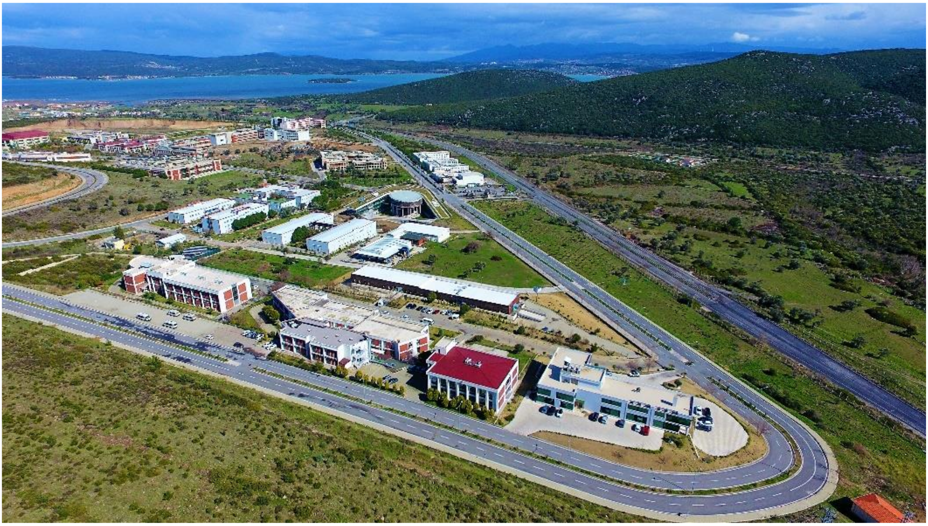
IZPHOTECH 2025

Talks on Photonics Science and Technology @ IZTECH



October 21-22

Izmir Institute of Technology, Urla/IZMIR

IZPHOTECH 2025

Talks on Photonics Science and Technology @ IZTECH

İZMİR YÜKSEK TEKNOLOJİ ENSTİTÜSÜ 1992

DEPARTMENT OF PHOTONICS
IZMIR INSTITUTE OF TECHNOLOGY

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Prof. Dr. Canan VARLIKLI
Head of IZTECH Department of Photonics

Dear Colleagues, Friends, and Students,

It is our honor and great pleasure to welcome you to the 2025 edition of the IZPHOTECH (Talks on Photonics Science and Technologies@IZTECH) conference series, organized as part of our celebration of the World Day of Photonics, proudly hosted by the İzmir Institute of Technology Photonics family.

The first IZPHOTECH meeting was held in 2022, and over the years, the event has continued to grow—expanding both its scope and audience. In 2025, we once again unite under the shared values of science, technology, and education. Our celebration of the World Day of Photonics also serves as a bridge connecting researchers, young academics, students, industry professionals, and educators-parallel to the efforts of our photonics undergraduate and graduate students and researchers striving to overcome the “valley of death” between TRL 4 and TRL 6.

We extend our heartfelt gratitude to our dedicated students for their tireless efforts, and to our international partners for their continuous support. Special thanks go to OPTICA and the IZTECH Foundation for their consistent backing since 2022, to OZOPTICS for supporting our undergraduate laboratory infrastructure and this event, and to the IEEE Photonics Society for their invaluable organizational support. We also thank all professors and collaborators worldwide who share our commitment to advancing awareness in photonics. Without their generosity, it would not have been possible to organize this event—free of charge—for the fourth consecutive year.

IZPHOTECH 2025 features fifteen scientific talks, eleven of which are invited lectures, covering innovations in photonic materials, devices, and systems. We are delighted to see the growing number of in-person participants each year. For the first time, we are including student oral presentations alongside the poster sessions we initiated last year, further encouraging our young Photonists, Light Scientists, and Engineers. This year, we are also hosting an “Author Workshop” to support young researchers in understanding and utilizing the importance of scientific publications in sharing new knowledge.

We hope that the contributions presented in this booklet, along with the talks and posters streamed on the official YouTube channel of the IZTECH Optics and Photonics Student Chapter, will inspire many future photonics enthusiasts.

With warm regards and best wishes for a fruitful and engaging meeting!

IZPHOTECH 2025 PROGRAM

<u>October 21, Tuesday Afternoon</u>

13:00 – 13:30 Opening Session

- **Canan Varlıklı** – Head of IZTECH Department of Photonics
- **Yann Amouroux** – Director of OPTICA Europe
- **Yusuf Baran** – Rector of IZTECH

13:30 – 14:15 Koray Aydın – *New Horizons in Photonics with Metasurfaces: Imaging, Sensing, and Quantum Applications*
(<u>Northwestern University, Evanston, IL, USA</u>)

14:15 – 14:30 Coffee Break & Poster Session

14:30 – 15:15 Liangcai Cao – *Intelligent Photonics: A Disruptive Technology to Shape the Present and Redefine the Future*
(<u>Tsinghua University, China</u>)

15:15 – 16:00 Ümit Demirbaş – *Periodically Poled, Precisely Tuned: Building Better Narrowband THz Sources for Guiding Lattice Motion*
(<u>Antalya Bilim University, Türkiye / Paul Scherrer Institute, Switzerland</u>)

16:00 – 16:15 Irem Saçın – *Enhanced Broadband Organic Photodetectors Based on a P3HT:PDI:PCBM Ternary Bulk Heterojunction*
(<u>İzmir Institute of Technology, Türkiye</u>)

16:15 – 16:30 Bedri Hızkan – *Targeting Distinct Photodegradation Pathways in OLED Materials with Antifader Additives*
(<u>İzmir Institute of Technology, Türkiye</u>)

16:30 – 17:00 Coffee Break & Poster Session

17:00 – 19:00 Author Workshop

- **Yalçın Ata –** *From Writing to Publication: Preparing and Navigating the Research Article Process* (<u>OSTIM Technical University, Türkiye</u>)
- **Alexey Bogdanov –** *On the Ethical Aspects of Scientific Publication* (<u>İzmir Institute of Technology, Türkiye</u>)

19:00 – … Dinner

IZPHOTECH 2025 PROGRAM

October 22, Wednesday Morning

09:00 – 09:45 Yashar A. Kalandaragh – *Advances in Super-Resolution Optical Microscopy and Tunable Microlens Array (Tunable MLA) Fabrication* (Gazi University, Türkiye)

09:45 – 10:30 Mehmet Berkay Ön – *Optics Enable Future Neuromorphic Computings (*Hewlett Packard Enterprise*)*

10:30 – 10:45 Cem Demir – *Fluorescence Lifetime Variations of Blue and Green Fluorescent Proteins Upon 'Stokes' and 'Anti-Stokes' Excitation/Detection* (İzmir Institute of Technology, Türkiye)

10:45 – 11:15 Coffee Break & Poster Session

11:15 – 12:00 Sezin Galioğlu – *Engineering Zeolites with Ultrafast Lasers: Insights into Gas Adsorption and Titanium Substitution (*Bilkent University, UNAM, Türkiye*)*

12:00 – 12:20 H. Azize Malay – *Towards a STEM-Based Photonics Literacy and Awareness Module: PhoTEM (*Uludağ University, Bursa, Türkiye*)*

12:20 – 13:30 Lunch Break & Poster Session

IZPHOTECH 2025 PROGRAM

October 22, Wednesday Afternoon

13:30 – 14:15 Cahit Yeşilyaprak - *Space Sciences Ecosystem: Türkiye National Observatories* (Türkiye National Observatories)

14:15 – 15:00 Kadir Durak – *Entanglement-Enabled Quantum Timing and Navigation* (Ozyegin University, Türkiye)

