IZPHOTECH 2024

Talks on Photonics Science and Technology @ IZTECH

October 21-22

Izmir Institute of Technology, Urla/IZMIR

IZPHOTECH 2024

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DEPARTMENT OF PHOTONICS

IZMIR INSTITUTE OF TECHNOLOGY

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

Dear Colleagues,

It is with great pleasure that we, the IZTECH Izmir Institute of Technology Photonics family, welcome you to this year's World Day of Photonics event. Our primary goal in organizing the annual Talks on Photonics Science and Technologies is to increase awareness, foster collaboration, share knowledge, and address the current challenges and opportunities in the field of photonics.

The IZTECH Department of Photonics, IZTECH Optics and Photonics, and the IEEE Photonics Student Chapters have come together to organize IZPHOTECH in celebration of the World Day of Photonics, with contributions from the IEEE Photonics Society Turkey Chapter and OPTICA. I would like to extend my heartfelt thanks to our dedicated students for their hard work, as well as to the international organizations for their financial support. Thank you for joining us to celebrate the remarkable advancements in this dynamic field. Your presence reflects your commitment to pushing the boundaries of knowledge and innovation in photonics across various sectors, including communications, healthcare, energy, and security.

Throughout İZPHOTECH'24, we will have the opportunity to listen to and engage with 13 scientific talks that highlight contributions to photonic technologies in fields such as biophotonics, communications, lasers, solar energy, and security. Eight of these presentations will be delivered in person. I would like to thank all our speakers for dedicating their invaluable time and expertise to this event. This year, for the first time, we are also excited to showcase 20 poster presentations, supporting the enthusiasm of our young Photonists, Light Scientists, and Engineers.

I hope that these valuable speeches and presentations, all of which will be streamed and archived on the official YouTube channel of the IZTECH Optics and Photonics Student Chapter, will inspire many photonics enthusiasts.

Thank you!

IZPHOTECH 2024 PROGRAM

October 21, Monday

09:00 – 09:30 Opening Speeches

09:30 – 10:30 **Martin Byrdin** – *Impact of Triplet State Population on GFP-type Fluorescence and Photobleaching*
(Jean-Pierre Ebel Institue of Structural Biology, France)

10:30 – 11:00 Break & poster presentations

11:00 – 12:00 **Kıvılcım Yüksel –** *Fiber Optic Sensor Applications*
(Izmir Institute of Technology, İzmir, Türkiye)

12:00 – 13:00 **Tawfique Hasan** – *Miniaturization of Optical Spectrometers*
(The Cambridge Graphene Centre, Cambridge University Engineering Department, UK)

13:00 – 14:00 Break & poster presentation

14:00 – 15:00 **Bengü Özuğur Uysal** – *Thin Films in Photonics*
(Imperial College London, UK)

15:00 – 16:00 **Yiğit Ozan Aydın** – *High Power Fiber Laser Sources near 3 µm: Applications, Advances and Challenges*
(University of Toronto, Miller Group and Atomically Resolved Dynamics, Canada)

16:00 – 17:00 **Ayşe Turak –** *Synergizing Stability and Precision: Harnessing Diblock Copolymer Reverse Micelle Templating for Tailored Perovskite Core-shell Nanoparticles*
(Concordia University, Montreal, QC, Canada)

17:00 – 18:00 **Fırat Yaşar –** *From Gravity Gradiometers to X-ray Space Telescopes: Photonic Systems Pioneering Space Missions*
(Jet Propulsion Laboratory, NASA, Pasadena, CA, USA)

IZPHOTECH 2024 PROGRAM

October 22, Tuesday

09:00 – 10:00 İsa Hatipoğlu – *Solar-Blind Photodetection and Its Applications*
(Gazi University, Department of Photonics, Ankara, Türkiye)

10:00 – 11:00 Mihai Irimia-Vladu - *The avenue to "Green" in Organic Bioelectronics*
(The Institute of Physical Chemistry and Linz Institute of Organic Solar Cells of Johannes Kepler University in Linz, Austria)

11:00 – 12:00 Maria Khrenova – *Molecular Modeling in Photophysics and Photochemistry of Biomolecules*
(Lomonosov Moscow State University, Russia)

12:00 – 12:30 Poster Award Presentation

12:30 – 14:00 Break

14:00 – 15:00 Talha Kuru – *Photocatalysis for Hydrogen Production: Industrial Applications*
(YEO-Reap battery, İstanbul, Türkiye)

15:00 – 16:00 Soner Mülayim – *Advance Fiber Optic Sensing Technologies for a Safer, Smarter Future*
(SAMM Technology, Kocaeli, Türkiye)

16:00 – 17:00 Alper Ülkü – *Leakage Current Reduction by Dielectric Permittivity-Graded Stacked Gate Oxides for FinFETs*
(ASELSAN, Ankara, Türkiye)

Martin Byrdin

Dr. Martin Byrdin earned his Master's in Biophysics from Moscow State University in 1994 and completed his PhD in Physics at Free University Berlin in 1999. Since 2004, he has been a researcher with the French Atomic Energy Commission, first at Saclay and later at the Institute for Structural Biology in Grenoble from 2009. Currently, he serves as Research Director at CEA Grenoble. His research centers on photoactivatable bio-nano-engines, particularly proteins, investigating their complex structure, dynamics, and functional relationships by pushing the limits of optical spectroscopies.

Impact of Triplet State Population on GFP-type Fluorescence and Photobleaching

Green fluorescent proteins (GFPs) are almost ideal markers to visualize the inner workings of a living cell. They are genetically encoded autofluorescent molecules and can be used to image any protein of interest with high selectivity and specificity. Their use revolutionized biological microscopy. But this gift of nature comes with an Achilles heel. In contrast to organic molecules or quantum dots, GFP-type proteins can undergo only a limited number of excitation-emission cycles (typically 104) before suffering light-induced destruction, a process also called photobleaching.

Almost fifty years ago, Hirschfed (1) showed that a fluorophors photobleaching propensity scales with both his absorption coefficient and his fluorescence quantum yield, leading to the unfortunate conclusion that the brightest markers are also the most photolabile ones. In the framework of his consideration, photodestruction scales linearly with excitation energy density, allowing for a straightforward means to quantify it by a power-independent parameter, the photobleaching lifetime.

Meanwhile, it has been observed, that for GFPs this linear relationship does not hold in general and both sub- and supra-linear behaviour has been reported (2). Here, we propose a framework to explain such unusual behaviour that specifically takes into account the first excited triplet state as a precursor for photobleaching. A mechanism is proposed to simultaneously maximize the fluorescence that can be harvested from a GFP molecule and to minimize the losses due to photodestruction (3).

1. Hirschfeld, T. (1976). Quantum efficiency independence of the time integrated emission from a fluorescent molecule. Applied Optics, 15(12), Article 12. https://doi.org/10.1364/ao.15.003135
2. Cranfill, P. J., Sell, B. R., Baird, M. A., Allen, J. R., Lavagnino, Z., de Gruiter, H. M., Kremers, G.-J., Davidson, M. W., Ustione, A., & Piston, D. W. (2016). Quantitative assessment of fluorescent proteins. Nat Meth, 13(7), Article 7. https://doi.org/10.1038/nmeth.3891
3. Byrdin, M., & Byrdina, S. (2024). Impact of Triplet State Population on GFP-type Fluorescence and Photobleaching. https://doi.org/10.1101/2024.02.19.580967

Kıvılcım Yüksel

Kivilcim Yüksel completed the M.S. degree in 2000 in Ege University, Electronics Engineering Department, where she worked as a research assistant. Afterward, she worked at Nortel Networks-Netas (Istanbul, Türkiye) as an optical research engineer. Between 2002-2005 she was with Multitel asbl (Mons, Belgium) Applied Photonics Group, mainly involved in the project on monitoring methods based on Optical Time Domain Reflectometry technique for point-to-multipoint optical access networks. She received a DEA and a Ph.D degree in fiber optics from the Faculté Polytechnique de Mons (FPMs, Belgium) respectively in 2006 and in 2011.

Since 2012 she has been working at the Electrical and Electronics Engineering Department of IZTECH, where she established the Fiber Optic Metrology and Sensor Applications Laboratory (FiSENS-Lab). Specific research areas she focuses on with her team at FiSENS-Lab include design and implementation of optical fiber reflectometry techniques, Distributed Optical Fiber Sensors, Fiber Bragg Grating sensors, and sensor data analysis.

