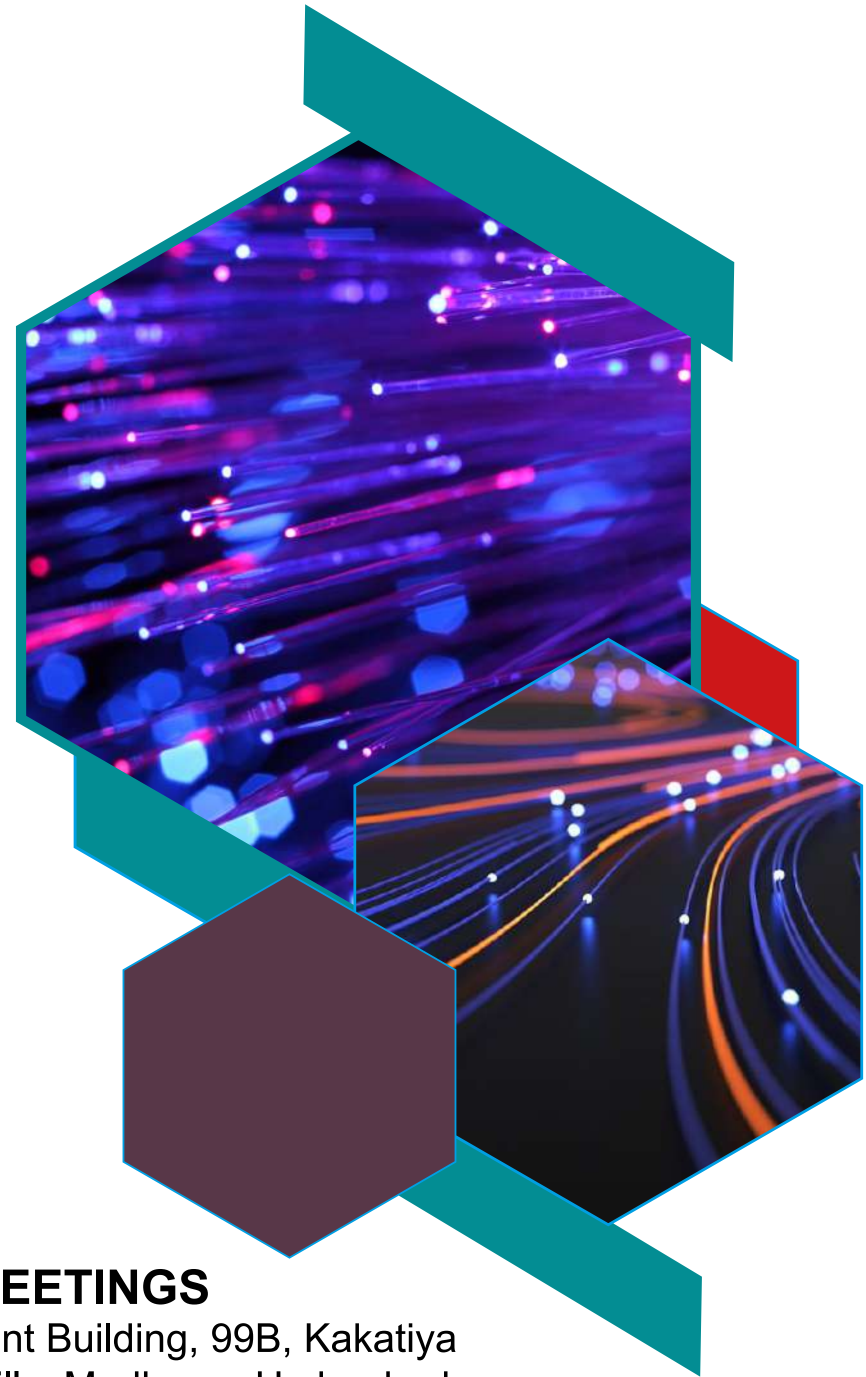
OPTICSMEET2023

2ND INTERNATIONAL MEET & EXPO ON LASER, OPTICS AND PHOTONICS

MAY 15, 2023 | BRUSSELS, BELGIUM



ALBEDO MEETINGS
Floor# 3, Advant Building, 99B, Kakatiya Hills, Kavuri Hills, Madhapur Hyderabad, TS 500033
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FOREWORD

It is our pleasure to invite all scientists, academicians, young researchers, business delegates and students from all over the world to attend the 2nd International Meet & Expo on Laser, Optics and Photonics will be held in Brussels, Belgium during May 15-17, 2023.

OPTICSMEET2023 shares an insight into the recent research and cutting edge technologies, which gains immense interest with the colossal and exuberant presence of young and brilliant researchers, business delegates and talented student communities.

OPTICSMEET2023 goal is to bring together, a multi-disciplinary group of scientists and engineers from all over the world to present and exchange break-through ideas relating to the Laser, Optics and Photonics. It promotes top level research and to globalize the quality research in general, thus making discussions, presentations more internationally competitive and focusing attention on the recent outstanding achievements in the field of Laser, Optics and Photonics.

We're looking forward to an excellent meeting with scientists from different countries around the world and sharing new and exciting results in Laser, Optics and Photonics.

Sincerely,
Prof. Dieter Bimberg
Excecutive Director
"Bimberg Chinese-German Center for Green Photonics", China
Founding Director, Center of NanoPhotonics
TU Berlin, Germany

COMMITTEES

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Invited Forum

Towards Noise Free Avalanche Multiplication for Low Photon Detection in Infrared Wavelengths

Chee Hing Tan*, Jo Shien Ng[1], Tarick Blain[1], Ye Cao[1], Benjamin Sheridan[1], Xiao Collins[2], David Price[2], Benjamin White[2]

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Abstract
An avalanche photodiode (APD) and a low noise amplifier combination is routinely used to detect low level of optical signal in application ranging from Light Detection and Ranging (LIDAR) to optical communication. The avalanche multiplication process often leads to an additional excess noise, due to the statistical spread in the impact ionization pathlengths for electrons and holes. A convenient method to compare different semiconductor materials is to use McIntyre's excess noise model, in which the ratio of electron to hole ionization coefficients, k, can be used to calculate the excess noise factor at a given multiplication factor. In the visible wavelength Silicon is the standout choice for APDs as it exhibit extremely low excess noise, corresponding to k = 0.01. At longer infrared wavelengths normally an InGaAs absorption region is combined with an InP multiplication region. However InP exhibits much higher excess noise, corresponding to k =0.2-0.4. In this work we present two materials that showed the lowest excess noise, with k ~0, among the III-V compound semiconductors. The first material is InAs which has a bandgap of 0.35 eV, and hence can cover wavelengths upto 3000 nm. It exhibits excess noise factors of 1.3-1.6, but will typically operate at low temperature to minimise the dark current. More recently the AlGaAsSb, grown on InP has been developed and exhibit excess noise factor <2 for multiplication factors up to 25 at room temperature. AlGaAsSb has also been successfully combined with an InGaAs absorption region (covering infrared wavelengths up to 1700 nm) to achieve an extremely low noise equivalent power of 69 fW/Hz1/2 at room temperature. This demonstrated the recent breakthroughs in achieving close to noise free avalanche multiplication process in InAs and AlGaAsSb.