15:00 – 15:30 Coffee Break & Poster Session

15:30 – 16:15 Ozan Arı – *Nonlinear Quantum Light Sources for Quantum Technology Applications* (Hacettepe University, Türkiye)

16:15 – 17:00 Sercan Özen – *Understanding Performance and Stability of Perovskite-based Multi-Junction Solar Cells for Space Applications* (Potsdam University)

17:00 – 17:45 Alper Yanılmaz – *Future-Ready Display Solutions: From Lab to Market* (Vestel)

17:45 – 18:00 Coffee Break & Poster Session

18:00 – 18:30 Awards Presentation

18:30 – … Dinner

Koray Aydın

Dr. Koray Aydin is a Professor in the Department of Electrical and Computer Engineering and Applied Physics Graduate Program, where he leads the Metamaterials and Nanophotonic Devices Laboratory. He received his B.S. and Ph.D. degrees in Physics from the Bilkent University in 2002 and 2008, respectively. He worked as a postdoctoral researcher between 2008-2010 and a research scientist between 2010-2011 at the California Institute of Technology under the supervision of Prof. Harry Atwater. His research interests span several cross-cutting research directions in nanophotonics, including metamaterials and metadevices, plasmonics, inverse-design and machine-learning assisted nanophotonic design, 2D materials, phase-change materials, DNA-assembled and 3D printed nanophotonic materials. Dr. Aydin received the prestigious 2017 ONR Young Investigator Program Award. In 2019, he is selected as The Top Outstanding Young Person (TOYP) in Turkey in the field of scientific and technological development. His work bridges physics, chemistry, materials science, and engineering, with applications ranging from imaging and computation to quantum information.

New Horizons in Photonics with Metasurfaces: Imaging, Sensing, and Quantum Applications

The rapid transformation in information processing, sensing, and communication technologies is redefining light control—not merely as an engineering challenge, but as part of a broad, multidisciplinary frontier in photonics. At the heart of this transformation are metasurfaces, which enable the manipulation of light–matter interactions at the atomic scale, paving the way for compact, fast, and multifunctional optical systems.

In this talk, I will introduce metasurface architectures developed in collaboration with my research group and highlight their photonic applications. Using machine learning and inverse electromagnetic design, we have engineered optical components that advance imaging, spectroscopy, and information processing. I will share examples such as real-time optical edge detection, demonstrating the potential of light-based computation systems that are both energy-efficient and high-speed.

In the final part of the presentation, I will explore the potential of resonant metasurfaces interacting with quantum emitters for building quantum networks. By discussing the role of metasurfaces in bridging classical and quantum photonic systems, and reviewing current research directions, I aim to provide a multidimensional perspective on the future of photonic technologies.

Liangcai Cao

Liangcai Cao received his BS/MS and PhD degrees from Harbin Institute of Technology and Tsinghua University, in 1999/2001 and 2005, respectively. Then he became an assistant professor at the Department of Precision Instruments, Tsinghua University. He is now tenured professor and director of the Institute of Opto-electronic Engineering, Tsinghua University. He was a visiting scholar at UC Santa Cruz and MIT in 2009 and 2014, respectively. His research interests are holographic imaging and holographic display. He is a Fellow of the Optica and the SPIE.

Intelligent Photonics: A Disruptive Technology to Shape the Present and Redefine the Future

In 2024, the Nobel Prizes in Physics and Chemistry were awarded for advancements in artificial intelligence (AI), which has made breathtaking progress in recent years, evolving into a strategic technology for pioneering the future. The growing demand for computing power—especially in demanding inference tasks, exemplified by generative AI models such as ChatGPT—poses challenges for conventional electronic computing systems. Advances in photonics technology have ignited interest in investigating photonic computing as a promising AI computing modality. Through the profound fusion of AI and photonics technologies, intelligent photonics is developing as an emerging interdisciplinary field with significant potential to revolutionize practical applications. Deep learning, as a subset of AI, presents efficient avenues for optimizing photonic design, developing intelligent optical systems, and performing optical data processing and analysis. Employing AI in photonics can empower applications such as smartphone cameras, biomedical microscopy, and virtual and augmented reality displays. Conversely, leveraging photonics-based devices and systems for the physical implementation of neural networks enables high speed and low energy consumption. Applying photonics technology in AI computing is expected to have a transformative impact on diverse fields, including optical communications, automatic driving, and astronomical observation. In this talk, recent advances in intelligent photonics are introduced from the perspective of the synergy between deep learning and metaphotonics, holography, and quantum photonics. This talk will also spotlight relevant applications and offer insights into challenges and prospects.

Ümit Demirbaş

Ümit Demirbaş received his B.Sc. degrees in Physics and Electrical Engineering (2004) and his M.Sc. in Materials Science (2006) from Koç University, and his Ph.D. in Electrical Engineering from the Massachusetts Institute of Technology (MIT) in 2010. He worked as a postdoctoral researcher at the University of Konstanz (2010–2012) and founded the Laser Technologies Laboratory at Antalya Bilim University in 2012, where he continues to lead research activities. He is currently a Professor at Antalya Bilim University and a Laser Scientist at the Paul Scherrer Institute, having previously worked at DESY (2016–2023).

Dr. Demirbaş has published over 80 papers in laser physics and ultrafast optics, and has received several awards, including the TÜBA Young Scientist Award (2019), EU Marie Curie Career Integration Grant, Alexander von Humboldt Fellowship, and IEEE Photonics Society Graduate Student Fellowship.

Periodically Poled, Precisely Tuned: Building Better Narrowband THz Sources for Guiding Lattice Motion

Terahertz (THz, trillion cycles per second) light can nudge the “soft” degrees of freedom in matter (phonons, magnons, and low-energy electronic modes) without heating the sample. When pulses are narrowband and tunable, we can hit a single mode on resonance to drive phase changes, reveal hidden states, and run cleaner pump–probe measurements. Organic-crystal emitters (DAST/DSTMS/OH1, pumped at 1.3–1.6 µm) deliver strong fields and even multi-cycle lines, but limited durability and thermal conductivity cap the repetition rate to a few hundred hertz, and they require a separate mid-IR laser, adding cost and complexity.

Our approach uses lithium niobate (LN), a robust, cost-effective platform that works directly with kHz Yb- or Ti:sapphire amplifiers. In periodically poled LN (PPLN), velocity mismatch and quasi-phase matching (QPM) let us dial in bright, narrowband emission with record spectral brightness. Single-color output is continuously tunable from 0.25 to 2.4 THz with fractional bandwidth near 1 to 2 percent, delivering multi-µJ internal energies from kHz-class pumps. Efficiency reflects a balance between ω^2 scaling and THz absorption, shifting the optimum from ~1 THz at 15 K to ~0.5 THz at room temperature. A slight negative chirp consistently boosts conversion by easing self-phase modulation. Beyond single tones, high-order QPM in 400 µm PPLN generates phase-locked, multicolor THz combs with odd harmonics from about 0.3 to 2.4 THz on a tabletop. To push the range beyond 2.5 THz toward 5 THz, we are considering QPM sources based on alternatives such as ZnSe, GaAs and GaP. Modelling indicates at least a tenfold gain in energy and spectral brightness with tailored pump shaping and refined poling, and sub-percent linewidths are within reach, enabling compact, mode-selective THz excitation for quantum materials, chemistry, and soft matter.

