ICLLT-2025

15 – 17 MAY

ANKARA-TÜRKİYE

5th INTERNATIONAL CONFERENCE ON LIGHT AND LIGHT-BASED TECHNOLOGIES

Abstract and Proceeding Book

ABSTRACT AND PROCEEDING BOOK

5th International Conference on Light and Light-Based Technologies (5th ICLLT 2025)

15th-17th May 2025, Gazi University, Ankara, Türkiye

Edited by

Prof. Dr. Süleyman ÖZÇELİK

First Published, Aug 6, 2025

This book is available on the ICLLT website: *https://icllt-5.gazi.edu.tr/*

ORGANISERS

- Photonics Application & Research Center (Gazi Photonics), Gazi University
- Photonics Department of Applied Science Faculty, Gazi University

Welcome to the 5th ICLLT-2025

Dear Distinguished Participants and Colleagues

"International Day of Light" has been declared on 16 May at UNESCO 39th General Conference held in Paris between 30 October and 14 November 2017. UNESCO aims with this precious day to raise awareness of people in all United Nations countries in light and light-based technologies. The goal of sharing knowledge and increasing cooperation from R&D studies on photonics, nanotechnology, microtechnology, and semiconductor technology of Gazi University Photonics Application and Research Center is in line with UNESCO's goal of creating Light Science awareness. With this aim, "5th International Conference on Light and Light-based Technologies (5th ICLLT2025)" was held at the Gazi University (Ankara, Turkey), from 15 to 17 May 2025.

The 5th ICLLT-2025 conference targets guests from various branches and disciplines related to Optics and Photonics Technologies. Its interdisciplinary approach is the key to maximizing the potential and development of light-based technologies and tools for various applications. The purpose of the conference is to explore new ideas, effective solutions, and collaborative partnerships for business growth by catalyzing the creation of a beneficial synergy between researchers, engineers, manufacturers, suppliers, and end-users of all sectors and making full use of this potential. At this event, the world's leading scientists in Optical and Photonic technologies discussed the latest developments in related technologies. 61 oral presentations, including 7 keynote speakers and 19 invited speakers, and 42 poster presentations were made by researchers from 9 different countries. While 40 of the presented papers (32 oral presentations and 8 posters) were presented by researchers from abroad, 63 papers (29 oral presentations and 34 posters) were presented by researchers from Türkiye. The event was held with 274 registered participants.

On behalf of the organizing committee, we would like to thank all participating academics, research institutions, and organizations, and especially young students from around the world, for the exchange of ideas and experiences at ICLLT-2025.

We are honored to invite you to the 6th ICLLT conference will be held in May 2026!

Prof. Dr. Süleyman ÖZÇELİK
Conference Chair

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PROGRAM

Thursday 15th May (Address: Mimar Kemalettin Hall, Rectorate Building of Gazi University)

09:00 – 09:30	**Opening Ceremony**
	Prof. Süleyman Özçelik *Conference Chair* *Director of Photonics Application and Research Center, Gazi University, Ankara, Türkiye*
	Prof. M. Öcal Oğuz *President of Turkish National Commission for UNESCO*
	Prof. Uğur Ünal *Rector of Gazi University, Ankara, Türkiye*
Session I	**Chair:** Prof. Yashar Azizian-Kalandaragh *Department of Photonics, Faculty of Applied Sciences, Gazi University, Ankara, Türkiye*
09:30 – 10:10	Plenary Speaker / Prof. Ekmel Özbay *Departments of Electrical and Electronics Engineering and Physics, Bilkent University, Ankara, Türkiye* **Centimeter-scale nanostructure**
10:10 – 10:30	**Coffee Break**
10:30 – 11:10	Plenary Speaker / Prof. Marc Sorel *Department of Electronic & Nanoscale Engineering, University of Glasgow, Scotland* **Photonic Integration for visible light and nonlinear optics applications**
11:10 – 11:40	Invited Speaker / Dr. Bereneice Sephton *The University of Naples Federico II, Italy* **A structured eraser: sculpting correlations with quantum interference**
11:40 – 12:10	Invited Speaker / Prof. Stefano Bellucci *UNISRITA – INFN LNF, Italy* **Tuning the Optical and Semiconducting Properties of Graphene Oxide Derivatives through Eco-Friendly Reduction Strategies**
12:10 – 12:40	Invited Speaker / Dr. Berna Morova *Department of Physics Engineering, Istanbul Technical University, Türkiye* **Advances in fiber bundle fluorescence microscopy for enhanced resolution and contrast**
12:40 – 13:40	**Lunch Break**
Session II	*Gazi University Faculty of Technology Conference Hall* **Chair:** Prof. Hamidreza Khalesifard *Department of Physics, Institute for Advanced Studies in Basic Sciences (IASBS), Zanjan, Iran*
13:40 – 14:20	Plenary Speaker / Prof. Raşit Turan *Department of Physics, Middle East Technical University (METU), Ankara, Türkiye* **Towards the theoretical efficiency limit in solar cell technologies: TOPCon solar cells and beyond**
14:20 – 14:25	**Short Break**

	Hall A	Hall B
	Chair: Prof. Hamidreza Khalesifard	Chair: Prof. Stefano Bellucci

14:25 – 14:55	Invited Speaker / Asst. Prof. Nasire Uluç *Middle East Technical University, Northern Cyprus Campus, Physics Group, Kalkanli, Türkiye* **Emerging Frontiers in Optoacoustic Imaging: From Foundational Principles to Mid-IR Spectroscopic Advances**	Invited Speaker / Dr. Sinan Genç Department of Electrical and Electronic Engineering, Abdullah Gül University, *Türkiye* **Disorder-Driven Hybrid Plasmonic Nanocavities for Broadband Enhancement of Quantum Emission in hBN**
14:55 – 15:25	Invited Speaker / Dr. Lala Rasim Gahramanli *Physics faculty, Baku State University, Azerbaijan* **Enhanced adsorption and degradation kinetics of methylene blue by Ag–Ag2S–CdS hybrid nanowires**	Invited Speaker / Dr. Michael Barbier *Photonics Department, Izmir Institute of Technology, Türkiye* **Laser-steered colloidal aggregation and pattern formation**
15:25 – 15:55	Invited Speaker / Prof. Bülent Çakmak *Department of Electrical and Electronic Engineering, Erzurum Technical University (ETU), Türkiye* **Fabrication and comparative experimental investigation of multi-section diode lasers with different configurations**	Speaker / Bilgehan Barış Öner *Gazi University, Türkiye* **Resonance and slow-light techniques for energy confinement in Fabry-Perot cavity designs** Speaker / Mehdi Fooladi-Vanda *Institute for Advanced Studies in Basic Sciences (IASBS), Zanjan, Iran* **Fabrication of Low-Cost Liquid Crystal-Based Adjustable Wave-Plates**
15:55 – 16:20	**Coffee Break**	
	Hall A Chair: Dr. Sinan GENÇ	Hall B Chair: Dr. Berna Morova
16:20 – 16:50	Invited Speaker/Dr. Eugenio Di Gaetano *Department of Photonics, Electronic & Nanoscale Engineering, University of Glasgow, Scotland* **High power and narrow linewidth output optimisation in semiconductor lasers for quantum system applications**	Invited Speaker/Dr. Mostafa Aakhte *Multiscale Biology, Department of Biology and Psychology, University of Göttingen, Germany* **Tailored Light Sheet Microscopy for Live and Cleared Tissue Imaging**
16:50 – 17:20	Invited Speaker/Assoc. Prof. Hasan Hüseyin Güllü *ASELSAN, Türkiye* **Advances in Optical Coatings: Material and Thin Film Solutions at ASELSAN**	Invited Speaker/Dr. Ghazanfar Ali Khan *Department of Physics, METU, Türkiye* **Flexible and Cost-Effective Substrates for Efficient Surface-Enhanced Raman Spectroscopy-Based Trace Detection**
17:20 – 17:35	Speaker/Halil Can Nalbant *TOBB University of Economics and Technology / Aselsan, Türkiye* **Analytic Design of Dual-Wavelength Diffractive Optical Elements for Mid-Wave Infrared**	Speaker/Cansu AKYOL KARPUZCU *Izmir Institute of Technology, Türkiye* **Development of ClAlPc-Loaded BSA Nanoparticles for Dual Action Against Cancer via Photodynamic and Sonodynamic Mechanisms**

17:35 – 17:50	Speaker/Sara Aminian *Institute for Advanced Studies in Basic Sciences (IASBS), Zanjan, Iran* **Neural Network-Based Calibration of Plasmonic Structures: A Simulation Study**	Speaker/Seyedeh Roghayyeh Seyedzadeh *Institute for Advanced Studies in Basic Sciences (IASBS), Zanjan, Iran* **Real-Time Surface Roughness Measurement Using DualIllumination Interferometric Microscopy**
17:50 – 18:05	Speaker/Salar Alizadeh *Institute for Advanced Studies in Basic Sciences (IASBS), Zanjan, Iran* **Identification of Salt-Dust Plumes Over the Urmia Lake Using a Scanning Polarization Lidar**	Speaker/ Negin Mohammadzadeh *Institute for Advanced Studies in Basic Sciences (IASBS), Zanjan, Iran* **The interplay between a bacterial ratchet motor and optical speckle fields**
18:05 – 18:20	Speaker/Maryam Nazari *Malayer University, Iran* **Energies and wave-functions of an anharmonic quantum oscillator bound in an infinite-wall quantum well found by finite difference algorithm for use in nonlinear optics**	Speaker/Saman Yarabi *Malayer University, Iran* **Simulation of a rainbow spectrometer for measuring the optical dispersion of fluids**
18:20 – 18:35	Speaker/Narmin Ahmedova *Baku State University, Azerbaijan* **Structural changing of CdS nanoparticle by the effect of cation-anion ratio**	Speaker / Shafiga *Alakbarova* *Baku State University, Azerbaijan* **YIG-Based Photonic Crystals and Their Role in Quantum and Optical Device Engineering**
18:35 – 18:50	Speaker/Mahkame *Abolfathi* *Institute for Advanced Studies in Basic Sciences (IASBS), Iran* **Optical Analysis of Methylene Blue in Water Sources Using Surface Plasmon Resonance Sensors**	Speaker/Sevinc *Hamidova* *Baku State University, Azerbaijan* **Fluorescence Properties of CdS Thin Films and Powders under 330 nm excitation**
18:50 – 19:05	Speaker/Amin Mirmammadov *Nano Research Laboratory, Baku State University, Azerbaijan* **Optical analysis of asymmetric AgNWs/PVA/Ag_2 S nanocomposites**	

Friday 16th May (75. Yıl Conference Hall, Faculty of Science, Gazi University)

Session I	Gazi University Faculty of Technology Conference Hall **Chair:** Prof. Mehmet Çakmak *Middle East Technical University, Türkiye*	
09:00 – 09:40	Plenary Speaker / Prof. Luis L. Sanchez-Soto *Faculty of Physics, Complutense University of Madrid, Spain* **Measuring impossible parameters with indefinite causal order**	
09:40 – 10:20	Plenary Speaker / Prof. Hamid Reza Khalesifard *Department of Physics, Institute for Advanced Studies in Basic Sciences (IASBS), Zanjan, Iran* **Optical remote sensing and identification of new dust sources inside the Iran Plateau**	
10:20 – 10:40	**Coffee Break**	
	Hall A Chair: Dr. Bereneice Sephton	Hall B Chair: Asst. Prof. Nasire Uluç
10:40 – 11:10	Invited Speaker/Prof. Tarık Asar *Department of Physics, Gazi University, Türkiye* **MSM Photodetectors with Different Materials**	Invited Speaker/Assoc. Prof. Ramazan Şahin *Department Of Physics, Akdeniz University, Türkiye* **Active Plasmonics in the Visible: Towards Programmable Nano-Optics**
11:10 – 11:40	Invited Speaker/ Prof. Özlem Duyar Coşkun *Department of Physics Engineering, Hacettepe University, Türkiye* **New Trends in Electrochromic Devices**	Invited Speaker/Dr. Fadıl İyikanat *ICFO- Institute of Photonics Sciences, Spain* **Polariton-Enhanced Nonlinear Optical Response in 2D Materials**
11:40 – 11:55	Speaker/Assoc. Prof. Meltem Babayiğit Cinali *Department of Physics Engineering, Hacettepe University, Türkiye* **Sputtered Silver-Based Low-Emissivity Coatings**	Speaker / Asst. Prof. Yakup Emül *Sivas Cumhuriyet University, Türkiye* **Mueller Matrix method for adjusting optical properties in a two-stage liquid crystal retarder system using Monte Carlo simulations**
11:55 – 12:10	Speaker/Veli Yuksektepe *University of Glasgow, Scotland* **Heterogeneous Integration of Photonic Crystal Surface Emitting Lasers on Silicon-On-Insulator**	Speaker/ssoc. Prof. Aziz Kolkiran *İzmir Katip Çelebi University, Türkiye* **Harnessing Quantum Correlations for Subwavelength Imaging**
12:10 – 12:25	Speaker/Dr. Hira Asif *Akdeniz University, Türkiye* **Coherent Control of Plexcitonic States via Optical Stark Effect**	Speaker/Dr. Özlem Bayal *Gazi University, Türkiye* **Analysis of Dislocation Density for Algan Based Hemts in Screw Mod**
12:25 – 12:40	Speaker/Mina Mollayi *Institute for Advanced Studies in Basic Sciences (IASBS), Zanjan, Iran* **Design and build of tunable micro-lens to increase microscopic resolution**	Speaker/Alireza Ale Kasir *Institute for Advanced Studies in Basic Sciences (IASBS), Zanjan, Iran* **Calibrating Nanometer Displacement with Fresnel Diffraction from Phase Step**
12:40 – 13:50	**Lunch Break**	

Session II	Gazi University Faculty of Technology Conference Hall **Chair:** Prof. Luis L. Sanchez-Soto	
13:50 – 14:30	Plenary Speaker / Prof. Gerd Leuchs *Max Planck Institute, Germany* **Quantum Technology, Quantum Computing, and the Role of Measurement**	
14:30 – 15:10	Plenary Speaker / Prof. Vahid Karimipour *Department of Physics, Sharif University of Technology, Iran* **Concepts and methods of quantum information, an introduction**	
15:10 – 15:15	**Short Break**	
	Hall A Chair: Prof. Tarık Asar	Hall B Chair: Prof. Şemşettin Altındal
15:15 – 15:45	Invited Speaker / Dr. Utku Er *Şişecam, Türkiye* **Highly Selective Multilayer Low-E Coatings on Flat Glass**	Invited Speaker / Berkay Uğurlu *Transvaro, Türkiye* **Critical Processes in Cooled IR Detector Packaging: Flip Chip Bonding and Underfill**
15:45 – 16:00	Speaker / Assoc. Prof. Ali Bayat *Zanjan University, Iran* **Investigation of aerosol types in Zanjan city using sun-photometer**	Invited Speaker / Dr. Rana Faik Khankishiyeva *Nano Research Laboratory, Excellent Center, Baku State University;* **UV-induced degradation and mechanical behavior of LDPE composites reinforced with nanochitosan: toward eco-friendly polymeric materials**
16:00 – 16:15	Speaker / Hafsa Moazzamia *Middle East Technical University (METU), Türkiye* **Mie-Scattering Based Detection of Microplastics in Beverages**	
16:15 – 16:30	Speaker / Gülçin Çorbaci *Gazi University, Türkiye* **Photovoltaic Performance Analysis of Perovskite CsSiF3 Compound**	Speaker / Zeynab R. Addayeva *Baku State University, Azerbaijan* **Study of the Modification of Optical Characteristics of Silver Nanowires During Sulphidation**
16:30 – 16:45	Speaker / Fateme Gheibi *Institute for Advanced Studies in Basic Sciences (IASBS), Zanjan, Iran* **White-Light Spectroscopy of SPR Sensors Based on Wavelength Scanning**	Speaker / Tutku Kübranur Ugip *Gazi University, Türkiye* **Electric and Electro-Optic Responses of a Schottky Diode with Si-(Gd_2O_3)/Polymer Structure**
16:45 – 17:00	Speaker / Furkan Akkaya *Istanbul Technical University / Şişecam Science, Technology and Design Center (ArTeGe), Türkiye* **Fabrication of SnS Solar Cells in Core–Shell Architecture Based on ZnO Nanorod**	Speaker / Dr. Sabreen A. Hameed *Gazi University, Türkiye, University of Diyala, Iraq* **On the current-voltage characteristics of the Ag/(NiO:rGO)/n-Si (MIS) Schottky barrier diodes (SBDs) in dark and 100mW/cm² conditions**
17:00 – 18:00	**Poster Presentations and Coffee Break**	
18:00 – 19:00	**International Year of Quantum Science and Technology Panel** **Chair: Prof. Gerd Leuchs**	

Saturday 17th May

10:00 – 12:00	Tour of ANITKABIR
12:00 – 14:00	**Lunch Break**
14:00 – 16:30	Tour of the Photonics Application and Research Center at Gazi University
16:30 – 17:00	**Break**
17:00 – 18:30	**Closing Ceremony and Best Presentation Awards at the Gazi University Faculty of Technology Conference Hall A**

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PLENARY SPEAKERS

PS1

Quantum Technology, Quantum Computing, and the Role of Measurement

Gerd Leuchs[1,2,4,5], Mojdeh S. Najafabadi[3,4], and Luis L. Sánchez-Soto[3,4,5]

[1]Department Physik, Universität-Erlangen-Nürnberg, Germany
[2]Department of Physics, University of Ottawa, Canada
[3]Max Planck U Ottawa Centre for Extreme and Quantum Photonics
[4]Max Planck Institute for the Science of Light, Erlangen, Germany
[5]Departamento de Óptica, Universidad Complutense, Madrid, Spain

Abstract: The field of physics sometimes coined "Quantum 2.0", or the second quantum revolution, is about experimenting with, understanding and exploiting single quantum systems. The enormous achievements progress made was rewarded with the Nobel Prizes in 2022, shared by A. Aspect, John F. Clauser and A. Zeilinger [1-3]. Quantum physics shares many complexities with other areas in physics and mathematics, especially when dealing with higher-dimensional systems. As an example, as soon as the dimension of a set is equal to, or larger than three, two operations mapping the set onto itself and applied consecutively, such as two multiplications, do not necessarily commute. This is well known in classical field theory, where the set can be e. g. a vector space or a function space. As is well known, even the vector product of two three-dimensional vectors does not commute. This contributes to the complexity of models and is ubiquitous. It is nothing specific quantum but it nevertheless plays an important role also in the quantum world. Likewise, superpositions and conjugate variables, related by Fourier transformation, are common features encountered in any wave phenomena, both in classical and quantum physics. And the Fourier-transformation-relation between conjugate variables is itself closely related to the non-commutativity of mutually conjugate variables. All this adds to the complexity of mathematical models – but is not specific quantum. What sets quantum physics apart from the rest of physics is the measurement process [4]. When combined with quantum measurements, a superposition of states in a composite system may show the typical properties of quantum entanglement: seemingly stochastic measurement outcomes when observing only individual parts of a composite system, but potentially very strong or even perfect correlations when comparing the results obtained for the individual parts. Ultimately such correlations are the reason why one can build a computer using a system operating in the quantum domain, despite of quantum uncertainty, which is sometimes a bit misleadingly called quantum noise. Most importantly, in quantum physics the outcome of a measurement depends critically on the details of how the measurement is done [5]. This talk is given at an introductory level for non-specialists and illustrates the core concepts of quantum technologies such as e. g. quantum computing.

Reference:

[1] https://www.nobelprize.org/prizes/physics/2022/aspect/lecture/
[2] https://www.nobelprize.org/prizes/physics/2022/clauser/lecture/
[3] https://www.nobelprize.org/prizes/physics/2022/zeilinger/lecture/
[4] C. Fabre, "Quantum Processes & Measurement – theory and experiment", Cambridge University Press, 2023.
[5] M.S. Najafabadi et al., Phil. Trans. Roy. Soc A 382, 20230337 (2024).

PS2

Concepts and methods of quantum information, an introduction

Vahid Karimipour

Sharif University of Technology, Iran

PS3

Photonic integrated circuits for visible light and nonlinear optics applications

N. Pruiti, E. McKay, D. Kelly, C. Suciu, J. Oludayo Adeniran, V. Yuksektepe, R.H. Cunningham, S. Munro, E. Di Gaetano, M. Sorel

James Watt School of Engineering – University of Glasgow (UK)

Abstract: The talk will review some recent results in photonic integrated circuits (PICs) at the University of Glasgow, with a particular focus on non-linear and visible light applications. We will begin by introducing the technological advances that have led to the demonstration of very low-loss waveguides in the blue and UV regions of the spectrum. This will be followed by results on the development of fundamental building blocks that enable the fabrication of complex photonic integrated circuits operating in the visible range. We will also discuss how the functionality of these devices can be significantly enhanced through the integration of multiple material stacks, such as lithium niobate, AlGaAs, alumina, and polymers. The talk will conclude with a discussion of relevant case studies—such as PICs for quantum applications, supercontinuum generation, and free-space beam analysis—and a forward-looking perspective on the challenges that must be addressed to keep pace with the rapid growth of the photonic integration technology market.

PS4

Towards the theoretical efficiency limit in solar cell technologies : TOPCon solar cells and beyond

Raşit Turan[1,2]

[1] *Center for Solar Energy Research and Applications (ODTÜ-GÜNAM),* [2] *Department of Physics, Middle East Technical University, 06800, Ankara-Turkiye*
E-mail: turanr@metu.edu.tr

Passivating contacts based on poly-Si/SiOx stacks also referred to as TOPCon (tunnel oxide passivated contacts) have substantially improved the performance of crystalline silicon (c-Si) solar cells in recent years. Efficiencies above 26% have already been reported. Further improvements in TOPCon solar technologies are being extensively studied in many research laboratories and companies. For example, TOPCon technology advancements may involve replacing locally diffused boron regions with local p+ poly- Si/SiO_x under metal contacts to mitigate recombination losses on the front side. Similarly, studies focusing on introducing full-area TOPCon structures on the front side for next-generation solar cell technology have been reported. Several issues like advanced hydrogenation, metallization, and UV degradation have been the main focus of research in recent years.

Next step in the c-Si technology for industrial applications is expected to be based on back contact solar cell technology. In this case, all junctions and connections are fabricated on the backside of the solar cell so that there is no shading effect originating from the metal elements on the front side of the cell. A net increase in the total generated current is then obtained. In order to improve the performance back junction cells, various architectures with TOPCon or heterojunction technologies have been proposed and used.

Another very promising approach for the next generation solar cells is the tandem solar cells with perovskite/Si stack structure where high energetic photons are absorbed by the top perovskite cell, low energy photons are used in the bottom Si solar cell. This structure is useful to exceed the Shockley-Queisser limit and reach an efficiency more than %35.

In this talk, the fundamentals of TOPCon solar cell technology, possible technological improvements, and activities at GÜNAM on this technology will be summarized. In particular, an introduction of local TOPCon structure, and a new TOPCon-like bottom cell structure for tandem applications will be presented. New promising technologies like back contact and tandem solar cells will be summarized. Also, a summary of Turkish PV eco-system and research and development studies at the Center for Solar Energy Research and Applications (ODTU-GUNAM) will be given very briefly

PS5

Measuring impossible parameters with indefinite causal order

Luis L. Sanchez-Soto

Complutense University of Madrid, Spain

PS6

Centimeter scale nanostructures: Lithography-free metamaterials for photoconversion, photodetection, light emission, sensing, and filtering

Ekmel Özbay

NANOTAM-Nanotechnology Research Center, Bilkent University, 06800 Ankara, Turkey
email: ozbay@bilkent.edu.tr

Abstract: The efficient harvesting of electromagnetic (EM) waves by subwavelength nanostructures can result in perfect light absorption in the narrow or broad frequency range. These metamaterial-based perfect light absorbers are of particular interest in many applications. Although advances in nanofabrication have provided the opportunity to observe strong light–matter interaction in various optical nanostructures, the repeatability and upscaling of these nano units have remained a challenge for their use in large scale applications. Thus, in recent years, the concept of lithography-free planar light perfect absorbers has attracted much attention in different parts of the EM spectrum, owing to their ease of fabrication and high functionality. In this presentation, we will explore the material and architecture requirements for the realization of light perfect absorption using these multilayer metamaterial designs from ultraviolet (UV) to far-infrared (FIR) wavelength regimes. We show that, by the use of proper material and design configuration, it is possible to realize these lithography-free light perfect absorbers in every portion of the EM spectrum. This, in turn, opens up the opportunity of the practical application of these perfect absorbers in large scale dimensions. In last couple of years, we adopted these lithography-free techniques in many applications including photoconversion, photodetection, light emission, sensing, filtering and thermal camouflage. This presentation will summarize our recent accomplishments in this field.

