and security inspections at airports.
Today, semiconductor detectors are widely used as radiation detectors. Because semiconductor detectors convert X-rays directly into electric charge, they are considered to have higher spatial resolution than scintillator-type detectors, which convert X-rays once into visible light.
In gamma-ray measurements, detectors using CdTe are widely used as semiconductor detectors that work at room temperature, but we focused on thallium bromide (TlBr), one of compound semiconductors. The TlBr detector can operate at room temperature with a band gap of 2.68 eV, and is expected to have higher detection efficiency than CdTe at higher energies due to its high atomic number (81 for thallium and 35 for bromine) and density (7.56 g/cm3). However, it has the disadvantage of longer rise time due to its lower carrier mobility than CdTe. Therefore, it is necessary to apply a high electric field for high-speed charge transfer, and we strive to create a diode. For this purpose, it is necessary to clarify the electrical characteristics of TlBr.
Therefore, in this study, a sample of TlBr crystal was vacuum-deposited with Tl as an electrode. Then, in order to clarify the electrical properties of TlBr, such as polarity and mobility, whether TlBr is n-type or p-type, Hall effect measurements and current-voltage characteristics were performed.

Topics:

Session C. Applied optics and engineering

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Material Science and Diagnostics / 69

Anomalous scattering of light: from invisibility to superscattering

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In the talk, diverse scenarios of invisibility will be reviewed and exemplified. Extensive development of invisibility cloaks which can make good scatterers invisible has been mainly connected with the raise of metamaterials in the early 2000s. Metamaterials enable Transformation Optics offering such desired distributions of the material parameters of the cloak, a specific coating of the object, that redirection of the light "rays" around the object enables its invisibility for far-zone observer, while nearly zero field values are kept within the object region. In turn, scattering cancellation is achieved in core-shell spherical or cylindrical structures, or arrays on their basis, due to the different signs of polarizability of the core and the shell, which are made of different homogeneous materials. Invisibility scenarios based on the inner resonances, such as Localized Surface Plasmon resonances, Mie resonances and Fabry-Perot interferences, typically do not allow keeping zero fields in the object region but still enable invisibility for far-zone observer. The numerical examples will be presented and discussed for the scenarios of this type. Moreover, the approaches were proposed to achieve invisibility of spatial distortions at a flat or a gradually curved surface, by covering them by a sophisticatedly designed coatings. Besides, the external cloaking will be discussed, which may hide a radiation source located outside the cloak. As a counterpart of invisibility, superscattering may appear which means that the scattering is unusually strong for a given small scatterer. The best known scenarios of superscattering utilize some kinds of Localized Surface Plasmon resonances. As far as the spoof surface plasmons are achievable by means of the structured metallic or metallo-dielectric surfaces, they constitute a suitable route to superscattering that allows avoiding scattering suppression connected to the losses in the used natural materials. Finally, examples will be presented for switching between weak and strong scattering regimes and for different mechanisms of invisibility in the closely spaced frequency ranges. The both are achieved by using tunable materials as the coating's materials.

Topics:

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Applied Optics / 70

Subjective Evaluation of Decreasing Primary Color Saturation of UHD-TV Displays for UHD gamut

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BT.2020's color gamut includes 99.9% of that of Pointer colors, which is colorimetric data representing the gamut of real surface colors. For this reason, BT.2020 compliant Ultra High Definition (UHD)

displays are required to have a wider color gamut than High Definition (HD) displays. Light-emitting devices and color filters are being developed for UHD displays. Due to issues with light-emitting elements and color filters, UHD displays do not meet the color gamut defined by the standard. UHD displays have the problem of different color gamuts for each display.
In the medical fields, color reproduction, which reproduces the same colors on displays as those seen by humans, is important. UHD displays has been considering for using in the medical fields. Different color gamut between displays are considering to affect color reproduction.
In this study, the perception of color change was evaluated when the saturation of one of primary colors was decreased in the display. Evaluation images were created from standard images while keep the hue and color temperature unchanged. The standard images and the images with changed saturation primary colors were displayed to the 21 subjects. The subjects evaluated the difference in color perception between one of standard images and one of images with different saturation. The results of the evaluation showed that the perception of the difference in saturation was greater when the standard image containing more red and green saturated colors were displayed.

Topics:

Session C. Applied optics and engineering

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Optoelectronics and detection technologies / 71

Investigation of neutron collimation method in the device for small-scale neutron imaging

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Fusion reactions, such as the D-D and D-T reactions, can be used to produce neutrons in smaller devices than conventional neutron sources such as nuclear reactors and large accelerators. Compared to conventional methods, this neutron source enables to make imaging devices smaller and more convenient.
The Small-scale neutron imaging device is consisted of a neutron source, detectors, and other imaging equipment, and a neutron shielding material that covers them. Because of the smaller space inside the device compared to conventional imaging devices, the distance between the wall and the detector is closer, and neutrons reflected and scattered by the wall are more frequently incident on the detector. Therefore, it is necessary to collimate by placing shield materials around the neutron source and the detector to prevent scattered and reflected neutrons from entering the detector. A suitable neutron shielding is necessary to ensure the supply of neutrons to the detector and to prevent the incident of scattered or reflected neutrons on the detector.Experiments were performed using PHITS to simulate neutron imaging using a small neutron source in a small-scale neutron imaging system. A neutron shielding material was placed around the source and detector to collimate the neutrons incident on the detector. High-density polyethylene with boric acid was used as the shielding material. The length of the shielding material and the distance between the source and detector were varied, and the change in neutrons incident on the detector was evaluated by changing the collimation situation.