Yashar Azizian-Kalandaragh

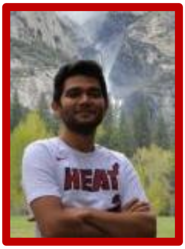
Yashar Azizian-Kalandaragh, born in Namin, Iran, received his Ph.D. in Physics from Baku State University, Azerbaijan. He is currently a Professor of Physics in the Department of Applied Sciences at Gazi University, Türkiye. His research interests include nanostructures, structured light, and photonics. Prof. Azizian-Kalandaragh has authored over 200 scientific publications and has supervised more than 40 M.Sc. and Ph.D. students to completion.

Advances in Super-Resolution Optical Microscopy and Tunable Microlens Array (Tunable MLA) Fabrication

Optical microscopy has undergone a profound transformation with the advent of super-resolution techniques that overcome the diffraction limit. This presentation explores the principles and applications of advanced methods, including Structured Illumination Microscopy (SIM), Near-Field Scanning Optical Microscopy (NSOM/SNOM), Stimulated Emission Depletion (STED), and single-molecule localization techniques such as PALM and STORM. The role of microsphere-assisted imaging and computational approaches, such as deep learning–based super-resolution and Fourier ptychography, in expanding imaging capabilities for life sciences and materials research is also highlighted.

A special focus is dedicated to Tunable Microlens Arrays (MLA), fabricated using innovative techniques such as molding, soft lithography, femtosecond laser machining, and two-photon polymerization. Particularly in liquid crystal–based designs, these arrays enable adaptive optical systems with high resolution and multifunctional performance.

Together, these innovations pave the way toward nanoscale imaging and advanced adaptive optical devices, exerting a significant impact on photonics, nanotechnology, and biomedical imaging.



Mehmet Berkay Ön

Mehmet Berkay On received the B.S. degree in electrical and electronics engineering from Bilkent University, Ankara, Turkey, and the Ph.D degree in electrical and computer engineering from University of California, Davis, CA, USA. He is currently working as a research engineer in HPE Large-Scale Integrated Photonics lab. His research interests include energy-efficient photonic neuromorphic computing, RF-photonic signal processing, fiber-optic communication/networking, and quantum networks.

Optics Enable Future Neuromorphic Computing

The computing paradigm is changing fundamentally. The famed Moore's law predicted that the semiconductor industry would double the performance of the classical processors almost every two years within the fixed chip area and power. However, as lithographic scaling approaches atomic dimensions, it has already started to flatten Moore's prediction. Another threat to conventional computers is massive performance demands from advanced artificial intelligence (AI) algorithms, which require high-throughput, low-latency, and energy-efficient matrix arithmetic operations. At this point, brain-inspired neuromorphic computing can meet the demand for AI models with energy efficiency and low latency. Although revolutionizing computing architecture promises significant performance improvements, the required innovations at the hardware level should be considered to realize the new paradigm. This work proposes photonics as an enabling computing hardware for neuromorphic computing. Photonic integrated circuits (PIC) can leverage silicon fabrication technologies. Therefore, silicon PICs can be dense, low-cost, and programmable. We propose Mach-Zehnder interferometer-based silicon PICs as synaptic interconnects of neuromorphic computers, which perform linear matrix-vector multiplications with massive parallelism through wavelength division multiplexing. Additionally, optoelectronic circuits with complementary metal-oxide semiconductor (CMOS) integration can implement the nonlinearity of the spiking neural networks (SNN).

Sezin Galioğlu

Dr. Sezin Galioğlu Özaltuğ is a principal investigator at the National Nanotechnology Research Center (UNAM), Bilkent University. She received her BS degree in Physics Engineering from Ankara University and a Ph.D. degree from the Micro and Nanotechnology Department at Middle East Technical University. Her doctoral work was mainly on the synthesis of various nanoporous materials and exploring them in application areas such as photochromism and ionic conductivity. She has established an interdisciplinary background in nanotechnology throughout her research career and got involved in collaborative TÜBİTAK and European Union projects. During her postdoctoral studies at UNAM, Bilkent University, she conducted experimental work on dissipative colloidal self-assembly using ultrafast lasers, which resulted in publication in *Nature Physics*. She invented a new ultrafast laser-driven assembly technique for nanoporous zeolite synthesis, published in *Advanced Materials*. She implemented the nonlinear laser lithography (NLL) technique (*Nature Photonics, 2013, 7, 897*) invented by Prof. F. Ömer Ilday at Bilkent University, where she proposed the idea of fabricating patterned thin films of nanoporous metal-organic framework (MOF) structures (funded under the TÜBİTAK 1001 basic science scheme). Currently, she is leading two TÜBİTAK projects - a 3501 Career project and a 1001 project - as the PI with her group.

Engineering Zeolites with Ultrafast Lasers: Insights into Gas Adsorption and Titanium Substitution

Zeolites are self-assembled microporous aluminosilicate nanocrystals. Their tunable composition, pore size, and high surface area enable diverse functions, including catalysis, ion exchange selective adsorption, CO_2 capture, and sensing, making them valuable for scientific and industrial applications. Various methods have been developed for synthesizing zeolites. While conventional hydrothermal synthesis offers benefits such as high-quality discrete crystals, ease of use, safety, and industrial scalability, it lacks precise control over nucleation and growth. A method that combines these advantages with the ability to produce zeolite crystals using low-energy photons within a short reaction time has not been developed yet. To address this, we introduce a new method, capable of delivering energy with unparalleled spatiotemporal precision on a timescale comparable to the polymerization reactions that drive crystal formation. Unlike conventional or emerging approaches, this method bypasses the need for specific temperature and pressure settings, as nucleation and growth are governed by dynamic phenomena arising from nonlinear light-matter interactions, such as convective flows, cavitation bubbles, plasma formation, and shock waves. We investigated the CO_2 adsorption and titanium substitution behavior of zeolites synthesized using ultrafast lasers.

Cahit Yeşilyaprak

Prof. Dr. Cahit Yeşilyaprak was born in Ankara in 1971. He graduated from the Department of Physics at Middle East Technical University (METU) in 1994 and completed his M.Sc. and Ph.D. degrees in astrophysics at Akdeniz University, Department of Physics, in 2003. During his graduate studies, he took part in the establishment and observational activities of TÜBİTAK National Observatory (TUG). In 2007, he worked as a postdoctoral researcher at METU and, in the same year, joined Atatürk University, Faculty of Science, Department of Physics, as a faculty member.

Within Atatürk University, he initiated the project studies of the Eastern Anatolia Observatory (DAG) in Erzurum in 2008 — home to Turkey's largest (4-meter diameter) and first infrared (IR) telescope — and served as the Principal Investigator of the DAG Project from its official start in 2012 until 2023. Academically, he established several key research and academic units at Atatürk University: the Astrophysics Research and Application Center (ATASAM) in 2012, the Department of Astronomy and Space Sciences and the Division of Astronomy and Astrophysics in 2013, and the Division of Optics and Photonics in 2021. He continues to serve as the director of these units. Between 2020 and 2024, he was a member of the TÜBİTAK-ARDEB Space Sciences Advisory Board, and between 2021 and 2024, he served as Turkey's national representative to the European Strategy Forum on Research Infrastructures (ESFRI) in the fields of astrophysics and astroparticle physics. He currently serves as a Board Member and Director of the National Observatories of Türkiye, which were established in 2023 under Law No. 6550 through the integration of DAG and TUG as a joint national research infrastructure.

Throughout his academic career, Prof. Dr. Yeşilyaprak has conducted research in astronomy and astrophysics, space science and technology, astronomical observation techniques and instrumentation, astronomical software and big observational data analysis, optical and photonic instrumentation, atmospheric and remote sensing studies, and infrared astronomy.