Keywords
Avalanche Photodiodes; Inas; Algaassb; Low Excess Noise.

Biography
Prof. C. H. Tan obtained his BEng and PhD in Electronic Engineering at the Department of Electronic and Electrical Engineering (EEE), The University Of Sheffield (TUOS) in 1998 and 2002, respectively. He was a Research Associate in 2001-03, appointed as a Lecturer in 2003 and has been a Professor in Optoelectronic Sensors since Jan 2014. He has taken on leadership roles within TUOS, including the Director of Research for EEE and the Deputy Director of Research&Innovations for the Faculty of Engineering. Since 2019 he has been

the Head of Department for EEE. His research includes advanced modelling of avalanche process, high quantum efficiency single photon avalanche diodes, APDs with lowest excess noise and APDs with very weak temperature dependence of breakdown voltage. He has led various research projects from the UK Ministry of Defence, Engineering, and Physical Science Research Council and EU. Some of the technologies he developed have been transferred to industry via several knowledge transfer projects to design infrared photodiodes and avalanche photodiodes. He has published more than over 100 journal papers and has delivered several invited talks in international conferences. He has carried out editorial roles for Optics.
Express, IET Optoelectronics and MRS Advances. In 2020 he co-founded a spin-out, Phlux Technology Limited, to commercialise a key breakthrough in low noise avalanche photodiodes. He was a Director of Phlux Technology Limited until 2022.

Design and Fabrication of Functional Micro-/ Nanostructures by Shaped Femtosecond Laser and their Applications

Cong Wang*
State Key Laboratory of High Performance and Complex Manufacturing, College of Mechanical and Electrical Engineering, Central South University, Changsha 410083, China

Abstract

With the advantages of making materials have new functions without damaging the original properties, the functional micro-/nanostructures have important applications in the field of aerospace, optics, biomaterials and so on. However, the materials used in these aforementioned fields have high mechanical strength, hardness and melting point. Therefore, it is difficult to fabricate the functional micro-/nanostructures by lithography and nanoimprint technology. In addition, the functional micro-/nanostructures have small size and high accuracy. Hence, it is critical to propose a new method for the manufacturing of the functional micro-/nanostructures. Recently, an effective method for the fabrication of functional micro-/nanostructures has been introduced by femtosecond laser micromachining. Due to the femtosecond pulse duration and the extremely high irradiance, femtosecond laser has been proved to be a promising tool for the fabrication of functional micro-/nanostructures. However, with the continuous requirements of extremely high quality and precision, there are still challenges and questions for the fabrication of functional micro-/nanostructures by using femtosecond laser, such as femtosecond laser-material interactions mechanisms, high efficiency, selective and controllable fabrication, and so on.

Based on these challenges and questions, we have proposed a new method for the fabrication of the functional micro-/nanostructures by shaped femtosecond laser. From the idea of material--structure--function integration, the effects and change mechanism of the functional micro-/nanostructures on the material special performance have been understand. The geometric configuration and spatial arrangement parameters of micro-/nanostructures have been designed and optimized. The multiscale models are established to describe the structure evolutions and formation of microstructures under femtosecond laser irradiation. Also, the influences of collaborative femtosecond laser manufacturing technology on the formation of the functional micro-/nanostructures have been investigated. The corresponding rules and form a set of processing technology have been summarized. In addition, the femtosecond laser cross-scale manufacturing equipment has been preliminarily established. The research results would provide theoretical basis and manufacturing techniques for the high efficiency and controllable fabrication of functional micro-/nanostructures by femtosecond laser to meet the continuous requirements, which has already been applied in microfluidic transport, anti-icing, parallel processing, focusing and imaging, etc.

Keywords
Functional micro-/nanostructures; Shaped femtosecond laser; Laser-material interaction

Biography

Dr. Cong Wang is the Associate Professor of Mechanical Engineering at Central South University. His research activities are focused on femtosecond laser micro-/nanofabrication. Dr. Wang has authored 65 papers in international journals and 12 patents. The papers have been cited for more than 1500 times. He is the leading international journals reviewer/guest editor, such as <Processes>, <Frontiers in Photonics>, <Current Physics> and so on. Up to now, the femtosecond laser manufacturing system for functional micro/nanostructures is preliminarily established, which has already been applied in many fields.

Cross-Relaxation Induced Efficient 1,55µm Emission in La1.95Er0.05Ti2O7 Towards an Application as an Amplifier for Silica-Fibers.

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Abstract
The La2-xErxTi2O7 samples (with x = 0 and 0.05) were synthesized using the conventional solid-state reaction method. The spectroscopic properties of La1.95Er0.05Ti2O7 were investigated. The temperature dependence emission spectra of La1.95Er0.05Ti2O7 display a several lines in the visible and infrared regions. Under the excitation of 488nm laser, La1.95Er0.05Ti2O7 exhibits efficient emission at 1,55µm. To explain the effecient emission at 1,55µm ; multiphonon-relaxation, energy transfer mechanism that contains cross relaxation processes were proposed. Under a pump of 488nm; La1.95Er0.05Ti2O7 could serve as an amplifier for silica-fibers.

Keywords
Cross-Relaxation, Energy Transfer, Amplifier, Silica-Fibers.

Biography
Faical Mselmi earned his PhD from the University of sfax in 2019, currently works at the Department of physics at the university of sfax in applied physics laboratory. Faical Mselmi does research in Atomic, Molecular and Optical Physics. Their current projet are synthesis new materials that could serve as an amplifier for silica-fibers and developing python script for simulating optical spectra using Racah theory.