Topics:

Session D. Biomedical optics and sensors technology

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Poster session / **72**

Application of laser speckles for analysis of structural dynamics of nanofluids based on carbon nanotubes

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Nanofluids are colloidal solutions of particles with a size of 0.1-100 nm. The unique physical and chemical properties of nanofluids make them promising materials for electronics, energy, pharmaceuticals, etc. The high value of the surface energy of nanoparticles contributes to their tendency to aggregation, which causes the structural instability of nanofluids.
We demonstrate the possibility of using dynamic laser speckle analysis to control the state of an aqueous solution of multilayered carbon nanotubes.
Dynamic speckle is a moving speckled pattern that arises as a result of the scattering of coherent radiation on moving inhomogeneities. The dynamics of speckles reproduces the dynamics of nano-inhomogeneities in the liquid medium. A standard optical scheme and a special signal processing algorithm were used [1].
Decorrelation is a decrease in the similarity of the picture over time, which is characterized by a certain law of decay and occurs for any dynamic speckle. In nanofluids, particles are in a state of Brownian motion. The autocorrelation function of their dynamic speckle has the form of a decaying exponent, where the decay constant depends on particle size, viscosity, and temperature. If other factors remain constant, the aggregation of nanoparticles leads to an increase in the decay constant.
We recorded different types of behavior of the aqueous suspension of carbon nanotubes depending on the concentration, sonication time, and storage duration. The obtained results will contribute to the optimization of nanofluidic technologies. It was also established that surface-active substances are able to stabilize the suspension for a certain time.

1. V.Pobiedina, A.Yakunov. Speckle decorrelation study of phase heterogeneous liquid medium. In SPIE Photonics Europe. 2016. International Society for Optics and Photonics.

Topics:

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Material science and nanotechnologies / **73**

Metasurface-enhanced fiber for extraordinary light coupling

Authors: Oleh Yermakov[1]; Matthias Zeisberger[2]; Henrik Schneidewind[2]; Jisoo Kim[2]; Andrey Bogdanov[3]; Yuri Kivshar[4]; Markus Schmidt[2]

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Remote collection and analysis of light is highly important for a plethora of applications including spectroscopy, endoscopy, biosensing, quantum communications, etc. Commercial optical fibers are the best platform for this purpose due to their ability to operate in strongly limited and closed spaces (particularly, in-vivo) in a wide range of environments and external conditions. The payback of this advantage is the low coupling of the incident light into fiber under oblique incidence. Practically, the efficient light coupling into fiber modes is possible only for incident angles less than 15 degrees.

Here, we propose to overcome this fundamental limitation by upgrading the fiber tips with axial-symmetric all-dielectric nanostructures. Namely, we demonstrate the enhancement of light in-coupling efficiency by several orders of magnitude at almost grazing incidence for the fibers empowered with coaxial silicon nitride nanorings [1]. This research was highlighted among "the most exciting research in optics and photonics in 2021" according to Optics & Photonics News journal [2]. Even more advanced polarization- and angle-independent in-coupling may be achieved with polymer aperiodic nanostructure implemented using 3D nanoprinting technique.

The corresponding author acknowledges the support from the Ministry of Education and Science of Ukraine under grant No. 0122U001482 and the U.S. Civilian Research and Development Foundation (CRDF Global) with funding from the United States Department of State under grant No. G-202202-68457, and thanks the Armed Forces of Ukraine for their service.

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[2] O. Yermakov et al., Optics & Photonics News, December 2021.

Topics:

Session C. Applied optics and engineering

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Optoelectronics and detection technologies / 74

Development of noise component improvement for scintillator type X-ray image detector using silicon grid substrate

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X-ray image have been developed for medical and non-destructive inspection, and higher resolution and larger area detectors are required due to the development of technology. Therefore, in this study, the spatial resolution of a scintillation type image detector, which is an indirect conversion type X-ray image detector can be easily enlarged has been improved. The cause of lowering the spatial resolution of the detector is the diffusion of scintillation light within the detector. Therefore, the scintillator was optically separated using a silicon substrate in order to suppress the diffusion of this visible light. A detector element was fabricated by processing a silicon wafer into a grid and filled a scintillator in each pixel. This grid structure improved the spatial resolution of the scintillator-type image detector, however reduced the uniformity of the image by increasing the

noise component. The purpose of this study is to improve the noise component of the scintillator type image detector using the grid structure. It is verified to improve noise component by increasing the detected emission intensity, and a method of applying reflectors to the walls of the grid and concentrating the visible light absorbed by the silicon was simulated. Therefore, the movement of visible light in a scintillator-type image detector using a silicon grid substrate was calculated using the Monte Carlo method. The spatial resolution, noise power spectrum and detection quantum efficiency were calculated with result of simulates and used as indicators for the realization of a scintillator-type image detector using a silicon grid substrate.

Topics:

Session D. Biomedical optics and sensors technology

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Optoelectronics and detection technologies II / **75**

Identification of buried objects using energy distribution of reflected X-rays.

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In recent years, the ability of X-rays to detect buried objects has led to calls for the detection of land mines buried underground and the inspection of aging reinforcing steel bars in aging buildings. In this study, A method called reflection x-ray imaging is used, in which X-rays are irradiated onto a target and the reflected X-rays are detected. Reflected X-ray imaging can detect objects regardless of their size and distance, and is expected to enable X-ray imaging in cases where the distance to an object, such as an underground object, and its size are unknown.

The purpose of this study is to identify buried objects by the difference of reflected X-ray spectra depending on the material, shape, and distance of the object. Reflected X-rays including complex scattering and absorption within the material were analyzed, and angle-dependent changes in the scattered X-ray spectrum due to the material of the buried object were verified. Measurements and verification were made to evaluate X-rays for the angles they scatter from 0° to 180° when they are applied to a target. Result showed that reflected and characteristic X-rays characteristic of each material could be detected, and that angle-dependent changes could be detected, but Complex scattering of incident and reflected X-rays., and it was difficult to determine the material and shape of the target from the detected X-rays. In future research, Reflected X-rays are analyzed for object identification using artificial intelligence.