Fiber Optic Sensor Applications

Fiber optic technologies have rapidly evolved and revolutionized various industries. They have become the backbone of modern communications, and their applications have extended far beyond telecommunications. From healthcare to infrastructure monitoring, from aerospace to environmental sensing, fiber optic sensors have a great impact.

In this talk, we discuss the operation principles, sensing mechanisms, challenges and newest applications of the distributed and quasi-distributed fiber optic sensors with a particular emphasize on the distributed acoustic sensing and fiber Bragg grating sensors. Recent progress obtained at the FiSENS-Lab (Fiber Optic Metrology and Sensor Applications Laboratory) through our research collaborations are also presented.

Tawfique Hasan

Tawfique Hasan is a Professor of NanoEngineering at the Cambridge Graphene Centre, Cambridge University Engineering Department and leads the group. He is also the Deputy Head of Electrical Engineering. He gained his PhD in Electrical Engineering from the University of Cambridge in 2009. He also has an MEng in Analog Microelectronics from the University of New South Wales, Australia. Tawfique got his BSc in Electrical and Electronic Engineering from the Islamic University of Technology, Bangladesh in 2001. He has held several research positions at Cambridge since his PhD, including a junior Research Fellowship at Kings College, Cambridge, a National Science Foundation China Foreign Young Scientist Research Fellowship and a Royal Academy of Engineering Research Fellowship. Professor Hasan is an Editorial Board Member of Advanced Photonics and a Fellow of Optica. He is also a Professorial Fellow and a Director of Studies in Engineering at Churchill College, Cambridge.

Miniaturization of Optical Spectrometers

Optical spectroscopy is widely used in non-contact materials analysis. Although laboratory bench-top spectrometers offer excellent resolution, range and sensitivity, their miniaturization is crucial for portable applications demanding indicative but instantaneous results. Among the recent developments in scaled-down spectrometers, an increasingly popular strategy is to use 'reconstructive' or 'computational' algorithm-based devices. Typically featuring spectral encoders with known optical responses, the measured electrical signals in such devices are combined to 'approximate' the incident spectrum through these algorithms. I will present an evolution of spectrometer miniaturization over the past 30 years and give examples of such disruptive concepts shaping future device technologies.

Bengü Özuğur Uysal

Prof. Bengü Özuğur Uysal completed a bachelor’s degree in physics engineering from Istanbul Technical University in 2000. Driven by a desire to advance academically, she embarked on a career in research, starting as a Research Assistant in the Faculty of Engineering at Kadir Has University in 2000. During her master’s studies in Physics, at Marmara University, she had the privilege of being mentored by Prof. Ulker Onbasli, who is renowned for holding the highest-Tc superconductor record. Then, she returned to Istanbul Technical University for PhD in Physics Engineering in 2004, focusing on the novel topic of thin films containing silica nanoparticles, which garnered significant attention in the scientific community. After she completed her PhD in 2012, she developed electrochromic and transparent conducting thin films with metaloxide nanoparticles. Continuing her academic journey as Asst. Prof. at Kadir Has University, she conducted research projects, gave lectures, advised graduate students and contributed to the academic community through publications, conference participation and collaborations for 23 years. In 2017, she received the title of Assoc. Prof. from UAK. She is the owner of the Material Design and Innovation Laboratory established at Kadir Has University in 2019. Her research has led to the successful application for two patents which have been internationally approved by WIPO. One is focusing on environmentally friendly bioplastics produced from algae and the other one is in relation to new methodology to measure indirect negative cavity water using polymers. A notable milestone in her career is being appointed as a Visiting Researcher, at the Department of Materials at Imperial College London, where her research interests perfectly align with the department's expertise, fostering a rich exchange of knowledge and collaboration. Since August 2023, she has been working in Prof. Julian Jones’ team on a project in researching sustainable polymer hybrids with silica nanoparticles extracted from miscanthus plant for bone regeneration. She was endorsed by the Royal Academy of Engineering, UK as a global talent with exceptional promise. Her research focuses on wide range of thin films with metal oxide nanoparticles, polymer hybrids, and two-dimensional materials enhanced polymer composites to interpret their physical parameters such as refractive index, extinction coefficients, activation energy, diffusion coefficients, drug release characteristics, optical band gaps, and elastic modulus controlling the particle size carrying out low-cost wet laboratory experiments for wide range of applications including biotechnology, drug design, agriculture, optoelectronics devices and photonics.

Thin films in photonics

Thin films, particularly those composed of metal oxide nanoparticles, have emerged as critical components in the advancement of photonic technologies. Their unique optical, electrical, and magnetic properties enable the development of high-performance photonic devices, including sensors, waveguides, and modulators. This talk explores the synthesis, characterization, and application of metal oxide thin films in various photonic systems. Emphasizing their role in enhancing light-matter interactions, we investigate how these films can be engineered to optimize device efficiency, sensitivity, and functionality. Through the controlled deposition of nanostructured thin films, we demonstrate significant improvements in optical properties such as refractive index, transparency, and nonlinearity, which are crucial for applications in Nanophotonics, Plasmonics, and Optoelectronics. Moreover, the integration of these films with polymer composites offers a pathway to flexible and tunable photonic devices, paving the way for innovations in wearable technology and advanced optical sensors. This research not only highlights the potential of metal oxide thin films in expanding the capabilities of existing photonic devices but also lays the groundwork for future developments in quantum photonics and other emerging fields. By leveraging the unique attributes of thin films, we aim to push the boundaries of photonic device engineering, offering new opportunities for high-speed, low-energy, and miniaturized photonic systems.

Yiğit Ozan Aydın

He holds a BSc in Physics and an MSc in Micro and Nanotechnology from Middle East Technical University, Turkey, followed by a PhD from Laval University, Center for Optics, Photonics, and Laser, Canada. His career spans both academic and industrial roles, including postdoctoral positions at the Center for Optics and Photonics at Laval University, Canada, and at the University of Toronto with the Miller Group and Atomically Resolved Dynamics. In laser industry, he served as a Senior R&D Scientist at Femtum, Canada, and FiberLAST, Turkey, and currently consults for various laser companies. He has contributed to over 30 scientific papers, including peer-reviewed journal articles, conference proceedings, and book chapters, and holds 2 patents.

High Power Fiber Laser Sources near 3 µm: Applications, Advances and Challenges

Fiber laser sources operating in the 2 to 5 µm range have made remarkable progress over the last decade, particularly in terms of compactness, reliability, pulse energy and output power. In the mid-infrared spectral region, laser emission around 3 µm and beyond is critical for numerous applications, including spectroscopy, countermeasures, and medical treatments. This talk will present recent advancements in soft-glass high-power fiber laser sources, highlighting their potential and actual applications, addressing current limitations, and exploring future expectations in the field.

Ayşe Turak

Ayse Turak is an Associate Professor in the Department of Physics at Concordia University, and adjunct Associate Professor in Engineering Physics and the School of Biomedical Engineering at McMaster University. Her research involves three intersecting areas: green energy via emerging 3rd generation photovoltaics, electrocatalysts, and batteries; disruptive technologies by way of optical sensors, anti-viral surfaces, and on-chip optical isolators; and advanced materials development for nanoparticles, hybrid organic-inorganic perovskites, and ferroelectrics. Her research vision is to drive engineering with nanoscience for easy, versatile, and inexpensive methods of producing, tuning and exploring nanostructures, targeting energy applications, sensing and magneto-optics. By making cheaper, more accessible, and more flexible products, her research makes an impact on how people use clean energy, access information and measure the world around them. Dr. Turak is an expert in materials and surface science, with 15 years of experience in the growth of nanoparticles and organic films. She has received an Early Researcher Award (2016), a Leadership in Teaching and Learning Fellowship (2017-2019) and the Petro-Canada Young Innovators award (2016). Prior to Concordia, she was a tenured Associate Professor in Engineering Physics (2012-2022), and Director for the Centre for Emerging Device Technology at McMaster University. In the international research community, she serves as the co-chair for the Canadian chapter for the Society for Information Display, and the director of the Functional Materials Research Consortium (with Hoseo University and A-Pro Ltd, S. Korea). She is an associate member of Regroupment Québécois sur les Matériaux de Pointe (RQMP), a member of the Canadian Printable Electronics Industry Association/intelliFLEX Innovation Alliance, and of EVATEG (Energy Efficient Electronic and Lighting Technologies Research Centre, Turkey). She also sits on the Editorial Board for the Journal of Materials Science: Materials in Electronics (Springer) and Scientific Reports (Springer-Nature), and as Associate editor for Frontiers in Photonics in Photovoltaic Materials and Devices. As a member of multiple equity seeking groups, she champions colleagues and students from under-represented communities, and celebrates their success, through her service in a variety of roles. She integrates equity, diversity, inclusion and accessibility in her teaching philosophy to achieve excellence in the pedagogy of science.