PS7

Optical remote sensing and new dust sources inside the Iran Plateau

Hamid R. Khalesifard

Department of Physics, Institute for Advanced Studies in Basic Sciences, Zanjan 4513766731, Iran

Abstract: The Iran plateau is located over the Earth dust belt and Northwest of Iran is a mountainous semiarid region with average annual precipitation of ~300 mm/y. This region is under the impacts of large dust sources like the Mesopotamia, Arabian Desert, and African Sahara. But during the past decades, due to mismanagement of water resources and increases of irrigated agriculture, new dust sources are appeared in the region. These includes dried lakes, dried marshlands, and subsidence of the farmlands.
In this talk I will talk about LiDAR measurements over the Urmia Lake, a hypersaline lake in Northwest Iran and investigating of dust layers via an aerosol LiDAR in Zanjan (a city in Northwest Iran) that may have raised from the north of Dasht-e-Kavir desert in center of the Iran plateau. Using the recorded polarized LiDAR signals, in the former we have been able to specify the salt and salt-dust particles that are raising form the dried bed of the lake and its costal area. The latter work shows considerable increase in the dust events that are originating from the central Iran plateau. These sources are spatially correlated with the regions that had experienced land subsidence.

INVITED SPEAKERS

IS1

High power and narrow linewidth output optimisation in semiconductor lasers for quantum system applications

Eugenio Di Gaetano

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Abstract: Semiconductor lasers are of interest for emerging quantum technologies such cold atom systems. However, such technologies require high-power, stable single-mode, and narrow linewidth sources at specific target wavelengths, e.g. 780.24 nm for D2 87Rb transitions. Several material properties, such as propagation losses, self-heating, and far-field emission pattern, are critical for laser performance, including power output before damage, coupling efficiency into optical components, and linewidth, following the Schawlow-Townes formula.
In this work, an optimisation approach for semiconductor laser design for quantum system applications is proposed and explored. The design improvement regards both the epilayer material and the cavity geometry, it aims to maximise the power output of the laser device while maintaining a quality output in terms of narrow Lorentzian linewidth, single mode emission, side mode suppression ratio (SMSR), and beam divergence. This optimisation was applied to GaAs/AlGaAs semiconductor laser targeting 778.1 nm, wavelength of interest for the 87Rb two-photon transitions. The employment of an aluminium-free active area, an asymmetrical mode expander into the AlGaAs claddings, and long weakly laterally-coupled grating geometry allowed to achieve sub-10 kHz Lorentzian linewidth, power output of 48 mW, and SMSRs exceeding 35dB as well as improved coupling into single-mode lensed fibre. Finally, this laser device is employed to probe the 87Rb two-photon transitions for a heated Rb cell in retroreflection configuration. Using an acousto-optical modulator for frequency scan, the laser resolved hyperfine levels for the 87Rb two-photon transition.

IS2

New Trends in Electrochromic Devices

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Abstract: The electrochromic (EC) materials and devices (ECDs) possess a reversible change in the optical properties like their transmission, reflection and/or absorption) of electrochromic materials under an applied external voltage. Electrochromic devices (ECDs) have recently gained prominence with their applications in many promising technologies such as smart glasses, low-power displays, and wearable electronics. The general structure of an ECD in full-cell configuration consists of the conductive layer grown on a substrate, an electrochromic layer, and a counter electrode layer in sandwich configuration separated by an ion conducting layer called as electrolyte.

In particular, ECDs using solid electrolytes and the search for different TCOs for being free of indium tin oxide (ITO) are important for the advancement of these technologies. This study will focus on the materials used in ECDs, device configurations, and applications, and will highlight the key issues and development trends on ECDs.

Indium tin oxide (ITO) is the most widely used conductive material due to its high conductivity and transparency, but due to increasing global demand, indium has become a rare and expensive resource for applications in various technological fields. Graphene has recently been attracting great interest for being used as a transparent conductive layer in ECDs.

The ion conducting layer can be liquid, gel or solid inorganic materials. The most important disadvantage of liquid and gel ion conductive layers is their leakage. Studies are ongoing to use metal oxides such as Ta_2O_5, ZrO_2 and lithium-containing inorganic materials such as $LiNbO_3$ and $LiTaO_3$ due to their good physicochemical stability and high optical transmission to eliminate leakage.

IS3

Polariton-Enhanced Nonlinear Optical Response in 2D Materials

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Abstract: Understanding the fundamental mechanisms governing the optical response in materials is crucial for designing systems with strong nonlinearities at reduced light intensity thresholds and for uncovering their potential applications. The emergence of pronounced photon-polariton interaction signatures in the linear optical spectrum of two-dimensional (2D) materials, attributed to the reduction in Coulomb screening and the amplification of quantum-confinement effects, has sparked active research into polaritonic effects in the nonlinear optical response of these materials [1,2]. In this talk, we will discuss several exemplary studies of the nonlinear response in 2D materials [3-5]. We introduce a specific collection of 2D materials, along with a range of excitation modes such as phonons, excitons, and plasmons (see Figure 1), which provide a suitable arena for monitoring the interactions between light and matter. Using first-principles methods, including density functional theory (DFT) and post-DFT approaches (e.g., GW and Bethe-Salpeter-equation) we reveal the detailed electronic and vibrational properties of 2D materials and predict their optical response in the presence of polaritons. Then, solving the equation of motion either in the time domain or with perturbative approaches, we obtain the nonlinear susceptibilities associated with second- and third-harmonic generation. In brief, our work demonstrates that various types of polaritons exhibit a robust, optically and electrically controllable nonlinear response in 2D materials. These polaritons offer numerous applications across a wide range of optical spectra in both optoelectronics and quantum optics.

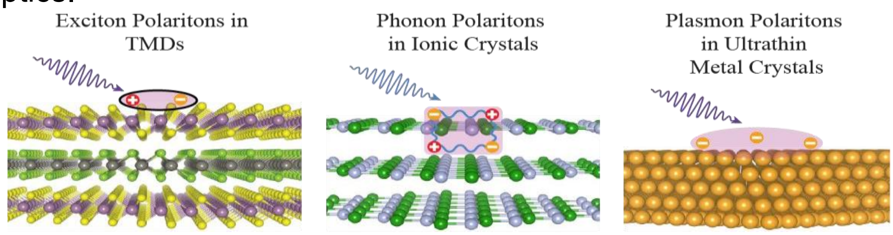

Fig. 1 Schematic representation of exciton, phonon, and plasmon polaritons supported by a wide range of 2D materials, including TMDs, ionic crystals, and ultrathin metal crystals. The interaction of photons with these polaritons can be tailored through various mechanisms, such as altering the thickness or constructing heterostructures, giving rise to a diversity of ultrafast processes and producing an enhanced nonlinear response.

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IS4

Disorder-Driven Hybrid Plasmonic Nanocavities for Broadband Enhancement of Quantum Emission in hBN

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Abstract: We present a scalable, low-cost strategy for enhancing quantum emission from hexagonal boron nitride (hBN) defects using disorder-engineered plasmonic nanocavities. By thermally dewetted thin silver films, stochastic Ag nanoparticles (AgNPs) form near hBN flakes, enabling two configurations: isolated AgNPs on silicon and hybrid cavities on gold/silicon dioxide substrates. These structures yield size-dependent emission modulation—small AgNPs quench photoluminescence (PL), while larger ones enhance it significantly.

Hybrid vertical nanocavities demonstrate up to 100-fold PL enhancement, attributed to strong field confinement between the AgNP and reflective substrate. Finite-Difference Time-Domain simulations and time-resolved measurements confirm controlled tuning of decay dynamics, including radiative and non-radiative processes.

This approach eliminates the need for lithography or precise emitter placement, making it highly suitable for large-scale integration. The technique holds promise for on-chip quantum photonic devices, efficient single-photon sources, and nanoscale sensors based on 2D materials like hBN. Our findings open new avenues for tunable, stochastic plasmonic architectures in quantum nanophotonics.

IS5

Tuning the Optical and Semiconducting Properties of Graphene Oxide Derivatives through Eco-Friendly Reduction Strategies

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Abstract: The ability to fine-tune the electronic and optical properties of graphene oxide (GO) is essential for its integration into next-generation optoelectronic and energy storage technologies. In this study, we explore an environmentally sustainable approach to reducing GO (Figure 1) [1], investigating how temperature and reaction time influence its semiconducting behaviour. Through UV–Vis spectroscopy and Tauc analysis, we demonstrate that the optical bandgap of reduced graphene oxide (rGO) [2] can be precisely modulated from approximately 2.2 eV to 1.6 eV, significantly enhancing its absorption in the visible spectrum. Structural characterisation using Raman spectroscopy, FTIR, and XRD confirms the gradual restoration of the sp^2-hybridised carbon network, which correlates with a marked improvement in electrical conductivity. Furthermore, we report an absorption coefficient increase of up to 7426 ml mg^{-1} m^{-1}, exceeding that of exfoliated graphene, thus reinforcing rGO's potential for optoelectronic applications. These findings highlight the effectiveness of green reduction methods in tailoring GO's properties, offering a scalable and sustainable route for the development of semiconductor materials with tunable characteristics [3].

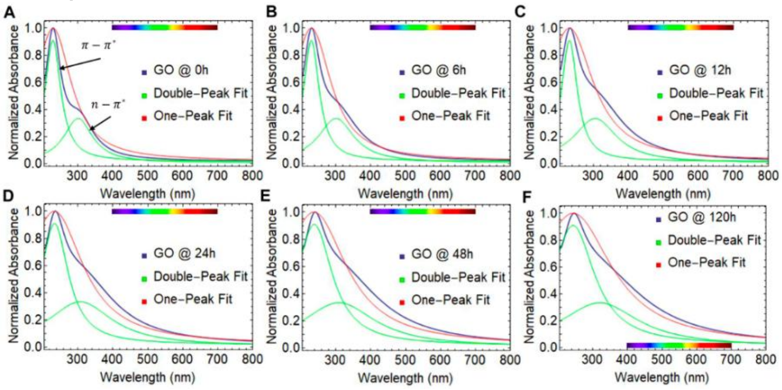

Fig. 1. Optical absorbance of GO at different reduction times.

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IS6

Laser-steered colloidal aggregation and pattern formation

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Abstract: Many complex systems found in Nature can be explained by self-assembly processes operating far-from-equilibrium. When represented by colloidal systems these processes consist out of simple particles exhibiting individually almost trivial behavior only influenced by some external parameters. Yet, their many-body characteristics make studying them a challenging task, representing a huge configuration space of possible patterns and their combinations. Here we implemented a reinforcement learning strategy to search through the parameter space of our experimental setup—in which particles form dynamic crystal patterns in quasi-2D—by simulations and found corresponding parameter ranges for observed target lattice types: square, rectangular, hexagonal, and Moiré type. Further, to understand the underlying mechanisms we classify defects, responsible for grain boundary formation and movement, and connect pattern transitions to external parameter changes. This work provides a means to assess fundamental physical processes in out-of-equilibrium colloidal systems and steer them towards specific target pattern configurations.

IS7

Flamingo: Tailored Light Sheet Microscopy for Live and Cleared Tissue Imaging

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Abstract: Light sheet fluorescence microscopy (LSFM) has become a key instrument in modern biology with its confined excitation and its capability to image live, intact biological samples fast and gently. In LSFM, optical sectioning is achieved by two orthogonal optical arms: one projects a laser light sheet into the sample, illuminating a thin section, and the other records the emitted fluorescence light perpendicularly with a camera. This configuration enables simultaneous collection of emitted light across the entire field of view (FOV), surpassing sequential point-scanning methods in photon efficiency and speed. Localized fluorescence excitation at the chosen plane significantly reduces photobleaching, critical for in vivo imaging. LSFM is also an effective method for imaging large and cleared tissues. It enables scientists to obtain high-resolution images across the entire intact sample, which is crucial for subsequent reconstructions and quantifications. However, the best and most specialized LSFM setups are home-built instruments and therefore not easily accessible to biologists. In the Huisken Lab, we have developed a novel, modular, and portable LSFM framework, named Flamingo, that allows us to put this advanced imaging technology into the hands of our collaborators. The LSFM covers various applications, from imaging a zebrafish's development to large mouse organs with subcellular resolution, offering new insights into biomedical imaging.

IS8

Emerging Frontiers in Optoacoustic Imaging: From Foundational Principles to Mid-IR Spectroscopic Advances

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Abstract: Optoacoustics (also known as photoacoustics) is a non-invasive hybrid imaging technique that combines optical excitation with acoustic detection. Based on light absorption and its conversion into ultrasound waves, this modality has demonstrated remarkable utility in biomedical imaging—particularly in high-resolution microvascular visualization, oxygen saturation mapping, and evaluation of the tumor microenvironment. The continuous evolution of optoacoustic imaging systems has been driven largely by advancements in laser technologies, especially the development of tunable laser sources with broader spectral coverage and higher pulse repetition rates. These innovations, along with application-specific sensor configurations, have significantly improved sensitivity, resolution, and imaging depth, thereby expanding the scope of optoacoustics across both preclinical and clinical domains [1]. Recent progress in system design and signal processing algorithms has further enabled precise quantification of physiological parameters such as oxygen saturation, hemoglobin concentration, and vascular dynamics. As these technologies mature, research interest is shifting toward novel spectral regions—most notably the midinfrared (Mid-IR) range. In contrast to conventional near-infrared techniques, Mid-IR optoacoustics enables label-free detection of fundamental molecular vibrations, allowing for direct identification of key biochemical constituents [2]. This enhanced spectral sensitivity opens up transformative opportunities for real-time, non-invasive metabolic imaging—particularly in tracking cancer-related signatures such as lipid and glucose metabolism. In this presentation, I will discuss emerging applications of optoacoustic imaging, with a specific focus on Mid-IR optoacoustic spectroscopy and its potential to revolutionize the monitoring of metabolic dynamics in disease contexts.

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IS9

Active Plasmonics in the Visible: Towards Programmable Nano-Optics

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Abstract: Active controlling of photonic integrated circuits (PIC) is critical for developing programmable devices, yet post-fabrication bandwidth tuning remains challenging, especially in the visible regime. We present (i) all-optical [1] and (ii) electro-optic tuning of photonic systems for dynamical extraordinary optical transmission (EOT) [2], spontaneous photon emission (SPE) [3], [4] and decay rate modulation of an atomic dipoles [5]. In the all-optical control, ultrashort pulse modulates the spectral and temporal dynamics of propagating and localized plasmon modes, yielding enhancement in EOT efficiency to 95% with a 100-fs lifetime enhancement. In the electrical control, a bias-tunable quantum emitter (QE) embedded in the EOT structure shifts the operational bandwidth, achieving a modulation depth of three orders of magnitude. In addition, we discuss the lifetime enhancement of nonlinear plasmon modes by coupling it to long-lifetime QE. For coherent quantum control, we actively tune plexcitonic states in hybrid plasmon-emitter system via the optical Stark effect (OSE). Stark field induces transparency (SIT) in an off-resonant plexcitonic states, enabling 350 meV Rabi splitting and tunable photoluminescence in the visible regime. Furthermore, the continuous tuning of radiative and non-radiative decay rates of a dipole up to two-orders of magnitude can be obtained by introducing a Fano transparency in plasmon spectrum through a voltage tunable QE. These approaches pave the way for reconfigurable visible-light photonics, enabling realization of on-demand entanglement/single-photon sources.

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IS10

Advances in fiber bundle fluorescence microscopy for enhanced resolution and contrast

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Abstract: We present the fabrication, characterization, and performance enhancement of flexible optical fiber bundles (FBs) for fluorescence microscopy and microendoscopic imaging. The FBs were fabricated using the stack-and-draw technique from thermally matched high-index and low-index glasses, including in-house synthesized zirconium-silicate ZR3, borosilicate SK222, sodium-silicate K209, and commercial F2 glass. The resulting FBs, comprising approximately 15,000 individual cores with pixel sizes ranging from 1.1 to 10 μm, exhibited high numerical apertures (NAs) of 0.53 (ZR3/SK222) and 0.59 (K209/F2), enabling improved light collection efficiency. A total of seven FBs with varying core sizes and bundle diameters were evaluated through brightfield and fluorescence imaging of micro-structured samples, including dye-stained paper tissue. FBs with core diameters >1.6 μm and inter-core spacing >2.3 μm demonstrated optimal imaging performance [1]. To further enhance image quality, we integrated a deep learning-based post-processing approach. Using data acquired from a custom-built FB-based multifocal structured illumination microscope (MSIM) employing a digital micromirror device (DMD), we trained an image-to-image translation model to transform conventional wide-field FB images into high-resolution outputs. The trained model, applied to images captured with our in-house fabricated high-NA FBs, yielded substantial improvements in both resolution and contrast-without requiring additional optical hardware [2]. These results highlight the synergistic potential of combining advanced fiber fabrication with data-driven image enhancement to push the performance limits of fiber bundle-based fluorescence microscopy.

Acknowledgement: This work was supported by TÜBİTAK (grant number 118F529). A. Kiraz acknowledges partial support from the Turkish Academy of Sciences (TÜBA).

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IS11

UV-induced degradation and mechanical behavior of LDPE composites reinforced with nanochitosan: toward eco-friendly polymeric materials

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Abstract: This study investigates the effect of chitosan particle size on the UV degradation and mechanical properties of Low-Density Polyethylene–Chitosan (LDPE/CH) and LDPE–Nanochitosan (LDPE/CHNP) composites. The composites were fabricated using solvent casting and peroxide-initiated melt compounding methods, incorporating chitosan nanoparticles of varying sizes. Mechanical analysis revealed that tensile strength and elastic modulus increased with decreasing chitosan particle size, with the LDPE/CHNP composite containing 15% nanochitosan (≤100 nm) achieving a maximum elastic modulus of 23.10 MPa and tensile strength of 3.52 MPa. UV degradation studies were conducted by placing the samples in a UV-light chamber with a total radiant exposure of 2.50×10^8 J/m² for 18 weeks. Degradation was evaluated using weight loss measurements, FTIR analysis for chemical bond changes, SEM for morphological alterations, and tensile testing for mechanical degradation [1]**.** Results indicated that nanochitosan-loaded composites exhibited higher degradation efficiency, with the 20% CHNP sample showing 50% weight loss and a degradation rate of 0.12 g/d after 21 days. Morphological analysis confirmed superior dispersion of nanochitosan, leading to enhanced mechanical stability and biodegradability. The addition of palm oil as a plasticizer improved hydrophilicity and further accelerated degradation. However, these findings highlight that adding nanochitosan to low-density polyethylene (LDPE) not only makes the material stronger but also helps it break down faster under UV light, making it a more eco-friendly alternative to traditional plastics.

Acknowledgement: This work was supported by the Azerbaijan Science Foundation - Grant № AEF-MGC-2024-2(50)-16/12/4-M-12

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IS12

Highly Selective Multilayer Low-E Coatings on Flat Glass

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Abstract: Low emissivity (Low-E) materials exhibit excellent transparency in the visible spectrum and high reflectance in the far-infrared range. This not only fulfills the illumination needs of buildings but also hinders the transmission of far-infrared heat through the treated glass, often quantified as the solar heat gain coefficient (SHGC). There are two types of Low-E glasses, which are distinguished by their manufacturing methods: offline and online. Offline Low-E glass undergoes coating through magnetron sputtering technique, involving silver layers usually integrated within metal oxide, nitride or oxynitride layers. The thickness uniformity for the non-metallic layers in the structure is crucial in order to adjust reflection colors. In this study, ultra-selective Low-E structures were developed and the effects of layer thicknesses on reflection colors were examined. Moreover, reflection color change was modelled using CODE software in the range of +/- 2% thickness fluctuations. This research aims to provide valuable insights into delineating production tolerances for the large-area deposition of highly selective low-e stacks.

IS13

Flexible and Cost-Effective Substrates for Efficient Surface-Enhanced Raman Spectroscopy-Based Trace Detection

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Abstract: The development of low-cost, eco-friendly, ultrasensitive, reproducible, and flexible surface-enhanced Raman scattering (SERS) platforms has attracted significant attention for the on-site detection of SERS analytes.[1–4] Herein, we report a facile, surfactant-free method for directly synthesizing three types of nanostructured plasmonic substrates i.e. silver (Ag), gold (Au), and gold-silver (Au–Ag) alloy on unmodified filter paper. These substrates are fabricated simply by soaking filter paper in respective metal precursor solutions, followed by reduction with sodium borohydride. Our findings demonstrate that both Ag and Au–Ag alloy nanostructured filter paper substrates exhibit remarkable performance. They effectively suppress the inherent fluorescence of the filter paper while simultaneously generating a high density of uniformly distributed plasmonic hotspots. This leads to excellent SERS sensitivity and signal reproducibility. Specifically, the Ag nanostructured filter paper substrate enabled ultrasensitive SERS detection of crystal violet and urea nitrate, utilizing both conventional drop-casting and practical swab-based sample preparation techniques. Furthermore, bimetallic Au-Ag alloy substrate proved highly effective for ultrasensitive swab-based SERS detection of fluorescent molecules, such as Rhodamine 6G under resonance excitation. This platform also facilitated efficient swab-based multiplex detection of Rhodamine 6G, Brilliant Cresyl Blue, and Crystal Violet. Collectively, these filter paper SERS platforms are distinguished by their high reproducibility, inherent flexibility, and scalability. Their rapid fabrication process and compatibility with swab-based analyte collection methods make them exceptionally well-suited for diverse real-world SERS-based trace detection.

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IS14

A structured eraser: sculpting correlations with quantum interference

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Abstract: Quantum interference lies at the heart of many quantum technologies, from computation to communication. In this talk, we demonstrate how combining the spatial structuring of overlapping photons with control over which-way information can realize a quantum eraser that sculpts bi-photon correlations. Using the Hong-Ou-Mandel effect as a foundation, we show that spatially varying the distinguishability of photons enables point-by-point control over interference outcomes. This allows us to locally engineer bunching, anti-bunching, or mixtures thereof across the output ports of a beam-splitter, offering an avenue for tailoring correlations.

IS15

MSM Photodetectors with Different Materials

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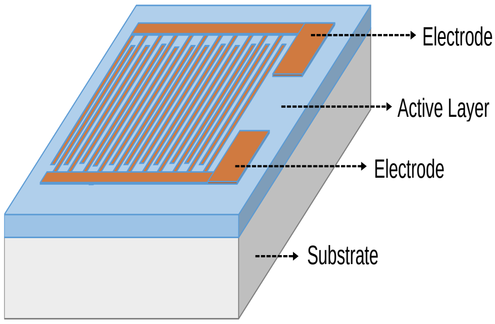
Photodetectors, such as Metal-Semiconductor-Metal (*MSM*) or *p-n* photodiodes, are devices that operate based on the principle of absorbing incident radiation and producing a measurable signal according to its intensity. *MSM* photodetectors, that is one type of photodetectors, essentially consist of two Schottky diodes connected back-to-back. The dual Schottky barriers provide a lower dark current than a single Schottky diode [1].

MSM photodetectors consist of a semiconductor active layer combined with two interdigital Schottky electrodes, as can be seen in the figure. The interdigital electrodes are often designed in the form of a comb structure, with a free semiconductor surface left between the two electrodes to form the active region in which light will be absorbed. While one of the electrodes plays a role in forming the photon flux, the other acts as a collector [2-3].