Topics:

Session C. Applied optics and engineering

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Material science and nanotechnologies / **76**

Hyperbolic Metasurfaces Based on Gold Nanodisks

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Metasurface is a periodic subwavelength array of scatterers that provides effective beam shaping, phase and polarization manipulation of electromagnetic waves. In contrast to bulk metamaterials, metasurfaces allow eliminating volumetric losses, simplifying the manufacturing process, and ensuring full integration into optical planar devices. They can serve as various optical devices including polarization converters, antennas, perfect absorbers, sensors, frequency selectors, etc. In addition, the miniaturization and planarization of optical components requires the in-plane control of the optical signal by means of surface electromagnetic waves. Surface waves are characterized by the spatial distribution of field profiles and the speed of propagation. Hyperbolic propagation regime is one of the most practically important. It may be applied for the spontaneous emission enhancement, planar hyperlensing, sensing, enhanced spin-orbit interactions of light and the in-plane electromagnetic signal transmission. In this work, we provide a practical guide of the hyperbolic metasurfaces engineering. First, we retrieve the surface conductivity of a metasurface consisting of gold nanodisks from the reflectance spectrum. Then, we analyze the dependence of the resonant wavelengths and the spectral width of hyperbolic regime on the period of metasurface and size of nanodisks. The results obtained may be used to design a hyperbolic metasurface based on gold nanoparticles for any relevant purpose on demand.

Topics:

Session C. Applied optics and engineering

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Applied Optics / **77**

Stimulated Raman Scattering of Self Focused Cosh-Gaussian Laser Beams in Underdense Plasma Targets: Effect of Density Ramp

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The phenomenon of stimulated Raman scattering (S.R.S) of intense self focused Cosh-Gaussian (ChG) laser beams in underdense plasma targets modeled by a ramp shaped different density profiles, has been investigated. An intense laser beam with frequency ω0 propagating through plasma gets coupled with a pre-existing electron plasma wave (EPW) at frequency ωep and produces a back scattered wave at frequency ωs=ω0-ωep. Semi analytical solution of the set of coupled wave equations (pump, EPW and scattered wave) has been obtained under W.K.B. approximation by using variational theory. It has been observed that S.R.S reflectivity of plasma is significantly affected under the effect of slope of density ramp.

Topics:

Session B. Laser physics and modern optoelectronics

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Ultrafast phenomena I / **78**

Spin transport at terahertz frequencies

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The time-domain terahertz (THz) spectroscopy has proven to be a powerful technique for investigation of the ultrafast electron transport. In this talk, it will be shown that it can also evidence the ultrafast dynamics of spin currents: their generation, spin-to-charge conversion and relaxation in conventional spintronic metals, as well as compensated magnetic materials or van der Waals systems. In addition, the synergy between the ultrafast spintronics and THz spectroscopy will be demonstrated on novel spintronic emitters of THz pulses.

Topics:

Session A. Physics of condensed matter and spectroscopy

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Applied Optics / **79**

Poisson Property of Sinogram and Related Mathematics

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The Photon Counting in Sinogram of CT is according to the Poisson distribution of X-ray photons. And every Sinogram contains the components of Pixel imaging, and every components receive the photons. So the numbers of photons in the components are the random numbers according to the Poisson distribution. Adding these random numbers, that is Sinogram become to the random numbers according to the Poisson distribution. (So called “Additional Reproduce Property of Poisson Distribution”.) The Sinogram component is the projection probability(random number) times the Pixel value(deterministic value).And the important parameter of Poisson distribution of Sinogram component λ,can be explained by the Pixel values. The Poisson distribution has the moment generating function(m.g.f.)and has the probability density function(p.d.f.) via some Integral formula. Then we get the stochastic property of the projection probability of Sinogram including its p.d.f. ,so we show the expectation of Sinogram data become to the harmonic mean of the data.

Topics:

Session C. Applied optics and engineering

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Light-matter interactions / **80**

Generation and control of the Raman active phonon mode in Bismuth Telluride nanofilm with sub-picosecond THz radiation

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Intense picosecond terahertz radiation has opened new opportunities in solid-state physics and materials science, allowing to probe and/or control different degrees of freedom of a solid by driving electrons, magnons, or phonons at ultrafast timescales with an intense electric field associated with photon energy in the meV range¹. Owing to significant spectral weight in the terahertz (THz) frequency range and the momentum conservation, THz radiation can be directly coupled to high-frequency optical phonons (1-40 THz range), while other phonon modes can be also excited as a result of nonlinear interaction². However, despite numerous reports on optical phonon generation with THz light, there are still some debates on the driving optical phonon generation mechanisms, possibly originating from the non-linear ionic Raman scattering³ or THz sum frequency excitation⁴.

Here, we conduct an experimental study on a well-known thermoelectric compound and topological insulator, 16nm thick semimetal Bi₂Te₃ film, grown by the molecular beam epitaxy on the mica substrate. To study the coherent optical phonon dynamics, the sample was excited with pulsed, high-peak (up to 300 kV/cm) field THz radiation, and we measure the change in the 400 nm probe beam transmittance in a pump-probe geometry. In this work, we report the controlled excitation of 1.85 THz A¹_{1g} Raman active optical phonon with THz radiation having a central frequency in the range of 0.53-0.72 THz. From the notions of the transient phase and THz field strength – optical phonon amplitude dependence, we then try to identify the various pathways of the A¹_{1g} mode excitation with pulsed THz radiation.