Space Sciences Ecosystem: Türkiye National Observatories

As part of the space ecosystem planned to be established under Türkiye's National Space Program, the 12th Development Plan, and Türkiye's Law No. 6550, this presentation will summarize the administrative, technical, and R&D processes of the "Türkiye National Observatories" research infrastructure, which will form the space science ecosystem, as well as the work carried out at our observatories that constitute this infrastructure. Some projects conducted within the scope of space sciences and optical technologies, which are the two most important areas of work and strategic objectives of this ecosystem as Türkiye National Observatories, will be discussed.

Kadir Durak

Kadir Durak received his B.Sc. Degree in Middle East Technical University Physics Department in 2009 and he started his PhD in National University of Singapore at the same year. After receiving PhD in 2015 he worked for two years in Centre for Quantum Technologies as team leader in a research group that works on space-ground quantum key distribution via a CubeSat. Dr. Kadir's main research areas are quantum cryptography, photonics, quantum electrodynamics and quantum information.

Entanglement-Enabled Quantum Timing and Navigation

Quantum entanglement serves as a cornerstone for both secure communication and precision sensing. Among its promising applications are quantum-based methods for time transfer and positioning, which may significantly surpass the performance of classical approaches. This talk will examine how pairs of entangled photons can be harnessed to achieve high-accuracy time synchronization. We will further illustrate how the principle of trilateration, widely used in conventional positioning, can be reimagined in the quantum regime through the use of multiple entangled photon sources. Emphasis will be placed on how the timing information derived from these systems can be transformed into reliable positioning data, and how this quantum-enhanced framework offers clear benefits over traditional positioning, navigation, and timing (PNT) infrastructures.

Ozan Arı

Ozan Arı is an Assistant Professor at the Institute of Nuclear Sciences, Hacettepe University, Department of Photonics. He received his BSc degree in Physics in 2009 from Ege University. He received his MSc (2011) and PhD (2017) degrees in Physics from the İzmir Institute of Technology. He then pursued his research as Chief Research Scientist at ASELSAN from 2018 to 2024. He established and managed the ASELSAN KUANTAL research laboratory, which focuses on practical implementations of quantum technologies for the defense business sector. He worked as a project manager for several Defense Industry Projects, including (Quantum RADAR and LIDAR) and was the group leader of ASELSAN Quantum Technologies Research Group. In 2024, he joined Hacettepe University to continue his research on integrated approaches to quantum technologies and founded “Integrated Quantum Optics and Sensing” (EKO) research group.

Nonlinear Quantum Light Sources for Quantum Technology Applications

Recent advancements in quantum technologies, including quantum computing, quantum sensing, cryptography, and navigation, have led to the emergence of prototypes and products characterized by high technology readiness levels. Quantum technologies are defined by the generation, manipulation, and detection of quantum states for practical applications. Nonclassical states of light (i.e. qubits and qumodes) are an essential resource for quantum technologies. Nonlinear light-matter interactions in solid-state materials are widely used for the generation of nonclassical states of light, including single photon states, correlated/entangled-photon pairs, and quadrature-squeezed states. In this talk, a brief introduction to discrete variables will be provided, and the generation of quantum states employing nonlinear interactions will be discussed. Furthermore, I will share the recent results from our research on quantum light sources and quantum technology applications.

Sercan Özen

Sercan Özen is a doctoral researcher in the ROSI (Radiation-Tolerant Electronics with Soft Semiconductors) Group, part of the Physics and Optoelectronics of Soft Matter Department at the University of Potsdam. He holds a B.Sc. in Physics and an M.Sc. in Photonics Science and Engineering, during which he focused on the experimental investigation of doped cesium lead halide perovskites.

Sercan's research background includes both experimental and computational studies on the structural, electronic, and optical properties of perovskite materials, as well as work on graphene-based flexible photodetectors. His academic path reflects a deep interest in light–matter interactions and optoelectronic device physics.

Currently, his Ph.D. research centers on the development and space qualification of perovskite solar cells, including both single- and multi-junction architectures. His work contributes to the broader effort of adapting next-generation photovoltaics for space applications, with a focus on radiation tolerance and operational stability.

Understanding Performance and Stability of Perovskite-based Multi-Junction Solar Cells for Space Applications

Multi-junction perovskite solar cells (MJ-PSCs) are a high-value candidate for space power, achieving high power conversion efficiencies (PCEs) and exceptional power-to-weight ratios that surpass conventional photovoltaic solutions. However, their reliability under the unique challenges of the space environment remains a critical hurdle. Beyond conventional degradation factors, the absence of Earth`s protective atmosphere introduces various stressors. In this presentation, I discuss AtOx-induced degradation, their radiation tolerance, and their operational characteristics under LILT conditions.

Atomic oxygen (AtOx) rapidly corrodes unencapsulated perovskite solar cells (PSCs), making ultralight barriers essential for future deployment. Yet even top-tier encapsulation can be breached by micrometeorite impacts. To address this risk, we studied how AtOx degrades PSCs with and without phenethylammonium iodide (PEAI)-based 2D surface passivation. Unexpectedly, devices with 2D passivation degraded more severely. Using injection-current-dependent electroluminescence (EL), EL imaging, intensity-dependent photoluminescence quantum yield (IPLQY), and resistance-photovoltage transients, we found that the 2D passivation layer accelerates degradation. The culprit: lateral diffusion of AtOx through the 2D surface, enabled by the wide interplanar spacing in the layered perovskite.

We tested unpassivated all-perovskite tandem solar cells under low-intensity, low-temperature (LILT) conditions relevant to deep-space missions near Saturn. At ~0.01 AM0 irradiance and ~100 K, typical spacecraft conditions, the tandem devices retained only ~50% of their original power conversion efficiency (PCE). In contrast, a control single-junction (1.5 eV) perovskite cell showed no performance loss. To investigate the cause of the PCE drop, we examined temperature-dependent trends in PCE, electroluminescence (EL), and photoluminescence (PL) across both cell types.

Alper Yanılmaz

Alper Yanılmaz received his Ph.D. in the department of Photonics from İzmir Institute of Technology (IZTECH) in 2023. His main research interests are fabrication and characterization of semiconductor-based lasers & sensors, and design & analysis of optical systems. He is currently working as Design Architect at Optical Design Unit in VESTEL Electronics, Manisa.

Future-ready Display Solution: From Lab to Market

Rapid advances in display technologies are leading the innovation of the visual information across industries. From laboratory-scale production to industrial display applications, micro-LEDs, organic-LEDs, quantum-dot-LEDs and their integrations, and new LCD architectures have provided unprecedented levels of resolution, brightness, color accuracy, durability and energy efficiency, while enabling new application-driven solutions in display technologies. From an optical design perspective, challenges remain in light management, uniformity, and scalability, yet these areas also present opportunities for innovation. Besides, providing vivid images by adjusting the color quality according to the customer requirements becomes one of the main responsibilities of the optical design unit. On the technical side, solving issues such as color mixing, angular dependency, and thermal management will determine how quickly these technologies can scale to mass production. This talk will highlight the key developments in emerging display technologies from laboratory to market, examine their optical design implications, and outline how they are shaping the future of visual systems and user interaction.

Yalçın Ata

Yalçın Ata (Senior Member, IEEE) received his Ph.D. degree in Electrical and Electronics Engineering from Gazi University, Ankara, Türkiye, in 2010. From 2004 to 2020, he served as a Senior Researcher, Chief Researcher, and Deputy Director at the TÜBİTAK Defense Industries Research and Development Institute and the TÜBİTAK Space Technologies Research Institute, Ankara, Türkiye. He is currently a Full Professor in the Department of Electrical and Electronics Engineering at OSTIM Technical University, Ankara.