Functionalizing Optical Waveguide Systems with 2D Materials

Gia Quyet Ngo[1,*], Emad Najafidehaghani[2], Ziyang Gan[2], Antony George[2], Alessandro Tuniz[3], Markus A. Schmidt[4], Andrey Turchanin[2], Falk Eilenberger[1]

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[4]Leibniz Institute of Photonic Technology (IPHT), Albert-Einstein-Str. 9, 07745 Jena, Germany

Abstract

Monolayer transition-metal dichalcogenides [1] (TMDs) possess highly intriguing photonic properties including large optical nonlinearities and unprecedented exciton binding energies. Their sheet nonlinear susceptibility is substantial and in the same order of magnitude as the commonly used nonlinear bulk crystal [2]. Remarkably, TMDs can be grown conformally as monolayer crystals on almost any conventional substrates. However, the minuscule thickness limits the total nonlinear conversion efficiency of such crystals. Hence, directly growing monolayer TMDs on the exposed core optical fiber (ECF) [3] could increase the nonlinear interaction and create novel opportunities in nonlinear light sources, fiber-based sensing, and single-photon sources, to name just a few. Here, we demonstrate TMD-functionalized ECFs as a novel nonlinear photonics platform possessing a large second-order susceptibility and show the enhancement of second-harmonic generation in resonance with excitons. In this work, our hybrid fiber exhibits a quantitative χ(2) value of 44 pm/V and an SHG conversion efficiency of 0.2×10-3 m-2W-1 [4]. This χ(2) value is 44x stronger than the relevant contenders for integrated SHG, for instance, Germanium doped glass.

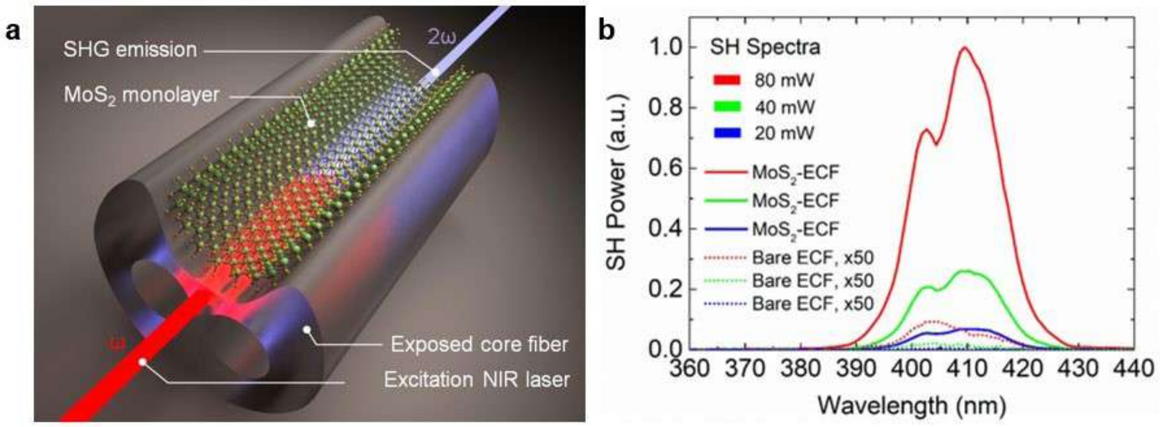

Fig. 1. (a) Illustration of the concept to demonstrate SHG with embedded MoS2 on an ECF. (b) Normalized SHG spectra of both bare and coated fibers with three different input powers.

Keywords
2D Materials; Nonlinear Optics; Waveguide; Photonics.

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2. A. Autere, H. Jussila, Y. Dai, Y. Wang, H. Lipsanen, and Z. Sun, "Nonlinear optics with 2D layered materials," Advanced Materials 30, 1705963 (2018).
3. G. Q. Ngo, A. George, F. Eilenberger, et al., "Scalable functionalization of optical fibers using atomically thin semiconductors," Advanced Materials 32, 2003826 (2020).
4. Ngo, Gia Quyet, et al. "In-fibre second-harmonic generation with embedded two-dimensional materials." Nature Photonics 16, 769-776 (2022).

Biography
Gia Quyet Ngo is working at the Institute of Applied Physics at the Friedrich Schiller University in Jena, Germany. He does research focusing on 2D materials, optical fibers, gas sensing and nonlinear optics. His current project are detecting toxic gases using functionalized optical fibers and optimizing the growth of 2D materials on fibers.

On Timeless Macroscopic Spaces

Gunter Nimtz*
Universität Köln, II. Physikalisches Institut, Germany

Abstract

Ishallbegin the talk with confusingcitations in recently published papers on the question: "how much time does a wave packet spend in a tunneling barrier?".A particle tunneling through a barrier appears to do so in zero time [1]. ..tunneling is unlike to be an instantaneous process [2]. ..Ionization time is close to zero [3]. ..All waves have a zero tunneling time. ..[4].I am looking for the 4th dimension in this fundamental phenomenon.

Biography

Günter Nimtz, 1959 Electrical Engineer, Dipl.Ing. FH Mannheim; 1961 Studying Physics, University Heidelberg; 1963 Studying Physics, University Vienna, Ph.D; 1974 Habilitation University of Cologne, Carrier Recombination in Narrow Gap Semiconductors; 1977-1978 Research Associate, McGill University/Montreal Since 1983 Professor II. Physikalisches Institut der Universität zu Köln; 1986 Chinese Academy of Science - Invitation to Peking, and to several branches to present Seminars on Narrow gap Semiconductor HgCdTe;1991 Invitation Int. Conference on Photo Electronics Shanghai; 1995-2005 Visiting professor at the University of Algarve/Faro, Portugal (photonics and biophysics); 2004 Shanghai University March-April as Ziquiang-specially-invited professor; 2004 Peking, Beijing University of Posts and Telecommunications, to give lectures about Photonics; 2010 India Bangalore 25-26 November INCEMIC 2010, Society of EMC Engineers, presenting Seminars on the nano-metal film electromagnetic broadband absorber technology; 2017 February York University UK, Colloquium on the tunnel effect.