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3. Melnikov, A. A. et al. Coherent phonons in a Bi2Se3 film generated by an intense single-cycle THz pulse. Phys Rev B 97, 214304 (2018).
4. Maehrlein, S., Paarmann, A., Wolf, M. & Kampfrath, T. Terahertz Sum-Frequency Excitation of a Raman-Active Phonon. Phys Rev Lett 119, 127402 (2017).

Topics:

Session A. Physics of condensed matter and spectroscopy

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Poster session / 81

Frequency mixing of two Q- Gaussian laser beams in plasma: Effect of cross focusing

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A scheme for second-harmonic generation (SHG) of a pair of q-Gaussian laser beams interacting nonlinearly with underdense plasma has been proposed. Due to the relativistic increase in electron mass under the intense fields of the laser beam, the resulting optical nonlinearity of plasma leads cross-focusing of the laser beams. The resulting nonlinear coupling between the two laser beams makes the oscillations of plasma electrons to contain a frequency component equal to the sum of frequencies of the pump beams. This results in a nonlinear current density at frequency equal to the sum of frequencies of the pump beams. If the frequencies of the pump beams are equal, then the resulting nonlinear current generates a new radiation at frequency twice the frequencies of the pump beams— a phenomenon known as SHG. Starting from nonlinear Schrodinger wave equation a set of coupled differential equations governing the evolution of beam widths of the laser beams and power of generated second-harmonic radiation with longitudinal distance has been obtained with the help of variational theory. The equations so obtained have been solved numerically to envision the effect of laser as well as plasma parameters on the power of generated second-harmonic radiation.

Topics:

Session B. Laser physics and modern optoelectronics

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Poster session / 82

Laser ellipsometry of diamond micro-sharpened aluminum mirrors

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Copper mirrors, which were deposited by various technologies, were investigated in the work. The basis for the mirrors was a ceramic substrate made by sintering and pressing silicon carbide. The working layer of copper with a thickness of 0.25-0.30 mm was applied by vacuum or galvanic deposition. After applying the copper layer, the reflective surface was formed by diamond microturning. Different optical characteristics from the angle of incidence were found for the samples. It has been found that the method of diamond turning of specimens brings mirrors to the highest quality surface, when the thickness of the oxide layer and the roughness is less.

Key words: ellipsometry, spectroellipsometry, optical properties, transition metals, oxide films, alloys, absorbtion spectra, reflection spectra.

Topics:

Session A. Physics of condensed matter and spectroscopy

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Poster session / **83**

Transition To High Temperature Superconductivity "A Review"

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Right after the discovery of high temperature superconductivity in 1986 it has provided a new path for scientific enquiry. In 1986, it was discovered that some cuprate-perovskite ceramic materials have a critical temperature above 90 K. For conventional superconductors such a high transition temperature is theoretically not possible. Right now we know only about their nature, however there are many unsolved issues over this topic. Its manufacturing issues and ambient pressure are challenging issues to make it practical. This paper gives a brief review on the recent developments taken place in field of condensed matter physics for achieving transition to high temperature superconductivity.

Topics:

Session A. Physics of condensed matter and spectroscopy

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Applied Optics / **84**

Stimulated Brillouin Scattering of q-Gaussian Laser Beams in Underdense Plasmas: Effect of Self Focusing

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This paper presents theoretical study of phenomenon of stimulated Brillouin scattering of q-Gaussian laser beams in nonlinearly-interacting with underdense plasmas. During propagation of intense laser beam with ω0, it gets coupled to pre-existing ion acoustic wave (IAW) at frequency ωia due to relativistic mass nonlinearity of plasma electrons. The nonlinear interaction of pump beam with IAW produces a back scattered wave at frequency ωs = ω0- ωia. Semi analytical solution of the set of coupled wave equations (pump, IAW and scattered wave) has been obtained under W.K.B.

approximation by using variational theory. It has been observed that power of scattered wave is significantly affected by self focusing of pump beam.

Topics:

Session B. Laser physics and modern optoelectronics

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Ultrafast phenomena II / **85**

Charge localization through symmetry breaking in doped perovskite nanocrystals for fast and efficient luminescence

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Lead-halide perovskite nanocrystals have emerged as high-performance semiconductors for efficient optoelectronic devices, especially in light-emitting diodes (LEDs) for bright and flexible displays. Atomic doping with transition metals other than lead has been shown to dramatically boost the luminescence of these nanocrystals. Yet, we still do not fully understand why these materials work so efficiently.
In this talk, I will give an overview of our recent work on understanding the high luminescence yields observed in a variety of doped nanocrystals, including Mn, Ni, and Zn.
We find that the dopant-induced lattice periodicity breaking results in transient charge localization, increasing the overlap of electron and hole wavefunctions. This leads to increased radiative recombination rates – a property that is typically intrinsic to a semiconductor and hard to change – and an overall higher luminescence yield. Our results pave the way to highly efficient displays and quantum emitters.

Topics:

Session A. Physics of condensed matter and spectroscopy

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Material science and nanotechnologies / **86**

Imaging Magnetic Systems at Large Scale Facilities

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An overview of imaging methods involving neutrons or synchrotron radiation at large scale facilities and their application to the investigation of magnetic materials is given. Dynamic neutron imaging

experiments analysing the behaviour of paramagnetic liquids in magnetic field gradients are presented. Furthermore, an introduction to the study of magnetic nanostructures with microspectroscopic techniques such as scanning transmission x-ray microscopy or ptychography at synchrotrons is given.