Synergizing Stability and Precision: Harnessing Diblock Copolymer Reverse Micelle Templating for Tailored Perovskite Core-shell Nanoparticles

Hybrid organic−inorganic halide perovskites have emerged as a disruptive technology, and recently, there has been increased interest in developing nanostructured perovskite materials, due to their extremely high photoluminescence quantum yields, optical absorption, and tolerance for defects. However, heterogenity limits the widespread use of nanoparticle devices. Additionally, metal halide perovskites are sensitive to moisture, heat, and light, leading to their performance degradation over time. There have been many attempts targeting the stability of hybrid perovskites, but no long-term solution has yet been achieved. Using various precursors, in two and three step loading approaches, we have been able to high density monodispersed metal−organic halide perovskite nanoparticles that emit across the visible spectrum using a diblock copolymer reverse micelle templating (RMD) [1,2,3,4]. Compared to traditional ligated methods, diblock copolymer micelle templating allows greater control over the size distribution and composition due to controlled the slower reaction kinetics for controlled crystal growth. Additionally, using micellar nanoreactors rather than dynamically stabilizing ligands allows the formation of monodisperse spherical 0D nanoparticles rather than nanoplatelets or nanorods, as is common particularly for perovskites with most approaches. Recently, we have also produced perovskite@metal oxide core shell nanoparticles, which show higher resistance to thermal and chemical degradation. Taking advantage of the tunability of these templates, we are able to produce particles of varying composition, structure, and size. With a complete picture of the synthesis process coming out of our research, it is possible to tailor nanoparticle properties for widespread applications.

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2. M. Munir, A. Salib, L. S. Hui, A. Turak, Chemistry 5, 2490–2512 (2023).
3. M. Munir, J. Tan, R. Arbi, P. Oliveira, E. Leeb, Y. Salinas, M. C. Scharber, N. S. Sariciftci, A. Turak, Adv. Photonics Res. 3, 2100372 (2022).
4. L. S. Hui, et al, ACS Appl. Nano Mater. 2, 4121-4132 (2019).

Fırat Yaşar

Dr. Firat Yasar is a postdoctoral fellow at the Jet Propulsion Laboratory, NASA, specializing in microelectronics, photonics, and optical systems. His research focuses on developing technologies for space applications. At JPL, Dr. Yasar works on advanced X-ray imaging detectors using GaN photonic crystals, Far-IR bandpass filters to enhance silicon nitride single-photon detectors, and quantum gravity gradiometers with space-qualified laser optic systems. Prior to JPL, Dr. Yasar worked at IBM/GlobalFoundries as Sr. Research & Dev. engineer, where he developed silicon photonics packaging and prototyped optoelectronic devices on CMOS chips. His work has earned him a few accolades, including the Microdevice Laboratory Team Award and the Global Foundries Spotlight Award. Dr. Yasar holds a Ph.D. (2020) and an M.S. (2014) in Materials Science & Engineering from the University of Wisconsin-Madison, and a B.S. in Physics from Anadolu University, Turkey.

From Gravity Gradiometers to X-ray Space Telescopes: Photonic Systems Pioneering Space Missions

Advances in photonic technologies are crucial for enhancing the capabilities of space missions. Dr. Yasar, in his presentation, will highlight three projects at the Jet Propulsion Laboratory (JPL), featuring advancements in X-ray imaging, far-infrared (Far-IR) filtering, and quantum gravity sensing. The GaN Photonic Crystal X-ray Imaging Detector leverages the unique properties of Gallium Nitride (GaN) photonic crystals to achieve high spatial resolution and energy-resolving capability through the self-collimation phenomenon. This advanced detector is pivotal for enhancing X-ray imaging in space applications like CHANDRA, and NuStar, offering robustness and efficiency in multi-layered architectures. The Far-IR Bandpass Filter, custom-designed and manufactured using membrane metasurface technology, effectively transmits 25-micron electromagnetic waves. This significantly improves the performance of silicon nitride single-photon detectors used in space missions like PRIMA, ensuring superior optical performance in the far-infrared spectrum. The Quantum Gravity Gradiometer project focuses on a space-qualified laser optic system designed to enhance the efficiency of an atom cooling system. By improving cooling temperatures and the number of atoms, this system advances gravity sensing capabilities, paving the way for more precise and reliable measurements of gravitational fields in space. These innovations collectively contribute to the advancement of space mission technologies, pushing the boundaries of current photonic and quantum sensing systems.

İsa Hatipoğlu

İsa Hatipoğlu earned his bachelor's degree in electrical and electronics engineering from Erciyes University, Turkey, in 2012. He completed his first M.Sc. in Electrical Engineering at the University of Alabama at Birmingham in 2016, where he focused on 2D real-time range imaging using a low-cost laser range finder. He then pursued a second M.Sc. in Optics and Photonics at CREOL, the College of Optics and Photonics at the University of Central Florida, in 2019, working on the fabrication and characterization of III-V lasers.

In December 2021, he earned his Ph.D. in Optics and Photonics from CREOL. His doctoral research centered on the epitaxial growth of metal oxide films and the design, fabrication, and characterization of photodetectors, particularly those based on gallium oxide and its alloys for solar-blind UV detection.

He began his academic career as an assistant professor at Şırnak University in Electrical and Electronics Engineering before joining the Department of Photonics at Gazi University's Faculty of Applied Sciences in Ankara, Turkey.

Integrated Multi-wavelength Lasers: Design, Control and Applications

Detection in the deep ultraviolet (DUV) range (~200-280 nm) is increasingly vital for applications like flame and missile detection, non-line-of-sight communication, as well as space-to-space and underwater communication. Ga2O3 has gained attention for DUV photodetectors due to its ultra-wide bandgap (~4.85 eV), n-type dopability, and excellent chemical stability. Despite these advantages, Ga2O3 faces several challenges, such as the lack of viable p-type doping, low hole mobility, and limited solar-blind coverage (~200-245 nm).

Recent advancements have sought to overcome these limitations by exploring both Ga2O3 and alternative materials to improve DUV detection. Epitaxial growth techniques, like molecular beam epitaxy (MBE), have been employed to finely tune material properties. Growth on substrates such as Si and sapphire has resulted in fast, highly responsive DUV photodetectors. Additionally, alloying Ga2O3 with elements like In and Sn has extended detection beyond 245 nm, achieving record photoresponsivities (~35 kA/W) in planar devices. The search for new materials for solar-blind photodetectors has accelerated, broadening the scope for future innovations in DUV detection.

Mihai Irimia-Vladu

Dr. Mihai Irimia-Vladu has been since 2019 Assistant Professor in the Institute of Physical Chemistry and Linz Institute of Organic Solar Cells of Johannes Kepler University in Linz, Austria, Austria. He was born in Craiova, Romania and obtained his B.S. in Mechanical Engineering from the University of Craiova in 1997. He completed his Ph.D. under the guidance of Prof. Jeffrey W. Fergus in the field of solid-state sensing, at the Materials Engineering Department of Auburn University, Alabama, in May 2006. He moved in July 2006 to Johannes Kepler University in Linz, Austria as post-doctoral fellow, working within the research groups of Prof. Serdar Sariciftci and late Prof. Siegfried Bauer. In Linz, he was the initiator and principal investigator of "green" materials for organic electronics. From 2012 to 2019, Dr. Irimia-Vladu was Senior Scientist at Johanneum Research, Department of Materials in Graz, Austria where he continued his research directions on biomaterials for sustainable circuits, energy conversion and storage, and bio-integrated electronics. Dr. Irimia-Vladu raised in excess of 2 million Euros in external funding, edited 1 book and authored 53 publications in peer reviewed journals, with 11 front cover highlights that received more than 5700 citations for an h-index of 28. He presented his group work through 10 tutorial/keynote, 27 invited presentations at international conferences and 28 seminars at various universities or research centers worldwide. Dr. Irimia-Vladu participated as an external member (opponent) of 4 Ph.D. defenses. For his first worldwide demonstration of "edible electronics", he was awarded in 2011 the "1st prize of Austrian Society for Environment and Technology" and was named "Austrian of the day" by the regional newspaper in the Upper Austria region. Among scientific discoveries that can be credited to Dr. Irimia-Vladu, is also the first report of semiconducting properties of the historic dye indigo, which helped open a new research field on hydrogen-bonded semiconductors. Dr. Mihai Irimia-Vladu is an active member of American Chemical Society and Materials Research Society and coalesced the emerging field of bioelectronics by co-organizing 5 international meetings, among them 4 Materials Research Society symposia. Dr. Irimia-Vladu's hobbies include history, literature, hiking, soccer and American football.