Study on Mechanoluminescence from Organic Materials

Kenji Murakami[1,*], Manoj Ranasinghe[2], Keita Suzuki[3], Yoshiki Iwai[3], Masayuki Okuya[3] and Masaru Shimomura[2]

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[2]Graduate School of Science and Technology,
[3]Graduate School of Integrated Science and Technology, Shizuoka University, 3-5-1 Johoku, Naka-ku Hamamatsy, Japan

Abstract

Mechanoluminescence (ML) is a phenomenon of light emission originated from a mechanical action on a solid. The ML is classified into fracto-, plastico- and elastico-MLs according to an excitation mode of the electrons. When the material structure is fractured then the electrons are excited to the higher energy levels followed by the relaxation process of electrons to lower energy levels. The energy difference is released as a light emission. This kind of luminescence is detected by a peeling of the tape in a vacuum. We have succeeded to synthesize the europium doped dibenzoylmethide triethylammonium (EuD4TEA) as an organic mechanoluminescent material. The synthesis is completed at very low temperature of 70°C by a controlled slow cooling method. The synthesized material shows a very strong ML at 612 nm in the visible region. Furthermore, we have found that an addition of 1-ethenylpyrrolidin-2-one [(polyvinylpyrrolidone) (PVP) enhances the ML intensity of EuD4TEA through the modification of ligand frameworks.

Recently, we have synthesized a different organic ML material based on a 1,10-phenanthroline and an acetylacetone with the doping of terbium (Tb), europium (Eu) or dysprosium (Dy). When each color center is doped separately, the synthesized material shows both the photoluminescence (PL) and the ML induced by each dopant whose main peak at 545 nm (Tb), 612 nm (Eu) or 573 nm (Dy). We have also found that the co-doping of Tb and Eu gives the luminescence corresponding to their doping amount ratio resulting in a visual color control, but the co-doping of Tb and Dy keeps the luminescence corresponding to Tb single doping with an enhanced intensity. The results suggest that the electron transition process is different between the Tb/Eu and Tb/Dy co-doping. In the case of Tb/Eu co-doping, each dopant induced each own luminescence due to a significant difference in the electron energy state level between Tb and Eu. In contrast, the energy state of Dy becomes an extra electron supplier to Tb for the Tb/Dy co-doping. The results can expand the application fields of mechanoluminescence.

The mechanoluminescence and photoluminescence intensities were characterized by using the photonic multichannel analyzer (Hamamatsu Photonics, PMA-12).

Keywords

Mechanoluminescence; Organic Materials; Photoluminescence; Co-Doping.

Biography

Kenji Murakami received his BE in Electronic Engineering from Osaka Prefecture University in 1976, and his ME and Ph.D. in Engineering from Osaka University, Japan in 1978 and 1983, respectively.He joined Shizuoka University in 1985 as an Assistant Professor of Research Institute of Electronics, and was a Professor of the Department of Engineering, Graduate School of Integrated Science and Technologies from 2014 and retired due to the age in 2019. Now he is a Specially Appointed Professor of Organization for Innovation and Social Collaboration, Shizuoka University. He was a Research Associate of the Pennsylvania State University, USA in 1983-1985, and a Visiting Scientist of the Max-Planck Institute of Solid State, Stuttgart, Germany in 1998 and 2000. His research interests are the research and development of energy conversion materials such as piezoelectric ceramics, dye-sensitized solar cells and mechanoluminescent materials. He is a member of the Japan Society of Applied Physics, and the Japan Society of Vacuum and Surface Science.

Four Layers Surface Plasmonic Resonance Structures with Amorphous Chalcogenide Thin Films Waveguides

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National Institute of R&D for Optoelectronics INOE 2000, 409 Atomistilor str., Magurele, Ilfov, Romania

Abstract

The interaction of light that has the wave vector in vacuum klowith matter at the interface between two solid media, one consisting of a dielectric and another being metal was considered. As is known, at the interface between a dielectric and a metal, plasmon-polaritonic waves with the vector kpp can spread. The excitation of these waves can be achieved by coupling the evanescent wave (Kretschmann method) of light with plasmon-polariton wave which takes place in resonant conditions klo·n·sinθ = kpp, where n-is the substrate refractive index, θ-is the incident angle of light. The value of the resonance angle θ is very sensitive to the refractive index of the environment, which paved the way for the development of very high-performance plasmonic optical sensors.

A multilayer structure is examined which includes thin film with refractive index higher than the refractive index of the glass substrate. The film constitutes a waveguide, with propagation constant β. [k]For waveguide are suitable amorphous chalcogenide materials, such as As2S3, As2Se3, which have refractive index in the range of 2.4 - 3.0. Thin gold films with thickness around 50 nm was considered as metal. The excitation of surface plasmonic wave occurs also in resonance conditions klo·n·sinθ=β as well, but β is dependent on film thickness.
Numerical simulations for reflection of light R(θ) were performed in the MATLAB application by using of transfer matrix method. Following these calculations, certain conclusions were established, namely: a) the coupling of light with plasmonic waves can be performed only for certain thicknesses of the film; b) the coupling takes place even if the refractive index is higher than that of the glass substrate; c) there is considerable shift of the resonance curves, which depends on film thickness. d) the sensitivity of the structure defined as relationship between the angular shift and the width of the resonance curve can be optimized.

The highlighted properties of plasmonic structure, which contains waveguide are useful for improving the characteristics of plasmonic optical sensors. The waveguide can be constituted of a material with a high refractive index, in this case from amorphous chalcogenide compounds of type As2S3, As2Se3. The higher the refractive index, the more confined the energy of light is.

Keywords
Plasmonic Resonance; Amorphous Semiconductors; Thin Films; Optical Sensors

Biography

Popescu A. was born 1950 in Rep. of Moldova, former USSR. He received master of sciences from Kishinev Polytechnic Institute in 1972. His Ph.D. was achieved from Moscow Lomonosov State University in 1978 in radio-physic, included quantum, specialized in nonlinear optics. From 1977 he works in the Institute of Applied Physics, Moldovan Academy of Sciences, were in 1987 he was appointed head of the Laboratory of Photonics, principal scientist. In 2003 he achieved Dr. Habil. from the Institute of Applied Physics, Moldovan Academy of Sciences. Habilitation was in physics and technology of semiconductors, specialized in physics and optics of amorphous chalcogenide materials. From 2008 A. Popescu activates at the National Institute of R&D for Optoelectronics INOE 2000 in rank one senior researcher position. Is specialized in photonics and optoelectronics. He is author of over 140 peer-reviewed publications, 63 in ISI database, 1 monograph, and a total of 11 patents.