In this invited talk, MSM photodetectors with different active semiconductor materials are discussed, as developed at the Photonics Application and Research Center at Gazi University. The performance of these devices depends on critical properties such as the structural morphology of the semiconductor material, the mobility and density of charge carriers, their lifetime and diffusion length, responsivity and detectivity, noise equivalent power (NEP) and normalized photo-to-dark ratio (NPDR), and other electrical output parameters of Schottky diodes [4–5].

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IS16

Fabrication and comparative experimental investigation of multi-section diodelasers with different configurations

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IS17

Advances in Optical Coatings: Material and Thin Film Solutions at ASELSAN

HasanHüseyin Güllü
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IS18

Enhanced adsorption and degradationkinetics of methylene blue by Ag–Ag_2S–CdS hybridnanowires

Dr. Lala Rasim Gahramanli
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IS19

Critical Processes in Cooled IR Detector Packaging: Flip Chip Bonding and Underfill

Berkay Uğurlu

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Abstract: Flip chip bonding and underfill operations are critical processes in the manufacturing of cooled infrared (IR) detectors, particularly for III-V semiconductors. These processes directly impact the mechanical stability, thermal performance, and long-term reliability of the detector.

Flip chip bonding enables high-precision connections essential for high-speed and high-sensitivity IR detectors. Self-alignment is a significant phenomenon in achieving micron-level placement accuracy, using the capillary forces of indium bumps. This effect ensures precise alignment without extensive mechanical intervention, reducing assembly time and improving device yield.

Underfill, on the other hand, provides critical mechanical support and thermal stress relief by filling the gap between the ROIC and the focal plane array (FPA). It minimizes the risk of bump cracking and delamination during thermal cycling, enhancing the overall performance of the detector. Proper underfill application, including pre-vacuum preparation and optimized curing profiles, is essential to prevent void formation and ensure long-term performance.

This presentation will cover the fundamentals of these processes, including alignment methods like collimator and optical sensor systems, as well as the challenges associated with indium oxidation, thermal expansion mismatch, and mechanical stress management.

SPEAKERS

S1

Simulation of a rainbow spectrometer for measuring the optical dispersion of fluids

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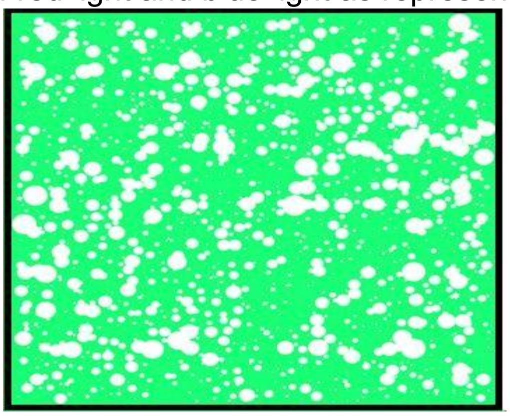
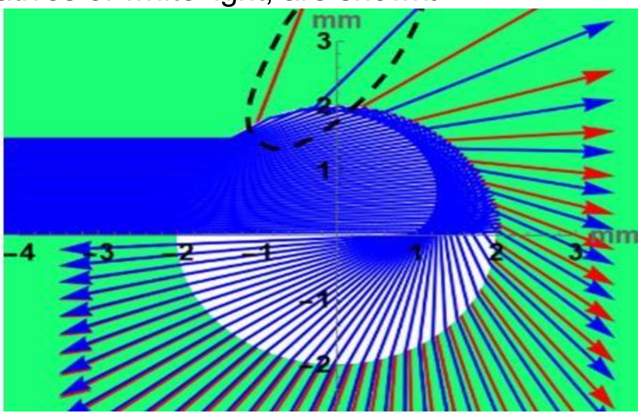
Abstract: One of the prominent characteristics of an optical medium is the refractive index and its wavelength dependency which is called optical dispersion. If experiments and ideas could be designed in this area that could easily and with high accuracy determine the dispersion relation and refractive properties of an optical medium, it would certainly be valuable. One of the well-known and important natural phenomena whose foundation is based on the light dispersion properties is the formation of a rainbow. This eye-catching and vibrant spectrum of colors appears in the sky after atmospheric turbulence and rainfall. Based on this phenomenon, it is possible to design refractometers and dispersion measuring devices. In this paper, we present a new design for dispersion measurement using an 'inverted rain' – which refers to the creation of fine bubbles of water or any other liquid or gas within the liquid of interest. The setup for this experiment is as follows: the liquid of interest is poured into a container, and numerous bubbles are created within it. White light is incident onto these bubbles, and its refraction is simulated. For this purpose, a computer program has been developed by the authors. In the figures below, an image of a liquid with multiple bubbles and an image of the dispersion of white light incident on it, consisting of red light and blue light as representatives of white light, are shown.





As is seen in the figure, we can conclude that, a new method based on the phenomenon of rainbow formation occurring in an inverted rain is presented and validated for designing an experiment to measure optical dispersion.

S2

White-Light Spectroscopy of SPR Sensors Based on Wavelength Scanning

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Abstract: In recent years, optical methods have emerged as powerful tools for developing accurate and non-invasive sensors. Among them, Surface Plasmon Resonance (SPR) has gained considerable attention due to its high sensitivity to minute changes in the refractive index of the surrounding medium. SPR arises from the excitation of surface plasmons (coherent oscillations of free electrons) at the interface between a thin metal film and a dielectric material. This phenomenon enables label-free, real-time sensing at the nanoscale, making it especially attractive for biosensing and chemical detection applications.
In this study, a white-light SPR system was developed using total internal reflection through a cylindrical BK7 prism, enabling both angle and wavelength scanning. Due to its higher sensitivity, the wavelength-scanning mode was primarily employed. A 50-nanometer-thick silver film was coated onto a glass substrate using the sputtering technique, and a 632 nm He-Ne laser was used for calibration. Reflectance spectra were analyzed to determine the spectral position of the resonance peak with high precision. Although no specific analyte was introduced, the system demonstrated the ability to probe the dielectric environment via the complex permittivity (ε), confirming its potential for future sensing applications.

S3

Sputtered Silver-Based Low-Emissivity Coatings

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Abstract: Low-emissivity (low-e) coatings effectively reduce infrared (IR) radiation transfer through windows, which reduces thermal leakage from indoors to the outdoor surroundings. These coatings are transparent to visible light (Transmittance, T = 80–90%) and present high reflectance within the far infrared range reducing the emissivity coefficient, ε, of the glass (approximately 0.84). The typical configuration of a soft low-e coatings is a three-layer dielectric/metal/dielectric (D/M/D; where D corresponds to dielectric layer, M corresponds to metal layer) stack. In this configuration, while the metallic layers reflect both short-wave and long-wave thermal radiation, the dielectric layers may provide antireflective functions in the visible spectrum while at the same time protecting the metallic layers from chemical and mechanical damage.

In this work, the Ag and AZO thin films were deposited from pure Ag and AZO targets, respectively, using RF magnetron sputtering technique. By changing the sputtering power and deposition time, four different Ag thin films with an approximate thickness were deposited. The effects of sputtering power on phase, microstructure, resistivity, optical properties and infrared emissivity of the films were characterized using UV–VIS–NIR spectrophotometery, XRD, SEM, four-point probe and FTIR, respectively. The film thicknesses and sheet resistances of the films were precisely determined simultaneously fitting of the optical transmission and reflectance measurements using Drude-Brendel model. It was observed that the reflectance in visible region as well as the infrared emissivity of Ag films were significantly affected by sputtering power. Ag films deposited at higher plasma power had a higher packing density, exhibited better crystallinity, had a lower resistivity and a lower infrared emissivity. This work proves that adjusting sputtering power is an efficient way to tune the infrared reflection and emissivity of the Ag films.

The low-e performance of the coating prepared in the present study is superior compared to those of the studies in the literature due to its both higher visible transmission (78.7%) and far infrared reflection (98%). The results also indicate that AZO/Ag/AZO structure with a high FoM (93.1) value prepared by sequential growth of the each layer using magnetron sputtering technique is a potential candidate to be used as TCEs.

S4

Scattering-Based Optical Assessment of Microplastics in Consumer Beverages

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Abstract: Microplastics originating from primary sources such as personal care products and secondary sources such as plastic fragmentation have become a pressing environmental concern [1]. Various studies have found them in food essentials like salt, meat, and water, and alarmingly in babies' diapers, mothers' placentas [2]. While critical exposure limits remain unknown, early detection tools are being developed to help prevent long-term health and environmental risks [3, 4].

In the presented study, a portable and cost-effective device based on the Mie scattering principle is employed to detect microplastics in packaged beverages. Samples were prepared with 8μm polystyrene (PS8) particles in water, including both PS8-containing and PS8-free beverage specimens. Scattering patterns were observed for each sample, and the experiment was repeated with two beverages and three different laser sources operating at 405nm, 514nm, and 650nm in a dark environment. Cloud-like scattering patterns were observed in PS8-free samples, likely due to the randomly sized dissolved particles, whereas samples containing PS8 produced distinct interference patterns that could be characterized by Mie resonance ring angles.

The results demonstrate the feasibility of using the Mie scattering setup as a detection method for microplastics in liquid media. The approach also enables analysis of refractive index, contributing to the characterization of the sample under study. Incorporating machine learning algorithms can further improve the accuracy of detection.

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S5

Investigation of aerosol types in Zanjan city using sun-photometer Data

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Abstract: This study investigates atmospheric aerosols over the city of Zanjan using data obtained from a ground-based sunphotometer installed in the region. Temporal variations and different types of aerosols are analyzed based on parameters derived from the sunphotometer measurements. Aerosol Optical Depth (AOD), which indicates the concentration of atmospheric particles, was measured at four wavelengths: 440, 670, 870, and 1020 nm. The Ångström exponent, which reflects the particle size distribution, was calculated by comparing AOD values at 440 and 870 nm. The results show that the presence of coarse particles—mainly due to dust transport from external sources, particularly Iraq—leads to a significant increase in AOD over Zanjan. Additionally, spectral data were used to calculate the single scattering albedo, a parameter representing the absorption characteristics of aerosols, and the particle linear depolarization ratio, to classify aerosol types during the measurement period. The analysis reveals that on approximately 30% of the days, the atmosphere over Zanjan was dominated by pure or mostly dusty conditions. On another 30% of the days, dust was present, but urbanindustrial aerosols were dominant. During the remaining days, only urban-industrial aerosols were observed in the atmosphere.

S6

Measurement and Investigation of Optical Properties of Aerosol Particles in the Shadegan Wetland Atmosphere

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Abstract: This Aerosols, which are solid or liquid particles suspended in the air, significantly influence human health, climate, precipitation, and visibility. In this study, measurements conducted using a Calitoo sun-photometer in the Shadegan region of Khuzestan Province are presented. Two key parameters were continuously recorded over an 18-month period from March 2023 to September 2024: the Aerosol Optical Thickness (AOT) at three wavelengths (465, 540, and 619 nm) and the Angstrom Exponent (AE) calculated over the wavelength interval of 465–619 nm. The results indicate that the average AOT values at 465, 540, and 619 nm were 0.35, 0.30, and 0.29, respectively, while the average AE over the studied wavelength interval was 0.71. An AE versus AOT analysis suggests that in most cases, the aerosols in the Shadegan Wetland atmosphere were predominantly composed of dust and mixed-type pollutants (accounting for 51.2%), with industrial-urban pollutants contributing a significant proportion (48.8%). These findings can be applied in air quality modeling and in monitoring climatic variations in the region.

S7

Fabrication of Low-Cost Liquid Crystal-Based Adjustable Wave-Plates

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Abstract: Liquid crystals represent a mesophase between solid crystals and isotropic liquids, sharing characteristics of both. Due to their asymmetric molecular structure, liquid crystal molecules are uniaxial and exhibit birefringence [1]. Therefore, liquid crystals can be utilized for fabrication of variable wave plates for controlling the polarization state of the transmitted light [2]. Nevertheless, currently available commercial adjustable retarders are of high cost. In this article, we report on the fabrication of low-cost liquid crystal-based variable retarders and examine the performance of the fabricated tunable retarder functioning as a quarter-wave and half-wave plate (QWP, and HWP, respectively) at two wavelengths, 633 nm and 532 nm, by applying an alternating low-frequency electric field to the liquid crystal cell. We designed and fabricated a liquid crystal cell as a tunable wave plate. The structure of the liquid crystal cell is schematically represented in Fig. 1(a). We experimentally measured the induced phase difference between the normal polarization modes of the incident field as a function of the frequency and the strength of the applied external alternating field. Finally, we evaluated the performance of the fabricated cell using a polarizer to measure the polarization rotation when used as a half-wave or quarter-wave plate. In Fig. 1(b), it is shown that the fabricated adjustable retarder can indeed operate as a quarter-wave plate for both incident wavelengths. Additionally, in Fig. 1(c) it is shown that by adjusting the strength of the applied alternating field the system functions as a half-waveplate for each of the incident wavelengths.

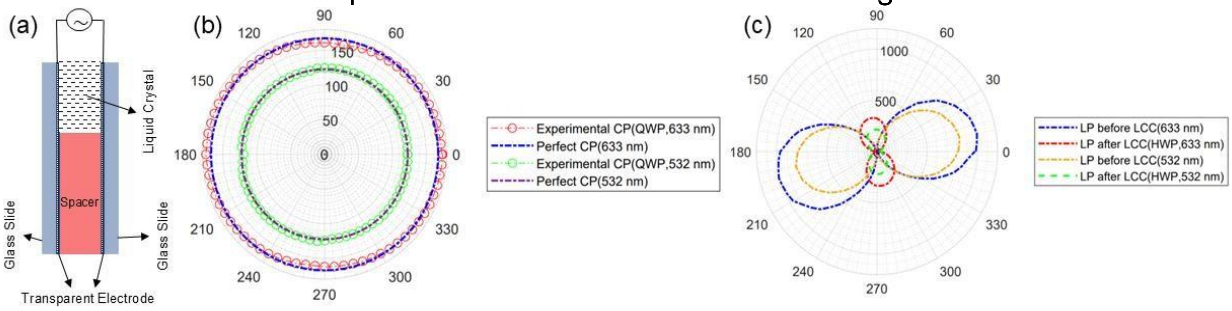

Fig 1. (a) Schematic representation of the structure of the liquid crystal cell. (b) and (c) operation of the liquid crystal cell as QWP and HWP, respectively, at two incident wavelengths of 633 nm and 532 nm.

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S8

Identification of Salt-Dust Plumes Over the Urmia Lake Using a Scanning Polarization Lidar

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Abstract: Since 1995, Urmia Lake has been experiencing a continuous decline in water level. Along with the sharp reduction in volume and surface area, its dried bed has turned into salt marshes, and this shallow and saline lake is now at risk of complete desiccation. The lakebed and the surrounding regions have the potential to generate aerosols, including dust, salt, or a mixture of both. On-site monitoring of atmospheric particles over Urmia Lake began in September 2018 using the IASBS Scanning Polarization Lidar (ISPL), located on the lake's southwestern coast. ISPL observations indicate that the most probable period for salt-dust particle presence in the atmosphere occurs during the summer months. The lake's atmosphere is influenced by nearby dust sources throughout the year. However, during the colder winter months, the atmospheric temperature inversion increases the influence of urban and industrial pollution. In September 2022, atmospheric scans near the lake's surface were conducted using the ISPL to identify aerosols originating from Urmia Lake. The lidar system scanned the atmosphere horizontally up to a range of 30 kilometers above the lake's surface, from sunset to sunrise. During a 14-night measurement, 120 scans were performed, and 40 aerosol plumes above the lakebed were detected and identified. Sequential scans revealed that these plumes moved rapidly, either returning to the surface or moving beyond the lidar's detection range. Examination of optical properties, such as the particle depolarization ratio, indicates the presence of dust particles, dry salt, wet salt, or their mixtures. In salt-dominated plumes, wet salt particles are typically surrounded by dry salt particles. Furthermore, changes in the depolarization ratio with increasing distance from the dense center of the plume indicate variations in particle type. Statistical analysis of such variations reveals that the plumes contain varying concentrations of dust and salt in both wet and dry forms.

S9

Harnessing Quantum Correlations for Subwavelength Imaging

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Abstract: Recent advances in quantum optics and imaging have demonstrated that superresolution and superradiant emission—phenomena once thought to require entangled or highly correlated quantum states—can also be achieved through the interplay of quantum interference, higher-order photon correlations, and near-field effects. Theoretical and experimental studies reveal that directional, enhanced emission, characteristic of Dicke superradiance, can arise not only from entangled symmetric W states but also from statistically independent or incoherent sources, provided that the detection scheme projects the system into collective states via multiphoton interference. This unifying perspective shows that superradiance and the Hanbury Brown–Twiss effect are fundamentally linked through quantum path indistinguishability and interference, with the measurement process itself playing a crucial role in generating collective emission properties.

Building on these insights, this research presents novel approaches to optical superresolution by combining quantum interference with near-field optics. By utilizing single-photon quantum emitters in close proximity to subwavelength structures, it is possible to exploit both the evanescent field and higher-order quantum correlations, achieving spatial resolutions that surpass the classical Rayleigh and Abbe limits. Theoretical models and numerical simulations confirm that increasing the number of emitters and the order of correlation measurements further enhances resolution, with practical implementations feasible using quantum dots, dye molecules, or other nanoscale emitters. The hybridization of quantum and near-field effects enables superresolution imaging in the far field, eliminating the need for scanning-type detectors or entangled photon sources.

Collectively, these results establish a new paradigm in quantum optical imaging and emission control, where both entangled and independent sources can be harnessed for directional, superresolved, and highly coherent light emission. The interplay of quantum multipath interference, state projection, and near-field effects opens pathways for advanced imaging technologies and a deeper understanding of collective light-matter interactions at the nanoscale. Furthermore, the experimental demonstration that even classical, statistically independent sources can exhibit superradiant-like emission through higher-order correlation measurements underscores the universality of these interference phenomena, bridging the gap between classical and quantum regimes and suggesting new directions for the development of quantum-enhanced optical systems.

S10

Simulation of Interference Pattern Formed by Light Scattering from a Plasmonic Nanoparticle and a Dielectric Nanoparticle

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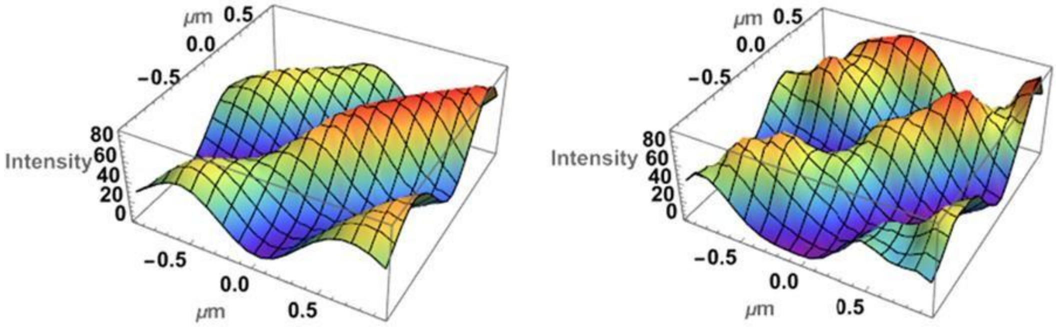
Abstract: In this paper, simulation of the interference of light scattering caused by two nanoparticles with different materials, one plasmonic and the other dielectric, is addressed. The goal of this simulation is to examine the precise effect of the detector in recording interference patterns. To this end, a computer code is developed by the authors in Mathematica. The simulation is carried out in two different modes:

1. **Passive Detector**: In this mode, the detector acts as a passive element and has no effect on the light scattered from the nanoparticles.
2. **Active Detector**: In this mode, the detector is considered as an active element and can influence the scattering fields of the nanoparticles. Additionally, the detector itself may also interact internally and, hence, has effects on the final interference pattern.

The figure presented below shows a comparison between the interference patterns obtained in the two modes. As is seen in the right figure (in comparison with the left one), the activity of the detector has a significant impact on the interference pattern.



More calculations reveal that if the activity of the detector exceeds a critical value, the interference pattern is severely distorted. In contrast, if the detector's effect is below the critical value, no significant impact on the interference is observed.

Conclusion: This research demonstrates that in the simulation of interference (and also holography) phenomena caused by nanoparticles, considering the role of the detector and its effect on the radiation field can significantly alter the results. Determining the critical value of the detector's effect and understanding the physical mechanisms governing it are among the key aspects in the design and optimization of nanoparticle-based interference and holography systems.

S11

Optical Properties of $Ga_{0.99}B_{0.01}Se$ Thin Films for Photodetector Applications

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Abstract: Gallium selenide (GaSe), a layered crystal with promising optical properties, has attracted significant interest for terahertz-frequency laser applications [1,2]. However, weak van der Waals forces between the layers can lead to the formation of uncontrolled defects, which significantly degrade the optical and electrical properties of the material [3]. To address this challenge, Ga atoms were partially substituted with boron to form $Ga_{1-x}B_xSe$ (x = 0.01) solid solutions synthesized via the melting method, and single crystals were subsequently grown using the Bridgman technique.

In this study, $Ga_{0.99}B_{0.01}Se$ thin films were deposited on glass substrates by vacuum thermal evaporation, and their optical properties were characterized using UV–Vis spectroscopy. The absorption coefficient as a function of photon energy was calculated from the recorded spectra, indicating a high absorption level and a direct optical transition. The optical band gap, determined via the Tauc method, was found to be 1.92 eV, consistent with previously reported values for $Ga_{0.99}B_{0.01}Se$ single crystals. These findings demonstrate the potential of this material for use in photodetector applications.

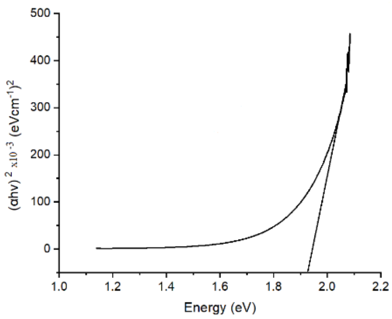

Fig.1. $(\alpha h\upsilon)^2$ versus $h\upsilon$ curves for $Ga_{0.99}B_{0.01}Se$ thin films.

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S12

Development of ClAlPc-Loaded BSA Nanoparticles for Dual Action Against Cancer via Photodynamic and Sonodynamic Mechanisms

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Abstract: Photodynamic therapy is a method most commonly used in cancer treatment.[1] However, as it has certain limitations too, when used along with a second method such as sonodynamic therapy, both the side effects of photodynamic therapy are reduced and a synergistic effect results when photodynamic and sonodynamic therapy are used together. ClAlPc (Chloraaluminum phtalocyanine) is not only an effective photosensitizer but also a sonosensitizer. However, due to its poor water solubility, it is not possible to use it directly in aqueous biological environments where there is abundance of water. Bovine serum albumin (BSA) nanoparticles are biopolymer-based nanocarriers possessing water solubility and biocompatibility. Moreover, the ClAlPc-loaded BSA nanoparticles were not morphologically distinct from their unloaded counterparts. It was also demonstrated that ClAlPc-BSA nanoparticles exhibited photodynamic and sonodynamic activities. In this paper, the entrainment of ClAlPc molecules into BSA nanoparticles effectively addressed the issue of water-insoluble ClAlPc. Consequently, water-soluble nanoparticles, which were also biocompatible and could confer both photodynamic and sonodynamic activities within a single system, were thereby prepared, thus providing a 'one-for-two' solution.