The avenue to "Green" in Organic Bioelectronics

Through its appealing avenues of processing the component devices at room temperature and from low-cost precursor materials, organic electronics has a tremendous potential for the development of products able to achieve the goals of production sustainability as well as environmental and human friendliness for electronics. In an effort to stave off the e-waste growth, the presenter and his research group went further down the path opened by organic electronics research and investigated a large number of biomaterials as substrates, dielectrics, semiconductors and smoothening layers for the fabrication of organic field effect transistors, integrated circuits and organic solar cells. The presentation will focus on the highlights of our recent research, especially with respect to materials investigated, devices fabricated and the immense potential for follow up research: (1) flexible natural and biodegradable substrates; (2) natural dielectrics; (3) bio-origin, H-bonded semiconductors in the families of indigos, anthraquinones and acridones; (4) bio-degradation protocols for organic semiconductors.

These highlights will be placed in the context of the mountain that one has to climb in order to reach the coveted "green" connotation for electronics, sensors and integrated circuits: (1) biocompatibility issue; (2) biodegradability issue; (3) compostability issue; (4) cost of production / energy expanded in production issue; (5) materials choice issue (carbon foot print); (6) toxicity and the environmental impact of the synthetic avenue for component materials.

The potential of follow-up research in the green electronics field is immense, with large area electronics fabrication, biomedical implants, bio-sensing and smart labeling, representing only the tip of the iceberg of many more immediate possibilities of high interest for our group. Natural and nature-inspired materials have the unrivalled capability to create "safe-first" electronic markets for humans and environment, with minimal or even neutral carbon footprint.

Maria Khrenova

Maria Khrenova graduated from the Chemistry Department of Lomonosov Moscow State University where she is currently a Professor and a Head of Laboratory of Quantum Chemistry and Molecular Modeling. Also, she is a Head of a Group of Molecular Modeling in the Research Centre "Fundamentals of Biotechnology" of the Russian Academy of Sciences. Her interests are focused on molecular modeling of mechanisms of enzymatic reactions as well as photochemical processes in proteins. She has the following awards: National stipend L'Oreal UNESCO "For Women in Science", Moscow Government award for Young Scientists and Professor of the Russian Academy of Sciences.

Molecular Modeling in Photophysics and Photochemistry of Biomolecules

Many biomedical and biophysical investigations require to move, stretch or mechanically probe a biological sample by exerting controlled forces in a non-contact way. Optical trapping of microscopic samples has been on the rise in recent years being a versatile technique for optical manipulation of biological samples at different length scales that can be combined with other measurement techniques for a better and/or more controlled experiment. In this webinar, I will be presenting the physical laws, advantages, disadvantages, and limitations of optical tweezers that make them suitable (or not) for a variety of applications in biomedicine and biophysics.

Talha Kuru

He got a Biotechnology BSc and MSc from Selçuk University in 2020 and 2023. Talha Kuru works as an R&D specialist at YEO, and he is also a PhD student in the Biotechnology department at Selçuk University. He worked on R&D projects for green hydrogen production, Biogas production and Power-to-Gas Systems. He conducts the design and synthesis of inorganic semiconductor catalysts for photocatalytic, electrocatalytic and piezo catalytic hydrogen evolution systems. Moreover, using advanced structural, morphological and electrochemical characterization techniques, he enlightens production mechanisms for hydrogen production systems by the synthesized catalysts. By developing national and international projects, he designs processes to bring different hydrogen production systems to an industrial scale.

Photocatalysis for Hydrogen Production: Industrial Applications

Photocatalysis for hydrogen production is a process that utilizes light energy, usually solar light, to develop chemical reactions related to water splitting and gain as an ultimate product hydrogen. This has drawn a lot of industry attention as a sustainable and responsible way, particularly in the green energy continues to exist. Photocatalysis for hydrogen production holds tremendous industrial potential, but most research on this promising technology is at the pre-application stage. This could find application for photocatalysis as a way to produce green hydrogen at large scale, that can be used in fuel cells and other industrial processes or transport sector. The hydrogen is produced via the photocatalysis can serve as a clean aqueous feedstock for ammonia and methanol (two important chemicals in the industries of chemical production), thus lowering the carbon intensity. Photocatalytic hydrogen can be stored and then electro-converted back to electricity in fuel cells, establishing a closed loop of clean energy. Photocatalysis has the potential to eliminate CO_2 emissions as it requires nothing but water and light for hydrogen production, compared to conventional hydrogen methods like steam methane reforming. State-of-the-art photocatalysts are highly efficient, but there is a lack of materials to work under common visible-light illumination or the conditions in large scales. Finding ways to reduce the instabilities of photocatalysts needed to generate hydrogen, ideally on an industrial or mass-production scale, would bring this technology in line with established methods. Addressing stability to long-term light exposure and environmental variations is crucial in order to translate the performance of photocatalysts on an industrial scale. The potential of photocatalysis for industrial-scale hydrogen production is great but a lot needs to be done in terms of materials sciences, reactor design and cost-efficiency before practical application of this approach can be established. Sustainable energy is still an exciting frontier.

Soner Mülayim

Soner Mulayim received his B.Sc. in Electrical & Electronics Engineering from Gazi University in 2016 and M.Sc. in Electrical & Electronics Engineering from Zonguldak Bülent Ecevit University in 2020. He is currently pursuing a Ph.D. in Electrical & Electronics Engineering at Gazi University, focusing on Cyber Security. Soner has worked as an R&D Engineer at SAMM Teknoloji since 2022, specializing in fiber optic sensing technologies, data analysis, and Python applications. He previously contributed to ASELSAN's Midas project, focusing on distributed acoustic fiber optic sensors and system calibrations. His research interests include fiber optic systems, signal processing, and cyber security in engineering applications.

Advance Fiber Optic Sensing Technologies for a Safer, Smarter Future

Fiber optic sensing technologies, such as Distributed Acoustic Sensing (DAS), Distributed Temperature Sensing (DTS), and Distributed Temperature Gradient Sensing (DTGS), have revolutionized how we monitor infrastructure and environments. DAS is widely used for pipeline intrusion detection and perimeter security, leveraging AI to classify events with precision. DTS provides real-time temperature monitoring and is applied in areas ranging from industrial processes to fire detection in tunnels. DTGS further enhances pipeline leak detection through detailed analysis of temperature gradients.

At Samm Teknoloji, we build upon these innovations to offer advanced, reliable solutions for diverse sectors. Our DAS systems enhance security through AI-driven event classification, while our DTS and DTGS technologies provide precise environmental monitoring and leak detection. Additionally, we are continually researching and developing new fiber optic sensing technologies, pushing the boundaries of what is possible in areas such as industrial monitoring, security, and infrastructure management.

Alper Ülkü

Alper ÜLKÜ received his B.Sc. in Electrical Engineering from Middle East Technical University and M.Sc. in Electrical Engineering from Gazi University, in 1991 and 1999. Currently he is a Ph.D. candidate in Materials Science and Engineering at Gebze Technical University and works as Team Leader / Chief Engineer of Display Technology in ASELSAN Microelectronics Guidance and Electro-Optics Business Sector, Turkey. His research interests include thin film transistors, display materials, display optics, radiometry and photometry, display ruggedization process and AMOLED device fabrication. He occasionally lectures on the technical elective course Optical Display Technology and Design course in Ankara and Karadeniz Technical Universities.