His research interests include optical wireless communication, free-space optics, quantum communication, optical turbulence in the atmosphere, underwater environments, and biological tissue, as well as beam propagation in turbulent media. He is an Editor of *JOSA A* and the founder of SCOPT Inc., Boston, USA.

From Writing to Publication: Preparing and Navigating the Research Article Process

This invited talk will provide practical guidance for researchers aiming to publish their work effectively. The first part will cover preparing to write, including journal selection, defining authorship, structuring an article, and tips on article conception. The second part will focus on navigating the publication process, addressing essential steps before submission, strategies for submission, insights into the peer review process, and constructive ways to deal with rejection.

The session will offer participants clear strategies to strengthen their manuscripts and increase their chances of success in the competitive world of scientific publishing.

Alexey Bogdanov

Alexey Bogdanov graduated with honors (summa cum laude) from the Department of Molecular Biology, Faculty of Biology, at Moscow State University in 2006, and earned his Ph.D. in Molecular Biology from the Russian Academy of Sciences in 2010. Since then, he has served consecutively as a Research Fellow and Senior Scientist at the Institute of Bioorganic Chemistry in Moscow, where he led a research team within the Department of Biophotonics. Together with his colleagues, he discovered the phenomenon of light-induced electron transfer from the GFP chromophore to external electron acceptors, proposed and implemented strategies to enhance the photostability of fluorescent proteins, and engineered a palette of genetically encoded fluorescence probes—including membrane voltage and pH indicators, as well as tags for Fluorescence Lifetime Imaging Microscopy (FLIM).

Currently, Dr. Alexey Bogdanov is an Associate Professor in the Department of Photonics at the Izmir Institute of Technology. His research interests span a broad range of topics in biophotonics, including the photophysics and photochemistry of GFPs, and the development of molecular tools for bioimaging and neurobiology.

On the Ethical Aspects of Scientific Publication

As part of a workshop on the intricacies of preparing scientific manuscripts and navigating the publication process, a presentation will address the ethical dimensions of these activities. Participants will examine both the written and unwritten rules that guide the scientific community, consider why publishing concentrates on such a wide range of ethical challenges, and clarify what is meant by research misconduct. Common situations in this area will be illustrated with real-life examples and accompanied by recommendations developed by the broader scientific community and leading publishers.

ORAL & POSTER ABSTRACTS

Enhanced Broadband Organic Photodetectors Based on a P3HT:PDI:PCBM Ternary Bulk Heterojunction

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Organic photodetectors (OPDs) are attractive for next-generation optoelectronic systems due to their lightweight, mechanical flexibility, and compatibility with large-area, low-cost fabrication. However, conventional binary bulk heterojunctions (b-BHJs) such as P3HT:PCBM suffer from limited spectral absorption, restricting device performance.

To address this, a ternary bulk heterojunction (t-BHJ) active layer was developed by incorporating a newly synthesized perylenediimide (PDI) derivative into the P3HT:PCBM system. Devices with an ITO/PEDOT:PSS/Active Layer/Al configuration and a 7 mm^2 active area were fabricated and characterized under inert conditions. The optimized P3HT:PDI:PCBM (1:0.25:0.5, wt.) blend achieved a photocurrent density of 5 mA/cm^2 and a dark current of 0.25 mA/cm^2 at −1 V under 25 mW/cm^2 illumination.

Compared to the binary reference (4.5 mA/cm^2, 0.7 mA/cm^2), the ternary device exhibited ~6% higher responsivity and ~62% greater detectivity. These results demonstrate that the t-BHJ strategy significantly enhances spectral coverage and charge transport, paving the way for high-performance broadband OPDs.

Targeting Distinct Photodegradation Pathways in OLED Materials with Antifader Additives

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Organic Light-Emitting Diodes (OLEDs), especially those emitting in the blue part of the spectrum, are limited in operational stability primarily due to intrinsic exciton dynamics. Upon excitation of light-emitting material, only about 25% of the excitons occupy singlet states while the majority (~75%) reside in triplet states. In case of fluorescent and hyperfluorescent OLEDs, these long-lived triplets are highly problematic: they promote non-radiative recombination, generate heat, and accelerate chemical degradation of the emissive material via radical formation, ultimately leading to bleaching and severe intensity loss. To address this challenge, we explored antifader additives as a means of suppressing photobleaching and promoting pathways that can recycle triplets back into radiative singlets.

A custom fluorescence spectroscopy setup was designed, enabling high-precision spectral measurements under continuous laser excitation with automated acquisition via LabVIEW. Poly(9-vinylcarbazole) (PVK), dissolved in chlorobenzene, served as a prototypical light-emitting system. Initial examination of PVK under photoexcitation showed a characteristic sharp drop in emission intensity, followed by a slower long-term decay. The first antifader tested (1,4-diazabicyclo [2.2.2] octane) extended the emission half-life ($t_{½}$) of by approximately a factor of 1.5. Interestingly, while the lifetime of the long-lived emission component increased almost 10-fold, the short-lived one remained unaffected. This might indicate two different photodegradation mechanisms involved. A second additive (benzene-1,2-diamine) produced unexpected spectral behavior: while accelerating rapid early-phase bleaching, it induced a red-shifted secondary emission with an ~8–9-fold longer half-life compared to the native PVK.

To broaden the scope, we employed an alternative solvent system (DMF) capable of dissolving a wider range of antifaders. In this medium, two additional additives demonstrated strong suppression of the rapid emission-decay component, thereby complementing the stabilizing effect of 1,4-diazabicyclo[2.2.2]octane shown earlier.

Our findings highlight that different antifaders can target distinct phases of the photodegradation process, likely corresponding to different excited-state reactions. Future work will combine these antifaders synergistically and transition to solid-state films to fabricate prototype OLED devices, where their ability to prolong device performance can be directly assessed.

Fluorescence Lifetime Variations of Blue and Green Fluorescent Proteins Upon 'Stokes' and 'Anti-Stokes' Excitation/Detection

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Fluorescent proteins play a central role in live-cell imaging and molecular labeling, making the detailed investigation of their photophysical properties essential. In this study, we performed a comparative analysis of fluorescence lifetimes in Blue Fluorescent Protein (BFP) and Green Fluorescent Protein (GFP) variants (five proteins were unpublished mutant BFP variants) under different excitation and detection conditions. To analyze the photobehavior of these fluorophores, we applied steady-state fluorescence spectroscopy to record the excitation-emission spectra and time-resolved spectroscopy, based on the time-correlated single-photon counting technique, to assess fluorescence lifetimes.The measurements revealed significant differences in fluorescence lifetimes among the protein variants, as well as between measurement regimes within specific variants. These findings provide insights into the photon emission dynamics of BFP and GFP, offering valuable information for the selection of fluorescent probes in bioimaging applications.

Journey to STEM-Based Photonics Literacy and Awareness Module: PHOTEM

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The TÜBİTAK project titled “Journey to STEM-Based Photonics Literacy and Awareness Module: PhoTEM” aims to integrate photonics education into elementary and high school levels through a STEM-based, interdisciplinary, and collaborative approach. The project consists of four main phases: defining the concept of photonics literacy, developing PhoTEM learning modules, conducting teacher training programs, and implementing these modules in real classroom environments.

Photonics is one of the fastest-growing fields of modern science and technology, underlying key innovations in communication, medicine, energy, and environmental monitoring. However, despite its increasing presence in everyday life, photonics remains almost absent in school curricula. Most existing outreach programs are designed by scientists rather than educators, and few studies explore its pedagogical dimensions.