Terahertz wave generation and measurement via parametric wavelength conversion

Shin'ichiro Hayashi* and Norihiko Sekinehors
National Institute of Information and Communications Technology, Tokyo, Japan

Abstract
Terahertz wave region (frequency: 0.1 – 10 THz (corresponding wavelength: 3000 – 30 μm)) are important not only in basic sciences, such as spectroscopy, electron acceleration, plasma measurement, and radio astronomy, but also in numerous industrial applications, such as in broadband wireless communication, high precision radar, global environmental measurement, and non-destructive inspection, since they have higher directivity than microwaves and higher transmittances in atmosphere and in soft materials than mid-infrared. Therefore, in the terahertz region, high-brightness and tunable sources, high-sensitivity and wideband detectors that could be widely used in these studies and applications are required. In this presentation, we show the generation of high-brightness terahertz wave using parametric wavelength down-conversion from infrared to terahertz wave in a nonlinear MgO:LiNbO3 crystal [1]. We also represent the measurement of terahertz wave using parametric wavelength up-conversion from terahertz wave to infrared in the same process. We speculate that the high-brightness generation and the coherent measurement of terahertz wave could be powerful tools not only for solving real world problems but also fundamental physics, such as real-time spectroscopic imaging, remote sensing, 3D-fabrication, and manipulation or alteration of atoms, molecules, chemical materials, proteins, cells, chemical reactions, and biological processes. We expect that these methods will open new fields.

[1] S. Hayashi, K. Nawata, T. Taira, J. Shikata, K. Kawase, and H. Minamide, Sci. Rep., 4, 5045 (2014).

Keywords
Terahertz wave; Wavelength conversion; Nonlinear Optics.

Biography
Shin'ichiro Hayashi received the Ph.D. degree in physics from Meiji University, Japan, in 2004. From 2004, he was with RIKEN, Japan, as a Researcher. In 2016, he joined the National Institute of Information and Communications Technology, as a Senior Researcher. His research interests include terahertz wave generation and measurement using nonlinear optics and their applications.

Poster Presentation

The First Effort Applying Photonic Jet Microscopy Using Endoscopy Camera and Glass Micro-Spheres

Andri Abdurrochman[1,*], Lusi Safriani[1]

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Abstract
The applications of photonic jet are proposed massively since it was coined in 2004, including for microscopy. Our first research proposing the application was photonic jet etching using a nanosecond Nd:YAG laser with 1064 nm wavelength; which yielded a patent in 2015. Since 2018, we shifted to photonic jet microscopy – that is more feasible to conduct in our home facility – than photonic jet etching. Moreover, we brought the emulation of photonic jet etching into photonic jet microscopy.

As in photonic jet etching, we used an optical fiber with a small camera: at di end (endoscope camera). Considering this optical fiber as a laser waveguide in photonic jet etching, use the endoscope camera to observe a micro meter size object. The results are quiet amazing that we have applying photonic jet microscopy using an endoscopy camera and a glass microsphere.

Keywords
Photonic Jet Etching; Photonic Jet Microscopy; Endoscope Camera; Glass Microsphere.

Biography
Andri Abdurrochman graduates from doctoral school in Unistra (Université de Strasbourg), France, and earned doctoral degree in photonic in 2015. As for bachelor and master degrees, his minor research was in instrumentation system which is finished in Indonesia. Now working as a lecturer in Universitas Padjadjaran since 2003.

Morphological and Sensing Properties of "Wet" Electrodeposited ZnO Films

G. Alexieva[1,2,*], K. Lovchinov[†1], G. Marinov[1], K. Lazarova[1], R. Gergova[1,3], N. Tyutyundzhiev[3,4] and T. Babeva[1]
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[2]Sofia University, Faculty of Physics, 5 James Bourchier Blvd., 1164 Sofia, Bulgaria
[3]Central Laboratory of Solar Energy and New Energy Sources, Bulgarian Academy of Sciences, 72 Tsarigradsko Chaussee, 1784 Sofia, Bulgaria
[4]Institute of Electronics, Bulgarian Academy of Sciences, 72 Tsarigradsko Chaussee, 1784 Sofia, Bulgaria

Abstract

Due to its unique properties like transparency in VIS and NIR spectral regions, low resistivity, long-termstability, biocompatibility and nontoxicity ZnO is traditional but increasingly relevant material with applications in different fields such as optoelectronics, pharmacy, bio and gas sensing. Among different methods applied for the synthesis of metal-oxide nanostructures the so called "wet" electrodeposition methods are very attractive because they are cost-effective, environmentally compatible, require relatively simple apparatus and offer easy control of morphology and stoichiometry of the produced structures by varying the deposition parameters. Nanostructured films of ZnO were deposited by electrochemical and electrospray methods on the gold electrodes of AT-cut quartz resonators.

The deposition of ZnO electrochemical films is carried out in an aqueous solution of ZnCl2 and KCl at 70 ºC and (vs SCE) using a three-electrode electrochemical cell. The solution for the electrospraying was prepared by dissolving zinc acetate dehydrate in deionized H2O, diluting with ethanol and subsequent adding of acetic acid for clearing the solution. The films were deposited using an electrostatic setup with vertical configuration at 18 kV and collector-emitter distance of 6 cm.

Optical Profilometry, Scanning Electron Microscopy (SEM), X-ray diffraction (XRD) and Quartz Microbalance method (QCM) were used to determine the morphology, structure and gas sensing properties. The influence of the electrodeposition conditions on film characteristics was studied. Possible applications for VOC's sensing and optoelectronic devices are discussed.

Keywords

Zinc Oxide; Thin Films; Electrochemistry; Electrospray

Acknowledgement

The financial support of Bulgarian National Science Fund under contract КП–06–Н38/7 (5.12.2019) is highly appreciated. Research equipment of INFRAMAT (part of Bulgarian National roadmap for research infrastructures) supported by Bulgarian Ministry of Education

and Science was used in this investigation.

Biography

Gergana E. Alexieva was born in Sofia, Bulgaria, on January 2, 1973. She received the PhD degree in Physics in 2013. Her present position is Assoc. Professor at the Department of General Physics, Faculty of Physics, Sofia University. Her current interests are focused in the field of ultrasonic material characterization, drug delivery systems and nanostructured layers.

En Route to Precise and Interpretable AI–LIBS

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[3]Faculty of Science and Technology, (Icfai Tech), ICFAI Foundation for Higher Education, Hyderabad, India.
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[6]Brno University of Technology, Faculty of Mechanical Engineering, Institute of Physical Engineering, Technická 2, CZ-61669, Brno, Czech Republic.
[7]Lightigo Space s.r.o., Renneská třída 329/13, 63900 Brno, Czech Republic.