Leakage Current Reduction by Dielectric Permittivity-Graded Stacked Gate Oxides for FinFETs

The creation of the 3D version of metal-oxide semiconductor field-effect transistors, or FinFETs, in which the semiconducting channel is vertically surrounded by conformal gate electrodes, is one of the most noteworthy developments in MOSFET technology. The neighboring gate oxide width (tox) and fin width (Wfin) of FinFETs have shrunk from approximately 150 nm to a few nanometers in recent decades. However, the limitations of lithographic precision have caused these dimensions to become saturated recently. Through the use of the Penn model and the Maxwell-Garnett mixing formula, we show in this study that FinFETs with two- and three-stage κ-graded stacks of gate dielectrics made of SiO2, Si3N4, Al2O3, HfO2, La2O3, and TiO2 perform better than their single-layer dielectric counterparts. Based on this, FinFETs simulated with κ-graded gate oxides were able to obtain a gate leakage current (IG) of 2.04 × 10−11 A for the Al2O3:HfO2:La2O3 com-bination and an off-state drain current (IOFF) decreased to 6.45 × 10−15 A for the Al2O3:TiO2 combination. As our research pushes the individual dielectric laminates below 1 nm, the effects of κ-grading and dielectric permittivity matching for gate oxides still have the potential to provide insight into the possibilities for higher integration and lower power consumption in the next generation of nanoelectronics.

POSTER ABSTRACTS

Comparison of Sensitivity of Fiber Bragg Grating Sensors and Distributed Temperature Sensing for Temperature Detection (poster no. 1)

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Temperature detection is a critical component in various industrial and scientific applications, ranging from structural health monitoring to environmental sensing. Among the array of technologies available, Distributed Temperature Sensing (DTS) and Fiber Bragg Grating (FBG) sensors are prominent for their accuracy and reliability. This poster presents a comprehensive comparison of DTS and FBG sensors, focusing on their performance characteristics, applications, and suitability for different temperature monitoring needs. DTS sensors utilize the principles of optical time-domain reflectometry (OTDR) to provide continuous temperature measurements along a fiber optic cable. This method offers high spatial resolution and the capability to monitor temperature variations over long distances, making DTS ideal for applications requiring extensive coverage, such as pipeline monitoring and large-scale environmental sensing. The poster discusses how DTS sensors excel in providing a comprehensive temperature profile across a wide area, highlighting their benefits in scenarios where spatially distributed data is essential. In contrast, FBG sensors rely on the shift in wavelength of light reflected from a periodic grating structure inscribed in a fiber optic. Each grating reflects a specific wavelength that shifts with temperature changes, allowing precise point measurements. FBG sensors are well-suited for applications demanding high spatial resolution at discrete points, such as structural health monitoring of bridges and buildings. This poster examines the advantages of FBG sensors in delivering localized and accurate temperature data, their sensitivity, and their performance in challenging environments. The comparative analysis in this poster explores key factors such as spatial resolution, temperature range, sensitivity, and deployment complexity. DTS sensors are highlighted for their broad coverage and ability to detect temperature changes over long distances, while FBG sensors are noted for their high precision and suitability for localized measurement. The study also addresses practical considerations such as cost, installation requirements, and maintenance needs.

In summary, both DTS and FBG sensors have distinct strengths that make them suitable for different temperature monitoring applications. By comparing these technologies, this poster aims to provide valuable insights for selecting the most appropriate sensor type based on specific requirements and application contexts.

Tunable Magnetism in Tetramethylammonium-intercalated MnPS3 (poster no. 2)

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In this study, the magnetic effects of tetramethylammonium (TMA) molecule intercalated into MnPS3 on MnPS3 were investigated. The intercalation process was observed using methods such as Raman spectroscopy and atomic force microscopy and the results were supported by measurements of the magnetic behaviour of the intercalated molecules in outer plane and inner plane magnetic fields. The results show that the intercalated organic cations have the appropriate size and orientation to ensure that the Mn2+ vacancies are mostly removed from the same spin sublattice. This study provides an important method for the modification of the magnetic properties of van der Waals-type 2D materials by the introduction of multisubstituted organic molecules.

Refractive Index of Sensors: Basis Ring Resonators (poster no. 3)

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This study investigates the refractivity of ring resonators at varying refractive indices using Finite Difference Eigenmode (FDE) and Finite Difference Time Domain (FDTD) methods. Lumerical software is employed to obtain simulation data, and these results are compared with digitally plotted graphs to identify errors. The analysis focuses on key design parameters, such as ring radius and waveguide width, to optimize sensor sensitivity and detection limits. Findings demonstrate high precision in detecting low-concentration analytes, underscoring the potential of ring resonator sensors in advanced optical sensing technologies.

Comparing Image Processing Approaches for Evaluating Light Distribution in Optical Systems (poster no. 4)

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The study aimed to analyze and characterize the light intensity distribution across lenses by post processing intensity diagrams derived from image data. This research was conducted to improve the performance of LiDAR technology for applications such as obstacle avoidance, crowd counting, etc., by enhancing the optical characteristics of its lens component, and it can also be applied to various other optoelectronic applications. Three distinct image processing methodologies implemented using Python to evaluate and compare their effectiveness in calculating light intensity distribution: Sobel-based edge detection, Canny-based edge detection by dynamic threshold, and static thresholding without edge detection.

The first method utilized the Sobel operator to detect edges by calculating gradients in the x and y directions. The gradient magnitude was used to derive a dynamic threshold, allowing the isolation of high-intensity regions. The resulting intensity data was visualized through scatter plots, providing insights into the lens's ability to distribute light.

In the second approach, the Canny edge detection algorithm was applied. Canny's multi-stage process, which includes Gaussian filtering, gradient computation, and non-maximum suppression, enabled precise detection of edges. The dynamic threshold was determined based on the intensity of detected edges, producing clean and more detailed intensity diagrams. This method proved particularly effective for capturing finer optical details in the lenses.

The third method employed a fixed threshold without the use of edge detection. A manually set threshold filtered out low-intensity pixels, retaining only high-intensity regions. Although this approach was less adaptive to complex images, it provided sufficient information for simpler optical analyses where edge precision was less critical.

Each technique was evaluated in terms of its ability to accurately model light distribution across the image. The findings from this study offer valuable insights into the selection of image processing methods for optimizing the optical performance of LiDAR systems, contributing to the advancement of precision sensing technologies.

The Translation, Validity, and Reliability Study of the Light Exposure Behaviour Assessment (LEBA) for Measuring Light Exposure (poster no. 5)

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Light plays a crucial role in synchronizing biological rhythms and sleep with the external environment. These rhythms influence physiological, hormonal, and psychological systems, significantly impacting cognitive performance and overall health. While light exposure enhances alertness and cognitive function in the morning, it can disrupt sleep patterns and performance in the evening. To ensure optimal lighting conditions, continuous measurement of light exposure over time is necessary, typically achieved using sensors, photometers, or spectroradiometers. However, light exposure preferences can also be assessed efficiently and inexpensively through questionnaires. The "Light Exposure Behaviour Assessment" (LEBA)[1] was developed in English to measure light-related behaviours. The LEBA consists of an initial 48-item pool, each item rated on a five-point Likert scale according to the frequency of the behaviour. Research on participants from diverse geographical and cultural backgrounds suggests that certain sub-factors of light exposure behaviour may vary across cultures. Our study aims to translate the LEBA into Turkish, adapt it culturally, and evaluate its validity and reliability. This is the first time the LEBA has been translated into another language, and the study will further demonstrate its applicability across different linguistic and cultural contexts. Additionally, we will correlate the effects of light exposure behaviours with sleep quality using the Pittsburgh Sleep Quality Index (PSQI). We anticipate that rapid identification of light exposure patterns through this questionnaire will contribute to optimizing health and cognitive function.

Multicomponent Spectroscopic Profiling of Dialysis Fluids for Enhanced Biomedical Inspection (poster no. 6)

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Aim: This study aims to quantitatively analyze metabolites (urea, glucose, etc.) in dialysate fluid samples from patients during hemodialysis using Fourier-transform infrared (FT-IR) spectroscopy, providing a reliable reference for future measurements with quantum cascade laser (QCL) based IR spectrometer setup in our laboratory.

Methods: Samples of dialysate fluids were collected from chronic kidney disease patients during hemodialysis (Ethical committee approval #2022/4/1). Reference samples were carried out in laboratory environment by adding certain molecules at various concentrations to sterile dialysate fluid. Reference and real samples were separately analyzed with both Bruker ALPHA II (20 µL sample) and Perkin Elmer Spectrum Two (2 µL sample) FT-IR spectrometers equipped with an attenuated total reflection crystal. The spectra were recorded in the mid-IR range. Data analysis was performed with OPUS 8.7.41 and MATLAB R2023a software.

Results: The FT-IR spectra of dialysate samples display characteristic IR peaks, corresponding to each metabolite. Observation of a decrease in the IR signals over time emphasizes the patient's detoxification during dialysis. Calibration models show high coefficients of determination ($R^2 \geq 0.87$), indicating strong correlations between absorbance and concentrations of metabolites (urea, glucose, etc.). Thus, the use of mid-IR spectroscopic technologies for precise quantification of metabolites is validated.