S13

Calibrating Nanometer Displacement with Fresnel Diffraction from Phase Step

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Abstract: In this study, we present a cost-effective and precise method for measuring millimeter-scale displacements with nanometric accuracy using Fresnel diffraction from a phase step. In this approach, light serves as the measurement reference. When semicoherent light encounters the edge of a transparent object, it undergoes an abrupt phase change, leading to diffraction. To implement this, two ultra-thin mirrors were arranged with partial overlap, forming a controllable phase step. By adjusting the separation between the mirrors, the height of the phase step (h) can be precisely varied. A laser beam is directed onto the overlapping region, where it experiences diffraction due to the height difference [Figure 1]. The resulting diffraction intensity patterns are recorded by a CMOS camera. This fringe-based analysis allows for the estimation of nanometric displacements by correlating fringe behavior with changes in phase step height. By analyzing the lateral shifts and modulation of the diffraction fringes, the relative displacement between the mirrors can be accurately quantified. This simple and robust setup can be utilized for calibrating piezoelectric transducers, atomic force microscopes (AFMs), and optical tweezers.

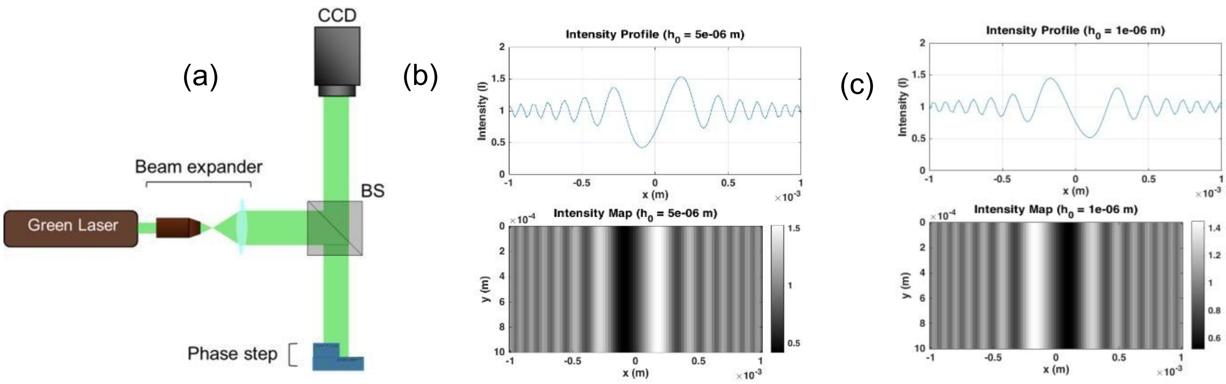

Fig. 1. (a) A schematic illustration of the experimental setup is shown. In this setup, the laser beam is first expanded using a beam expander and then directed toward the phase step. The resulting diffraction pattern is recorded by a CMOS camera. (b)(c) These images show the change in the diffraction pattern as the height of the phase step increases from 1×10^{-6} meters to 5×10^{-6} meters. As the height increases, a noticeable shift in the diffraction fringes occurs, demonstrating the high sensitivity of this method to extremely small displacement variations. By analyzing these fringe shifts, the relative displacement between the two mirrors can be quantitatively measured with nanometer-scale accuracy.

S14

Fabrication of SnS Solar Cells in Core–Shell Architecture Based on ZnO Nanorods

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Abstract: This study reports the successful deposition of SnS thin films onto glass substrates through single-source thermal evaporation utilizing sintered SnS powder. Comprehensive characterization of the as deposited and annealed films was conducted to examine their optical, structural, morphological, and electrical properties. The analysis confirmed the formation of single-phase SnS films exhibiting an orthorhombic (Pnma) crystal structure with no detectable secondary phases. The optical band gap and electrical resistivity were determined to be 1.33 eV and 770 Ω·cm, respectively, while the average crystallite size was calculated to be approximately 15.6 nm.

The optimized SnS thin films were subsequently employed as absorber layers in solar cells. Vertically well-aligned n-type ZnO nanorods (NRs) were first grown on ITO-coated glass substrates via a hydrothermal method. Morphological characterization revealed nanorod diameters between 70 and 100 nm and lengths ranging from 400 to 600 nm. A CdS buffer layer was then conformally deposited on the ZnO NRs using the chemical bath deposition technique. Following this, the SnS absorber layer was thermally evaporated, and silver (Ag) contacts, 1 mm in diameter and 100–150 nm in thickness, were applied to complete the device structure.

The resulting core–shell architecture, consisting of a Glass/ITO/ZnO-NRs/CdS/SnS/Ag configuration, was tested under standard AM 1.5G illumination (100 mW/cm²). The constructed solar cell exhibited an open-circuit voltage (V_{oc}) of 0.38 V, a short-circuit current density (J_{sc}) of 18.3 mA/cm², a fill-factor (FF) of 19%, and a power conversion efficiency (PCE) of 1.32%. This represents the highest PCE reported thus far for core– shell structured ITO/ZnO-NRs/CdS/SnS/Ag solar cells. These results highlight the potential of ZnO/CdS/SnS-based core–shell solar cells as promising candidates for lowcost, environmentally benign, and scalable photovoltaic technologies.

S15

The interplay between a bacterial ratchet motor and optical speckle fields

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Abstract: Microscopic asymmetric ratchets can rotate in active baths due to the energy transferred from the active particles. For example, 50 μm diameter micro-ratchets immersed in an E. coli bacterial bath have been observed to rotate at speeds of up to one cycle per minute. E. coli is a bacterium that propels itself forward by rotating its flagella in the counterclockwise direction. The collective behavior of an ensemble of such randomly moving active particles induces the rotation of the micro-device, a mechanism known as a bacterial ratchet motor.
In this research, we introduce another random phenomenon. The random intensity distribution of speckle patterns comprises several bright grains surrounded by a network of dark regions, creating subtle intensity gradients throughout the field. Consequently, microscopic particles within such fields can be influenced by the trapping forces associated with these intensity gradients and be briefly trapped within the grains. This phenomenon is termed speckle tweezers. We demonstrate that bacterial ratchet motors, when subjected to speckle tweezers, exhibit different rotational behaviors due to the additional presence of light-driven statistical randomness. We use a hanging droplet arrangement to confine the ratchets to the water-air interface at the bottom of the droplet. The speckle tweezers indirectly influence the ratchets by affecting the local movements of the bacterial bath.

S16

Analytic Design of Dual-Wavelength Diffractive Optical Elements for Mid-Wave Infrared

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Abstract: Cascaded Diffractive Optical Elements (DOEs) offer a promising solution to the wavelength sensitivity limitations of single-layer designs. In this work, we present an analytically designed dual-wavelength cascaded grating that operates with high first-order diffraction efficiency at 3.7 μm and 4.7 μm in the mid-wave infrared (MWIR). Using complementary dispersion properties of sapphire and germanium, we construct a structure that ensures a combined 2π phase shift at both wavelengths. Material combinations are evaluated using a determinant-based metric to minimize total thickness for manufacturability. Simulations confirm efficiency above 99.8% in the first diffraction order across the MWIR band. Additionally, we investigate the impact of lateral misalignment and angular incidence on efficiency, identifying practical assembly tolerances. Compared to single-layer implementations, our cascaded approach provides superior broadband performance while remaining feasible for fabrication using diamond turning and wafer bonding. This method presents a compact and high-efficiency alternative for MWIR imaging systems.

Keywords: Cascaded Diffractive Optics, Mid-Wave Infrared (MWIR), Dual-Wavelength Design, Material Selection, Assembly Tolerance"

S17

Photovoltaic Performance Analysis of Perovskite CsSiF3 Compound

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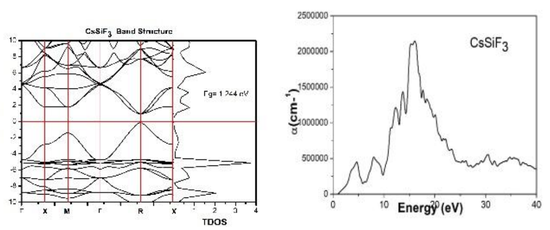
Abstract: The growing demand for sustainable energy solutions has increased interest in environmentally friendly and stable perovskite solar cells (PSCs). Perovskite solar cells (PSCs) are emerging photovoltaic technology that has attracted significant attention due to their high power conversion efficiencies (PCEs) and low-cost fabrication methods. In this study, we propose a novel silicon-based perovskite absorber material, $CsSiF_3$, and investigate its integration within the solar cell architecture FTO/ $Cd_{0.5}Zn_{0.5}S$ / $CsSiF_3$/ MoO_3/ Au. The impact of the absorber, electron transport layers (ETL), and hole transport layers (HTL) on device performance was systematically analyzed using SCAPS-1D simulation software. The ETL and HTL layers significantly influenced charge transport and recombination dynamics [1]. To further understand the role of the $CsSiF_3$ absorber, first-principles calculations were performed within the framework of density functional theory (DFT). The band structure revealed a direct bandgap of approximately 1.244 eV, which is optimal for solar energy absorption. The total density of states (TDOS) and charge density difference plots indicated that silicon atoms are critical in charge distribution and photon interaction processes. The optical absorption spectrum derived from DFT was also used to construct an ABS file for SCAPS simulations. This integration allowed a realistic representation of light-matter interaction in the absorber layer, improving the accuracy of simulated efficiency outcomes [2]. Following extensive parameter optimization, the simulated device achieved a PCE of 23.8%, with an open-circuit voltage (V_{oc}) of 0.83 V, a short-circuit current density (Jsc) of 3.15 mA/cm², and a fill factor (FF) of 86.3%. These findings position $CsSiF_3$ as a promising candidate for next-generation, lead-free perovskite solar cells.



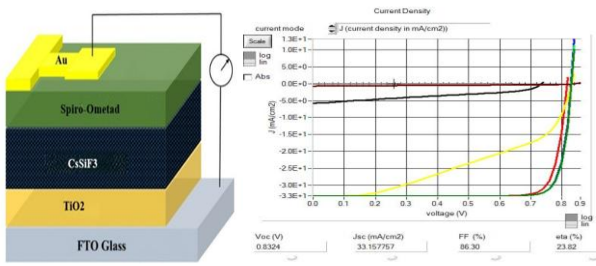


Fig. 1. Band graph and absorption graphs of $CsSiF_3$. **Fig. 2**. Device structure and J-V curves.

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S18

Real-Time Surface Roughness Measurement Using Dual-Illumination Interferometric Microscopy

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Abstract: Surface roughness measurement is essential in various industries, and interferometric microscopy is a well-established technique for achieving high precision. However, traditional methods often depend on costly piezoelectric actuators and are sensitive to environmental factors, limiting their practicality for broader applications. Developing simpler and more affordable techniques without compromising accuracy is crucial for expanding the use of surface metrology in fields like microelectronics, biomedical engineering, and micro-machining. This work presents a new approach combining coherent and incoherent light sources with a color camera for real-time surface roughness measurement. Coherent fringes are used to track displacement, while localized incoherent fringes serve as an optical probe for identifying surface features. By analyzing the fringe behavior during sample movement, we achieve nanometer-level precision without the need for expensive displacement systems. In the figure below you can see one-, two-, and three-dimensional views of the measured sample. A step height of 4.4 μm was measured between the upper and lower surfaces of the sample. The results demonstrate the method's effectiveness. This cost-effective proposed method has the potential for reliable measurement across diverse surface types.

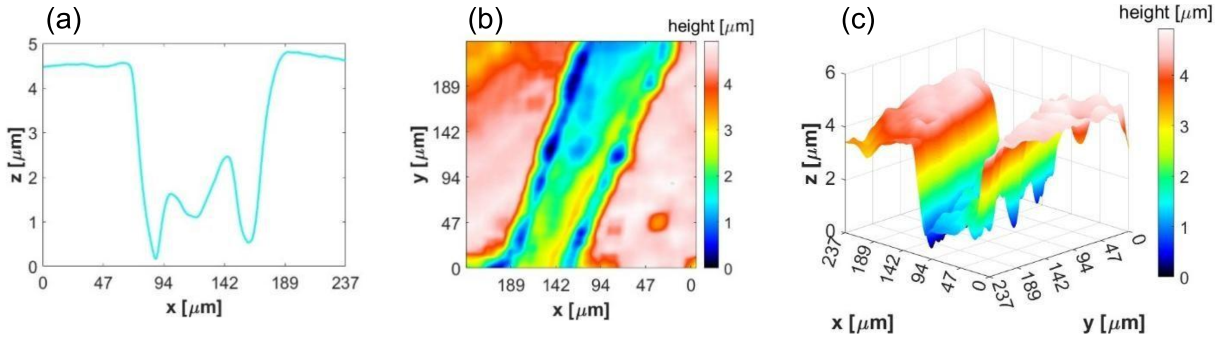

Fig.1. (a) one-, (b) two-, and (c) three-dimensional views of the measured sample. The step height between the upper and lower surfaces of the sample was determined to be 4.4 μm.

S19

ANALYSIS OF DISLOCATION DENSITY FOR ALGAN BASED HEMTS IN SCREW MOD

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Abstract: In design of optoelectronic cards quick response is an important feature. For this reason in this study structural properties of GaN/AlN/AlGaN HEMTs grown by metal organic chemical vapor deposition (MOCVD) technique are investigated by using high resolution X-ray diffraction (HRXRD). The main property of these kind of materials is they are resistant to high voltage, temperature and pressure. Although their performance is worse than silicon, for they are forcing limit standards, they are a wide research field. In this study the investigated thing is dislocation density stemming from lattice mismatch between layers and wafer causing cracks on the surface. In HEMT structure calculation of dislocation density for GaN and AlN represents all structure. High dislocation density for AlN layer is determined because of aggressive behaviour of Al element in structure. Also it is seen that, quantized GaN layers stop moving of dislocations and prevents surface cracks.

S20

Hyperspectral Imaging of plastics Combined with Acoustic Trapping

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Abstract: Hyperspectral (HS) imaging combines imaging and spectroscopy to create spatially resolved spectral maps. A key challenge in HS imaging is minimizing background interference while securely immobilizing samples. Here, we present acoustic trapping (AT) as a non-contact, nondestructive, and straightforward method for stabilizing particles—up to several millimeters—for HS analysis. We demonstrate the effectiveness of the integrated HS-AT setup in identifying various plastic types, which are major environmental pollutants. Fluorescent HS imaging captures distinct spectral signatures from acoustically trapped plastics. Additionally, acoustic manipulation enables rotational control, facilitating tomographic spatio-spectral analysis of complex plastic mixtures. This compact, combined system holds promise as a practical benchtop tool for plastic identification.

S21

The effect of cation-anion ratio on the optical properties of CdS nanostructures

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Abstract: Cadmium sulfide (CdS) is a II–VI semiconductor compound characterized by its wide band gap (2.4–4 eV), low absorption loss, compact crystallographic structure, and suitable electron affinity. These properties make CdS a promising material for various optoelectronic applications, including solar cells, photodiodes, light-emitting diodes (LEDs), nonlinear integrated optical devices, laser heterostructures for visible spectrum emission, field-effect transistors, and many others in the semiconductor industry. A variety of synthesis methods have been used to produce CdS nanoparticles, such as electrochemical synthesis, chemical bath deposition, pulsed laser deposition, spray pyrolysis, SILAR, and the sonochemical method. In the presented study, CdS nanoparticles are synthesized by the sonochemical method with various cation-anion ratios (Cd:S). To determine the effect of cation-anion ratio on the optical properties of CdS, Ultraviolet-Visible spectroscopy was used, using the Tauc relation, direct and indirect band gap values for each sample have been determined and demonstrated in Fig.1.

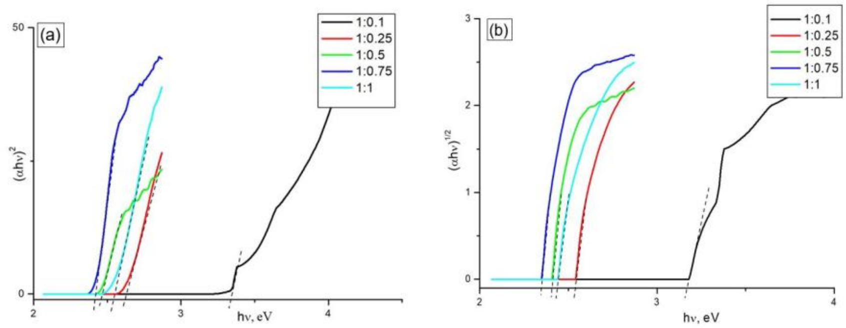

Fig. 1. Direct (a) and indirect (b) band gap values for CdS nanoparticles.

The purpose of UV-Vis. analysis is to indicate that sulfur content necessarily changes the electronic properties of the material, resulting in systematic variations in the direct and indirect band gap values and absorption. When the Sulfur content increases from 1:0.1 to 1:0.75, the direct and indirect bandgap values successfully reduce based on the improve crystallization of the material, in this case band gap tends to the bulk value of CdS (about 2.4 eV) due to the loss of the quantum size effect and when there is lower sulfur content (1:0.1- 1:0.25) the more energy is required for electron transitions between valence and conduction band resulting and increased band gap value. At the identical stoichiometric proportions of CdS, both direct and indirect band gap energies increase because of the stable phase, making it less defect structure.

S22

Energies and wave-functions of an anharmonic quantum oscillator bound in an infinite-wall quantum well found by finite difference algorithm for use in nonlinear optics

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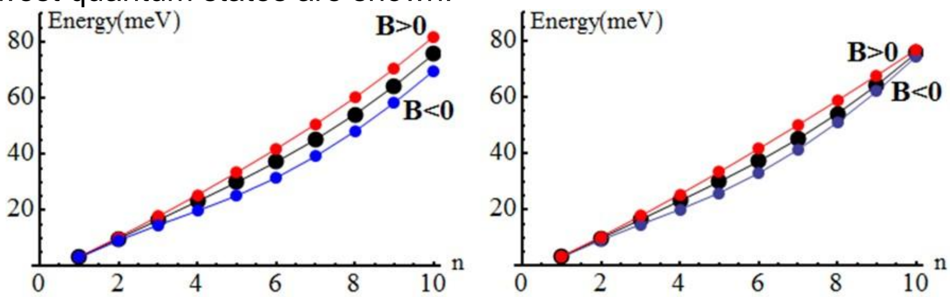
Abstract: In quantum physics, two highly important problems are the "particle in an infinite potential well" and the "simple harmonic oscillator." These are of such importance that solving them provides deep introduction with fundamental quantum concepts, including the wave function, energy quantization, applying boundary conditions, and even operational concepts . Each of these two problems, in a way, serves as a simplified model for understanding atomic and molecular structures. Many electronic and optical features of atoms and molecules can be interpreted using these two basic quantum examples. The development of new quantum concepts (such as collisional forces, quantum statistics, and others) can also be readily understood using these two simple quantum models. In the present paper, an anharmonic quantum oscillator is placed within an infinite-wall quantum well and its governing Schrodinger equation is solved using a finite difference algorithm in a home-made Mathematica code. The governing potential is as follows:

$$v(x) = \begin{cases} \infty & |x| > \frac{L}{2} \\ \frac{1}{2}m\omega^2x^2 + Bx^4 & |x| \le \frac{L}{2} \end{cases}$$

where ‘B’ is anharmonicity coefficient. In the following figure, the energies of oscillator for 10 lowest quantum states are shown:



From the figure, the effect of potential anharmonicity and deviation from ladder-energy behavior of a simple harmonic oscillator is completely evident. By controlling width of the potential well, one can, mitigate the anharmonicity effects in an arbitrary state and retrieve the simple harmonic oscillator energies and wavefunctions (as seen in the right figure). The conclusion is that by engineering the well geometry, the behavior of a bound nonharmonic oscillator can be brought closer to that of a bound harmonic oscillator.

S23

Scattering of light from $\chi^{(2)}$ active sphere and simulation of angular distribution of second harmonic

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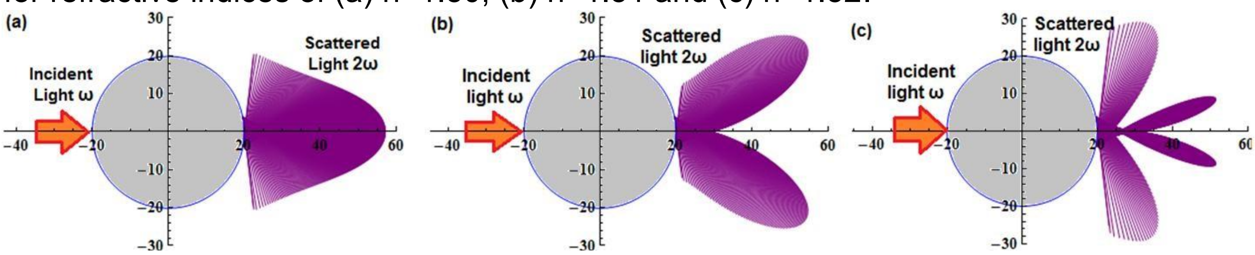
Abstract: Nonlinear optics is an important branch of optics that contributes to the generation of new frequencies. With nonlinear optics, processes such as second harmonic generation, sum-frequency generation and others can be implemented. In most models presented for nonlinear optics, a simple one-dimensional geometry is used. While this simple model captures the main concepts, it often does not provide detailed answers to more specific aspects of the process. For example, the formulation and details of second harmonic generation in a nonlinear medium with a spherical geometry are rarely discussed in the literature. In this paper, we extend the existing nonlinear optics formulations by generalizing the light scattering geometry from a flat one-dimensional model to a spherical one, and we investigate the results through simulations using a code written by us. This code operates based on one-dimensional formulation within the framework of geometric optics. In this simulation, a monochromatic light beam is incident on a $\chi^{(2)}$ active nonlinear spherical medium with known optical properties. According to the geometric optics, the light refracts within the sphere and eventually exits it. Depending on the path length traveled by each ray inside the sphere, the generated second harmonic is computed using one-dimensional models. Finally, the angular distribution of the output light at the second harmonic frequency is calculated. The results show that this angular distribution is highly sensitive to the dispersion of the medium and refractive index at the second harmonic frequency. The figure below presents the intensity distribution of the second harmonic for refractive indices of (a) n=1.50, (b) n=1.51 and (c) n=1.52.



It is evident from the above figure that light scattering from the nonlinear medium exhibits a highly refractive index-sensitive angular distribution. Similar to a diffraction grating, the incident light is scattered to a number of branches with doubled frequency. Such a behavior is of great interest and can have many applications in the optics and photonics such as new ideas for beam splitters and interferometry.

S24

Resonance and slow-light techniques for energy confinement in Fabry-Perot cavity designs

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Abstract: This study addresses ultra-compact and ultra-high quality factor waveguide cavities designed by artificial intelligence. All high quality factor cavitation designs naturally include a slow wave light mode that is a linear combination of another fundamental propagation modes. In this manner, initially genetic algorithm was used as the main optimization methodology and waveguides capable of achieving slow light have been considered. Later on, a regression based model was trained by a dataset consisting randomized simulation parameters of the hole radii on dielectric (or dielectric rod radii on air background), positions, and numbers with corresponding quality factors. Resonance modes were also examined with a modeling program package utilizing finite difference method in time domain and comparisons were made with frequency domain. The quality factor values above 10^6 were obtained for both transverse magnetic and transverse electric polarization modes. This outcome will facilitate the identification of essential subcomponents for various devices, including electromagnetic and optical logic circuits, as well as sensor structures.

S25

On the current-voltage characteristics of the Ag/(NiO:rGO)/n-Si (MIS) Schottky barrier diodes (SBDs) in dark and 100mW/cm^2 conditions

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Abstract: In this work, Au/n-Si (MS) Schottky barrier diodes (SPDs) with Nicle Oxide (NiO:rGO) nanocomposite interlayer were fabricated. Then their main electrical parameters and conduction-mechanisms were investigated in the dark and under 100mW/cm^2 illumination intensity by utilizing forward and reverse bias current-voltage (I-V) characteristics in the voltage range of ±3V at room temperature. The semilogarithmic I-V plot has a distinctive linear behavior in the intermediate bias voltage and then deviates from linearity for higher bias voltages because of series resistance (Rs) and interlayer. The density of interface-traps (Dit) and Rs values were also obtained from the Card-Rhoderick and Ohm's law, depending on the applied bias voltage before and after illumination. The photosensitivity (S), photoresponsivity (R), and photo selectivity (D*) versus voltage were also obtained under 100mW/cm^2 conditions. Some basic electronic parameters like ideality/ factor (n), leakage current (I_0), barrier-height (BH), Rs and shunt resistance (R_{sh}) were calculated. The high value of n was attributed to the existence of interlayer, interface traps, and barrier inhomogeneities. All these parameters were found strong function of illumination and bias voltage. Experimental findings that the fabricated Ag/(NiO:rGO)/n-Si (MIS) SD can be used in photonic and sensor applications instead of traditional metal/semiconductor (MS) SD.