Abstract
Laser-induced breakdown spectroscopy (LIBS) is a powerful physical chemistry method. Since the development of its calibration-free methodology (CF–LIBS), it has been a frequent tool for analysing chemical samples of all states without any preceding calibrations necessary. In recent years, however, LIBS applications have crossed the borders of chemical analysis and started to resonate in the fields of chemical physics, geochemistry, and astrochemistry. All such disciplines deal with large amounts of data and require a number of precise computational analyses and predictions. While CF–LIBS generally relies on simple and comprehensible physical models, the complexity of laser-induced plasma casts doubts on applying its conventional analytical protocols in more complex cases. Due to the stochastic nature of most issues faced therein, numerous high-level machine learning methods were successfully addressed to enhance LIBS assays. However, their relevance notwithstanding, such approaches prefer speed and accurateness to clear interpretability and simpler physical reasoning. Our computational methodology therefore attempts to build on conventional CF–LIBS protocols and broaden their applicability by using novel numerical methods. In this contribution, we overview the development of the numerical protocols and exemplify their performance by solving several case studies relevant to the above fields of research. The results of both conventional CF–LIBS and our numerical assays were used as training data sets to supervised machine learning models, introducing their powerful statistics as an a posteriori computational enhancement. Testing cases presented suggest that our numerical protocols introduce lesser uncertainties

to the training data and achieve higher consistency within parameter predictions. This, in turn, implies that our numerical schemes may be used as an independent tool for detailed physical interpretations of both existing and novel machine learning LIBS models. We draw upon such findings to propose a novel artificial intelligence-assisted LIBS (AI–LIBS) network which shall combine the interpretability of calibration-free models, the achieved precision of numerical simulations, and the speed and prediction capacity of machine learning.

Keywords
Chemical Physics; Plasma Spectroscopy; Numerical Simulations; Machine Learning

Biography
Homa Saeidfirouzeh completed her PhD at the Alzahra.University in the filed of condensed matter physics and is carrying on with her postdoctoral fellowship at J. Heyrovský Institute of Physical Chemistry, Czech Academy of Sciences since 2019. Recently she got the resercher postion in the Czech Academy of Sciences. She focuses on cutting-edge spectroscopy and material research, in which she has published 20 peer-reviewed papers, receiving the h-factor of 8 (excluding self-citations). Her work in this field was awarded by multiple scientific awards.

Properties tuning of electro sprayed ZnO films through co-doping with Al and Co

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Abstract
ZnO is a wide-band gap semiconductor of the II-VI group with good transparency, high electron mobility and strong room-temperature luminescence. ZnO has been considered as a suitable host material for doping with different metals thus providing tunability of structural, morphological, optical and electrical properties.

A versatile fabrication method of electrospray was utilized for deposition of thin ZnO films co-doped with Al and Co. A liquid precursor prepared by dissolving of zinc acetate dehydrate in deionized water, ethanol and acetic acid with added aqueous solutions of aluminum nitrate and cobalt acetate was dispersed into a fine aerosol by applying of high voltage (18 kV) on emitter. The emitter was a stainless steel needle of a syringe with the liquid precursor inside connected to a syringe pump. The film substrate is placed on grounded collector kept at 300oC located 6 cm from the emitter.

Scanning Electron Microscopy, Transmission Electron Microscopy, X-ray Diffraction and Selected Area Electron Diffraction were used to determine the morphology, structure and phase composition of the films. The optical properties were investigated through ellipsometric and photoluminescence measurements. For comprehensive characterization, the surface energy and water contact angle were studied as a function of doping. The influence of the dopant on film properties was investigated. Possible applications for VOC’s sensing were discussed.

Keywords
Zinc Oxide; Thin Films; Electrospray; Doping.

Acknowledgement
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Biography
Assoc. Prof. Dr. Katerina Lazarova has been a scientist at the Bulgarian Academy of Sciences for the last 9 years. In 2013 she began her doctorate in the field of photonic crystals and optical sensors based on zeolites and porous materials. In 2016 she became a chief assistant at the IOMT-BAS and from 2019 to 2021 was a postdoctoral fellow with a scholarship in the same field. Currently Dr. Lazarova is Associate professor. Author of more than 40 articles, with awards for presentations in scientific forums and participation in numerous scientific projects in collaboration with other scientific organizations.

Laser Ablation and Luminescence Properties of Eu3+Dopedzno-B2O3-WO3-Nb2O5 Glasses

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Abstract
The effects of laser ablation with femtosecond pulses on the morphology andluminescence properties of 50ZnO:40B2O3:(10-x)WO3:xNb2O5:1Eu3+(x=0 and 5 mol%) glassesare investigated in this work. The synthesized glasses express a good transmittance and homogeneity. The amorphous state of the glasses is demonstratedbyX-ray diffraction analysis (XRD). The thermal parameters such as glass transition temperature, glass crystallization temperature and thermal stability of the glasses are determined by differential thermal analysis. Irradiation by femtosecond laser pulses at wavelength of 800 nm is applied in order to induce composition changes of the studied glass and to deposit material on a substrate. Its characteristics are studied in details as a function of the processing conditions. The laser processing induces different morphology changes that are influenced by the processing conditions and can vary from micro- to nanosized structures. Periodic structures (ripples) are also observed at certain conditions. Photoluminescence emissions due to the 4f transitions 5D0→7Fj (j=0-4) of Eu3+ ions is observed in the irradiated zones, and also in the deposited material.

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Optical SPR Sensor with Amorphous As2S3 Thin Films for Ethanol-Methanol Distinction

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Abstract

The principle of operation of SPR (surface plasmonic resonance) optical sensors is based on the determination of the ambient medium refractive index. The SPR sensors that use this principle are label-free.The coupling of light with the plasmonic wave was realized in Kretschmann configuration by using the evanescent field that occurs at the total reflection of thelight. The sensor sensitivity can be increased in the case of SPR configurations containing four layers. The four-layer structure consists of: transparent substrate- gold metallic film-semiconductor film-medium. The semiconductor films must have the refractive index higher than other layers. AmorphousAs2S3 chalcogenide films have high refractiveindex about 2.45, which leads to strong field confinement.This one may increase the sensors sensibility.
The calculations based on transfer matrix method for SPR curves reveal that for 1000 nm As2S3 film thickness, the methanol (refractive index is 1.317)has the resonance angle of 36.56°. The ethanol (refractive index is 1.350) has the resonance angle of 36.99°. This means that the chemicals are well distinct as the half-width of the resonance curve constitutes 0.25° only. The SPR configuration was:rutile prism-gold 40 nm film-As2S3 thin film-methanol (ethanol). The probe wavelength of light 1550 nmwas considered. The best selectivity was obtained for thethickness of As2S3of 1000nm nm and the worst for the thickness of 800 nm.In terms of refractive index selectivity, the ratio $\Delta\theta min/\Delta n$ =4.89°/RIU.
Finally, we conclude that 4-layers SPRconfigurations is very sensitive to the refractiveindex change of ethanol/methanol. The sensitivity can be optimized by selecting the chalcogenide film thickness. The refractive index resolution as small as 3.4·10-4 can be obtained. The SPR sensing methodis label-free and can be applied for identification of several alcohols. The resonance angle can beadjusted to the selected chemical by setting the incident angle. Use of telecommunications wavelength of 1550 nm represents a good opportunity for the development of fiber optics information networks.