Conclusion: The high accuracy of calibration models suggests that mid-IR spectroscopic technologies can be reliably used for biomedical monitoring of metabolites, with potential applications in clinical diagnostics and real-time patient monitoring during hemodialysis. Future work regarding the setup QCL-based IR spectroscopy for enhanced sensitivity and precision is in progress.

Species and Photoreceptor-Specific Quantification of Light (poster no. 7)

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Light serves as a vital environmental regulator of physiology and behaviour, with ecological light pollution disrupting circadian rhythms and impacting animal health and well-being. Ensuring proper lighting is crucial for indoor-housed mammals. However, the commonly used lux measurement, based on human-perceived brightness, is inadequate for capturing non-visual light effects and varies significantly across species. To address these limitations, we have designed a species-specific framework for quantifying light that accounts for evolutionary differences in photoreceptor types, spectral sensitivities, and eye anatomy [1]. This approach utilizes a high-throughput method to determine spectral sensitivities from recombinantly expressed Opsin proteins and used to establish the melanopsin sensitivity of twelve non-human mammals. Additionally, we compiled data on pre-receptoral light transmission across these species which allowed us to obtain more accurate cross-species comparisons of photosensitivity. Our findings highlight the superiority of species-specific light measurements over lux in predicting physiological responses in both laboratory and ecological settings. To simplify implementation, we created an online toolbox and validated a low-cost, multichannel sensor for practical, accessible light measurement. This approach demonstrates that measuring light considering differences between species is superior to the existing unit of lux and holds the promise of improvements to the health and welfare of animals, scientific research reproducibility, conservations against ecological light pollution, and energy usage.

A prospective, multicentre, cross-sectional cohort study to assess personal light exposure (poster no. 8)

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Light significantly influences various aspects of human physiology and behaviour, such as the synchronization of the circadian clock, melatonin production, and cognitive function. These effects, known as the non-visual effects of light, have mainly been studied in controlled laboratory environments where factors like light intensity, spectrum, and timing can be precisely manipulated to link them to physiological outcomes. Recently, growing feasibility of wearable light loggers has allowed for the examination of personal light exposure in real-life situations, revealing connections between light exposure and health outcomes and highlighting the importance of sufficient light exposure at the right times for overall well-being. However, there is currently a lack of comprehensive protocols that account for both environmental factors such as geographical location, season, climate, and photoperiod and individual variables (including culture, personal habits, behaviours, commute styles, and professions) that influence measured light exposure. In this context, we propose a protocol that integrates smartphone-based experience sampling with high-quality light exposure data collection from three body locations: the near-corneal plane between the eyes (mounted on spectacles), a neck-worn pendant/badge, and a wrist-worn watch-like device. The median melanopic equivalent daylight illuminance (mEDI) will be calculated based on objective measurements taken by the light logger for the corresponding hour. This approach aims to capture daily factors related to individuals' light exposure. We plan to implement this protocol in an international multi-centre study across Germany, Ghana, the Netherlands, Spain, Sweden, and Turkey, with a minimum target of 15 participants per site and an overall goal of 180 participants. Our dataset will characterize light exposure and assess the effectiveness of light logging devices across various geographical and sociocultural contexts. This will aid in identifying context- and lifestyle-specific factors linked to healthy light exposure patterns, serving as an initial step toward developing effective public health interventions.

Photonics in 5G: Revolutionizing High-Capacity Optical Communication (poster no. 9)

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The evolution of 5G networks is poised to transform global telecommunications by delivering ultra-fast, low-latency, and high-capacity data services. A critical enabler of this transformation is optical communication, particularly through the use of fiber optic cables. Fiber optics provides the backbone for 5G's high-speed data transmission, supporting key infrastructure elements like backhaul, fronthaul, and small cell densification. With the advent of technologies such as Dense Wavelength Division Multiplexing (DWDM), fiber optics can carry massive amounts of data on multiple wavelengths over a single fiber, significantly increasing network capacity. In dense urban areas, where the deployment of numerous small cells is necessary to handle massive data volumes, fiber ensures that these cells can communicate with the core network with minimal delay. Additionally, Fiber-to-the-Home (FTTH) plays a vital role in 5G deployment by extending fiber connectivity directly to end users, ensuring that high-speed, low-latency connections are available not just at the core of the network but at the access level. FTTH enhances the user experience by providing homes and businesses with the bandwidth necessary to support 5G applications such as virtual reality, cloud gaming, and smart home technologies. Optical communication also plays a crucial role in enabling network slicing, allowing 5G to support diverse applications with varying performance needs—such as enhanced mobile broadband (eMBB), massive machine-type communications (mMTC), and ultra-reliable low-latency communications (URLLC)—over the same shared infrastructure. As the demand for data continues to surge with the growth of IoT, autonomous systems, and immersive technologies like AR/VR, fiber optics remains essential for the scalability and sustainability of 5G networks, paving the way for future advancements in global connectivity.

Simultaneous Automatic Reconstruction of Digital Off-axis Holograms (poster no. 10)

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Quantitative Phase Imaging (QPI) is a technique that exploits the phase shift produced by transparent specimens to measure the phase of the cross-correlation function captured in holograms, using this data to generate intrinsic contrast. QPI has applications across diverse fields, including material science, optics, environmental monitoring, and biomedicine. Digital Holographic Microscopy (DHM), an off-axis QPI technique, enables single-shot, wide-field acquisition with nanometer accuracy by employing Mach-Zehnder interferometry and digital sensors (CCD or CMOS). These distinctive capabilities make DHM a powerful tool for optical thickness measurements, surface topography analysis, and dynamic live cell studies.

Challenges arise during the development of DHM setups and the recording of holograms. DHM requires a perfectly aligned interferometric setup, which can be challenging. Additionally, intrinsic aberrations, such as off-axis distortion and lens aberrations, further complicate the setup [3]. The choice between telecentric and non-telecentric configurations significantly impacts performance, with non-telecentric setups introducing added complexity due to mismatched wavefront curvature in the optical design. Even after the setup is optimized, the recording process presents further difficulties. Typically, hologram recording is separated from the reconstruction process, which is performed as a post-processing step. This separation poses challenges for real-time assessment, particularly in live cell studies, where phase reconstructions can only be evaluated after complete acquisition.

To address these limitations, we have developed a practical Python-based interface for off-axis DHM that enables automatic real-time reconstruction. The algorithm is integrated into an open-source camera application and requires minimal input parameters, such as wavelength and sensor pixel dimensions, customized to the user's setup. The algorithm automatically reconstructs amplitude information for telecentric and non-telecentric setups and can reconstruct phase information for telecentric setups. The interface displays the hologram domain, Fourier domain, amplitude reconstruction, and phase reconstruction in separate frames based on the user's preference. This automatic real-time monitoring capability greatly enhances setup alignment and facilitates efficient digital holographic reconstruction. The multifunctional tool is compatible with custom-built and commercial DHM systems, providing flexibility across various applications. Nevertheless, the algorithm faces challenges with non-telecentric setups due to the increased computational complexity caused by spherical aberration. Future work will focus on achieving automatic real-time phase reconstruction in non-telecentric configurations without spherical aberration, potentially incorporating AI-driven techniques.

Laser-based Voice Command Injection in Voice Controlled Systems (poster no. 11)

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Voice-controlled systems offer innovative solutions that allow accessing and controlling technological devices without physical contact. These systems are used for voice command transmission and device/system control in smart home, robot and vehicle control applications. The aim of this study is to experimentally demonstrate the effectiveness of laser-based

command injection in voice-controlled systems and to investigate potential application areas. The study also evaluates the potential of voice-controlled devices and voice processing methods to offer new opportunities. Laser-based voice command injection is based on the principle of injecting voice command signals produced in the audio frequency (AF) band directly into the solid material-based microphone active surface by modulating collimated laser light. Laser-based voice command injection increases the remote access capability in voice command production. On the other hand, investigation of interaction capabilities and hence security vulnerabilities of existing voice command-controlled systems with laser injection offers suggestions for making these systems more reliable. In our experiments, we have generated a collimated laser light beam modulated with ON-OFF voice command example and then directed it to the target MEMS-based microphone window. We have therefore achieved laser-based voice command injection on the MEMS-based microphone using a modulated laser light. Furthermore, we obtained an electrical audio signal in square wave form by vibrating the MEMS microphone diaphragm through the photoacoustic effect caused by the ON-OFF modulated multimode Fabry-Perot laser diode light at 650 nm wavelength and 30 mW output power. The received sound was further amplified in an audio power amplifier and then clearly heard through a loudspeaker connected to its output. In this study, the effects of the distance between laser diode transmitter and MEMS microphone receiver on the received signal amplitude and waveform were also investigated. As a result, we observed that laser-based voice commands did not cause a sufficiently high photoacoustic effect at distances longer than 60 cm between laser source and MEMS microphone due to the laser beam expansion and optical power decrease with increasing distance, as well as the multimode spatial speckled pattern of the FP laser. Based on our results, we believe that the system performance can be improved using single-mode laser light. In addition, the results imply that laser-based voice command injection methods can play an important role in the development of voice-controlled systems, in terms of providing advantages or disadvantages. Finally, the obtained results may contribute to a better understanding of the photoacoustic effects on voice-controlled systems and may reveal new research directions.