Topics:

Session A. Physics of condensed matter and spectroscopy

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Plenary / **87**

Applications relying on laser filamentation in air

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An intense femtosecond laser pulse propagating in air undergoes a filamentation process, during which beam self-focusing due to the optical Kerr effect is counterbalanced by beam defocusing due to plasma generation. As a consequence, the propagating laser pulse maintains a high intensity over very long distances. I will describe some applications exploiting this effect. It includes remote investigation of atmosphere by broadband lidar, triggering and guiding of electric discharges, guiding of lightning, the possibility of improving the speed of trains and of supersonic flights, the fabrication of a furtive plasma antenna.

Topics:

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Plenary / **88**

Terahertz Technology at the Frontier of Chemistry

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Topics:

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Opening / **89**

Opening remarks

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Topics:

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Plenary / **90**

Stable Negative Capacitance in MOSFET Transistors: Possible or Not?

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Topics:

Contact Email address:

Plenary / **91**

Applications of Strain Sensors to CG, VR and Rehabilitation Equipment

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We have synthesized spinnable carbon nanotube (CNT) [1] and have developed the CNT strain sensors as components of a textile based, wearable sensing system for real-time motion detection [2]. The aligned CNT layer was formed by stacking CNT webs drawn from a spinnable CNT forest. In the strain sensors, we sandwiched the aligned CNT sheet between elastomer layers. We have applied the CNT strain sensors to the data glove. The data glove detects fine finger motions and collecting electric motion data when worn on the hand. When a finger joint bends, the respective CNT strain sensor elongates, and the resistance increases. The data glove has generated significant outcomes in various fields that require electric expression of human finger motions, such as virtual reality (VR) studies, animation and computer graphics (CG) production, and ergonomics. In the presentation. I will introduce the data glove with the CNT strain sensors and the demonstration of the CG, VR and rehabilitation equipment using the data glove.

[1] Y. Inoue, K. Kakihata, Y. Hirano, T. Horie, A. Ishida, and H. Mimura, Appl. Phys. Lett. 92 (2008) 213113.
[2] K. Suzuki, K. Yataka, Y. Okuyama, S. Sakakibara, K. Sako, H. Mimura and Y. Inoue, ACS sensors (2016) 817.

Topics:

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Material science and nanotechnologies / **92**

Raman spectroscopy probe of the structure of semiconductor nanocrystals

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Topics:

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Special session / **93**

Research and Industry-Academia Cooperation of Shizuoka University

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First, the current state of national universities in Japan will be explained. On top of that, we will discuss the future direction of local universities in Japan, where declining birthrate and population continue. Even for local universities, having strengths is important to promote research and industry-academia collaboration for survival.
Shizuoka University's Hamamatsu Campus will celebrate its 100th anniversary next year. In 1926, Dr. Kenjiro Takayanagi of Hamamatsu Technical School, the predecessor of Shizuoka University's Faculty of Engineering, invented an all-electronic television system. Since then, Shizuoka University has consistently continued imaging research, creating various innovations and contributing to society. In 1965, the Institute of Electronics was established at Shizuoka University to commemorate Dr. Takayanagi's achievements. For Shizuoka University, this applied photonics research centered on imaging technology is the research potential that distinguishes it from other institutions. So far, we have achieved practical 8K image sensors, detectors for high-energy rays such as X-rays, development and application of continuous-wave terahertz light sources, development of high-fidelity color reproduction technology, and development of sensors for medical measurement.
In addition, Shizuoka University is focusing on creating university-initiated startups as one way of giving back to society through university education and research. So far, there have been 43 startups from Shizuoka University, creating more than 700 jobs. Several startups have begun to produce results through M&As and listings, and the impact of Shizuoka University startups is drawing attention from society. Shizuoka University will establish an innovation ecosystem by leveraging our strength in imaging technology.

Topics:

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Light-matter interactions / **94**

Laser ultrasonics: optical excitation and detection of ultrasounds at GHz frequencies or GPa pressures

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Topics:

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Optoelectronics and detection technologies / 95

Brain-Implantable Flexible Multimodal Sensor for Simultaneous Measurement of Electrocorticography

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Topics:

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Applied Optics / 96

LIBS spectrometry for the analysis of the chemical composition of materials

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LIBS (Laser-Induced Breakdown Spectroscopy) allows to measure the concentration of major and trace elements in solid, liquid, or air samples. LIBS technology has the advantage of adapting the research to any situation, from online measurements in an industrial environment to analyses in the laboratory.
LIBS technology is designed to meet detection and analysis needs in a wide variety of fields, such as the analysis of metals, metal alloys, rocks, archeology and construction materials. The method has proven itself well in the research of cement, glass, polymers, ceramics, semiconductor materials, etc. The advantages of LIBS are that the analysis is fast and requires no sample preparation. LIBS is sensitive to light elements including H, Li and Be.
The LIBS method is an excellent tool for quantitative and qualitative determination of the elemental composition of materials.
The article was prepared in cooperation with GLOOR Instruments (Switzerland)

Topics:

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Material Science and Diagnostics / 97

Laser-combined scanning tunneling microscopy

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The comprehensive knowledge of the mechanism involved in the charge carrier separation in nanoscale structures is of high interest regarding applications and fundamental researches. A microscopy technique that enables the visualization of subpicosecond carrier dynamics in nanometer-scale structures is laser-combined scanning tunneling microscopy [1]. OptoPulSTM simultaneously realizes STM spatial resolution together with the temporal resolution of the optical pump–probe technique.