Keywords

Plasmonic resonance; Amorphous semiconductors; Thin films; Optical sensors.

Biography

Popescu A. was born 1950 in Rep. of Moldova, former USSR. He received master of sciences from Kishinev Polytechnic Institute in 1972. His Ph.D. was achieved from Moscow Lomonosov State University in 1978 in radio-physic, included quantum, specialized in nonlinear optics. From 1977 he works in the Institute of Applied Physics, Moldovan Academy of Sciences, were in 1987 he was appointed head of the Laboratory of Photonics, principal scientist. In 2003 he achieved Dr. Habil. from the Institute of Applied Physics, Moldovan Academy of Sciences. Habilitation was in physics and technology of semiconductors, specialized in physics and optics of amorphous chalcogenide materials. From 2008 A. Popescu activates at the National Institute of R&D for Optoelectronics INOE 2000 in rank one senior researcher position. Is specialized in photonics and optoelectronics. He is author of over 140 peer-reviewed publications, 63 in ISI database, 1 monograph, and a total of 11 patents.

A Facile Approach to Synthesis of Inorganic Perovskite Nanocrystals

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Abstract
Inorganic halide perovskite nanocrystals, CsnPbX2+n have attracted significant attention as an optical material for display and optoelectronic devices, as an alternative to quantum dot materials. Despite their interesting optoelectronic properties, they are very susceptible to humidity. In addition, the presence of Pb, a toxic element, in perovskite nanocrystals raises critical concerns with regard to commercialization. In our research group, we have focused on synthesis of high stability and pb-free perovskite nanocrystals with high luminescent properties. We recently synthesized the Cs4PbBr6 nanocrystals by water assisted solid-state reaction (WASSR) method, which can easily synthesize nanomaterials at low temperature. The Cs4PbBr6 perovskite nanocrystals showed a bright green emission, with a narrow emission band centered at 518 nm with a full width at half-maximum of 26 nm. It showed excellent durability at 85 °C and 85 % humidity for 24 h, and maintained 82 % of the initial PL intensity. In addition, the Pb-free CsMnBr3 and Cs3MnBr5 nanocrystals was selectively synthesized with solvent concentration by modified hot-injection. The emission peaks of CsMnBr3 and Cs3MnBr5 nanocrystals were observed at 650 nm (red) and 520 nm (green), respectively. After a durability test at 85 °C and 85% humidity for 24 h, the lead-free perovskite CsMnBr3 nanocrystal powder maintained its initial emission intensity. Finally, perovskite nanowires were fabricated and their lasing characteristics could be confirmed. In this study, we present and discuss the synthesis and properties of these perovskite nanocrystals, and beyond this, the perovskite nanowires will be briefly described.

Keywords
Perovskite Nanocrystals; Lead-Free Perovskite; Nanowire

Biography
Sun Woog Kim is currently working as a chief researcher at the Korea Institute of Ceramic Engineering and Technology. He obtained bachelors and master's degrees in materials engineering from Changwon University and his Ph.D. in applied chemistry from Osaka University. He has been an assistant professor at Niigata University and Sejong University. His research interests are diverse, such as luminescent materials, nano materials, solid electrolyte materials for all-solid-state batteries, catalysts for decomposing harmful gases, and glass materials. He has published a number of papers in this regard.

Tailoring Morphological and Optical Properties of Nb2O5 / SiO2 Composite Films for Sensing Applications

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Abstract

Nanocomposite thin films were obtained by doping of sol-gel Nb2O5 matrix with SiO2 nanoparticles. Niobium sol was prepared by the sonocatalytic method using NbCl5as a precursor, ethanol and distilled water as solvents and commercially available colloidal silica (LUDOX®) as doping oxide. LUDOX® is a stabilized aqueous dispersion of discrete nano-sized spherical SiO2 particles with amorphous structure, nominal diameter of 12 nm and very narrow particle size distribution. Thin composite films were obtained by spin coating of mixtures of Nb sol and Ludox at different volume fractions thus obtaining thin films with different chemical compositions. To tailor the films porosity, selective stepwise removal of silica nanoparticles was utilized through wet-etching in a very dilute aqueous solution of nitric and hydrofluoric acids. The process of selective etching was controlled by calculating the volume fractions of two constituents and the free volume in the film using Bruggemann effective medium approximation.

Morphology and structure of the films were studied by Transmission Electron Microscopy and Selected Area Electron Diffraction (SAED), respectively. Wetting behavior was analysed by measuring films static water contact angles. Optical properties and analyte response of the films were investigated through reflectance measurements in different ambient: air, argon and acetone vapors and nonlinear curve fitting of measured reflectance spectra. Additional study of adsorption ability of the films was performed by depositing them on quartz resonators plates and measuring mass variation by QCM (Quartz Crystal Microbalance) when exposing to different vaporanalytes.The influence of chemical compositionand morphology on optical and sensing properties of the composite films was revealed and discussed.

Keywords

Sol-Gel Niobia; Sio2 Nanoparticles; Thin Films; Sensing

Acknowledgement

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Biography

Tsvetanka Babeva is currently Full Professor and Director of the Institute of Optical Materials and Technology at the Bulgarian Academy of Sciences, Sofia, Bulgaria. She received her M.S.

in physics, major applied optics at Sofia University in 1994 and PhD in Physics of condensed matter at Central Laboratory of Photoprocesses, Bulgarian Academy of Science in 2003. In 2007 she was awarded Arnold F. Graves fellowship and spent 2 years as a postdoctoral researcher in Centre of Industrial and Engineering Optics at Dublin Institute of Technology (now TechnologicalUniversity of Dublin), Ireland. Her professional experience includes 28 years as a researcher, supervision of 3 PhD and 4 master students, post-doctoral researcher and 8 young researchers, participation as a team member of more than 20 projects and team leader of 9 scientific and infrastructural projects. She has co-authored more than 100 papers h-index 14 and has more than 130 participations in national and international conferences. Her present research is devoted to optical characterization of thin films, wet methods of films deposition, developing of porous materials and photonic structures for optical sensing applications.