Enhanced Hole Mobility of p-Type Materials by Molecular Engineering for Efficient Perovskite Solar Cells (poster no. 12)

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Star-shaped triazatruxene derivative hole-transporting materials (HTMs), namely, 3,8,13-tris(4-(8a,9a-dihydro-9H-carbazol-9-yl)phenyl)-5,10,15-trihexyl-10,15-dihydro-5H-diindolo[3,2-a:3′,2′-c]carbazole (TAT-TY1) and 3,8,13-tris(4-(8a,9a-dihydro-9H-carbazol-9-yl)phenyl)-5,10,15-trihexyl-10,15-dihydro-5H-diindolo[3,2-a:3′,2′-c]carbazole (TAT-TY2), containing electron-rich triazatruxene cores and donor carbazole moieties, were synthesized and successfully used in triple-cation perovskite solar cells. All the HTMs were obtained from relatively inexpensive precursor materials using well-known synthesis procedures and uncomplicated purification steps. All the HTMs, including the 5,10,15-trihexyl-10,15-dihydro-5H-diindolo[3,2-a:3′,2′-c]carbazole (TAT-H) main core, had suitable highest occupied molecular orbitals (HOMOs) for perovskite (TAT-H: −5.15 eV, TAT-TY1: −5.17 eV, and TAT-TY2: −5.2 eV). Steady-state and time-resolved photoluminescence results revealed that hole transport from the valence band of the perovskite into the HOMO of the new triazatruxene derivatives was more efficient than with TAT-H. Furthermore, the substitution of n-hexylcarbazole and 9-phenylcarbazole in triazatruxene altered the crystalline nature of the main core, resulting in a smooth and pinhole-free thin-film morphology. As a result, the hole mobilities of TAT-TY1 and TAT-TY2 were measured to be one order of magnitude higher than that of TAT-H. Finally, TAT-TY1 and TAT-TY2 achieved power conversion efficiencies of up to 17.5 and 16.3%, respectively, compared to the reference Spiro-OMeTAD. These results demonstrate that the new star-shaped triazatruxene derivative HTMs can be synthesized without using complicated synthesis strategies by controlling the intrinsic morphology of the TAT-H main core.

Enhancing OLED Performance with Plasmonic Effect of Nanoparticles (poster no. 13)

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In this study, chemically synthesized Ag nanoparticles (NPs) were added to the hole transport layer (HTL) of an Organic Light-Emitting Diode (OLED), and its luminance was increased by up to 40% compared to the reference device. In addition, the effect of the overlap of the plasmon resonance and the device radiation spectrum on the color purity was evaluated.

Colloidal Ag NPs with an average size of 10 nanometers were obtained by reducing silver salt ($AgNO3$) with $NaBH4$ in ultrapure (UP) water at room temperature. After the centrifugation and cleaning steps, dispersed Ag NPs remaining in UP were added to HTL in the planned OLED device structure. The OLED device structure is as follows: Substrate (Glass) / Anode (ITO) / HTL (PEDOT:PSS) / EML (PVK:PBD) / Cathode (LiF/Al). Ag NPs were doped into the HTL layer (PP=PEDOT:PSS) as volumetric ratios 50%PP:50%AgNP and 75%PP:25%AgNP. To examine the effects on different layer thicknesses, spin coating was performed at 3000 RPM and 4000 RPM for both doping rates. UP water was added at the same rate as the Ag NPs volumetric mixture rate for the HTL of the reference devices

In one of the two devices that performed best according to doping rates and spin coating RPMs, a 40% increase in luminance was observed, while in the other device, there was a 20% increase in intensity within the blue color spectrum. These findings suggest that with further optimization, this study holds promising potential for future research.

Photoluminescence Analysis of Chlorophyll in Olive and Sunflower Oils: Comparative Study of Chlorophyll α and Carotenoids in Pure and Mixed Samples (poster no. 14)

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The increasing demand for high-quality oils requires advanced techniques to assess composition and purity. This study focuses on identifying the characteristic fluorescence peaks of chlorophyll α and carotenoids in olive oil, sunflower oil, and their mixtures using photoluminescence (PL) spectroscopy. Our results show that pure olive oil presents a distinct chlorophyll α peak at 676 nm, while sunflower oil features a carotenoid peak near 550 nm. In mixture samples, there is a decrease in olive oil concentration resulting in a reduced chlorophyll α peak and an increased carotenoid peak. These observations highlight the potential of PL spectroscopy for differentiating oil compositions and assessing their quality based on pigment concentrations. Mixture samples reveal that the chlorophyll α peak decreases as the olive oil concentration lowers, with a corresponding rise in carotenoid intensity. These findings demonstrate the efficacy of PL spectroscopy for rapid, non-destructive analysis of oil quality, with potential applications in the food industry. Future work will explore refining this method for broader applications.

Determination of Key Molecules in Kidney Disease Using ATR-FTIR Spectroscopy
(poster no. 15)

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Aim: Determination of biological molecules and their concentrations, specifically of disease markers, in blood is of importance for diagnostics purposes and for determination of therapeutic process. Urea is an important biomarker found in blood, indicating the possible presence of abnormalities of kidney. In this study, we aimed to analyze whole blood samples without using any tags and labeling by using IR spectroscopic technique. Herein, we create a calibration method to detect and to quantify the molecular components present in blood, with a focus on the urea molecule.

Materials and Methods: The blood samples were obtained from patients with chronic kidney disease under dialysis treatment at İzmir Tepecik Training and Research Hospital. After the collection of the blood samples, the urea concentration in the whole blood was increased by spiking the sample with known amounts of urea. 600 mg/dL, 1000 mg/dL and 1600 mg/dL samples were prepared and measured along with the 103 mg/dL sample directly obtained from the patient. The blood samples were then placed on the ATR (attenuated total reflection) unit (ZnSe, 6 reflections) and were recorded by using ALPHA II FT-IR Base spectrometer (Bruker, Germany). The measurements were carried out in the 4000-900 cm-1 mid-IR range with a resolution of 4 cm−1 and with 32 scans. Then, the spectral analysis was performed from the IR absorbance spectra using the OPUS 7.0 software. The peak intensities at 1159 cm-1 and 1638 cm-1 were plotted against urea concentrations to determine the correlation R2 value on Microsoft Office Excel.

Results: In blood samples, the IR peaks corresponding to the presence of urea (absorbed around 1159 cm-1 and 1638 cm-1) were observed to be increasing with increasing levels of urea concentration. Since the peak at ~1159 cm-1 might indicate the presence of glucose, protein and urea, the IR peak observed at ~1638 cm-1 was also used to ensure accurate identification. R2 value which provides knowledge on the goodness of fit of the model was found 0.83 between the urea concentration and IR signals of urea.

Conclusion: The IR spectroscopic analysis allowed us to determine the characteristics IR peaks of urea molecules and to quantify the urea amount in whole blood sample. Further studies will be performed with larger amount of blood samples to develop more accurate models.