The PhoTEM project addresses the urgent need for educational involvement in photonics. Photonics literacy—a concept derived from scientific literacy on photonics—refers to individuals’ ability to understand, reason, and make informed decisions about photonics-related phenomena, technologies, and their ethical, social, and environmental implications.

By combining expertise from education, physics, and engineering, the PhoTEM team develops STEM-based photonics learning modules to enhance students’ conceptual understanding, curiosity, and critical thinking. The project ultimately aims to cultivate a scientifically literate generation capable of appreciating, applying, and innovating with photonic technologies from an early age—contributing to a more informed, ethical, and sustainable society.

Predictive Crack Detection in Glass Fiber Composites using Embedded FBG Sensor Data with a Neural Network

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We investigate embedded Fiber Bragg Grating (FBG) sensors for strain monitoring in 12-layer composite beams. Test samples were produced with an FBG embedded specifically between the 10th and 11th layers of the laminate. Three-point bending experiments were performed to observe how strain is transferred through the structure. The tests were carried out with different loading spans, starting from 27 cm and then reduced step by step to 23, 19, 15, and 11 cm. The wavelength shifts measured by the optical interrogator were analyzed. Results show a clear and nearly linear relation between applied load and measured strain in the elastic region. We have trained a convolutional neural network (CNN) with thousands of data samples to predict crack initiation based on the analyzed strain data to provide early indications of possible damage. This approach demonstrates a simple and effective method for real-time structural health monitoring.

Drying Dynamics and Molecular Fingerprints of Small Molecules by FT-IR and Raman Spectroscopy

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Aim: This study investigates the drying behavior of key metabolites through time-lapse Fourier-Transform Infrared (FT-IR) measurements and characterizes their molecular signatures with Raman spectroscopy, providing insights into humidity-dependent interactions and potential applications in biophysical monitoring.

Materials & Methods: Powder samples of urea, creatinine, glucose, sodium lactate, and phosphates were obtained from commercial suppliers and dissolved in H2O at a final concentration of 20 mg/mL. Time-resolved FT-IR spectra (4000–400 cm-1) were collected in every 10 seconds until complete drying using a PerkinElmer Spectrum Two spectrometer. Raman spectra of liquid samples were acquired with two acquisition settings: (i) 10-second exposure time with 5 accumulations for full-range spectra (4000–120 cm-1), and (ii) 1-second exposure time with 50 accumulations for a narrow range (1800–300 cm-1) to enhance resolution. Measurements were performed on an inVia Qontor Confocal Microscope equipped with 532 nm and 785 nm laser sources. Data processing was carried out in OPUS (v8.7), and visualization in MATLAB (R2023a).

Results: Sequential FT-IR spectra of metabolites revealed shifts in characteristic wavenumbers during the transition from liquid to dried state (e.g., urea from 1158 to 1155 cm-1, δ(NH2); creatinine from 1491 to 1488 cm-1 and returning to 1492 cm-1 upon complete drying, ν(C=N); glucose from 1035 to 1023 cm-1, ν(C–O)). Raman spectra of metabolites dissolved in H2O, acquired using two different laser sources, displayed distinct spectral features (e.g., urea at 1008 cm-1 ν(C–N), and 1160 cm-1 δ(NH2); creatinine at 862 cm-1 (ring breathing); sodium lactate at 855 cm-1 ν(C–C) + δ(CH3)). Also, employing a 1-second exposure time with 50 accumulations in narrow-band mode enhanced the resolution of these key wavenumbers.

Conclusion: FT-IR results demonstrated that the fingerprint wavenumbers of small-molecule vibrational modes are influenced by relative humidity, highlighting the need to carefully distinguish between dried and non-dried samples depending on the context. Raman spectroscopy of metabolites in aqueous solutions provided complementary insights to the predominantly solid-state studies in the literature, enabling more comprehensive profiling of their spectral properties when combined with sequential FT-IR measurements.

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Design and Fabrication of a Single Lens Using a Digital Micromirror Device

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In this study, a single lens structure was designed and fabricated with the aim of achieving precise optical characteristics. The lens was fabricated using maskless lithography based on a Digital Micromirror Device (DMD); eliminating the physical mask not only reduces fabrication cost and time but also provides rapid pattern modification and high flexibility in the microfabrication process. After fabrication, the surface topography of the mold of lens—including height, formability, and surface defects—was measured and analyzed with nanometer precision using a nanoprofilometer. The results demonstrate that this method is capable of producing lens with high accuracy and desirable uniformity, and it can serve as an efficient foundation for the development of microlens array and advanced optical structures.

Fiber – Optic Sensor for Liquid Level Measurements in the Industrial Sites

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Accurate and real-time liquid level measurement is essential for safe and efficient operation in many industrial sectors such as chemical processing, water treatment, and energy systems. Incorrect level readings can lead to issues like overflow, equipment damage, or process interruption. Traditional methods often face challenges like mechanical wear, environmental interference, or safety risks. This project aims to design and test fiber-optic-based liquid level sensing systems that offer higher reliability, safety, and flexibility.

Two different approaches were explored and implemented: one using an Optical Time Domain Reflectometer (OTDR), and the other using a Plastic Optical Fiber (POF) system integrated with a microcontroller. The OTDR-based method analyzes the reflection behavior of light at the open end of an optical fiber, which varies depending on the refractive index of the surrounding liquid. Data collected in air, water, and glycerin environments were processed using MATLAB to determine reflectance and attenuation parameters. These results show that the OTDR method can be used not only to detect faults in fiber systems but also to differentiate between liquid types based on their optical properties. The second method utilizes a plastic optical fiber with micro scratches to enhance sensitivity to external mediums. When the scratched area is immersed in liquid, light loss decreases due to the refractive index match, and this change is measured with a photodetector circuit. The system, controlled by an ESP-32 microcontroller, allows remote monitoring via Wi-Fi and includes a user interface for calibration and threshold adjustment. This low-cost system avoids direct electrical contact with the liquid, improving safety in hazardous environments.

In conclusion, both methods demonstrated that fiber-optic systems can be effectively adapted for liquid level measurement. The OTDR approach offers precise analysis for multi-point sensing, while the POF method provides a practical and scalable solution for real-world applications. These results support the further development of fiber-optic sensors in industrial automation and smart monitoring systems.

A Label-Free Plasmonic Biosensor for the Detection of a Rare Disease: Familial Mediterranean Fever

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Familial Mediterranean Fever (FMF) is a rare inherited autoinflammatory disease, predominantly affecting populations from the Eastern Mediterranean region, including individuals of Turkish, Armenian, Arab, and Sephardic Jewish descent. It is usually diagnosed in childhood or adolescence and is caused by mutations in the MEFV gene, which lead to abnormal pyrin protein expression and uncontrolled inflammatory responses. Clinically, FMF is characterized by recurrent episodes of fever, serositis, arthritis, and sometimes skin rashes. In the absence of a timely and accurate diagnosis and without the initiation of appropriate treatment, such as colchicine therapy, FMF can lead to serious complications, including secondary amyloidosis, which is associated with progressive renal impairment and a high risk of end-stage kidney failure. Despite the importance of early and accurate diagnosis, current diagnostic approaches mainly rely on genetic testing, which can be costly, time-consuming, and inconclusive, especially in heterozygous individuals.