S26

Simulation of x-ray diffraction from titanium quantum dots

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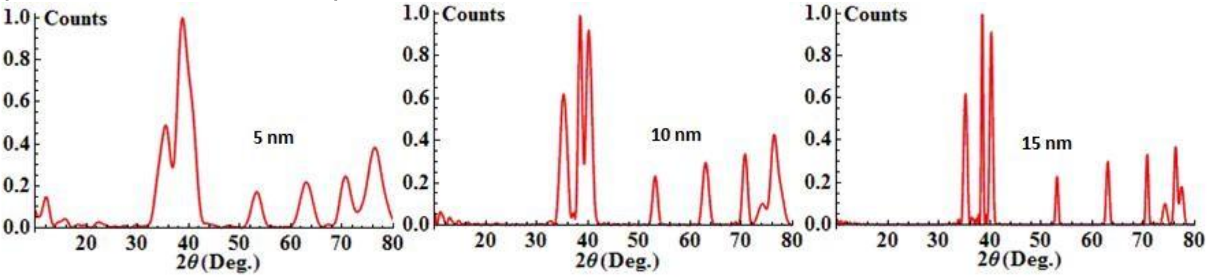
Abstract: Metallic nanoparticles, especially transition metals, have outstanding optical, electrical, magnetic and chemical properties. Synthesis of metallic nanoparticles and their experimental investigation is not an easy work and hence, simulation studies to estimate their properties can be very important. In the present work, x-ray powder diffraction pattern (XRD) of titanium metallic quantum dots with hexagonal crystal structure is computationally simulated. There are two identified crystal structure for titanium metal: one with body centered cubic (BCC) structure and the other with hexagonal closed packed (hcp) structure. At the ambient normal conditions of pressure and temperature, the hcp structure is more stable than BCC one. For this trigonal symmetry the lattice constants are a=b=2.95Å and c=4.68Å. Each primitive unit cell includes two titanium atoms with coordinates $Ti_1 = (0,0,0)$ and $Ti_2 = \left(\frac{a}{\sqrt{3}}\mathrm{Cos}(30), \frac{a}{\sqrt{3}}\mathrm{Sin}(30), \frac{c}{2}\right)$. To simulate x-ray diffraction of Ti nanoparticles, a computer code is developed by the authors. In the home-made computer code, the original formulation of light diffraction is used which is very more general than the Bragg diffraction formulation. In the following figure the simulation results are presented for titanium quantum dots with different sizes of 5 nm, 10 nm and 15 nm:



The simulated XRD peaks are overall consistent with the standard JCPDS=01-1198 card belonging to p63/mmc space group with number 194. It is evident that the peaks have some broadening which originates from the small sizes of the particles due to deviation from perfect crystalline structure. The results of the simulation (seen in above figure) say that for quantum dots with sizes larger than 15 nanometers, the pattern has no notable differences (expect for peak heights) with the bulk crystal; but, for sizes smaller than 10 nm, the pattern shape and especially the peaks width strongly will depend on the nanoparticle size. The results of the paper can be used in the nanotechnology of metals for promising and emerging photonic areas such as metamaterial structures and photonic crystals. Development of the code to yield more physical information is in progress.

S27

ELECTRIC AND ELECTRO-OPTIC RESPONSES OF A SCHOTTKY DIODE WITH Si-(Gd_2O_3)/POLYMER STRUCTURE

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Abstract: The main goal of this research is to create metal-semiconductor (MS) type Au/n-Si and metal-polymer-semiconductor (MPS) type Au/PVA:Gd_2O_3/n-Si Schottky barrier diodes (SBDs) on the same n-Si wafer under the same conditions to evaluate if the (PVA:Gd_2O_3) organic interlayer improves the performance of the MS SBD. To achieve this, Gd_2O_3 nanostructures were synthesized using an microwave-assisted method and subsequently analyzed through X-ray diffraction (XRD), ultraviolet-visible (UV-Vis) spectroscopy, scanning electron microscopy (SEM), Fourier-transform infrared (FTIR), and attenuated total reflection (ATR) spectroscopy. The average submicron crystallite sizes of the Gd_2O_3 nanostructures were determined using the Debye-Scherrer method. The Williamson-Hall (WH) method was utilized in the XRD analysis to estimate crystallite sizes and evaluate micro-strains within the crystal lattices. The optical bandgap of the Gd_2O_3 nanostructures was calculated using the Tauc plot method. Following this, the electrical properties of the fabricated SBDs were assessed through I-V measurements conducted over a wide voltage range of ±3.8V, along with their optical response in both darkness and under illumination intensities of 40-120 mW/cm^2 at room temperature. The research also explored the current conduction mechanisms (CCMs) and the key electrical and optoelectrical characteristics of these Schottky barrier diodes through I-V analysis, applying thermionic emission (TE), Norde, and Cheung's methods. The energy-dependent profile of surface states (N_{ss}) was derived using the Card-Rhoderick method. All experimental results indicate that the MPS type SBD outperformed the MS type SBD, demonstrating lower values of ideality factor (n), leakage current (I_0), and surface states (N_{ss}), as well as higher values of rectification rate (RR), barrier height (Φ_{B0}), and photosensitivity (S). In conclusion, the optoelectrical response suggests that the MPS type Au/PVA:Gd_2O_3/n-Si Schottky diode could effectively serve as a replacement for traditional MS-type Schottky diodes in photovoltaic and photodetector applications.

S28

Heterogeneous Integration of Photonic Crystal Surface Emitting Lasers on Silicon-On-Insulator

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Abstract: We present the design and fabrication of a silicon-integrated photonic crystal surface-emitting laser (PCSEL) operating at the 1550 nm telecom wavelength. The structure consists of a two-dimensional silicon photonic crystal (2D-PhCs) cavity bonded to an InP-based multiple quantum well (MQW) gain medium. Finite-difference timedomain (FDTD) simulations optimized the crystal lattice for high-Q band-edge mode operation, facilitating in-plane feedback and vertical emission. This aims for single-mode operation in a compact, CMOS-compatible cavity [1]. The silicon photonic cavities were fabricated on silicon-on-insulator (SOI) wafers using electron-beam lithography and inductively coupled plasma reactive ion etching. Optical tests confirmed resonances near the design wavelength at 1550 nm (see Fig 1. a and b). An InP wafer with strained AlGaInAs MQWs was thinned and flip-chip bonded to the SOI PhC, ensuring the MQW active region overlapped with the PhC cavity, similar to other transfer-printing methods used for integrating III-V lasers on silicon [2].

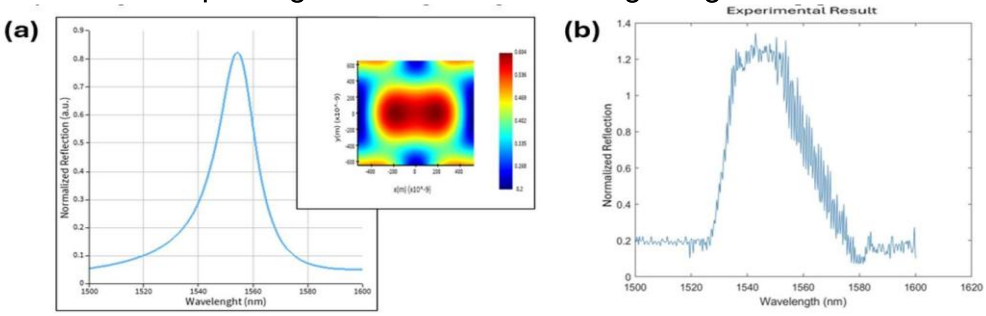

Fig. 1. Simulation and experimental results of square lattice hole-based SOI-PhC. (a) Simulation result of normalized-reflected light emission peak and electric field intensity in xy planes. (b) Experimental result of normalized-light emission peak.

Pulsed optical pumping of PCSEL devices has achieved surface-normal emission at 1550 nm. Currently, we use a continuous-wave optical pump modulated at 1 kHz for lock-in detection, but we plan to switch to true pulsed excitation in future experiments with III-V materials to manage thermal effects and observe threshold behavior. We are also investigating circular Bragg grating resonators on SOI to reduce device size and enhance beam shape. This integration of PCSELs with future CBG designs will promote efficient, compact on-chip light sources for next-generation integrated photonic systems.

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S29

Mueller Matrix method for adjusting optical properties in a two-stage liquid crystal retarder system using Monte Carlo simulations

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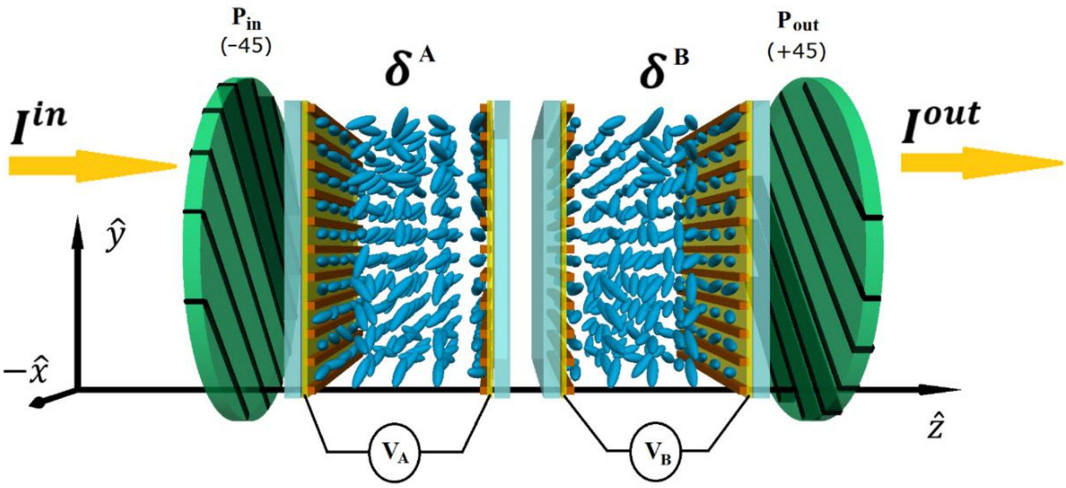
Abstract: Liquid crystals (LCs) are crucial in photonics and imaging applications, particularly for their tunable birefringence properties, enabling adjustable optical anisotropy through molecular orientation control. This orientation can be managed via molecular interactions, anchoring forces, electrical/magnetic fields, and optical torque, making LCs attractive alternatives to conventional optical retarders. The Mueller matrix formalism provides a powerful method for analyzing birefringence and polarization characteristics, representing optical elements with 4×4 matrices and polarization states with 4×1 Stokes vectors. This study investigates the optical properties of a two-stage LC retarder system using Monte Carlo simulations. The system comprises two planar-aligned nematic LC cells and crossed linear polarizers. LC molecular orientations were determined by simulations employing a lattice Hamiltonian model, considering Lebwohl-Lasher interactions, external fields, and Rapini-Papoular anchoring. Analyses spanned wavelengths of 400–800 nm, showing that LC cell thickness and external fields significantly impact transmission characteristics. Thinner LC layers yielded sharper wavelength selectivity and higher sensitivity to external fields, whereas thicker layers provided broader transmission spectra. The combination of Monte Carlo simulations and Mueller matrices offers reliable optimization methods for advanced LC-based optical devices.



S30

Optical analysis of asymmetric AgNWs/PVA/Ag_2S nanocomposites

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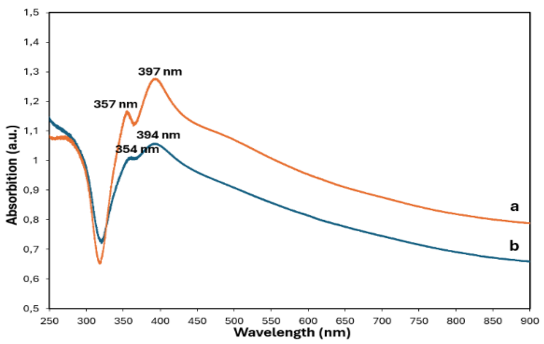
Abstract: In this study, silver nanowires were synthesized by polyol method. The obtained AgNWs were incorporated into PVS solution at a concentration of 0.73 mmol/g, respectively, to prepare AgNWs/PVA nanocomposite and dried at room temperature. The lower part of the prepared sample was treated with H_2S gas and the formation of asymmetric structures was observed depending on the concentration of AgNWs, as well as the interaction of Ag^+ ions within the nanocomposite with H_2S gas. As a result of ultraviolet-visible (UV-Vis) spectroscopy, a redshift and a decrease in intensity of the plasmon resonance peaks were recorded, which is explained by the conversion of AgNWs to silver sulfide (Ag_2S). The reaction of the nanowires with H_2S gas produces Ag_2S and reduces the concentration of free electrons. The Ag_2S layer formed on the surface of the Ag nanowires changes the dielectric properties around the Ag nanostructures. Since the Ag_2S semiconductor has a lower free electron density compared to metallic AgNWs, the formation of the Ag_2S layer shapes the electron density of the nanocomposite and causes the plasmon resonance to shift to longer wavelengths. This change is associated with the different electronic structure of Ag_2S and ultimately leads to a decrease in the energy band gap of the AgNWs within the nanocomposite from 1.6 eV to 1.15 eV. The formation of Ag_2S weakens the quantum size effect in Ag nanowires and narrows the energy band gap because the electronic structure of Ag_2S is different compared to pure Ag. According to the literature, the energy band gap of Ag_2S nanocrystals is in the range of Eg = 0.9–1.1 eV. These results confirm that the optical properties of AgNWs-based nanocomposites can be tuned in a simple and effective way through the sulfidation process.



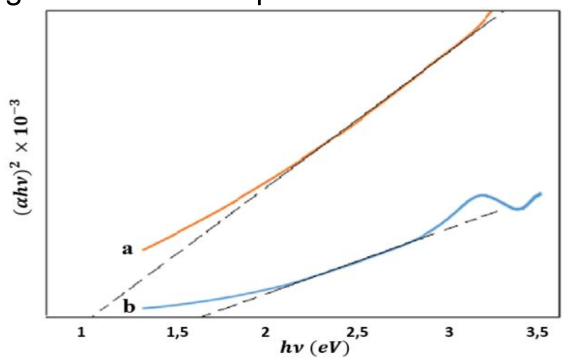


Fig. UV spectra and band gap of AgNWs-PVA (a) and AgNWs-Ag_2S-PVA (b) based nanocomposites.

S31

Study of the Modification of Optical Characteristics of Silver Nanowires During Sulphidation

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Abstract: Silver nanowires (AgNWs) have recently garnered significant attention owing to their promising applications in solar energy technologies and their strong antimicrobial capabilities. The high sensitivity of one-dimensional (1D) structures to external conditions necessitates detailed investigations for their effective utilization. In this study, we investigated how varying concentrations of sodium sulfide (Na_2S) solution affect the optical behavior of AgNWs over time.

The silver nanowires were synthesized through a modified polyol process and subsequently dispersed in ethanol. To assess the kinetics of optical property changes, the nanowires were immersed in Na_2S solutions with concentrations of 0, 0.001, and 0.01 M. UV-Vis spectroscopy was employed to characterize the samples, as shown in Fig. 1. Initially, the AgNWs exhibited two prominent absorption peaks at 350 nm and 379 nm, corresponding to surface plasmon resonance phenomena and confirming the successful synthesis of the wires. Upon treatment with a 0.001 M Na_2S solution, one of the absorption peaks disappeared (Fig. 1A), attributed to structural fragmentation and thinning as a result of sulphidation. Over a period of 60 minutes, a gradual decay was observed, along with a slight shift of the plasmon peak from 379 nm to 376 nm. Additionally, an increase in the concentration of free charge carriers was recorded, rising from an initial $N=3.11\times10^{21}$ cm^{-3} to $N=3.16\times10^{21}$ cm^{-3}, indicating the progressive breakdown of the nanowires.

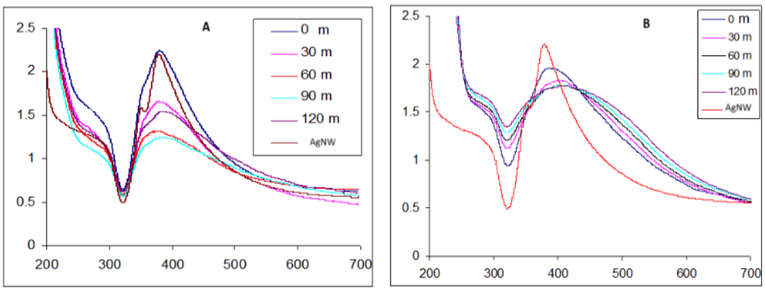

Fig 1. Uv-Vis spectrum of A) AgNW+0.001M Na_2S and B) AgNW+0.01M Na_2S

S32

Structural changing of CdS nanoparticle by the effect of cation-anion ratio

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Abstract: CdS is a II-VI group binary metal chalcogenide semiconductor in nanocrystalline form has luminous characteristics, photosensitivity, nonlinear optical characteristics, as well as other important physical and chemical properties. Due to its unique properties, CdS has been employed in many optoelectronic technologies such as optical thin film filters, high-density magnetic information storage, heterogeneous photocatalysis, window layer in solar cells, gas sensors, etc. The varying cation to anion ratio can influence the structural, as well as physical properties of CdS nanoparticles. In the presented study, CdS is synthesized using the sonochemical method. Cd/S varied as 1:0.1; 1:0.25; 1:0.5; 1:0.75 and 1:1. By using X-ray Diffraction (XRD), the structural changes were analyzed concerning different values for the cation-anion ratio and shown in Fig.1.

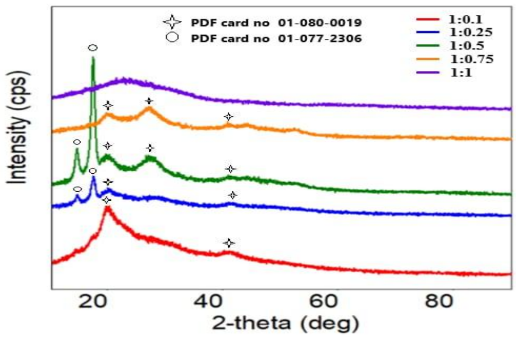

Fig. 1. XRD analysis of different cation-anion ratios for CdS nanoparticles.

The XRD analysis of CdS nanocomposites reveals distinct changes in crystalline phases depending on the CdS ratio. At 1:01, the material shows the presence of a clear wurtzite crystalline phase with well-defined peaks indicative of a stable crystalline structure. At the ratio 1:0.25, transition from cubic to hexagonal phase, where the cubic phase is dominant. At the ratio 1:0.5, the material exhibits a more balanced mixture of both cubic and hexagonal phases. At the 1:0.75 ratio, the material shows predominantly a hexagonal phase with the peaks indicating a more developed and consistent wurtzite structure than the 1:0.5 ratio. For a 1:1 ratio, there are no distinct crystalline peaks, showing formation of an amorphous phase, and his amorphous structure may be due to a stoichiometric imbalance or making clear distinction from the crystalline behavior observed at other ratios.

S33

YIG-Based Photonic Crystals and Their Role in Quantum and Optical Device Engineering

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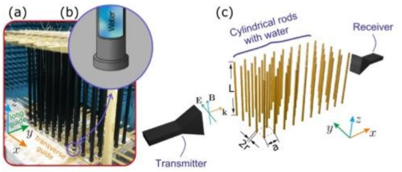
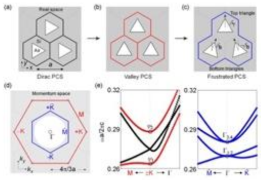
Abstract: This study provides a comprehensive analysis of recent advancements in photonic crystal (PhC) technology and its profound impact on nanophotonics, quantum computing, and optical communication. Significant innovations in photonic crystal engineering have greatly improved light-matter interactions, reduced transmission losses, and enhanced photonic density states. Key contributions include the integration of quadrupole magnetization in metamaterials [1], cavity quantum electrodynamics (QED) with photonic crystals [2], hollow-core photonic crystal fibers (HCPCFs) [3], and atomic excitation localization [4], each playing a vital role in advancing telecommunications, sensing, and quantum information processing. Yttrium iron garnet (YIG)-based photonic crystals enable the co-localization of magnons, phonons, and photons, addressing scalability challenges in quantum systems. The first nanofabricated YIG photonic crystal, with its superior magnetic and optical properties, facilitates efficient magnon-photon coupling and quantum wavelength transduction, advancing the development of scalable quantum platforms [5]. Twisted photonic crystals and hollow-core photonic crystal fibers (HCPCFs) improve light confinement and reduce transmission losses, enhancing optical communication and sensing [3, 6]. Advancements in nonlinear optics and continuum-state studies have refined light-matter interaction, essential for robust quantum networks. Furthermore, research on atomic excitation dynamics and defect-driven localization offers key insights into scalable quantum computing architectures [4]. The experimental setups employed include a square lattice of high-index cylindrical rods fabricated from PVC to explore magneto-optical effects in photonic systems [1]. The YIG-based optomechanical cavity (OMC) design optimizes electric field distribution for efficient quasiparticle coupling, as evidenced by its band structure, which includes guided TE-like and TM-like modes [5]. Furthermore, the design of supercell photonic crystal slabs (PCSs) with triangular meta-atoms demonstrates complex Brillouin zone dynamics and Dirac/valley band structures, providing new avenues for waveguide and valleytronic applications [7]. This research underscores the transformative role of photonic crystals in advancing quantum communication, optical device engineering, and high-sensitivity sensing. The integration of novel metamaterials, fiber structures, and theoretical models highlights the critical importance of photonic crystals in shaping the future of quantum technologies and optical devices.


(a)
(b)
Water
(c)
Cylindrical rods with water
Receiver
long guide
transverse guide
Transmitter
E
B
k
L
2r
a

[1]


Dirac PCS
Valley PCS
Frustrated PCS

[7]

S34

Coherent Control of Plexcitonic States via Optical Stark Effect

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Abstract: Achieving coherent control in quantum plasmonic systems is vital for programmable photonic integrated circuits. We theoretically demonstrate active tuning of plexcitonic modes in off-resonant and resonant plasmon-emitter systems using the optical Stark effect (OSE). In off-resonant systems, a Stark field shifts quantum emitter (QE) degeneracy, driving off-resonant plexcitonic states closer to resonance, creating a transparency window (Stark-induced transparency, SIT) and enabling tunable photoluminescence (PL) with on/off modulation. Resonantly coupled systems exhibit Stark-induced splitting of QE excited states, forming Mollow triplets in plexcitonic modes with energy splittings up to 491 meV. Increasing Stark field strength enhances splitting between upper (UP) and lower (LP) plexcitons while reducing PL intensity, enabling dynamic control over photon emission. These findings enable actively tunable photonic components for quantum information processing.

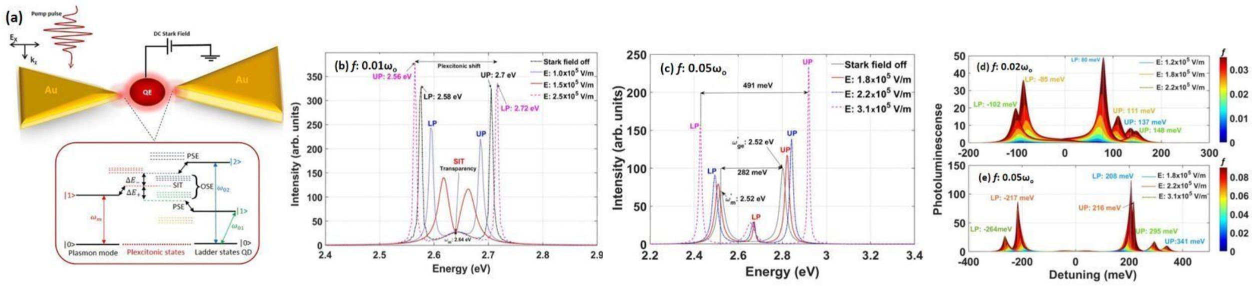

Fig. 1. (a) Hybrid quantum plasmonic system of Au bow-tie nanoantenna and voltage-tunable QE. (b) Stark-induced SIT in the off-resonant coupled system. (c) Stark-induced Rabi splitting in resonantly coupled plexcitonic states. (d) PL spectra of Stark-tuned plexcitons as a function of detuning for different strengths of the Stark field in the weak (f: 0.02ωₒ) and (e) strong coupling (f: 0.05ωₒ).

