EUROPT(R)ODE XVII

JENA | GERMANY | March 29 – April 1, 2026

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Presented by:

biophotonics 4 FUTURE

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CHEMICAL & BIOMEDICAL IMAGING

INDEX

WELCOME

Juergen Popp
Conference Chair

Dear colleagues,

It is a great pleasure to welcome you to the XVII EUROPT(R)ODE Conference in Jena from March 29 to April 1, 2026. EUROPT(R)ODE has long been recognized as a leading international forum for advances in chemical and biochemical optical sensing.

The 2026 program reflects the dynamic evolution of the field – from fundamental photonic concepts and novel transduction principles to integrated sensor platforms, data-driven analysis strategies, and emerging application scenarios in life sciences, environmental monitoring, and industrial process control. Optical sensing technologies are increasingly driven by the convergence of multiple disciplines, including photonics, materials science, analytical chemistry, micro- and nanofabrication, as well as artificial intelligence and data science. This interdisciplinary progress is rapidly expanding the capabilities of optical sensors and accelerating their transition from laboratory demonstrations to robust and deployable sensing systems.

EUROPT(R)ODE 2026 provides a structured scientific environment to critically discuss these developments, assess technological maturity, and explore pathways toward scalable and application-ready sensing solutions. Particular emphasis is placed on: Novel sensing architectures and functional materials, Miniaturization and system integration, Multimodal and multiplexed detection strategies, Data analytics, chemometrics, and AI-assisted interpretation, Translational aspects bridging laboratory innovation and real-world deployment.

Beyond the scientific sessions, the conference offers valuable opportunities for in-depth exchange and international networking. The Conference Dinner on March 31 will provide an informal setting to continue scientific discussions and strengthen collaborations across disciplines and career stages. EUROPT(R)ODE thrives on rigorous debate, scientific curiosity, and the active participation of its community. I warmly invite you to contribute your expertise and perspectives to shaping the next generation of optical sensing technologies.

I look forward to inspiring discussions and to welcoming you in Jena.
Juergen Popp

JENA – THE CITY OF LIGHT

“City of Light” stands as a synonym for everything that has constituted and continues to constitute Jena’s supra-regional radiance: the flashes of inspiration from its brilliant minds, the light of the Enlightenment, the first-class research institutions that tirelessly bring the light of knowledge into the darkness, the world-renowned high-tech companies, and the young, innovative businesses for whom light is a key means of success. Light is both a tool and an object of research.

With over 150 years of industrial history, Jena is considered the cradle of the optical industry in Europe and a recognized research center in the fields of optics and photonics. What began with the meeting of Carl Zeiss, Ernst Abbe and Otto Schott not only culminated in the scientifically sound construction of microscopes. It also laid the foundation for the internationally successful companies and consolidated one of Jena’s most important traditions: the close integration of research and industry. Here, world-class interdisciplinary research and practical implementation go hand in hand.

GENERAL INFORMATION

Date:

March 29 – April 1, 2026

Venue Address:

Volkshaus Jena // Carl-Zeiss-Platz 15 // 07743 Jena // Germany

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Congress Chair

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GET-TOGETHER AT VOLKSHAUS JENA
SUNDAY, MARCH 29, 2026

We welcome all participants on the first evening in the reception hall of the conference center. Meet old and new colleagues over snacks and drinks. We wish you a wonderful evening!

You will receive your congress materials at the registration counter.

Venue Address:
Carl-Zeiss-Saal
Volkshaus Jena
Carl-Zeiss Platz 15
07743 Jena

Time:
Start 18:00

CONFERENCE DINNER AT VOLKSBAD JENA
TUESDAY, MARCH 31, 2026

The "Volksbad" in Jena was a public bathing facility that was built between 1907 and 1909 by the Jenaer Volksbad-Verein, officially opened on April 13, 1909. In the early 2000s, it was decided to use the Volksbad as a center for culture and education. It was renovated, with the emphasis on leaving its former use visible. This gives the building a unique charm.