1. Terada, Y., Yoshida, S., Takeuchi, O. et al. Nature Photon 4, 869–874 (2010)

Topics:

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Ultrafast phenomena II / 98

Ultrafast optical properties of the liquid phase exfoliated Antiferromagnetic 2D Semiconductor NiPS3

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Antiferromagnets (AFMs) are promising materials for spintronic and opto-electronic applications due to natural spin dynamics in the THz range and, at the same time, they have no net magnetization. This leads to the absence of stray fields which is a useful property for data storage applications. A promising approach here is to combine the unique magnetic properties of AFMs with the strong coupling of optical and magnetic properties of semiconductors. Recently, semiconducting AFMs attract a lot of attention with several studies focusing on van der Waals layered AFMs from metal phosphotrichalcogenides such as NiPS3, FePS3, and MnPS3. For our studies, we have chosen NiPS3 because of its non-trivial exciton behavior of Zhang-Rice singlet and triplet states. Beside of that the liquid phase exfoliation (LPE) of NiPS3 was performed to bring the bulk NiPS3 crystals into the low-dimension phase. Depending on the conditions of the LPE the size of the low dimensional flakes of material are formed which leads to their different optical properties.
In order to investigate light-induced spin dynamics of the excited state and electronic populations

in semiconducting NiPS3, we use time-resolved transient absorption (TA) at cryogenic temperatures. This technique provides access to spectral information about changes in absorption induced by the excitation of non-equilibrium carrier populations and the dynamics of the carrier and exciton recombination. We will further report our results on time and spectrally resolved optical detection of the Neel vector at cryogenic temperatures through complex Zhang-Rice multiplet excitonic states of NiPS3 antiferromagnet by measuring the polarization properties of absorbed and emitted light.

Topics:

Session A. Physics of condensed matter and spectroscopy

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Ultrafast phenomena I / **99**

Controlling non-equilibrium properties of quantum materials: from fundamental research to artificial intelligence applications

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Topics:

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Ultrafast phenomena I / **100**

Physical and optical properties of ZnO nanorods/Sb-doped ZnO sol-gel thin film structure prepared by chemical process

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Topics:

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Ultrafast phenomena I / **101**

Time-domain investigation of quantum materials by ultrashort X-ray pulses at SwissFEL

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Topics:

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Quantum coherence and Nonlinear Optics / 104

Towards a quantum simulator on circular Rydberg atoms

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Topics:

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Ultrafast phenomena II / 106

Developing 2D-IR instrument using pulse shaping and attenuated total reflection

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Two-dimensional infrared (2DIR) spectroscopy has been widely used in structure study and energy transfer of bulk samples. However, in the last decade, 2DIR spectroscopy has been extended to study molecules at interfaces. Our target was to develop a user-friendly 2D ATR IR spectrometer, which will benefit a broad group of laboratories and researchers, expanding the borders of regular 2DIR experiments. In order to perform rapid 2DIR measurements over a broad range of frequencies, we developed and built a fully automated beam stabilization scheme that allows us to optimize the spatial overlap of the beams in the sample. The measurements occur in attenuated total reflection (ATR) mode, which benefits thin samples. It also allows us to use liquid samples and even samples in water which were not suitable before due to high absorption in IR. In addition to that, we developed and built the Pulse shaper, which brings ample opportunities of altering IR pulses. It permits alternating the phase of a single pulse, chopping every other pulse, or creating double pulses with an arbitrary delay between them. The combination of all units makes our spectrometer a very versatile instrument, we can measure linear and different 3rd-order 2DIR as well as relaxation-assisted 2DIR. Besides, the instrument was designed to be fully automated. Therefore, no additional alignment will be required during regular use.

Topics:

Session C. Applied optics and engineering

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Ultrafast phenomena II / 107

Charge carrier dynamics in Mn-doped Methylammonium Lead Bromide.

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One of the most challenging tasks for LED applications is emitting 100% polarized light from the device. Typically, this is achieved by introducing an additional layer of polarization filter which leads to losing half of the light intensity. To overcome this issue, one has to find a system with a high degree of photoluminescence (PL) polarization. A promising approach here is using magnetic metal doping in combination with a highly efficient semiconductor. Metal-halide perovskites have attracted the attention of many scientific groups around the world as one of the most promising candidates for solar cell applications and light-emitting diode (LED) technology. In our work, we will present how doping of methylammonium lead bromide (CH3NH3PbBr3) with the transition metals Ni, Co, and Mn induces dramatic changes in the magneto-optical properties and carrier dynamics due to interactions between the magnetic moments of the dopants and Coulomb interactions of the excitons.

We have chosen to use transient absorption (TA) spectroscopy at cryogenic temperatures to investigate changes in the optical properties induced by magnetic metal doping in CH3NH3PbBr3 since it gives spectral information about the energies of electronic states and dynamic properties of the photoexcited carriers. We find a change in the main ground state bleach (GSB) peak position in doped CH3NH3PbBr3, which depends on the transition metal used. The main GSB peak of pure CH3NH3PbBr3 at 4 K is at 2.32 eV. Doping CH3NH3PbBr3 with Mn leads to a shift of the main peak to lower energies by 0.04 eV. The modifications of the TA spectra are associated with changes in the bandgap energy, which is the result of doping-induced lattice expansion or compression.

We investigate spin dynamics and charge carriers' dynamics in doped and undoped samples using CTA and transient Kerr effect. We found that in the 50% Mn-doped sample spin lifetime is approximately 100 ps which is approximately 3 times longer than the lifetime in the undoped sample. We attribute these changes in spin life to the interaction of the polarized excitons with Mn spins. Spin lifetimes in doped and undoped materials were confirmed both by CTA measurements and by the transient Kerr effect.