In this study, we developed a label-free plasmonic biosensor capable of detecting the pyrin protein directly from clinical blood samples. The biosensor uses gold nanoparticles (AuNPs) functionalized with anti-pyrin antibodies and achieves a limit of detection (LOD) of 0.24 ng/mL with high specificity against other inflammatory markers (CRP, TNF-α, IL-6, Albumin, etc.). The signal remains stable for up to 6 months, and the platform demonstrates excellent reproducibility. In a clinical validation with 30 human samples (12 healthy, 18 FMF+), the biosensor successfully distinguished FMF patients from healthy individuals. Additionally, the results from the biosensor showed a strong correlation with those from the ELISA. The entire test workflow, including sample loading, signal acquisition, and data interpretation, was completed within 30 minutes, without the need for complex preparation or expensive instrumentation. These results suggest that this biosensor offers a rapid, cost-effective, and clinically reliable alternative to genetic testing for early diagnosis of FMF.

Multi-Output Regression Approach for MAPbI3 Perovskite Solar Cells

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In this study, Random Forest (RF), Multi-Layer Perceptron (MLP), and Deep Neural Network (DNN) models were used to predict the PCE, VOC, JSC, and FF parameters of the MAPbI3 (Methylammonium Lead Iodide) perovskite solar cell using multiple output regression learning. The models were trained on the training data and evaluated on the test data using three metrics—R^2 score, Mean Absolute Error (MAE), and Root Mean Square Error (RMSE)—to assess their accuracy and reliability. The RF model was found to have an R2 value ranging from 0.80 to 0.54 for both the test and training data. Similarly, the RMSE value ranged from 0.05 to 2.60, and the MAE values ranged from 0.03 to 1.78. For the MLP model, the R^2 value for the test and training data ranged from 0.70 to 0.44, the RMSE value was between 0.06 and 3.12, and the MAE values were from 0.04 to 2.07. For the DNN model's test and training data, the R2 value was found to be in the range of 0.70-0.36, the RMSE value was in the range of 0.06-3.29, and the MAE values were in the range of 0.04-2.17. The model's performance, potential bias, and the presence of overfitting were determined by drawing parity and residual plots. The graphs demonstrate that the three models applied do not exhibit a high level of overfitting or bias. A thorough analysis of the parity and residual plots was conducted, revealing that the RF model performed better than the other models employed. The SHAP plots were used to derive feature importance. Multi-output regression methodologies have been identified as a means of enhancing the design process for perovskite solar cells (PSCs).

Investigation of L-Valine/Pyrite Interaction by Multispectroscopic Methods

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Understanding the interactions of amino acids with minerals is an important aspect in the fields of prebiotic chemistry, mineral processing, surface chemistry. In the current work, the interaction of L-valine (a proteogenic amino acid that cannot be synthesized by mammals) with natural pyrite (FeS_2, commonly occurring sulfur mineral on Earth) was investigated by using multispectroscopic methods.

The characterization of pyrite was performed with X-ray diffraction (XRD) and Fourier transform infrared (FTIR) spectroscopy. XRD analysis was carried out using a Bruker D8 ADVANCE XRD with a Cu Kα X-ray tube and a Lynxeye detector. The FTIR spectra of both pyrite and pyrite–L-valine complexes incubated in artifical sea water matrix (ASW) were recorded under identical parameters in the 4000–400 cm^{-1} (mid-IR) spectral range using FTIR spectrometer (PerkinElmer, UATR Two) equipped with an attenuated total reflection (ATR) unit. Each sample was incubated with solutions at varying mass ratios of pyrite to L-valine (3.5:1, 5:1, 17:1, and 30:1). For control experiments, L-valine and pyrite in ASW were also prepared. All samples were incubated at 24 °C and centrifuged at 8000 rpm for 10 minutes.

XRD results showed that the main phase of the analysed samples was pyrite, with marcasite (orthorhombic FeS_2) components. ATR-FTIR analysis of pyrite samples exhibited peaks in the 990–1210 cm^{-1} region, corresponding to the asymmetric S–O stretching vibrations of the SO_4 group. The bands observed between 400–460 cm^{-1} were attributed to Fe–S lattice modes, while the band at 592 cm^{-1}, with a shoulder near 620 cm^{-1}, was associated with Fe–O bonds of magnetite (Fe_3O_4). The peaks in the 1040–1065 cm^{-1} region were present in all pyrite-containing samples but appeared much weaker in the valine control samples, indicating oxidized sulfate (S–O) species on pyrite. With decreased valine adsorption at higher pyrite ratios, the peaks in the 1068–1095 cm^{-1} region shift towards lower wavenumbers. At lower mass ratios, the bands near 1130 cm^{-1} might be attributed to sulphate–amino acid interactions.

These results strongly suggest that L-valine interacts with pyrite surfaces through sulphate-related functional groups, with variations in adsorption behaviour depending on the pyrite-to-valine ratio, implying that such mineral–organic associations could have played a role in the adsorption and organization of biomolecules under prebiotic conditions.

From Scalability to Uniformity: Optimizing Inkjet Printing of Perovskite Quantum Dot Layers

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Inkjet printing offers a scalable and material-efficient approach for fabricating perovskite quantum dot (PQD) optoelectronic devices. In this work, $CsSn_{0.5}Pb_{0.5}Br_3$ PQDs and their SiO_2-coated core–shell derivatives were formulated into stable inks and utilized as active layers in photovoltaic structures. The PQDs were pre-crystallized and colloidally stabilized, eliminating the need for post-deposition crystallization steps such as antisolvent or inert gas treatments; only mild thermal annealing was applied. Surface modification with (3-aminopropyl)triethoxysilane (APTES) replaced native oleylamine ligands, enhancing ink–substrate interaction and promoting uniform droplet spreading. To achieve precise control over printed film morphology, DPI optimization was conducted based on a simple geometric model considering mass conservation, spherical droplet geometry, static contact line, and no overlapping between droplets, while contact angle and shrinkage were adjusted according to ink molarity.

Small-angle X-ray scattering (SAXS) confirmed structural integrity in solution with an average particle radius of ~9 nm (Fig.1b), and photoluminescence (PL) analysis showed a strong emission peak centered at ~513 nm (Fig.1a), indicating preserved optical quality. This combined theoretical–experimental approach demonstrates that accurate droplet modeling and surface modification can significantly enhance the uniformity and reproducibility of inkjet-printed PQD layers, providing a pathway toward scalable fabrication of high-performance perovskite quantum dot photovoltaics.

The Role of Lighting Design in Sustainability and Student Performance in Educational Buildings

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Effective lighting design in educational environments requires an interdisciplinary approach to connect technical performance with human experience. The measurable attributes of light such as its spectrum, intensity, and distribution determine its visual and non-visual effects. These effects shape its biological effectiveness in regulating circadian rhythms, mood, and cognitive performance. At the same time, light plays a key architectural role in shaping comfort, defining space, and creating atmosphere within built environments. When these factors are well balanced, lighting can enhance alertness, comfort, and wellbeing which can lead to better performance and learning outcomes. Recent lighting standards emphasize non-visual effects and introduce metrics like melanopic Equivalent Daylight Illuminance (mEDI). These standards recommend maintaining around 250-lx mEDI during the day to support alertness and circadian health, with lower levels at evening to prevent overexposure and rhythm disruption. While natural daylight provides the most effective cue for biological alignment, it is often insufficient indoors, making artificial lighting essential. The widespread shift from fluorescent to LED systems reflects this need, offering improved energy efficiency and control options. However, beyond meeting visual and technical criteria, the success of this transition also depends on how people experience, perceive, and interpret light in their everyday learning environments.