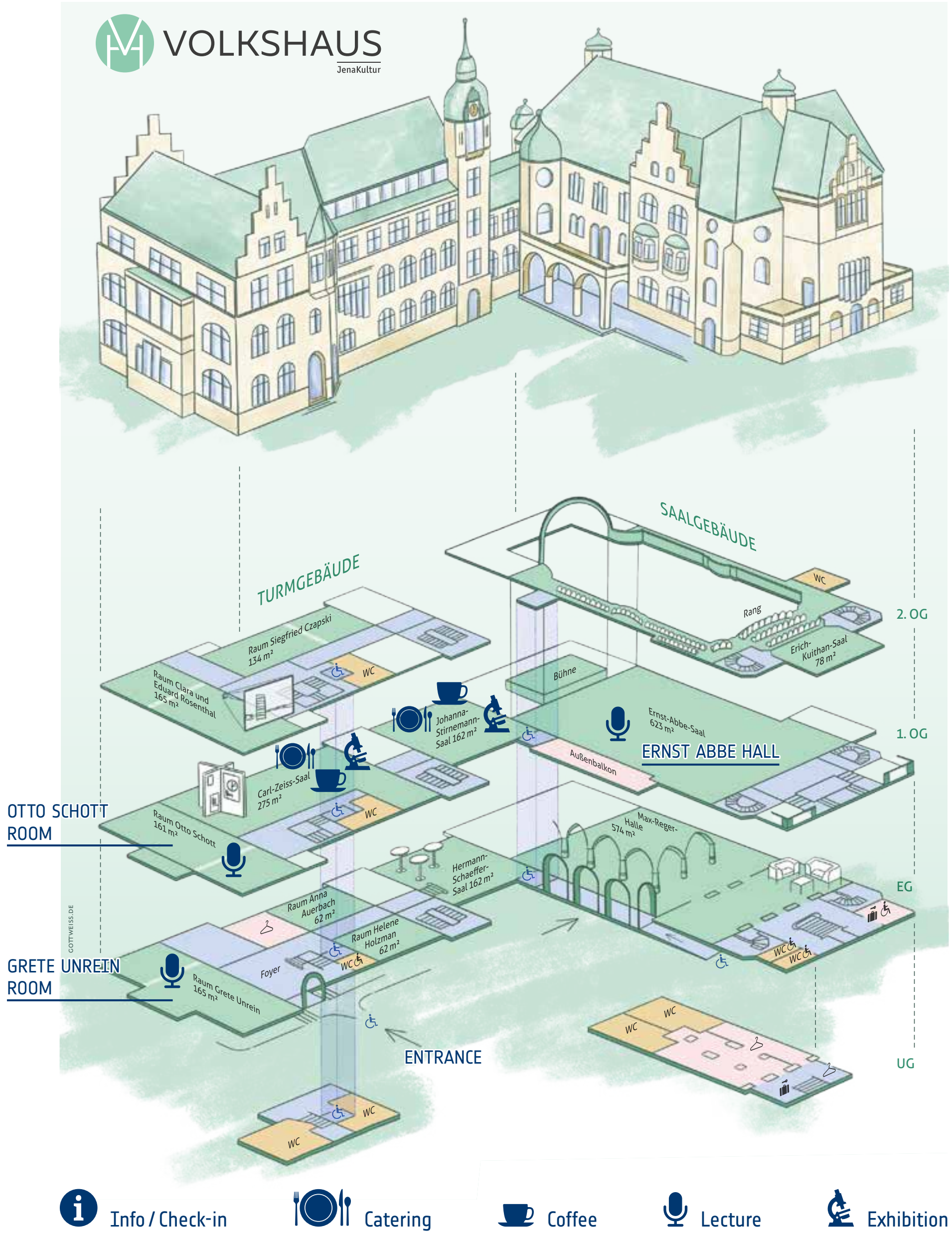
You are cordially invited to spend a social evening together in this special location. Exchange ideas with your colleagues over dinner and drinks.

Adding a creative spark to our evening: Alexander Otto, capturing guests in his signature live speed portrait drawings.