S35

Neural Network-Based Calibration of Plasmonic Structures: A Simulation Study

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Abstract: Surface Plasmon Resonance (SPR) is a highly sensitive optical phenomenon that occurs at the interface between a noble metal and a dielectric medium. In this phenomenon, incident light couples to surface charge oscillations under specific resonance conditions. Due to its strong dependence on the refractive index of the surrounding environment, SPR has become a fundamental mechanism in the development of label-free optical sensors for biosensing, chemical detection, and environmental monitoring. The accuracy of SPR-based sensors relies heavily on precise calibration, as variations in metal film thickness and deviations from standard dielectric models can significantly affect performance. This study introduces a deep learning-based calibration method using a Multilayer Perceptron (MLP) neural network trained on simulated reflectance data under various conditions. The trained network accurately estimates calibration parameters such as effective thickness and complex permittivity. For instance, the figure shows that the neural network reports the layer thickness, imaginary and real coefficients of a system, with errors of 1.08%, 3.4%, and 0.35%, respectively.

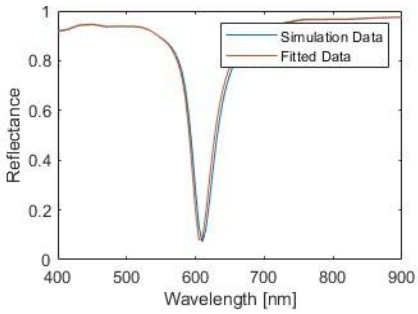

Fig. 1. A comparison between fitted and stimulation data for 70 nm Ag layer and water measurement environment. The Johnson and Christy model has been used for the dielectric function.

MLPs offer several advantages over classical fitting methods, including no need for a precise physical model, higher noise resistance, faster predictions without iterative optimization, and the ability to model complex nonlinear behaviors. Once calibrated, the sensor can become more accurate and enhance the performance of the SPR sensor in non-ideal conditions.

POSTER PRESENTATION

P1

Simulation and computational validation of an optical cavity composed of point dipoles

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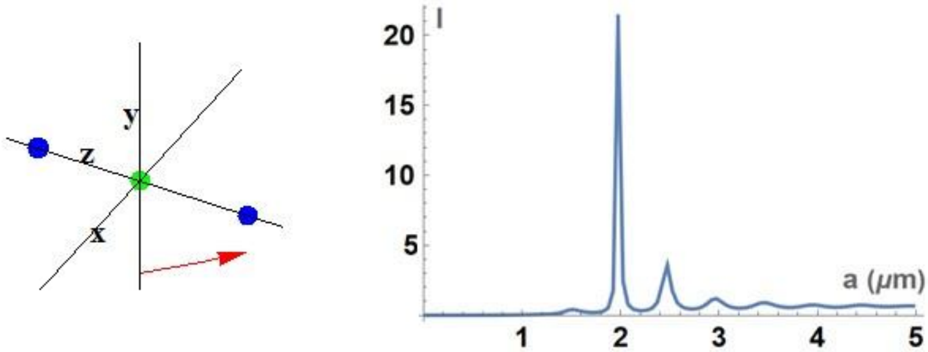
Abstract: Optical cavities are devices used to resonate specific frequencies of light. Various optical cavities exist such as Fabry-Perot, whispering-gallery-mode, plasmonic and etc. One of the best places where cavities play role is in lasers. The working mechanism of all cavities is such that a radiation source re-receives part of its radiation through mirrors present in the arrangement, allowing for amplification and re-emission. In other words, presence of feedback systems within a cavity is necessary for resonance. Design of new cavities, their characterization, and finding novel applications (especially in the fields of lasers, sensors, and more) are among the essential fields of photonics. In this paper, we propose a new cavity based on point dipole emitters, simulate its resonance modes, and validate the resonance process. The general schematic of the problem considers at least three dipoles where two serve as mirrors and one acts as an emitter. Using the dipole radiation formulation and considering an incoming light this system is simulated. The radiation re-emitted by these dipoles leads to an equilibrium state, and the stable dipole moments are obtained through a computer code. This code determines the radiation characteristics of this setup. Subsequently, using the Poynting vector and the electromagnetic flux output from a hypothetical spherical surface, the amount of emitted energy is calculated. The following figure presents a schematic of the cavity and its resonance characteristics.



From the figure, it is evident that the cavity has sharp and distinct resonance peaks, indicating that this point dipole system behaves like a resonator. This resonant system can have many applications in the field of sensors and lasers, which are among the ongoing works of the authors.

P2

Simulation of Thermal Lens Characteristic Time and Thermal Conductivity of C_2H_5OH, CH_3OH, and CCl_4 Using Finite Element Method

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Abstract: Laser thermal lens spectroscopy is an optical method for measuring the thermophysical parameters of liquids with high accuracy. In this study, the thermal lensing process for the organic liquids C_2H_5OH, CH_3OH, and the toxic liquid CCl_4 was simulated using the finite element method (FEM); The Nd: YAG laser was used as the heating source, and the He-Ne laser was employed as the probe laser. For this purpose, the Flex PDE software was used to numerically simulate and measure the thermal lens characteristic time for the mentioned liquids. The calculations utilized the heat transfer equation in fluids and analyzed the heat distribution in the samples. The simulation results show that the thermal lens characteristic time for C_2H_5OH, CH_3OH, and CCl_4 was obtained as 1.37, 1.18, and 1.65 milliseconds, respectively. Subsequently, the thermal diffusion and thermal conductivity of the mentioned liquids were calculated. The obtained results were in good agreement with the experimental results of our previous work.

P3

The performed Au/n-Si (MS) structures with/without Mo:PVC interlayer, and investigation electric and negative dielectric properties of them

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Abstract: In this study, both the Au/n-Si (MS) and Au/(Mo:PVC)/n-Si (MPS) structures were grown onto same n-Si wafer in same conditions to determine the interlayer effects on the performance of these devices. Therefore, their current-voltage (I-V), capacitance/conductance-frequency (C/G-f) for 1.5V measurements were performed in wide range of frequencies. Some important fundamental parameters of them like reverse-saturation-current (Is), barrier-height ($\Phi b(IV)$), ideality-factor (n), rectification-ratio ($RR=I_F/I_R$ ±3V), series/shunt resistance (R_s, R_{sh}) were calculated from the I-V data. The energy-dependent density of interface-states/traps (N_{ss}-(E_c-E_{ss})) were also obtained from the forward bias voltages by considering the voltage dependent on BH and n values. The real and imaginary components of the complex-dielectric ε* (=ε'-jε") were calculated from the capacitance and conductance data as function of frequency for MPS type structure. The observed negative capacitance (NC) or negative dielectric (ND) at low frequencies was attributed to the N_{ss}, the decrease of electrons in the electrodes, and injection of minority carrier injection. In addition, while the value of C decreases with decreasing frequency, G/ω increases and such behavior of them implied that sample behaves an inductive behavior. When they compared all these experimental results for MS and MPS type structure like metal. The use of (Mo:PVC) organic interlayer between Au and n-Si, have been quite improved the performance of MPS structure in respect of lower-values of leakage current, R_s, N_{ss} and higher values of BH, RR, R_{sh}, ε', ε" values. Therefore, we can say that the (Mo.PVC) interlayer can be successfully used instead of conventional insulator layers in the electric, dielectric, and energy storage capacitor applications.

Keywords: A compare of MS and MPS structure; Mo:PVC interlayer; I-V, C/G-f features, Electric/dielectric properties; Negative dielectric, Energy dependent of interface traps

P4

Printing High Reflectance Fiber Bragg Gratings on 30/400 Double-Clad Fibers for Fiber Laser Systems

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Abstract: Fiber laser technology is in a much more advantageous position in terms of usage advantages, beam quality, cooling advantages, and less maintenance requirements compared to solid state lasers and gas lasers in both the defense industry and industrial products, and its place in the laser industry continues to increase.

Optical lenses are used as a laser gain medium in laser technology. However, these optical lenses cannot be integrated into fiber laser systems as an integrated (internal) structure. It is difficult to integrate the optical lenses added externally into the laser system. Fiber Bragg gratings (FBG) can be added internally to rare-earth element-doped active fibers, which are the laser gain medium, by the fiber welding method. Thanks to these features, they have both easy installation and very low insertion losses. Due to these advantages, they have completely replaced optical lenses and have become one of the indispensable elements of fiber laser technology.

Fiber Bragg gratings, which serve as mirrors for the gain medium in fiber lasers, are developing and diversifying in parallel with the development of fiber laser technology.

In this study, the fabrication and characterization of high reflectivity fiber Bragg gratings in 30/400 double-clad fibers with a wide mode area for use in increasing fiber diameters parallel to higher power requirements are discussed.

P5

Polarization-based Optical Fiber Sensors for Electrical Current Measurement

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Abstract: Monitoring and protection in power and grid networks require continuous measurement of electrical current and voltage. Due to the high voltage and current levels, direct connection of measuring devices and protection relays is neither technically nor economically viable. Traditional magnetic transformers, commonly used for current measurement in power systems, suffer from saturation, poor response, low accuracy, and costly protection mechanisms. In contrast, optical methods, such as fiber optic sensors, overcome these limitations. This study explores electric current measurement using polarization-based fiber optic sensors. The polarization of light within the optical fiber shifts under the influence of an electric current and its induced magnetic field, following the Faraday effect. By measuring the rotation of linearly polarized light, the current magnitude is determined. In experiments, currents ranging from 30 to 300 A were applied, revealing a linear increase in output intensity with current. The system responds solely to a 50 Hz frequency, with no high harmonics detected. Current values calculated from polarization changes closely matched the applied currents.

P6

Investigation of the Effect of Plasma Exposure Time on the Functionalization of Glass Substrates

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Abstract: Surface functionalization to enhance polymer adhesion in the field of microfluidics and microchannel fabrication is of paramount importance. One of the conventional methods in this context is using a plasma cleaner, which is renowned for its ability to generate reactive functional groups on surfaces. Interferometric microscopy is a precise and non-destructive analytical tool that facilitates the quantitative assessment of surface topography and the evaluation of modifications induced by surface treatment processes. In this study, morphological alterations of the surface resulting from the plasma cleaning procedure were examined and analyzed through the application of interferometric microscopy. In this study, the substrates were degreased and thoroughly cleaned to eliminate surface contaminants. The initial surface properties were then analyzed using interferometric microscopy with water droplets. Following this, surface modifications were induced through treatment with a plasma cleaner. The experiment was conducted using a $100W$ power setting for 100 seconds. Surface changes were investigated by analyzing interferometric microscopy data of water droplets, captured at three distinct time intervals.

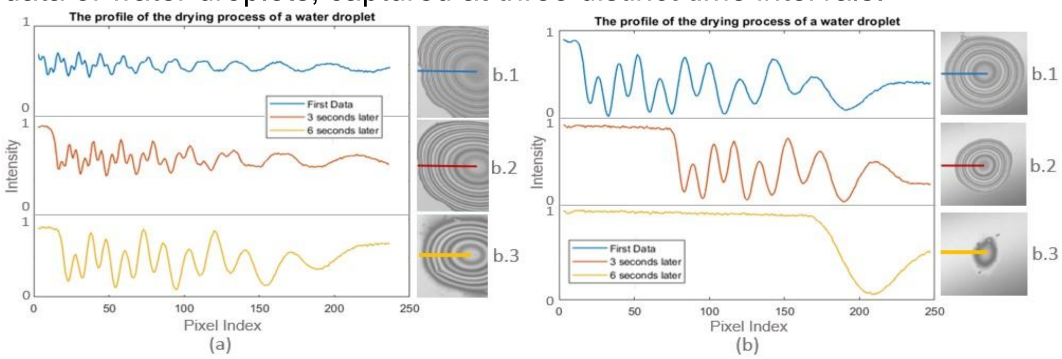

Fig. 1. This figure demonstrates the droplet drying process at three and six seconds after the initial data point. Figure (a) shows this process before substrate functionalization, while Figure (b) illustrates it after substrate functionalization.

The obtained data indicate that following plasma-induced functionalization, the spreading of the water droplet on the surface led to an increase in surface hydrophilicity, thereby accelerating the evaporation rate. Furthermore, the frequency variations of the fringes at the droplet edges reflect changes in its slope before and after functionalization.

P7

First-Principles and SCAPS-1D Analysis of $TlSnCl_3$ for Photovoltaic Applications

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Abstract: Solar energy is considered an important renewable energy source for solving energy problems due to being a clean and unlimited resource. Solar energy is used to reduce climate change and control global warming by converting it into electrical energy. The efficiency of solar cells largely depends on the materials used. Perovskite solar cells (PSCs) attract attention due to their advantages, such as high photoelectric conversion efficiency, low cost, and easy production process. The efficiency of PSCs has exceeded 26%, making them an attractive option for future photovoltaic devices. The chemical formula of perovskites is ABX_3, where cations occupy the A and B sites, and anions or halogens occupy the X site. Elements such as Ge and Sn used in the B site stand out as non-toxic and high-efficiency perovskites. In this study, SCAPS-1D simulation will be conducted to investigate the potential of perovskite structures of TlSnCl as a solar absorber layer. During this simulation, optimum electron transport layer (ETL), hole transport layer (HTL), absorber layer thickness, power conversion efficiency (PCE), open-circuit voltage (V_{oc}), short-circuit current (J_{sc}), and fill factor (FF) will be examined. Additionally, the effects of factors such as series resistance, shunt resistance, back contact work function, and temperature on the performance of solar devices will be evaluated. The band structure, density of states (DOS), and optical properties of the $TlSnCl_3$ perovskite structure will be calculated with Density Functional Theory (DFT) via VASP, and carrier mobility will be obtained from the calculated effective mass of the charge carriers from the band structure. The results obtained in this study are expected to be an important step toward the development of lead-free and environmentally friendly solar cells.

P8

Electrospun SiO_2/TiO_2-Based Dielectric Nanofibers for Optical Enhancement of Glass Surfaces

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Abstract: In this study, dielectric nanofiber coatings based on SiO_2 and TiO_2 were deposited onto soda-lime silicate (SLS) glass substrates via electrospinning to enhance their optical performance. The objective was to reduce surface reflection and increase light transmittance, thereby assessing the potential applicability of these coatings in photovoltaic and optoelectronic systems. Three different precursor solutions were formulated using polyvinylpyrrolidone (PVP) and/or polyvinyl acetate (PVAc) polymers, with N,N-dimethylacetamide (DMAc) as the solvent. Tetraethyl orthosilicate (TEOS) and titanium(IV) isopropoxide (TTIP) were used as the silica and titania precursors, respectively. Electrospinning was conducted under an applied voltage of 20–30 kV, a flow rate of 0.5–1.0 mL/h, and a needle-to-collector distance of 15–18 cm, with spinning durations ranging from 5 to 30 minutes. Subsequently, the coatings were sintered at 550 °C for 2.5 hours to remove the organic matrix and obtain porous, amorphous dielectric layers.

Characterization of the coatings was carried out using UV-Vis-NIR spectroscopy, field-emission scanning electron microscopy (FE-SEM), X-ray diffraction (XRD), Fourier-transform infrared spectroscopy (FTIR-ATR), atomic force microscopy (AFM), and water contact angle (WCA) measurements. The results indicated that optical transmittance values reached up to 93% at certain wavelengths, while the amorphous structure was preserved after sintering. A homogeneously distributed surface morphology was also observed. Furthermore, the changes in surface wettability and low surface roughness contributed positively to optical transmission. These findings demonstrate that electrospun coatings developed through this approach offer functional surface solutions with anti-reflective properties, high transparency, and compatibility with low-temperature processes.

P9

Spectral analysis of alterations in pepper plant induced by Tomato brown rugose fruit virus using hyperspectral imaging

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Abstract: This study aimed to investigate spectral alterations in pepper plants (*Capsicum annuum* L.) induced by Tomato Brown Rugose Fruit Virus (ToBRFV) and to identify effective wavelengths for early detection. ToBRFV causes significant damage to pepper crops, leading to symptoms such as chlorotic spots and mosaic patterns on the leaves and fruits. In this study, hyperspectral imaging of pepper plants was performed over 17 consecutive days at a consistent time each day using a SPECAM camera (model HIS-Vis-Nir-100fps with a spectral range of 400-950 nm). The acquired spectral data were analyzed using MATLAB software. To minimize noise and baseline variations, Z-score normalization was applied during data preprocessing. Linear Discriminant Analysis (LDA) was employed to differentiate the spectral signatures of healthy and ToBRFV-infected plants and to identify distinguishing spectral features. The results suggest that key wavelengths at 571.17 nm, 628.72 nm, 649.55 nm, 684.63 nm, and 690.11 nm play a significant role in accurately reflecting the spectral changes associated with viral infection. The identification of these effective wavelengths represents a crucial step towards the development of rapid, non-destructive, and accurate methods for the early detection of ToBRFV in pepper fields, potentially reducing economic losses and enhancing disease management strategies. Furthermore, the comparison of spectra discriminated by LDA provides a better understanding of the interaction between the virus and the spectral characteristics of the plant, paving the way for future research in this domain.

P10

Simulation of Quantum Teleportation and Denial-of-Service (DoS) Attacks in Small-Scale Quantum Networks

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Abstract: Quantum communication technologies offer significantly enhanced security compared to classical communication methods, particularly through entanglement-based information transfer [1]. In this study, a basic quantum teleportation protocol is simulated on a small-scale quantum network consisting of two nodes. During the simulation, entangled qubit pairs (EPR pairs) are generated between nodes; a Bell-state measurement is performed at the sender node, and the results are transmitted to the receiver node via a classical channel. The receiver reconstructs the original quantum state by applying local quantum operations conditioned on the received classical data [2]. In the second phase of the study, Denial-of-Service (DoS) attack scenarios targeting the classical communication channel are modeled. Specifically, the effects of timing delays and packet loss on teleportation performance are analyzed to assess the system's resilience. The findings indicate that DoS attacks directly impact qubit fidelity and communication integrity. Moreover, the study highlights the critical dependence of quantum teleportation on the security of the classical channel [3]. Overall, the results demonstrate that quantum communication networks require robust security mechanisms not only at the quantum protocol level but also within their classical support infrastructure. This work contributes to the early detection of vulnerabilities and the development of countermeasures for future quantum network deployments.

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P11

Holographic simulation of point dipoles with a hologram recorded by an array detector

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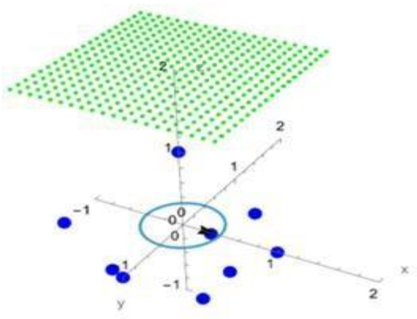
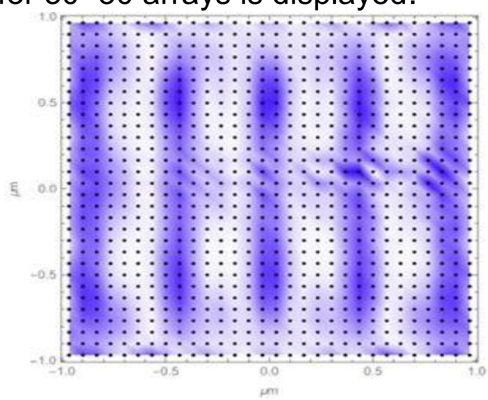
Abstract: In this article, we discuss the holographic simulation of electric radiating dipoles. The goal is to find information about a set of electric radiating dipoles whose interference pattern is recorded on detectors consisting of an array of dipoles (of different materials). The simulation method is based on the following algorithm: First, the entire system (particles and detector) is illuminated with an incident light. Then, depending on the electric structure of each component, various radiating dipoles are formed. Next, the interference pattern recorded on the detector for different resolutions (including 20×20, 25×25, and 30×30 arrays) is obtained. After that, the electric property of each detector element is adjusted according to the interference pattern (light intensity in the interference pattern). With this, dark areas will have a dipole property of X=0, and bright areas will have a dipole property of X_{max}, and other intensities will also be distributed based on this scale. Finally, with the redistributed dipoles, the hologram simulation phase begins. In this phase, the same initial setup is considered, but without the presence of radiating dipoles. The final output of the simulation is actually the distribution of electric fields on the detector surface. This distribution is a type of holography that displays valuable information about the particles. The simulation output is shown in the figure below, and the distribution of particles and their final holography for 30×30 arrays is displayed.





Extracting information from this holography image and its relationship with the properties of scattering dipoles and inferring more information from the hologram are among the ongoing works of the article's authors.

P12

INVESTIGATION OF THE CORROSION RESISTANCE PERFORMANCE OF MoC THIN FILM COATING FOR PEM TYPE FUEL CELLS

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Abstract: In this study, the performance of molybdenum carbide (MoC) thin film coatings, developed to enhance the corrosion resistance of bipolar plates (BPs), a key component of proton exchange membrane (PEM) fuel cells, was investigated. PEM fuel cells are environmentally friendly and highly efficient energy conversion systems, widely used in automotive and portable power applications. Since BPs account for 80% of the stack's total mass and 45% of its cost, they play a critical role. Although metallic materials such as stainless steel (SS) are preferred over brittle graphite for BP production, they are susceptible to corrosion in the PEM cell environment. To overcome this issue, protective and conductive coatings are applied. MoC stands out as a promising coating material due to its high electrical conductivity, hardness, thermal stability, corrosion resistance, and cost-effectiveness. In this study, MoC thin films were deposited on stainless steel (SS), silicon (Si), and soda lime glass (SLG) substrates using two different techniques: a hybrid method combining magnetron sputtering with plasma-enhanced chemical vapor deposition (PECVD), and a magnetron co-sputtering method. While films produced by the hybrid method exhibited structural defects, those fabricated using the co-sputtering technique met the corrosion resistance standards set by the U.S. Department of Energy (DOE). MoC-coated SS plates showed a 50% improvement in interfacial contact resistance (ICR) compared to uncoated plates. Furthermore, potentiodynamic polarization measurements revealed a very low corrosion current density of 5.813×10^{-7} A·cm^{-2}, which is below the DOE target of 1×10^{-6} A·cm^{-2}. These findings demonstrate that MoC thin film coatings offer innovative solutions to corrosion issues in fuel cell technologies and present materials engineering approaches with the potential to revolutionize the energy sector.

P13

DEVELOPMENT OF AN INTERFERENCE MICROSCOPE USING DIFFUSER AND POLYSTYRENE MATERIALS

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Abstract: The increasing demand for cost-effective, accessible, and portable optical imaging systems has driven significant innovation in microscopy technologies. Especially in educational and low-resource settings, there is a growing need for simple yet effective instruments capable of visualizing fine structures with high precision. Interference-based microscopy techniques, known for enhancing contrast and revealing phase information without staining, have emerged as promising solutions for such needs.

In this study, we propose a novel, low-cost interference microscope concept utilizing a diffuser and polystyrene materials as core optical components. The diffuser acts as a scattering medium to generate a uniform and coherent light field necessary for interference pattern formation, while polystyrene sheets serve as substrates and optical paths due to their lightweight, transparent, and easily moldable properties. The optical setup is designed to be compact and user-friendly, facilitating rapid assembly and alignment. Preliminary designs suggest that by optimizing the surface roughness of the diffuser and the thickness of the polystyrene layers, clear interference fringes can be observed even with simple illumination sources such as LEDs.