Development of High Thermal Stability of Nay9si6o26:Yb3+ Phosphor and Its Crystals Structure and Luminescent Properties for NIR Anti-Counterfeiting

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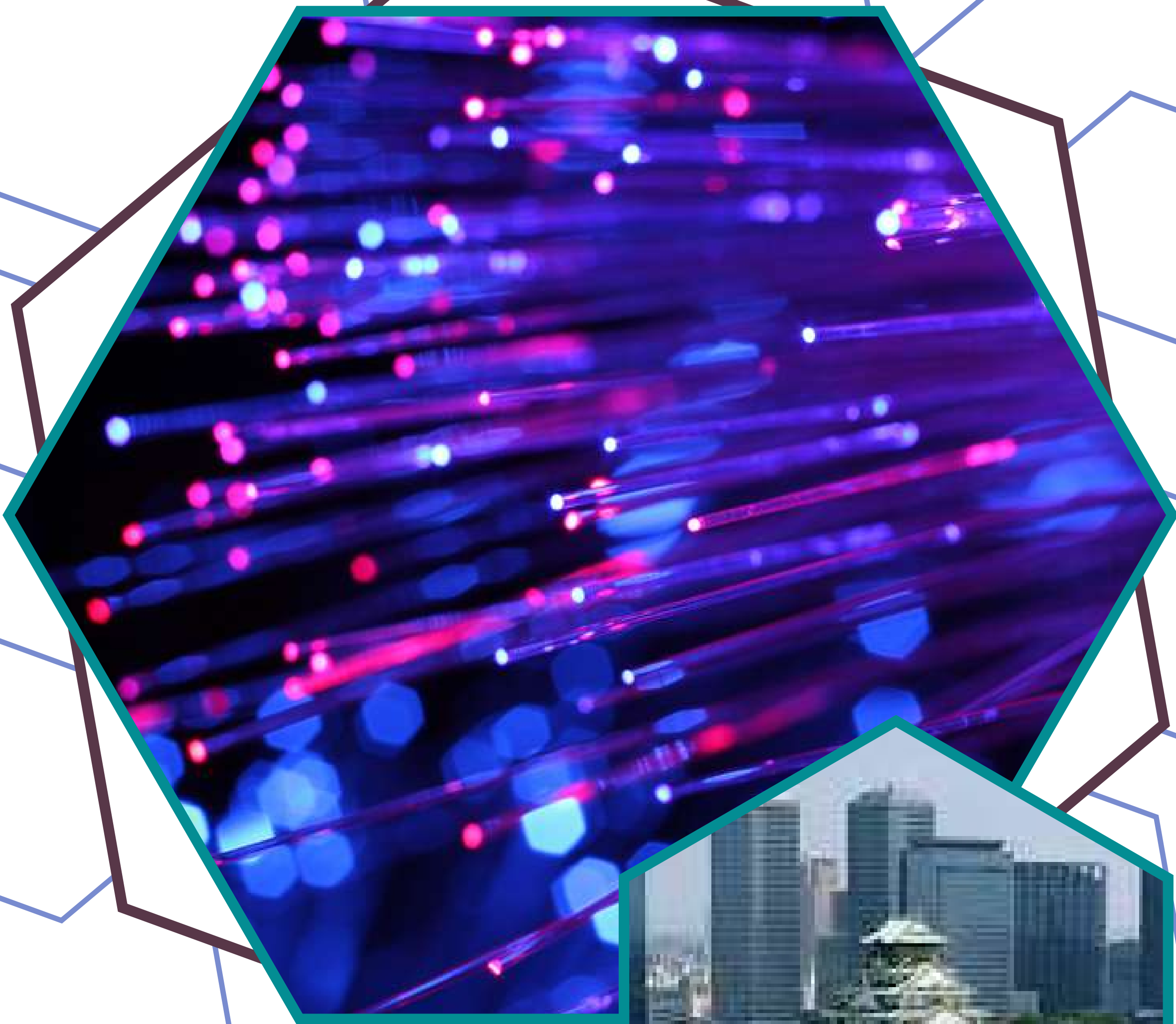
Abstract
Near-infrared (NIR) radiation has generated considerable industrial and research interest. NIR phosphors applied to chemistry, pharmaceutical, medical, cosmetics, food sciences, security have attracted extensive attention worldwide. However, NIR phosphors for this are limited by low quantum efficiency and broad spectra. Rare-earth-containing compounds doped with activators as host systems for NIR phosphors may resolve these limitations. Herein, we developed the new NIR-emitting Yb3+-doped NaY9Si6O26 phosphors using conventional solid-state reaction. All of the synthesized NaY9Si6O26:Yb3+ phosphors have the hexagonal structure. The phosphor powder was observed to have an angular shape with a size of 1-3 μm. The NaY9Si6O26:Yb3+ phosphors showed a broad near-infrared emission from 950 to 1000 nm, which was attributed to the 2F5/2 → 2F7/2 transition of Yb3+ ions under 270 and 920 nm excitation. The excitation spectra of the NaY9Si6O26:Yb3+ phosphors, recorded by monitoring the emission at 985 nm, showed two broad excitation bands in the ultraviolet and infrared regions, respectively. The former was attributed to the charge transfer transition of Yb3+ ions, and the latter was attributed to the transition from the lowest Stark level of the ground 2F7/2 to three Stark levels of the excited 2F5/2 in Yb3+ ions. The excellent thermal stability of NaY9Si6O26:Yb3+ phosphor was evident from the fact that the relative PL intensity of NaY9Si6O26:Yb3+ phosphor was 82% of the initial PL intensity at 300 °C. The emission intensity that showed thermal quenching up to 300 °C recovered to its initial emission intensity when cooled to 25 °C. Thus, it was confirmed that a minimal amount of thermal degradation occurred. The results of our study suggest that NaY9Si6O26:Yb3+ phosphors are promising next-generation candidates for advanced anti-counterfeiting applications.

Keywords
Nay9si6o26:Yb3+ Phosphor; NIR Emission; Anti-Counterfeiting.

Biography
Tae Wook Kang is currently working as a senior researcher at the Korea Institute of Ceramic Engineering and Technology. He received bachelor's, master's, and Ph.D. in materials engineering from Pukyong National University. His research interests are diverse, such as luminescent materials, electroluminescent devices, nano materials, and solid electrolyte materials for all-solid-state batteries. He has published numerous papers in this field of research.



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