Venue Address:
Volksbad Jena
Knebelstraße 10
07743 Jena

Time:
Start 19:00 (doors open at 18:30)

VOLKSHAUS JENA



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PROGRAM

SUNDAY, MARCH 29, 2026

18:00-21:00 Get-Together – Volkshaus Jena

MONDAY, MARCH 30, 2026

9:00 Opening // Jürgen Popp, Guillermo Orellana

9:30 Plenary Lecture I – Quantum Sensor Networks // Alexey Gorshkov (College Park, USA) // Chair: Jürgen Popp – Ernst-Abbe-Saal

10:15 COFFEE BREAK

10:45 Molecular and Single-Molecule Detection Methods I – Ernst-Abbe-Saal
Chair: Dmitri Papkovsky

10:45 Invited Lecture – Flourescent Molecular and Nanoscale Probes for Biosensing // Andrey Klymchenko (Strasbourg, FR)

11:15 Molecular Detection of Drug – Target Interactions of Antimalarials in Infected Red Blood Cells // Timea Frosch (Jena, DE)

11:30 A Novel Method for Label-free Colorimetric Biosensing // Arturo Patrone Garcia (Valencia, ES)

11:45 A Holistic Approach to Viral Vector Production Analytics Using Label-free Biosensing // Alexander Krauth (Tübingen, DE)

12:00 Studying Dynamics of the Peroxisomal Membrane by 3D Tracking of Peroxisomal Membrane Proteins Using Minflux Super-resolution Microscopy // Katharina Reglinski (Jena, DE)

10:45 Plasmonics and Quantum-Enhanced Optical Sensing I – Raum Otto Schott
Chair: Dana Cialla-May

10:45 Invited Lecture – Molecular (Bio)Sensing by Plasmonic Nanoparticles // Wolfgang Fritzsche (Jena, DE)

11:15 Intratissular and Intracranial SERS Nanofibers for Monitoring Proteins in Brain Tissues // Jean-Francois Masson (Montreal, CA)

11:30 Plasmonic Biosensors with Digital Assay Format // Jakub Dostalek (Prague, CZ)

11:45 Sensing With Gold Nanoparticles Excited With an Eco-friendly Fluorescent Optical Fibre // Joel Villatoro (Bilbao, ES)

12:00 Snapshot Spectral Imaging Plasmon Sensor // Ondrej Stranik (Jena, DE)

10:45 Wearable, Implantable, and Miniaturized Sensor Systems I – Raum Grete Unrein
Chair: Neso Sojic

10:45 Invited Lecture – Sensor Arrays for Complex Analytical Applications // Emilia Witkowska-Nery (Warsaw, PL)

11:15 Towards Ultra-miniature and Wearable Raman Spectrometers for Real-World Biomedical Applications: Some Industrial Experience and Perspective // William Yang-Terziyan (San Jose, US)

11:30 Cellulose Paper-based Optode Device (CPOD) for Reversible, Colourimetric Sensing of pH and Mg^{2+} Ions // Deepak Joshy (Zagreb, HR)

11:45 Biomedical Technologies for Early Detection of Catheter Associated Infections // Hatice Ceylan Koydemir (College Station, US)

12:15 LUNCH BREAK

13:30 Plenary Lecture II – DNA Moiré Superlattices // Laura La Niu (Stuttgart, DE) // Chair: Guillermo Orellana – Ernst-Abbe-Saal

14:15 Molecular and Single-Molecule Detection Methods II – Ernst-Abbe-Saal
Junior Chair: Aradhana Dwivedi

14:15 High-throughput Molecular Microarray-based for Rapid, Cost-effective Detection of Clinical Strains of Klebsiella Pneumoniae // Abdinasir Abdilahi (Jena, DE)

14:30 Artificial Intelligence-Aided Massively Parallel Slitless Spectroscopy for Single-Molecule Bioaffinity Detection in Aqueous Solution // Antonín Hlaváček (Brno, CZ)

14:45 Sub-diffraction, Lens-free Fluorescence Imaging On-chip via Sparse Optical Lattices // Steven Vanuytsel (Leuven, BE)

15:00 Agarose – Chitosan Nanoreactor Beads Reveal Core–Shell Mechanism for Multiplex Barcoding // Katharina Heise (Jena, DE)