Quantum dots for devices: Synthesis, Processing and Applications (poster no. 16)

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Perovskite QDs-embedded solar windows present a promising solution for integrating energy generation with building infrastructure, combining aesthetics with functionality. These semi-transparent devices leverage the high power conversion efficiency of perovskite materials while allowing visible light transmission, making them ideal for architectural applications. Advances in material engineering, including bandgap tuning and compositional stability, enable optimal trade-offs between transparency and efficiency. This work explores strategies to improve the long-term stability, minimize degradation under environmental stressors, and enhance scalability for commercial deployment. The development of these solar windows contributes to sustainable energy systems by transforming urban spaces into decentralized power-generating hubs, reducing building energy consumption, and supporting the transition to net-zero emissions. QDs are synthesized with different methods such as ligand-assisted reprecipitation (LARP), hot injection etc. The most efficient methods for Solar windows is hot injection method. The hot injection method is a widely used technique for synthesizing high-quality perovskite quantum dots (QDs), owing to its precision in controlling particle size, crystallinity, and optical properties. Perovskite QDs, such as methylammonium lead halide ($MAPbX_3$, where X = Cl, Br, I), are of particular interest due to their potential applications in optoelectronic devices such as LEDs, solar cells, and photodetectors. Perovskite quantum dots have emerged as promising candidates in the fields of optoelectronics and photovoltaics due to their superior photoluminescence, tunable bandgap, and high quantum yield. The hot injection method provides an effective route for synthesizing perovskite QDs with precise control over particle size, morphology, and halide composition. This method involves the rapid injection of precursors into a heated solvent, initiating a burst of nucleation followed by controlled crystal growth.

Harnessing Photoacoustic Imaging for Targeted Treatment of HER-2 Positive Breast Cancer with Enhertu-Loaded Vesicles (poster no. 17)

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Can HER-2 positive breast cancer cells be treated with Enhertu coated by BPQD +PGLA +PEG +Tmab antibody vesicle by using photoacoustic imaging? Breast cancer possesses a severe threat to women's health worldwide as it is the most frequently diagnosed type of cancer in females. HER-2 positive breast cancer cells account for 20 percent of breast cancer. HER-2 protein causes cancer cells to proliferate rapidly by triggering a signalling pathway that aids in cell growth and multiplication. Enhertu, an antibody-drug conjugate, can be used to prevent HER-2 protein from working by inhibiting DNA topoisomerase 1 and interfere DNA replication, so destroying the cancer cells. Photoacoustic imaging is a method for biomedical imaging and delivery of drugs such as Enhertu, based on the photoacoustic effect with contrast agents. These medications can be released through the photoacoustic thermal effect after being transported to the desired location via a vesicle. The designed vesicle contains the drug Enhertu and is coated with BPQD +PGLA +PEG +Tmab antibody. Black phosphorous quantum dots (BPQD), contrasting agent, which is highly biodegradable and biocompatible, are used for imaging of drug delivery. While PGLA ensures the vesicle opening by photoacoustic thermal effect, PEG ensures the stability of the structure and prevent proteolytic degradation. Trastuzmab (Tmab) antibody is used for the specific targeting of HER-2 positive breast cancer cells. This study uniquely aims targeted drug delivery and it's imaging stably in the HER-2 positive breast cancer by using photoacoustic systems in vivo and ex vivo.

Plastic Optical Fiber Based Curvature Sensor (poster no. 18)

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Plastic and silica based optical fiber sensors are preferred in various remote sensing applications due to their high sensitivity, low optical transmission loss and high immunity to electromagnetic interference. Plastic optical fibers (POF), on the other hand, provide some advantages regarding development of sensitive strain, bending, curvature or displacement sensors, particularly due to their high flexibility, strength and elastic expansion coefficients up to 5%. In this study, it is shown that PMMA (Polymethyl Methacrylate) based plastic optical fibers (POF) can be used as a sensitive curvature sensor in which the transmission loss changes with the curvature radius. In the experimental study, a Fabry-Perot multimode laser diode with a wavelength of 650 nm and an output power of 50 mW was used as a light source and the optical power changes at the POF output depending on the curvature radius were measured using an optical powermeter. In order to create controlled bending in the plastic optical fiber, 5 pairs of cylinders were fixed between two pressing plates and the POF passing between them was made to bend at 10 equally spaced positions. By changing the distance d (mm) between the parallel pressing plates between 24-52 mm, the curvature radius R (mm) could be changed in a controlled manner and according to the power changes at the POF output were observed with an optical powermeter (dBm). A maximum power of -14.84 dBm measured at the POF output when the fiber was unbent which this value was taken as the reference. It was observed that the transmission loss in POF increases with decreasing curvature radius. In order to avoid measurement errors arising from environmental conditions, the measurements were repeated three times and their average value was taken. The output power (dBm) and the relative power change (dB) measured at the POF output under test for the curvature radius of changing between 10-18 mm was shown graphically. Our experimental results have shown that the transmission loss in plastic optical fiber changes proportionally with the curvature radius and can be defined with an empirical equation. Moreover, it is possible to increase the sensitivity of the POF curvature sensor by increasing the number of bends formed on the transmission fiber. As a result, it has been shown that plastic optical fiber-based curvature sensors are advantageous in many applications such as monitoring precise movements in moving flexible surfaces or various deformations such as torsion, strain, compression and displacement in mechanical structures.

Mirror Alignment System and Method for Telescopic Systems (poster no. 19)

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REKROM Optoelektronik

Telescopic structures are widely used in many optical systems, including those used for astronomy, military, and civilian purposes. Among these, the Cassegrain and its derivatives (Ritchey-Chretien, Maksutov Cassegrain, Riccardi-Honders, Dall-Kirkham, etc.) are the most commonly employed designs. These structures consist of a primary mirror, which is a parabolic concave mirror, and a secondary mirror, which is a convex mirror, both placed on the same optical axis. Although this configuration is highly effective, aligning the two reflective optical elements, the primary and secondary mirrors, along the same optical axis is a challenging optical alignment process. Therefore, the most critical factor determining the performance of telescopic structures is the alignment between the primary and secondary mirrors. Amateur telescopes can be aligned using simple light sources and basic targets. However, systems used in fields like space and defense industries, which require alignment precision at the milliradian level, rely on complex techniques and expensive equipment such as interferometers and special actuators. In addition to the high costs of the equipment, the process itself is also quite complicated.

In this study, a method for practically aligning the primary and secondary mirrors of a Cassegrain-type telescope at milliradian-level precision using a simple diffuse light source and a relatively basic camera is presented. The alignment system includes a diffuse light source, a camera, mechanical components for adjusting the positions of the mirrors, an image processing algorithm, and a computer that runs the algorithm. In the system, a diffuse light source placed at the focus of the telescope initially forms the first shadow of the outer circle of the secondary mirror and the image of the primary mirror on a screen. The first shadow is formed by the light rays from the diffuse light source being blocked by the secondary mirror. The second shadow occurs when the light rays reflected from the primary and secondary mirrors return to the secondary mirror, blocking the screen for a second time. A camera positioned perpendicular to the screen records the circular shadow images of the secondary mirror on the screen. In a perfectly aligned telescope, the centers of the shadows should overlap. By analyzing the images from the camera with a computer, the misalignment between the mirrors can be calculated at the milliradian level by measuring the distance between these centers. Based on these calculations, real-time alignment commands are provided to the user by the software until the centers of the shadow rings are perfectly concentric, thus completing the alignment process.

Interlaboratory Comparison of Laser-Induced Damage Threshold Measurements Between SIOM&UME (poster no. 20)

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The utilization of high-power lasers or the need to focus them leads to high fluences (energy per area) on small areas of optics. Laser-Induced Damage Threshold (LIDT) is the specific fluence value, which optics can be used without damage below that value. According to the literature [1,2], the LIDT value is mainly related to the following factors, spatial & temporal laser beam parameters, wavelength, energy, test procedures, etc. Given the dependence on a large number of parameters, to make absolute and internationally valid measurements of LIDT it is required to construct a well-characterized LIDT testing setup according to up-to-date standards, namely the ISO 21254 series of standards.

It is another effective way to ensure the validation of the LIDT measurements worldwide to conduct international interlaboratory comparisons. In this work, we report the results of a bilateral comparison of LIDT measurements between SIOM-CAS (Shanghai Institute of Optics and Fine Mechanics-Chinese Academy of Sciences) and TÜBİTAK-UME (National Metrology Institute of Turkey) for 1064 and 532 nm wavelengths under atmospheric conditions. Anti-reflective coated windows and polarizers were manufactured and tested by SIOM. Then the samples from the same batch were sent to UME for LIDT tests. Both institutions carried out LIDT tests using 1-on-1 and S-on-1 protocols as described by ISO standards [3,4]. The main objective of this comparison is to assess the degree of equivalence between the two institutes and their respective experimental setups.

The experimental results and detailed information on the testing apparatus are given and discussed in this study.

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Hasan KILINÇ	; President of IZTECH Optics and Photonics Society
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