The first stage of this research involved field measurements in classrooms to evaluate short-wavelength-enriched LED lighting through Spectral Power Distribution (SPD) and mEDI. Measurements from both student and teacher perspectives showed that mEDI levels often fell below the 250-lx threshold when blinds were closed, indicating potential reductions in alertness and cognitive function. In other cases, mEDI levels exceeded recommended limits, suggesting possible circadian disruptions. These findings highlight the importance of balancing circadian stimulation with visual comfort and daylight integration. The second stage explored users' subjective experiences through interviews with students and academics, shifting attention from measurable outcomes to lived perception. Participants described daylight as uplifting, activating, and connecting them to time and weather, while artificial light was often seen as sterile or monotonous. Their reflections reveal that occupants actively feel and interpret light as part of the classroom's emotional and temporal atmosphere.

This study examines lighting in educational settings by integrating quantitative measurements of spectral and circadian data with qualitative insights gathered from phenomenological interviews. By considering lighting as both a measurable factor and a personal experience, it provides a more comprehensive understanding of lighting quality in educational settings and its role in supporting alertness, wellbeing, and learning outcomes.

Light Manipulation in PMMA Metasurface Waveguides: A Simulation-Based Study

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A simulation-based study on polymer waveguides integrated with metasurface layers for enhanced light manipulation is presented. The material chosen for the waveguides are made of PMMA (polymethyl methacrylate), a transparent, low-loss, and easily fabricated material. Two metasurface geometries—square and hexagonal lattices—were designed and analysed using Tidy3D, an FDTD electromagnetic solver, to evaluate their optical performance at the 1550 nm telecommunication wavelength.

Results indicate that the hexagonal lattice provides smoother light propagation, reduced scattering, and higher transmission efficiency, reaching over 90% in optimized configurations. These findings suggest that PMMA-based metasurface waveguides offer a promising route toward compact, flexible, and high-efficiency photonic components for telecommunications, sensing, and integrated optical systems.

Optical and Structural Characterization of Al_2O_3 Thin Films Deposited by Electron-Beam Evaporation System

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Aluminum oxide (Al_2O_3) thin films with thicknesses of 100 and 300 nm were deposited from high-purity sapphire single crystals onto corning glass and silicon substrates using the electron-beam (e-beam) evaporation system under high-vacuum conditions. A rigorous systematic investigation was conducted to ascertain the impact of the film thickness on structural and optical properties.

The structural characteristics of the two deposited films were examined using X-Ray Diffraction (XRD), revealing an amorphous structure which is consistent with the results obtained through Fourier-Transform Infrared (FTIR) fingerprinting. Scanning Electron Microscopy (SEM) analyses of the surface and the profile were utilized to investigate surface morphology and film thickness. A cross-comparison was conducted of film thickness measurements obtained through distinct methods: Scanning Electron Microscopy (SEM), profilometer, and in-situ Quartz Crystal Microbalance (QCM) measurements.

The spectroscopic analysis was conducted using UV–Vis–NIR spectrophotometry, with the measurement range extending from 200 to 1100 nanometers. The obtained transmittance spectra of the deposited two Al_2O_3 thin films demonstrated an average optical transmittance of approximately 90% in the visible region. The optical band gaps were determined utilizing Tauc plots, as around 5.5 eV.

The obtained results of the study demonstrate the optical transparency and structural stability of e-beam-evaporated Al2O3 thin films, thereby affirming their suitability for utilization as dielectric spacer layers, optical coatings or passivation layers in optoelectronic and photonic devices.

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Developing a Machine Learning System for Cough Detection and Humidity Optimization Based on Circadian Time

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Personalized health care wearable devices and home systems greatly improve patient monitoring, allow acquisition of real-time data and immediate intervention. In respiratory diseases, where the patient's environmental conditions during sleep such as air humidity and room temperature are important, this type of approach also provides the opportunity of adapting environmental conditions together with constant monitoring. However, currently available systems are neither sufficiently versatile nor widespread available. This work introduces a machine learning–based framework for personalized cough detection and humidity optimization, tailored to nocturnal conditions. Using data collected from Arduino-connected sensors, the system employs a Gradient Boosting Classifier to identify cough events and distinguish between illness-related and environmentally triggered responses. Simultaneously, a Random Forest Regressor predicts the ideal humidity range for each situation. Real-time feedback control ensures that the humidifier operates only when necessary, enhancing user comfort while preserving energy. Designed with a self-learning structure and circadian awareness, the proposed embedded hardware design paves the way for affordable intelligent and personalized respiratory care at home.

Preliminary Experimental Results on the Use of Silver Nanoparticle Interlayers in OLEDs

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The external quantum efficiency (EQE) of organic light-emitting diodes (OLEDs) is fundamentally constrained by internal photon losses arising from waveguiding and plasmonic modes within the device [1]. Integrating metallic nanostructures into the device architecture has emerged as an effective strategy to mitigate these losses and enhance light extraction [2]. In this study, a plasmonic approach was employed by introducing a silver nanoparticle (Ag NP) interlayer. Although a reduction in turn-on voltage compared to the reference device was obtained, preliminary results demonstrate that optimizing the Ag NP interlayer parameters is crucial for performance enhancement.

Identification of Monolayer Cu-Sc-S Phases via Electronic and Optical Properties

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Motivated by the recent experimental realization of ultra-thin CuScS2 layers and the growing interest in expanding the library of ternary 2D chalcogenides, we conduct a comprehensive first-principles investigation of six monolayer Cu-Sc-S phases. It covers stoichiometric and non-stoichiometric compositions and exhibits various structural symmetries and atomic arrangements. Our analysis reveal how slight differences in the arrangement of atoms and the composition of chemicals affect vibrational, electronic, optical and mechanical responses. As well as providing insight into the intrinsic properties of unsynthesised monolayer forms, these results offer predictive guidance for future experimental efforts in the Cu-Sc-S family.

Ultrafast Laser Synthesis of Titanium Substituted Zeolites

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Titanium Silicalite-1 (TS-1) is a microporous titanium-containing zeolite whose unique redox activity, hydrophobicity, and framework-incorporated titanium sites make it a model system for selective oxidation catalysis and photocatalysis. However, the catalytic performance is fundamentally limited by the extent of titanium incorporation into the zeolite framework, which rarely exceeds ~2.5 Ti per MFI unit cell under conventional hydrothermal synthesis conditions. Traditional synthesis remains energy-intensive, requires extended reaction times, and often results in framework defects at elevated temperatures.

In our recent work that is published in Advanced Materials (2025), we introduce an ultrafast laser driven synthesis platform that uses femtosecond pulses to precisely control the energy delivery into the precursor suspension. By tuning key laser parameters such as pulse fluence, repetition rate, and focal geometry, we create a well-defined formation zone where multiphoton absorption generates localized high-temperature (10^5 K) and high-pressure. This dynamic environment promotes silica polymerization reactions and might enhance the probability of titanium incorporation into tetrahedral framework sites, potentially pushing the material closer to its theoretical substitution limit.

Through systematic modifications of laser conditions, we demonstrate the ability to synthesize TS-1 zeolite crystals with uniform size distribution, and accelerate nucleation and growth. Comprehensive characterization by SEM, XRD, HR-TEM ICP-OES, FTIR, UV-Vis, and UV-Raman confirms the improved crystallinity. The amount of Titanium substitution and effect of laser synthesis to photocatalytic activity will be tested through dye degradation reactions for further validations, using laser synthesized samples and together with commercial products.

This work highlights the synergy between laser–matter interaction physics and zeolite synthesis, establishing a versatile, tunable, and scalable approach for fabricating titanium silicalite-1. The methodology opens a path toward parameter optimized, ultrafast laser synthesis of advanced framework materials for next-generation catalytic and photonic applications.

NOTES

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Talks on Photonics Science and Technology @ IZTECH

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