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Ultrafast phenomena II / 108

Transient nematicity of FeSe0.8Te0.2 superconductor

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To be added later

Topics:

Session A. Physics of condensed matter and spectroscopy

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Ultrafast phenomena II / 109

Ultrafast control of collective excitations in of $BaFe_2As_2$

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Topics:

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Material Science and Diagnostics / 110

Development of p-n junction CdTe detector by backside irradiate doping

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Compared to scintillator detectors, semiconductor detectors have higher spatial resolution because of the direct generation of electric charge when X-rays are incident inside the semiconductor. Among semiconductor detectors, CdTe semiconductor detectors are used as radiation detectors at room temperature. Since the thickness of the CdTe device used as a radiation detector is as thick as approximately 1 mm, a high voltage is applied to increase the charge collection efficiency. Accordingly, it is required to suppress the dark current flowing in the CdTe when high voltage is applied. Therefore, a diode junction is suitable for the junction between CdTe and electrode. Among diode junctions,

we chose the pn junction because the hole mobility of CdTe decreases when the bulk is heated, making thermal diffusion and ion implantation annealing methods difficult. Therefore, we developed a pn junction CdTe radiation detector by direct laser irradiation of the interface between CdTe and electrode as a method for doping the n-layer. By controlling the doping layer and doping concentration by changing the irradiation intensity and frequency, an appropriate pn junction is formed inside the CdTe to suppress dark current. The fabricated pn-junction CdTe radiation detectors were subjected to current-voltage characteristic evaluation, gamma-ray spectral evaluation, SIMS evaluation.

Topics:

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Quantum coherence and Nonlinear Optics / 111

Wavelength dependent Raman scattering: Fundamentals and application to material science

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Topics:

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Quantum coherence and Nonlinear Optics / 112

Peculiarities of dye lasing in thin organic-inorganic films

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Topics:

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Poster session / 114

Peculiarities and conditions for the occurrenceStimulated Raman scattering of dyes in multiple scattering media

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Topics:

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Poster session / 115

Biosensor's system of remote-presence robot for monitoring of infected patients

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The covid pandemic that has taken over the world since 2019 has shown the need for the development of remote patient monitoring and control systems. The need to protect personnel from contamination has led to the use of various methods of disinfection of medical and sanitary facilities in which patients (staff) may be at the time of treatment.
All these problems that humanity faced at that moment actualized the tasks of modifying and developing new medical systems that would not only clean and disinfect medical premises, but also record the basic medical indicators of the patient. Data on temperature, oxygenation, general condition and tests for the virus are the basic markers that guide the doctor when examining the patient. Therefore, as one of the ways to protect the doctor (medical personnel in general), we proposed a robotic biomedical (measuring) system based on the Texas Instruments Robotics System Kit (TI-RSLK), which includes a set of sensors for measuring human biological parameters, a disinfection unit, power supply (charging station) and control unit.
As a result, such a system was modeled and developed. The measuring part that interacts with the patient includes: a fingerprint sensor, a non-contact temperature sensor, a saturation sensor, a heart rate sensor. Also, the system has its own battery, a disinfection system based on ultraviolet lamps and a visual interaction system with the patient

Topics:

Session D. Biomedical optics and sensors technology

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Poster session / 116

Random lasing in a nonuniformly scattering medium

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Topics:

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Poster session / 118

Simulation of a microresonator for observing the structure of its spatial field using appropriative optical quasi-degenerate macroresonator

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Topics:

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Poster session / 119

Modification of the optical properties of the surface of porous silicon by the action of external chemical factors

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The investigation of the influence of various chemical substances on the properties of the surface layer of porous silicon is relevant for the creation of sensors of gaseous and liquid impurities. In work, the decoration by isopropyl alcohol of the surface of the porous silicon with different porosity was studied by ellipsometry. The obtained ellipsometric data were processed in a single-layer model. It was found that a thin transparent film exists on the surface of porous silicon. This film is modified porous silicon, the porosity of which is greater than the porosity of the base substance by approximately 6%. The refractive index n and thickness d of this film were obtained as a result of such simulation. The decoration of porous silicon samples by isopropyl alcohol was carried out for one day. Then ellipsometric measurements were performed for two months at some intervals when these samples were in the air atmosphere. It was found that when the porous silicon is kept in isopropyl alcohol, the pores of the transparent film on the surface of the samples are filled with alcohol molecules. As a result of this process, the refractive index of the modified layer decreases, and its thickness increases slightly. It is assumed that this behavior of the refractive index of the modified layer is due to the oxidation processes of free silicon, which forms the pore framework.

Topics:

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Poster session / 120

Optical anisotropy of surface layers of ribbons of the iron-based amorphous alloys

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Optical properties of the rapidly quenched ribbons of the Fe-based amorphous alloys in the infrared λ = 2–25 μm were studied by spectral ellipsometry. The ellipsometric parameters Δ and Ψ were measured for several azimuthal directions α in own plane of the samples to detect of its optical anisotropy. The frequency dependencies of the real ϵ_1 and imaginary ϵ_2 parts of the dielectric function were then calculated.
It was found that dependencies of ϵ_1 for iron-based amorphous alloys are Drude-like ones in the infrared. Also the $\epsilon_1(h/nu)$ curves for different azimuthal angles α differ significantly. Such behavior of the $\epsilon_1(h/nu)$ de-pendencies is evidence of the optical anisotropy in these ribbons. It was also investigated how optical anisotropy manifests itself in the change of parameters of the electronic subsystem of amorphous films. The plasma p and relaxation frequencies were calculated from azimuthal ellipso-metric measurements by applying the functions F1–F3 that are based on the Drude ratio. It was found that the plasma and relaxation frequencies of the Fe-based amorphous alloys are change significantly with the gradual azimuthal rotations of the ribbons in their own plane. Such be-havior of optical and electronic properties is a consequence of the pres-ence of the deformation and elastic stresses formed on the surface layer of ribbons.