Additionally, the system aims to maintain high visibility and resolution without the need for expensive objective lenses or precision stages. The robustness and affordability of the proposed microscope make it particularly suitable for educational purposes, field research, and applications in resource-limited environments. These findings highlight the potential of combining diffuser-generated coherent fields with polystyrene-based optics to create interference microscopes that democratize access to advanced imaging technologies.

P14

Examining the Thermal Characteristics of Solder Used Between the Heatsink and Substrate in High Power Fiber Coupled Laser Diodes and Investigating the Effects of Solder Characteristics on the Laser

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Abstract: This study aims to investigate the thermal properties of solder used between the cooler and the substrate in high-power fiber-coupled laser diodes and to explore the effects of these solders on the laser diode's performance. High-power laser diodes find extensive applications in various industrial fields, where their thermal management is crucial for efficiency and durability. This research seeks to characterize the thermal conductivity properties of solder materials (such as SAC305, Au(80)Sn(20), Bi52Sn(47)Ag(1)) used between the substrate and cooler of the laser diode through experimental methods. It aims to evaluate the impact of these solder materials on the cooling system of the laser diode and identify the optimal solder material. Furthermore, the study will analyze the thermal effects of the identified optimal solder material on the laser diode to understand the mechanisms affecting its performance, employing a combination of experimental and theoretical approaches. Additionally, the research will address the influence of substrate materials and soldering processes, such as reflow soldering or eutectic soldering, on the choice of solder material and its effects on laser performance. Ultimately, this investigation could represent a significant step towards improving the thermal management of high-power fiber-coupled laser diodes and optimizing their performance.

P15

Enhanced Refractive Index Metrology: Integrating Computational Fresnel Diffraction and Image Processing for Liquids and Thin Films

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Abstract: This study introduces a high-precision refractive index measurement platform leveraging Fresnel diffraction and computational image analysis, achieving resolutions of ~10^{-4}–10^{-5} for liquids while proposing a theoretical framework for thin films. The refractive index, a critical parameter in optical engineering, photonics, and material science, governs light-matter interactions and is essential for designing lenses, optical sensors, and photonic devices. Here, a transparent wedge generates a controlled phase step at liquid-solid interfaces, producing Fresnel diffraction patterns. Refractive indices are determined by quantifying fringe displacements in captured images via image processing. This approach minimizes manual subjectivity inherent in conventional methods (precision ~10^{-2}–10^{-3}), delivering reproducible results for liquids and its mixtures.

For thin films, where direct mechanical measurement risks damaging delicate samples, a non-contact spectral methodology is theoretically proposed. UV-VIS-NIR transmission spectra would be analyzed using the Swanepoel method, which extracts thickness and wavelength-dependent refractive indices from interference extrema. By computationally modeling interference patterns, this framework circumvents challenges like substrate effects and mechanical fragility. While experimental validation remains ongoing, the synergy of diffraction-based liquid analysis and spectral thin-film modeling establishes a versatile metrology platform.

The study addresses growing demands for precision in industries such as telecommunications, biomedical sensing, and laser systems, where refractive index accuracy directly impacts device performance. By bridging experimental optics with computational tools, this work advances high-precision optical characterization, offering scalable solutions for academia and industry alike. Future efforts will focus on thin-film experimental validation and integrating machine learning to further enhance robustness.

P16

The Optical and Electrochromic Properties of Indium Tin Oxide (ITO) Thin Films Deposited by RF Magnetron Sputtering

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Abstract: The optical properties such as transparency and color of electrochromic devices (EC) materials as well as devices (ECDs) can be reversibly changed when an external voltage is applied. The efficiency and performance of ECDs depend on the quality of the transparent conductive electrodes (TCEs) to be used for the application of external voltage. ITO, the most commonly used material as a TCO layer, offers both high electrical conductivity and high optical transmission in the visible and near infrared region. The current study focuses on the deposition of ITO thin films on glass substrates by using the RF (Radio Frequency) magnetron sputtering technique and the effects of the film deposition parameters on the optical and electrochromic properties of the film have been investigated. The variation of deposition parameters such as working pressure and sputtering time, the aim is to determine the optimal thin film deposition conditions to obtain ITO films can be used for electrochromic applications, i.e., providing both low resistance (high conductivity) and high optical transmittance simultaneously.

P17

Quantum Algorithms for Satellite Threat Detection

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Abstract: In this study, an innovative approach has been developed to detect potential reconnaissance satellites posing threats over Türkiye. As the increasing density of satellites in Low Earth Orbit (LEO) amplifies the need for highly accurate and real-time surveillance systems, an interdisciplinary framework combining quantum-enhanced machine learning (QML) models has been proposed. Using Two-Line Element Set (TLE) data, orbital movements were computed and objects passing over Türkiye were identified, while Doppler shifts observed in satellite signals were analyzed through Quantum Fourier Transform (QFT) to enhance temporal and spectral resolution[1]. Quantum Support Vector Machines (QSVM) were employed to classify orbital datasets[2], and Quantum Generative Adversarial Networks (QGANs) were utilized to synthetically expand training datasets, addressing class imbalance issues. Stacking-based machine learning models performed risk assessments, achieving high accuracy in detecting known reconnaissance satellites. Satellites conducting signal intelligence (SIGINT) and electronic intelligence (ELINT) activities were evaluated based on their transit frequencies and data collection capabilities, and their threat levels were systematically assessed. When the classification performance of the model is evaluated, the overall accuracy rate is quite high with 86.67%. In terms of threat detection, the model shows an acceptable sensitivity (recall) by capturing 67% of real threats, while making strong and reliable decisions with 80% accuracy (precision). In terms of F1-score, a balanced performance between precision and recall was achieved with 73%. These results support the usability of the model in the field and its potential for integration into intelligence systems.

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P18

Design of IR zoom lens system for long-range detection in cooled MWIR camera

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Abstract: This paper presents the design of a compact and lightweight mid-wave infrared (MWIR) continuous zoom lens system with a focal length range of 20–275 mm and an F-number of 5.5, intended for use with a cooled 640×512 pixel detector. The system achieves near-diffraction-limited performance across the entire zoom range, making it suitable for reconnaissance, surveillance, and target tracking applications. The optical design is optimized using ZEMAX optical design software, ensuring consistent image quality throughout the zooming process. The zoom mechanism consists of three moving lens groups: one zoom group and two variator groups, all operated by just two motors to reduce mechanical complexity. The lens system comprises eight elements in total, including only two germanium lenses and two diffractive surfaces, significantly reducing material cost and overall system weight. Most lenses are made of silicon to further lower cost and enhance thermal robustness. The lens is athermally optimized to operate in harsh environmental conditions, ranging from -32°C to +70°C. With a total optical length of only 98 mm, the system is ideal for Size, Weight, and Power (SWaP)-critical platforms. The design offers a detection range of up to 14.9 km, highlighting its superiority over similar systems in the market in terms of performance-to-size ratio.

P19

Detailed SEM Analysis of Au/Ta_2O_5/Al Thin Films Fabricated by RF Sputtering for Reflective Color Filter Applications

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Abstract: Nowadays, structural colors are increasingly replacing traditional pigment-based coloring methods. Due to their high resistance to environmental influences, structural colors have recently become a significant area of interest for researchers [1]. Thin film technologies and material selection play a crucial role in the generation of structural colors. This is because parameters such as film thickness and the number of layers must be optimized to achieve the desired optical properties [2]. In this context, an Au/Ta_2O_5/Al/Si structure was designed for the fabrication of structural colors. RF magnetron sputtering technique was employed for the deposition of all thin films. By depositing the selected dielectric material, Ta_2O_5, at varying thicknesses (100, 150, 200, 250, 300 nm), different structural colors were successfully produced. During the thin film deposition process, a 10 nm thick gold (Au) layer was used as the top metal layer, and a 100 nm thick aluminum (Al) layer was used as the bottom metal layer. These thicknesses were kept constant for all samples. The structural detailed analysis of produced thin films is crucial for identifying factors such as grain structure and size, evaluating film quality, and examining the internal and crystalline structure of the film. For this reason, detailed structural and morphological analyses of the samples we produced were carried out by taking SEM measurements. When the SEM cross-sectional analysis results were examined, it was determined that the samples were successfully produced structurally. Additionally, the SEM surface images showed that the surfaces of all the samples exhibited a homogeneous distribution. The desired optical properties and different structural colors were successfully achieved due to the structural and surface characteristics of the produced samples. As a result, it has been determined that Ta_2O_5 material could be an advantageous option in the design of metal-dielectric based reflective color filters.

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Acknowledgement

This study is supported by TÜBİTAK (2209-A) with the project number 1919B012325961 and by CB-SBB with the project number 2019K12-149-045.

P20

ZnO Nanorod Arrays for High-Performance Photonic Devices: Synthesis, Characterization, and Applications

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Abstract: In recent years, nonlinear optical (NLO) phenomena have attracted considerable attention within the field of optical science, driven by advancements in nanotechnology and innovative fabrication methods. Transition metal oxides (TMOs), most notably ZnO, are of particular interest due to their high UV absorption, long carrier diffusion lengths, and strong luminescence [1]. ZnO, a direct band gap semiconductor (Eg: ~3.3 eV), is characterised by high electron mobility and chemical stability. It displays a variety of nanoscale morphologies and is extensively utilised in optoelectronic applications [2]. The hydrophilic nature of ZnO can be modified using low-surface-energy materials, such as PDMS, to achieve superhydrophobic properties. One-dimensional ZnO nanostructures, with a particular emphasis on nanorods (NRs), exhibit remarkable optical, electrical, and piezoelectric behaviour [3]. Notably, under 532 nm laser excitation, ZnO nanorods exhibit strong two-photon absorption and second-harmonic generation, with significantly enhanced luminescence compared to nanocrystals, making them promising candidates for advanced photonic and nonlinear optical applications. In this study, ZnO seed layer was deposited on soda-lime glass and PDMS substrates via high-vacuum physical deposition at 60 W of power and for 9 min of deposition time. Al-doped ZnO (AZO) thin films were prepared via high-vacuum physical deposition at 30 W of power for 15 and 20 min of deposition time. Pristine and Zr-doped ZnO nanostructured thin films were prepared via a low-temperature hydrothermal synthesis method at 80°C for 3h.

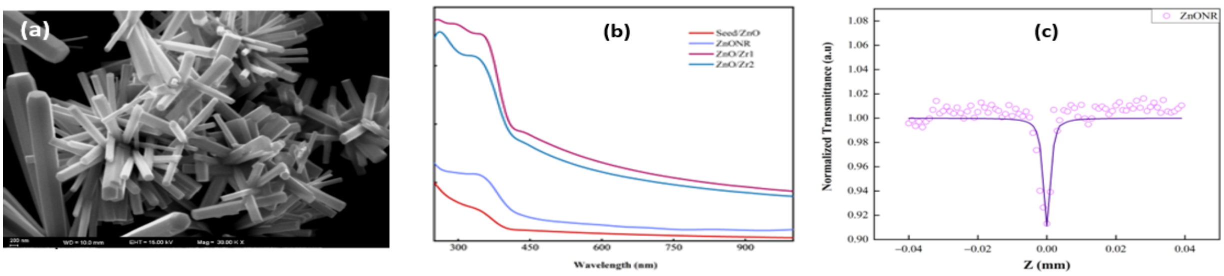

Fig. 1. a) SEM image of ZnO nanorods grown on a PDMS substrate, b) absorption spectra of Pristine and Zr-doped ZnO nanostructured thin films and c) OA Z scan curves for ZnO nanorods.

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P21

DEVELOPMENT OF A PAPER-BASED NH_3 GAS SENSOR VIA AEROSOL JET PRINTING FOR FOOD PACKAGING APPLICATIONS

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Abstract: The rising demand for fresh, minimally processed, and ready-to-eat foods, along with the increasing complexity of global supply chains, poses serious food safety challenges. Key concerns include temperature fluctuations, packaging failures, and microbial spoilage, especially in animal-based products like meat, fish, and poultry. Gas sensor technologies have thus gained attention for their ability to detect early signs of spoilage in packaged foods. Among these, flexible substrate-based sensors that detect ammonia (NH_3), a key spoilage indicator, have emerged as promising tools for smart packaging.

This study presents an eco-friendly, low-cost, and flexible NH_3 gas sensor suitable for integration into food packaging. The sensor was fabricated on paper using aerosol jet printing (AJP), where interdigitated electrodes were formed with carbon nanoparticle ink (Novacentrix JR-038). Among the paper types tested—Whatman Grade 2, nitrocellulose, and standard filter paper—Whatman Grade 2 was selected for its durability and heat resistance. The sensing mechanism is based on the interaction between NH_3 and adsorbed water molecules, producing OH^- ions ($NH_3 + H_2O \rightarrow NH_4^+ + OH^-$), which increase conductivity and cause a measurable resistance to change between electrodes.

The sensor was annealed at 100 °C for 10 minutes, achieving a surface resistance of 210 kΩ. In testing, aqueous ammonia gradually evaporated, reaching ~140 ppm NH_3 in 20 minutes. During this period, the sensor's resistance dropped from 600 MΩ to 9 MΩ, indicating successful gas detection. These results highlight the potential of aerosol jet printed carbon-based sensors as effective components of smart packaging to enhance food safety and reduce waste.

Acknowledgments
This work was supported by TÜBİTAK (2209-A, Project No: 1919B0123117551) and the Presidency of Strategy and Budget of Türkiye (CB-SBB-2019K12-149045). Support from the Photonics Application and Research Center is also gratefully acknowledged.

P22

Development of a Ray-Tracing Software for Simulation and Analysis of Optical Systems

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Abstract: In this study, we present the development of a MATLAB-based ray tracing optical design program tailored for the analysis and evaluation of Cassegrain-type telescopic systems. The motivation behind this project is to provide an educational and research-oriented tool that allows students and early-stage researchers to visualize and interpret fundamental optical behaviors without relying on commercial software. The program can simulate paraxial and marginal rays, generating spot diagrams, ray fan plots, optical path difference (OPD) maps, grid distortion evaluations, and basic Seidel aberration analysis. All calculations are derived from geometric optics principles and are implemented using ray propagation matrices and surface normal interactions. The system is specifically modeled for a 200 mm aperture telescope operating at the He-Ne laser wavelength (632.8 nm). Results obtained from this custom software will be compared with Zemax simulations to validate the program's accuracy and reliability. This work contributes to the democratization of optical design tools and supports educational efforts in photonics and optical engineering.

P23

Synthesis and Characterization of Protective, Anti-Reflective Diamond-Like Carbon (DLC) Thin Films

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Abstract: Amorphous carbon (a-C) is a carbon phase consisting of a mixture of sp^3 and sp^2 bonds, and carbon thin films in this phase are called diamond-like carbon (DLC) [1]. In the studies, DLC thin films have been applied to flat surfaces even at low temperatures and have been observed to have properties such as high hardness, high wear resistance, low coefficient of friction, high chemical stability, high gas barrier properties, high resistance to burning, biological compatibility and high infrared transmittance, and have been applied in areas such as electrical and electronic equipment, cutting tools, optical elements, automotive parts and windows [2]. While sp^3 bonds in DLC thin film coating affect the mechanical properties of the coating, sp^2 bonds affect the optical and electrical properties [3]. Within the scope of this study, it was aimed to increase optical transmittance, as well as to improve hardness, tribological and corrosion resistance properties by depositing DLC thin film coating on ZnS optical windows used in the infrared region utilizing magnetron sputter (MS) technique. Si substrates were cleaned in an ultrasonic cleaner with acetone, isopropyl alcohol and pure water for 10 minutes, respectively. Before coating, the system was lowered to a base vacuum of 4 μTorr. Plasma cleaning was performed on the substrates under 80 mTorr Ar pressure. In the MS system, using ZnS and graphite targets, first the ZnS layer was deposited under 8 mTorr Ar pressure and then the DLC layer was deposited under 4.8 mTorr Ar + 1.2 mTorr CH_4 pressure to fabricate the Si/ZnS/DLC structure. Delamination of the DLC layer has been overcome by introducing C to the system towards the end of ZnS sputtering step via reactive and co-sputter in the ZnS coating stage. In this fabricated structure, no delamination occurred in the DLC film deposited on the upper layer. Raman scattering, SEM image and FTIR optical transmittance measurements are obtained. Mechanically intact DLC coating on ZnS has led to 16% optical transmittance as opposed to 11% of pure ZnS in the 8-10 μm wavelength range.

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P24

Development of Flexible Temperature Sensors in Wearable Technology Using Aerosol Jet Printing Technique

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Abstract: In recent years, continuous efforts have been made to improve the quality, sensitivity and durability of sensors for optical-photonic applications. Advances in science and technology have led to the development of low-cost, next-generation sensors on flexible substrates for electronic applications in various fields. Thus, with the advancement of flexible electronics, flexible sensors for wearable technological applications aimed at real-time monitoring of physiological parameters have increasingly become the focus of research. Recently, wearable temperature sensors with favorable detection performance such as high sensitivity and fast response have been widely reported [1-2]. To achieve better temperature measurement performance, new materials such as graphene, carbon nanotubes, and metal nanowires are being used as temperature sensing materials [3]. Among these materials, carbon nanotubes are commonly preferred in temperature sensors due to their superior electrical, mechanical and thermal properties. In this study, carbon flexible temperature sensors were developed in wearable technology. As a first step, Ag interdigital electrodes were printed on Kapton substrate using silver ink by the aerosol jet printing technique. Subsequently, a carbon nanotube sensing element was developed between the Ag interdigitated electrodes using carbon ink, again employing the aerosol jet printing technique. The thickness of the carbon nanotube sensing element was measured as 3.16 μm, the average line width was 56.5 μm and the resistance was 1Ω. Changes in the resistance values of the developed sensor have been periodically observed.

Acknowledgments: This study was supported by TUBITAK as a 2209-A student project with the project number 1919B012323335 and by the Presidency of the Republic of Turkey Strategy and Budget Presidency with the project number 2019K12-149045.

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P25

EFFECT OF RESISTIVITY AND STRUCTURAL PROPERTİES OF GALLIUM-DOPED CZ SILICON ON PERC SOLAR CELL PERFORMANCE

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Abstract: This study investigates the effects of gallium doping in monocrystalline silicon grown by the Czochralski method and its potential to improve the performance of PERC solar cells. To eliminate light-induced degradation (LID), gallium (Ga) was used as an alternative to boron in the Czochralski (CZ) crystal growth process. Measurements taken at millimeter intervals along the crystal growth direction showed that, due to Ga's very low segregation coefficient, the Ga concentration in the ingot varies significantly, leading to sudden changes in resistivity. To control this variation and prevent efficiency losses, wafers were classified into narrow resistivity ranges. The impact of resistivity variation on solar cell efficiency was systematically studied, and the crystal growth process was optimized accordingly for advanced photovoltaic applications. Additionally, the structural properties of Ga-doped silicon were analyzed using infrared (IR) spectroscopy. Samples taken from the top, middle, and bottom sections of the ingot were examined to gain insights into the material's chemical structure and bonding characteristics [1,2,3,4].

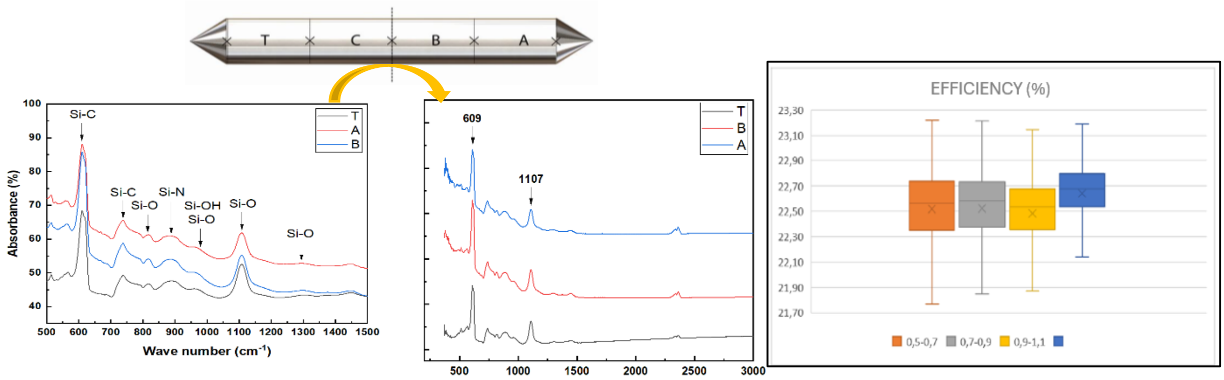

Fig.1. Detailed Analysis Results of the Study.

I would like to sincerely thank Kalyon PV for providing the facilities and technical support throughout this study, and I also express my special gratitude to all the professors in the Department of Photonic Science and Engineering at Gazi University, particularly Prof. Dr. Süleyman Özçelik, for their valuable contributions and guidance during the research process.

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P26

Microwave-Assisted Synthesis of Nitrogen-Doped Carbon Dots from PET Waste for Photonic Applications

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Abstract: Carbon dots (CDs) have outstanding potential in various application areas, including sensors, photodetectors, light-emitting diodes (LEDs), fluorescent inks, light (electro)catalysis, biomedicine, biological imaging, and analytical detection, due to their superior properties such as low cost and simple preparation, good biocompatibility, high stability, low toxicity, strong absorption in the UV–Vis region, tunable emission wavelengths, excellent photoluminescence, and remarkable photostability [1,2]. A wide range of carbon-containing materials can be utilized as precursors for CD synthesis. In this context, the production of CDs from plastic waste presents a valuable opportunity for high value-added upcycling and the reduction of environmental pollution. Among plastic wastes, polyethylene terephthalate (PET) stands out as a promising raw material due to its high carbon content and abundance of benzene rings [2]. In this study, nitrogen-doped CDs were synthesized via a microwave-assisted solvothermal method using terephthalic acid (TPA) and p-phenylenediamine as the carbon and nitrogen sources, respectively. TPA was obtained from the depolymerization of PET bottles through an alkaline hydrolysis process, achieving a conversion yield of 92%. The average particle size of the CDs was determined to be 6.7 nm using the small-angle X-ray scattering (SAXS) technique. The photoluminescence (PL) emission peak was centered around 600 nm under excitation wavelengths of 355 nm, 450 nm, 475 nm, 500 nm, and 550 nm. Additionally, a second PL peak appeared in the higher energy region of the visible spectrum (435 nm) when the excitation wavelength decreased to 355 nm.

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P27

Photoresponse and photosensitivity properties Au/TiO_2/p-GaAs (MIS) diode

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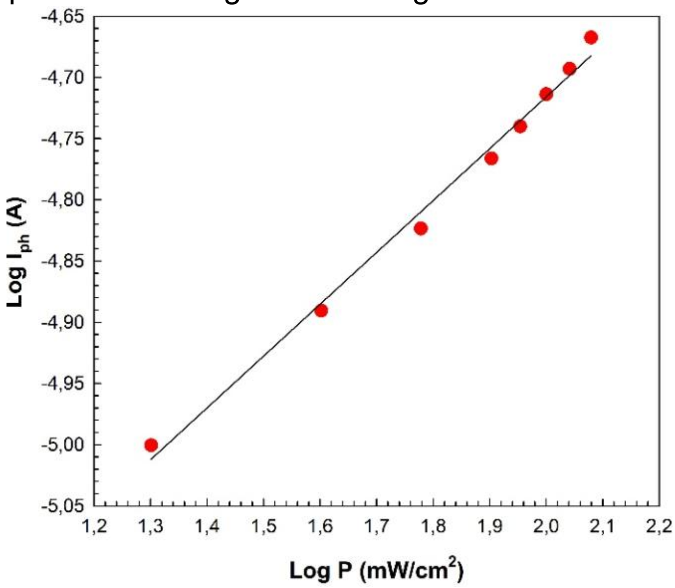
Abstract: In this study, current-voltage (I-V) characteristics of the fabricated Au/TiO_2/p-GaAs metal-insulator-semiconductor (MIS) diode were investigated under illumination intensity ranging from 20 to 120 mW/cm². From the I-V characteristics, it was seen that the current in the reverse bias increased with increase in illumination intensity. However, the current in the forward bias remained almost the same. Also, the photocurrent in the reverse bias was observed to be higher than the dark current. The results show that the MIS diode is sensitive to light and displays photoconductive behavior. The dependence of photocurrent on illumination intensity was analyzed by power law and given in the figure. It is seen that this graph exhibits a linear behavior.