Topics:

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Poster session / **121**

Light-emitting properties of colloidal ZnO nanocrystals embedded in different polymer matrices

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There are many ways to protect nanocrystals from degradation and to improve NC properties. One of the most promising is embedding NCs in polymer matrices. NCs in transparent polymers is perspective material for applications in photonics and bio-imaging, thus investigation of their light-emitting properties is important. While NCs in conductive polymers attracts considerable attention due to the promising application for photovoltaics, electroluminescence, and photodetectors [1]. Here, we investigate the effects of embedding the ex-situ synthesized colloidal ZnO NCs [2] in different water-soluble polymers, such as polyvinyl alcohol (PVA), polyvinylpyrrolidone (PVP), polyethylene glycol (PEG), gelatine, and PEDOT:PSS. Embedding NCs in the polymer matrix causes changes in the shape of PL spectra and emission intensity, we infer possible recombination mechanisms of the NC PL and ways of the interaction between NCs and polymer. It was detected 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. Gelatine caused unexpectedly quenching of both PL excitonic (EPL) and DPL. 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

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Topics:

Session A. Physics of condensed matter and spectroscopy

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Poster session / **122**

Ag nanoparticles synthesized from Ganoderma lucidum for SERS-applications

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Long-standing intense research on synthesis and functionalization of Ag nanoparticles (NPs) is due to the unique combination of antibacterial, optical, electrical, and catalytic properties, stimulating various applications. Most progress is currently made in the area of anti-pathogen applications and applications based on localized surface plasmon resonance (LSPR), such as sensors and SERS-substrates (surface-enhanced Raman spectroscopy). Among numerous synthesis routes, there is an increasing number of reports on phytosynthesized silver NPs, based on an extract of different parts of plants.
Here we report application of mycosynthesized Ag NPs, obtained using Ganoderma lucidum fruit body extract as the bioreducing and stabilizing agent, as a substrate for Surface-Enhanced Raman Scattering (SERS). Stable Ag NPs colloids with distinct plasmonic resonance in UV-blue range (Fig. 1a,) were obtained for a broad pH range (5-11). At very acidic conditions, pH=2.5, synthesis efficiency drops but the formation of plasmonic NPs still takes place. All the NP samples were tested as a SERS-substrate, using standard dye analyte, rhodamine 6G. In addition to the dependence of the enhancement efficiency on the NP synthesis conditions, we observe spectral effects that can be related to the adsorption geometry of the molecule on the NP surface in different conditions, in particular, in solution and after drying the Ag NP/analyte composite on the substrate.
The work was funded by NRFU projects no. 2020.02/0204 (OS, VD, VY, NM) and no. 2020.02/0022 (OY).

Topics:

Session A. Physics of condensed matter and spectroscopy

Poster session / **123**

SERS-enhancement of chalcogenide films

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The effect of plasmonic nanoparticles (NPs) on Raman spectra and underlying structural changes in thin chalcogenide films are investigated. As2S3 and Se films with a thickness of several tens of nanometers were deposited by thermal sputtering for comparison on ordinary glass and SERS substrates based on arrays of gold nanostructures. Films on glass are practically not detectable by Raman spectroscopy, while using arrays of gold NPs as substrates allows for reliable registration of Raman spectra of both As2S3 and Se films, with all the features present, which are usually manifested in films with a thickness of 1 μm or more. Based on our analysis of spectra obtained using different excitation wavelengths, we can conclude that the main contribution to the enhancement of the Raman signal from chalcogenide films is provided by a chemical mechanism of SERS. Adjustment of the parameters of SERS substrates to tune their plasmon band position in resonance with exciting laser radiation enables the contribution of plasmonic enhancement to be increased.
It is concluded that the main contribution to the enhancement of the Raman signal from chalcogenide films is provided by a chemical mechanism, presumably due to the involvement of the Fermi level of the gold NPs in the resonant Raman scattering in the chalcogenide. Additional adjustment of the parameters of SERS substrates to tune their plasmon in resonance with exciting laser radiation allows one to increase the enhancement factor. It is shown that As2S3 and Se chalcogenide films are quite sensitive to photo- and thermal excitation leading to rearrangement of the local structure, which can correspondingly affect their other properties.
The work was partially funded by a NAS of Ukraine projects No.0122U000583 and No.0121U108529 and supported by research works of young scientists of the NAS of Ukraine in 2021-2022: “Investigation of ultrathin chalcogenide films by surface-enhanced Raman spectroscopy” No. 17-04/17-2022 (0121U111868).

Topics:

Session D. Biomedical optics and sensors technology

Poster session / 124

Raman study of the Flash-lamp annealing influence to Cu2ZnSnS4 nanocrystals and PEDOT:PSS composite thin films

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One of the trends for the future of renewable energy is the use of materials that can combine photovoltaic and thermoelectric properties in hybrid solar cells. These materials should also fulfill a number of other requirements. For instance, they should have a bandgap suitable for photovoltaics and constituent elements should be abundant and non-toxic. All these requirements are covered by the materials from the Cu2ZnSnS4 (CZTS) family. Obtaining them by low-temperature „green“ colloidal synthesis in the form of nanocrystals (NCs) makes these materials even more perspective for the third generation of photovoltaics. The improvement and tuning of the NCs properties after synthesis and deposition onto a (flexible) substrate are very important tasks. Flash-lamp annealing is gaining popularity due to the short time of treatment, scalability, and no need for special conditions such as atmosphere and pressure. PEDOT:PSS is a very well-known conductive polymer widely used in photovoltaics and thermoelectrics. Here we report the effect of flash-lamp annealing (FLA) with optimised energy density on composite films with different ratios of CZTS NCs and PEDOT:PSS in the solution deposited onto a glass. There are so far no studies about FLA treatment of PEDOT:PSS or the mixed composites. Using Raman spectroscopy as a main characterisation tool it is shown that the influence of FLA treatment on the composite films differs significantly from the influence on the pure materials and that PEDOT:PSS plays a protective role with respect to the CZTS NCs.

Topics:

Session A. Physics of condensed matter and spectroscopy