Moreover, it was observed that the photosensitivity of the MIS diode increased with rising illumination intensity. The outcomes prove that the device displays photoconductive behavior. It was concluded that the MIS diode exhibits good photosensitivity and photoresponse properties.

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P28

Effect of Sn Doping on MoS_2 Thin Films for Photovoltaic Applications

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Abstract: Two-dimensional molybdenum disulfide (MoS_2) has recently attracted attention as a prominent material among transition metal dichalcogenides (TMDs) and has great potential for photovoltaic applications [1]. MoS_2, which exhibits remarkable electronic and optical properties due to its unique two-dimensional (2D) structure, is an n-type semiconductor and its optical band gap varies between approximately 1.2 and 1.9 eV [2]. Thanks to these properties, the integration of MoS_2 with Si, which has been frequently studied in solar cell applications in recent years, improves photovoltaic performance by improving charge separation and carrier transport. Moreover, the efficiency of MoS_2 in photovoltaic applications can be further increased through doping [3]. In this study, MoS_2 and Sn-MoS_2 thin films were deposited on Si and CG substrates at 380 ºC substrate temperature using RF magnetron sputtering system. In order to investigate the effect of Sn doping on the photovoltaic properties of MoS_2 thin films, Sn-MoS_2 thin films with different Sn doping ratios were obtained by changing the RF power values (1W, 2W, 3W, 4W and 5W). MoS_2 film thickness was kept constant in all samples as 100 nm. The photovoltaic properties of the obtained thin films were investigated using the currentvoltage (I-V) system. The measurement results revealed that Sn doping provides positive effects on MoS_2-based solar cells. Accordingly, it is anticipated that the obtained data will make significant contributions to the development of MoS_2-based solar cell applications.

Acknowledgement

This study is supported by TÜBİTAK (2209-A) with the project number 1919B012422718 and by CB-SBB with the project number 2019K12-149-045.

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P29

Development and Characterization of CdS-Polymer Nanocomposites-Based Optical Filters and Semiconductor Materials via SILAR Method

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Abstract: In this project, CdS (Cadmium Sulfide)-polymer nanocomposites will be synthesized using the Successive Ionic Layer Adsorption and Reaction (SILAR) method. The integration of nanostructured CdS materials into a polymer matrix aims to enhance the optical and electrical properties of the resulting materials. SILAR offers precise control over nanoparticle size and distribution, enabling the adjustment of the nanocomposite's optical band gap. The project focuses on developing tunable optical filters that selectively transmit or block specific wavelengths of light, with potential applications in photonic devices, optoelectronic systems, and sensor technologies. Characterization techniques such as UV-Visible spectroscopy, FTIR, XRD, and SEM will be employed to analyze the optical, structural, and surface properties of the nanocomposites. Furthermore, the mechanical strength, flexibility, and processability of the materials are expected to improve through the polymer matrix integration. The anticipated results include the production of cost-effective, high-performance materials suitable for solar cells, LEDs, lasers, and advanced optoelectronic devices. This study is expected to contribute significantly to the fields of nanotechnology and materials science by providing innovative solutions for optical filter technologies.

P30

The investigation of photosensitivity sensors based of the quaternary metal-oxide (ZnCdNiTiO2) semiconductor structures

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Abstract: In the present study, the photonic sensor comprising of p-Si and quaternary ($ZnCdNiTiO_2$) metal-oxide interfacial layer with (4;2;2;2) ratios have been fabricated and then both electric and optoelectronic parameters of them investigated by utilizing current - voltage (I-V) measurements both in the dark and under 140 mW/cm^2 in voltage range of ±5V at room temperature. The fundamental electrical parameters like zero bias barrier-height (Φ_{Bo}), ideality factor (n), and series resistance (R_s) were calculated from the intercept and slope of the linear part of forward bias Ln(I_F)-V_F plot both in dark and under 140 mW/cm^2 conditions. In addition, the energy density distributions of the interface traps (D_{it}) were obtained from the I_F-V_F data by taken into account voltage dependent of n and barrier height. The basic photonic parameters such as photo-current (I_{ph}), photosensitivity (S), photoresponsivity (R), and photo-detectivity (D*) were also obtained as functions of applied bias voltage in the reverse bias region. The other electric parameters such as n, BH, and R_s were calculated a second way by using Cheung functions to see the discrepancies between calculated method and voltage depending on these parameters. All these experimental findings indicate that a photonic sensor comprising of Al-(ZnCdNi:TiO_2)-pSi (MIS) structures exhibit satisfying rectification and photo-reaction behaviors under 140 mW/cm^2, so it can be successfully used as a photonic sensor and preferred in other photonic applications instead of conventional MIS type structures.

Keywords: Quaternary functional (Al/(ZnCdNi:TiO_2)/p-Si) devices; Photonic sensor applications; Electrical characteristics; Energy depended on profile of interface traps.

Acknowledgements: This study has been supported by TUBITAK with the research-project number-121C458 and Gazi University Scientific Research Project (BAP) with FYL-2024-9859.

P31

Investigation of f/# and MTF Relationship of Double Gauss Design for Lightweight and Low Volume Objectives

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Abstract: In modern optical design, achieving an optimal balance between performance, weight, and compactness is crucial, particularly in defense applications where portability and operational efficiency are of paramount importance. The Double Gauss lens design, characterized by its symmetrical configuration and effective aberration correction, remains a widely adopted solution for imaging systems that demand high optical quality within a compact form factor. A key parameter influencing the performance of a Double Gauss lens is the f-number (f/#), which directly governs light throughput, depth of field, and image quality. A lower f/# enhances light collection, improving low-light performance; however, it also introduces challenges in aberration control and imposes tighter tolerances in manufacturing. Conversely, higher f/# values contribute to increased depth of field and system robustness but may limit resolution due to diffraction effects. The Modulation Transfer Function (MTF) serves as a fundamental metric for evaluating these trade-offs, offering insights into how contrast and spatial resolution evolve across varying optical configurations. This poster presents a theoretical analysis of the relationship between f/# and MTF in Double Gauss lens systems, emphasizing their implications for lightweight and compact optical designs. The discussion highlights key design considerations specific to defense applications, focusing on the optimization of optical performance while maintaining minimal weight and volume. A thorough understanding of these relationships is critical for the development of next-generation imaging systems that fulfill the stringent demands of modern defense technologies.

P32

Investigating Quantum Reservoir Computing for Time Series Forecasting

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Abstract: This project investigates the application of Quantum Reservoir Computing (QRC) for time series forecasting, focusing on harnessing quantum dynamics to process temporal data efficiently. QRC is a quantum adaptation of classical reservoir computing that uses a fixed, randomly initialized quantum system as a computational medium, where only the readout layer undergoes training. This significantly reduces computational costs compared to deep learning models. The project outlines the methods for encoding classical input data into quantum states, modeling quantum reservoirs through unitary evolution and Lindblad-type noise, and extracting measurable outputs via projective measurements and Positive Operator-Valued Measures (POVMs). Several physical platforms for implementing QRC—such as trapped ions, NMR systems, superconducting qubits, and photonics—are discussed for their practical advantages and challenges. Benchmarking experiments, including NARMA, MackeyGlass, and Lorenz time series predictions, assess QRC's performance using metrics like Mean Squared Error (MSE) and Normalized Root Mean Squared Error (NRMSE). Although preliminary results indicate promising potential for dynamic modeling and complex pattern recognition, further empirical validation and optimization are necessary to fully realize QRC's capabilities in real-world forecasting applications.

P33

Quantum Metrology on a Remote Network

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Abstract: This research explores quantum-enhanced metrology in distributed networks, focusing on estimating linear functions of remote phase parameters using entangled quantum states. A central party (Alice) prepares entangled states, such as GHZ states, and distributes them to multiple remote parties (Bobs), who locally encode unknown phases. By analyzing quantum and classical Fisher information, the project examines the precision limits and the influence of different measurement strategies and noise models, including bit-flip and depolarizing noise. The study emphasizes the role of parity measurements across various bases (X, Y, Z) to reveal quantum correlations and optimize information extraction. Numerical simulations complement analytical calculations to visualize performance trends and the impact of noise. Findings show that while GHZ states offer high theoretical sensitivity, they are extremely fragile under realistic noise conditions. Optimal measurement choices, particularly in the Ybasis, are critical to fully utilize the entanglement advantage. This work contributes to understanding the feasibility and robustness of quantum metrology over remote networks and offers insights for designing future quantum sensor systems.

P34

Alloy Nanoparticle Generation By Laser Ablation of Pure Metals

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Abstract: With the widespread usage of nanotechnology, the importance of nanoparticles and nanomaterials has gradually increased. For this reason, fast and easy nanoparticle synthesis methods have become more important. Laser ablation technique, which is one of the applications of light-matter interactions, is a very effective method in nanoparticle synthesis [1]. Depending on the variability of optical and structural properties of nanoparticles synthesized by the laser ablation method, they are used in different fields such as solar cells, electronic circuits, and biomaterials. In this study, the laser ablation technique was applied to pure Silver (Ag) and pure Copper (Cu) metals in a liquid medium by using a high-energy femtosecond pulsed laser. As a result of the laser ablation process, it was aimed to produce nanoparticle alloys with the properties of Silver and Copper. In order to determine the optical and structural properties of the nanoparticle solution, characterization processes were carried out using Scanning Electron Microscope (SEM), UV-Visible Spectroscopy (UV-Vis), and Energy Dispersive X-Ray Diffractometry (EDX). The shape, size, and structure of the formed nanoparticles can be controlled by selecting appropriate laser parameters and experimental conditions [2]. In addition, it was concluded that the high-energy femtosecond pulsed laser used during the experiment was more suitable for laser ablation than nanosecond pulsed and picosecond pulsed lasers.

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P35

Hybrid ASE Light Source Design: Impact of Erbium-Doped Fiber Length on Spectral and Thermal Stability for IFOG Applications

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Abstract: An Inertial Measurement Unit (IMU) is a device that measures a system's motion using a combination of accelerometers and gyroscopes to determine orientation and acceleration without relying on external signals. These sensors work together to provide continuous, real-time motion data, making IMUs essential for navigation and control in various applications. Achieving this requires highly sensitive gyroscopes, and Interferometric Fiber Optic Gyroscopes (IFOGs) have become prominent due to their superior sensitivity, precision, and cost-effectiveness.

Two critical components determine IFOG performance: the fiber optic coil and the light source. The light source is particularly vital as it directly affects accuracy and stability. Among available options, the Amplified Spontaneous Emission (ASE) light source is preferred for its high-power, broadband, incoherent output, typically generated using an erbium-doped fiber (EDF). The incoherent nature of ASE reduces noise and phase errors, thereby enhancing bias stability and mitigating thermal drift and polarization fading.

This study investigates a hybrid ASE configuration that combines double-pass forward and double-pass backward configurations. We developed light sources using 6- meter and 11-meter EDFs and analyzed their spectral and thermal responses. As expected, the ASE spectrum evolved with fiber length: the dual-peak structure at ~1530 nm and ~1550 nm for the 6 m EDF transitioned to a single peak near 1562 nm for the 11 m EDF, accompanied by a narrowing of the full width at half maximum (FWHM) from 18 nm to 10 nm. Output power decreased from 32.6 mW to 16.6 mW at 250 mA pump current with increased EDF length. Thermal tests at –25°C and +60°C revealed enhanced wavelength stability for the 11 m configuration under extreme conditions, despite similar stability at room temperature. These results demonstrate the significant role of EDF length in shaping the ASE spectrum and thermal outputs, offering valuable insights for optimizing light sources in IFOG systems according to needs of the system.

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P36

Morphology-Controlled Plasmonic Coloring of Ag and Au Thin Films on Glass Substrates

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Abstract: This study investigates the optical and morphological properties of silver (Ag) and gold (Au) thin films deposited on 5×5 cm soda-lime float glass substrates via magnetron sputtering. This scalable technique offers a precise alternative to conventional glass tinting methods. Thin films with thicknesses of 3, 5, 7, 9, 12, and 15 nm were subjected to post-deposition annealing at 300, 400, 500, and 600 °C under vacuum conditions to promote surface diffusion and morphological reorganization while minimizing oxidation. After treatment, Ag and Au layers formed hemispherical, discrete nanostructures, while Au films exhibited almost uniform pinkish colors due to plasmonic activity. The resulting colors were due to surface plasmon resonance (SPR), which is highly influenced by the nanoparticles' size, shape, and distribution. Characterization was carried out using atomic force microscopy (AFM), scanning electron microscopy (SEM), and UV–Visible spectrophotometry to evaluate both structural evolution and plasmonic behavior. This work contributes to developing colored glass technologies using plasmonic nanostructured coatings. The research focuses on finding better ways to produce glass with tunable and selective optical responses to different wavelengths of light. This helps visualize the findings presented by plasmonic nanostructured coatings. Glasses with various thicknesses and coatings exhibit different optical properties due to structural changes, allowing for variations in the responses and shapes of the surface morphology.

Acknowledgments: This work was supported by TÜBİTAK (1505, Project No: 5240027) and the Presidency of Strategy and Budget of Türkiye (CB-SBB-2019K12-149045). Support from the Photonics Application and Research Center is also gratefully acknowledged.

P37

Substrate-dependent Investigation of $CuI/Cs_3Sb_2I_9/Nb_2O_5$/AgNW Structures for the Development of Lead-Free Perovskite Solar Cells

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Abstract: This study presents a substrate-dependent investigation of $CuI/Cs_3Sb_2I_9/Nb_2O_5$/AgNW multilayer structures for the development of flexible and lead-free perovskite solar cells. In the first step, silver nanowire (AgNW) transparent conductive electrodes were deposited onto various substrates, including flexible polymer-based (PEN, Kapton, PI) and rigid glass substrates, using Aerosol Jet Printing (AJP). In the second step, Nb_2O_5 thin films were prepared via the sol-gel method and applied onto the AgNW-coated substrates using spin coating under previously optimized parameters, followed by thermal annealing. Optical transmittance and electrical conductivity measurements were performed to evaluate film quality. In the third step, a $Cs_3Sb_2I_9$ perovskite solution was synthesized using a sol-gel process and coated onto the Nb_2O_5/AgNW/substrate stacks, followed by annealing and transmittance measurements. In the fourth step, a CuI hole transport layer was prepared by mixing CuI and dipropyl sulfide under an inert atmosphere and subsequently spin-coated onto the perovskite layers. The resulting $CuI/Cs_3Sb_2I_9/Nb_2O_5$/AgNW structures on all four substrates were annealed, and their optical properties were analyzed. Finally, Ag top contacts were thermally evaporated onto the CuI surface, and current–voltage (I–V) measurements were conducted to assess the electrical performance. The findings demonstrate the impact of substrate type on the optoelectronic behavior of environmentally friendly, solution-processed solar cell architectures.

Acknowledgments: This work was supported by TÜBİTAK (1001, Project No: 121F379) and the Presidency of Strategy and Budget of Türkiye (CB-SBB-2019K12-149045). Support from the Photonics Application and Research Center is also gratefully acknowledged.

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Design and Development of Modular Black Body Source for Infrared Calibration Systems

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Abstract: Blackbody radiation sources with high thermal stability are an important tool in the calibration of IR remote sensing systems. Accurate operation of thermal imaging systems relies on the availability of stable and reliable temperature references [1]. This study presents the design of a portable blackbody radiation source for mid-range thermal calibration tasks, featuring an extended area radiating surface. The system is built with a modular architecture and incorporates a bidirectional thermal control mechanism. A high- emissivity surface treatment was selected, and thermal distribution uniformity was optimized with integration into optical test environments in mind. The developed device is designed to provide a stable radiating surface that is unaffected by ambient temperature variations. For this purpose, it is equipped with a thermal control system that precisely compensates for potential surface temperature deviations and is optimized accordingly.

Preliminary evaluations demonstrate that the system delivers satisfactory performance in terms of thermal stability and surface uniformity within the targeted operating range. Ongoing development aims to extend the operating temperature range of the device to support the calibration of advanced thermal imaging systems used in high-precision applications. The proposed system is intended for a wide range of applications, including target simulation in defense technologies, validation of medical thermal imaging systems, and the creation of thermal reference platforms in scientific research laboratories.

Reference:

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Determination of Responsitivity of NiO Photodetector Structures

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Abstract: Nickel oxide (NiO), one of the metal oxide semiconductors, is an important p-type material for optoelectronic and thin film device applications. In this study, NiO thin films were deposited on n-Si substrates at different gas pressures (5, 10, 15 mTorr) by RF Magnetron Sputtering technique to fabricate NiO/n-Si heterojunction photodetector structures. In our previous studies, X-ray diffraction (XRD) and UV-Vis measurements of NiO thin films were investigated. As a result of the analyses, it was observed that the NiO samples had a cubic crystal structure and band gaps of approximately 3.8 eV. In this study, the surface morphology of the films was investigated by Atomic Force Microscopy (AFM) and low root mean square (RMS) roughness values were determined as 0.87, 0.82 and 0.87 nm, respectively. Current-Voltage (I-V) measurements were performed under different wavelengths of light in the ultraviolet and visible region. Responsivities of the samples were calculated using these results. Thus, the variation of the responsitivity of NiO photodetectors to light at different wavelengths with respect to the film coating gas pressure was investigated

Acknowledgements: This study was supported by TUBITAK with the 2209A project number 1919B012334055 and by the Presidency of Strategy and Budget (Türkiye) with the project number 2019K12-149045

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Morphological and Conductive Optimization of Silver Nanofibers Produced by Electrospinning

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Abstract: Transparent conductive films (TCFs) are key components in various optoelectronic applications such as photovoltaic cells, display technologies, and flexible electronics. Traditional materials like indium tin oxide (ITO) face limitations including brittleness, high cost, and scarce availability [1]. This study aims to develop high-transparency, low-resistance transparent electrodes by electrospinning silver nanofibers (AgNFs) onto glass and PET substrates. For this purpose, a solution containing $AgNO_3$, PVP, and N,N-dimethylformamide (DMF) was used to produce silver nanofibers via electrospinning. This formulation resulted in continuous, peelable nanofibers with well-defined morphology. The presence and structure of the nanofibers were confirmed by scanning electron microscopy (SEM) imaging, and representative SEM micrographs are presented in Figure 1. These findings highlighted the significant role of the solvent system in nanofiber formation dynamics and provided valuable guidance for the optimization of electrospinning parameters. To further enhance optical performance, anti-reflective (AR) dielectric nanofibers composed of SiO_2 and TiO_2 will be electrospun onto the reverse side of the substrates. The final goal is to achieve dual-functional transparent films with over 90% optical transmittance and sheet resistance below 30 Ω/sq. Early experimental observations indicate that this scalable, vacuum-free fabrication route holds strong potential for producing next-generation TCFs applicable to solar cells, flexible displays, and wearable devices.

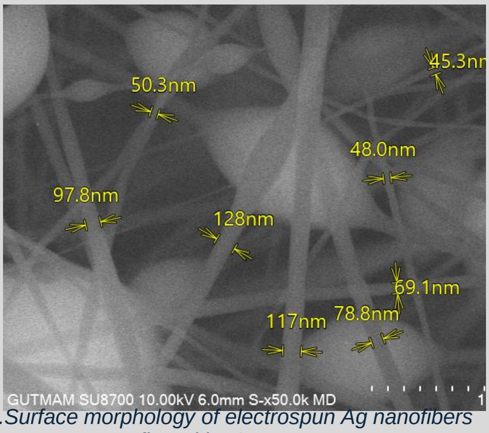

***Figure 1**.Surface morphology of electrospun Ag nanofibers confirmed by SEM.*

Reference: Lee, Y. I., & Choa, Y. H. (2012). Synthesis of silver nanofibers via an electrospinning process and two-step sequential thermal treatment and their application to transparent conductive electrodes. *Korean Journal of Materials Research*, *22*(10), 562-568.

Acknowledgements: *This study was supported by TÜBİTAK with project number 1139B412302886 (2209B), Gazi University with Project Number FPD-2024-9229, CB-SBB with project number 2019K12-149045 and ASENTEK Defense and Energy Technologies Company.*

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Microstructural and Characterization of $Al_xGa_{1-x}N$/GaN Structures Using Williamson–Hall and Chemical Bond Techniques

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Abstract:

Gallium Nitride (GaN) is a widely studied material in the literature due to its excellent electrical, thermal, and optical properties, making it highly suitable for high-power and high-frequency device applications. Owing to its durability under extreme conditions such as high temperature and pressure, AlGaN structures are commonly used for transistor application. In this study, strain–stress behavior, lattice spacing, and crystallite size of both graded and ungraded GaN samples were calculated and compared. The analyses were performed using High-Resolution X-Ray Diffraction (HR-XRD). Additionally, chemical bond strengths were determined and evaluated using Raman spectroscopy techniques. The graded AlGaN structure can be especially well-suited for data processing across a broad frequency spectrum.

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SWIR 10x Continuous Zoom Lens Design

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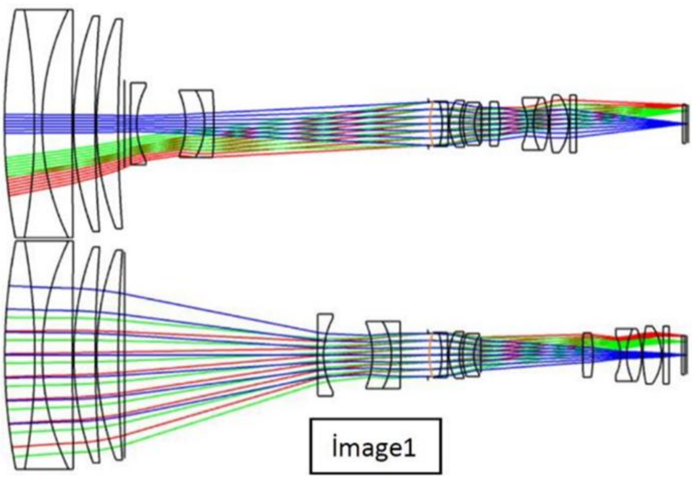
Abstract: SWIR radiation is the commonly accepted term for emission in the wavelength range of 0.9–1.7 micrometers in the electromagnetic spectrum; unlike mid- and long-wavelength infrared radiation, photons in the SWIR range exhibit properties similar to those of visible light. The SWIR band shares the properties of reflection and absorption with visible wavelengths. While mid- and long-wavelength infrared radiation typically arises from thermal emission from objects, SWIR provides high contrast and therefore higher resolution(1). In addition, due to its longer wavelength than visible light, SWIR interacts less with environments where visible light is scattered, such as fog, smoke, turbulence, haze, and clouds, making it advantageous for imaging in such conditions (1). SWIR is also used to detect low-level reflected light from long distances and laser dots (1.06µm and 1.53µm)(1). However, because SWIR imaging relies on reflected light, it requires illumination at night, which is often undesirable as it can activate target devices. Therefore, it is generally used for laser point detection rather than general night imaging. In this study, an optical system providing continuous zoom in the near-infrared region with a 10X zoom ratio was designed by moving two lens groups (a variator and a compensator) for a 640×512 pixel² detector with a pixel size of 15µm. The focal length of the system varies from 25mm to 250mm, while the F-number ranges from 4 to 5.5. The half field of view (HFOV) is calculated to be approximately 13.9° to 1.4°. In Figure 1, the upper design represents WFOV and the lower design represents NFOV. The study includes analysis of material selection, optical configurations, modulation transfer function (MTF), spot diagrams, and ray aberrations of the designed lens group. All analyzes and design processes were performed using the Zemax optical design software.



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