15:15 Seeing Without Labels: Multimodal and Non-linear Raman Microspectroscopy for Intracellular API Localization // Julian Plitzko (Jena, DE)

14:15 Plasmonics and Quantum-Enhanced Optical Sensing II – Raum Otto Schott
Chair: Wolfgang Fritzsche

14:15	Improving Nanoplasmonic Sensor Performance: Validated Simulation Design // Kevin Thomschke (Dresden, DE)
14:30	Use of SERS for Holistic Analysis of Patterns in Alzheimer's Extracellular Vesicles // Sergio Quintero Moreno (Braga, PT)
14:45	Polarisation-based Sensing of Tissue Phantoms with Quantum Metrics // Vira R. Besaga (Jena, DE)
15:00	Voltarefractometry of Individual Nanoparticles // Vladimir Mirsky (Cottbus, DE)
15:15	Broadband, Spatially Extended, and Single-handed Optical Chirality Enhancement from 3D Archimedean Sieve // Jer-Shing Huang (Jena, DE)

14:15 Wearable, Implantable, and Miniaturized Sensor Systems II – Raum Grete Unrein
Junior Chair: Jyothi Nair

14:15	Development of a Biocompatible Cellulose-Based Sensing Film for the Colourimetric Detection of Biomarkers // Iva Karneluti (Zagreb, HR)
14:30	Filter, Flip, and Fabricate: Wax-Assisted Stamp Transfer Approach for $Ti_3C_2T_x$ MXene Flexible Electrochemical Transducers // Zaheer Ud Din Babar (Naples, IT)
14:45	Optical Biosensor Towards In-vivo Biomolecular Monitoring // Khulan Sergelen (Heidelberg, DE)
15:00	Spectroscopy Without Borders: Empowering Global Solutions Through Portable Technology // Christian Huck (Innsbruck, AT)

15:30 COFFEE BREAK

16:00 Electrochemical and Photoelectrochemical Sensing – Ernst-Abbe-Saal
Chair: Xudong Wang

16:00	Invited Lecture – Scanning (Photo)electrochemical Probe Microscopy: Insight Into Light-driven Catalytic Processes // Christine Kranz (Ulm, DE)
16:30	Photo-induced Electrochemiluminescence Sensing and Imaging at Semiconductor Surfaces // Neso Sojic (Bordeaux, FR)

16:45	Microfabricated Coreactant-Free ECL Platform Enabling Next-Generation Multiplexed Portable Diagnostics // Somayyeh Bozorgzadeh (Cork, IR)
17:00	Electrochemical Detection of Methylmercuryusing a Cataliytic Protein-based Impedance Sensor // Allwin M. Raj (Ljubljana, SI; Maribor, SI)

16:00 Fiber- and Waveguide-based Optical Sensors I – Raum Otto Schott
Chair: Artur Dybko

16:00	Invited Lecture – Plasmonic Fiber Grating Biosensors: From Early Concepts to Prospects for Industrial Deployment // Christophe Caucheteur (Mons, BE)
16:30	Dual Lossy Mode Resonance-based Biosensor for Multianalyte Detection // Francesco Baldini (Sesto Fiorentino, IT)
16:45	Self-aligned Nanobead Arrays with Tunable Size on Imaging Fibers for Spectroscopic Platforms // Marine Lavainne (Bordeaux, FR)
17:00	Multiplexed Interferometric Optical Fiber Biosensors // Chalimar Salameh (Grenoble, FR)

16:00 AI and Data Analytics in Sensor Applications I – Raum Grete Unrein
Chair: Thomas Bocklitz

16:00	Automation Meets Analytics: Smart Detection in Laboratory and Chemical Workflows // Simon-Johannes Burgdorf (Rostock, DE)
16:15	Rapid ATR-FTIR Spectroscopy for Field Detection of Dengue Fever Infections // Bayden R. Wood (Melbourne, AU)
16:30	Final-stage Data Processing for Improved Performance of Fiber Optic Resonator Sensors Beyond Virtual Vernier Effect // Ander Zornoza (Bilbao, ES)
16:45	AI-enhanced Raman – SERS Nanotheranostics for Intracellular Tracking and Gene-targeted Therapy in Bladder Cancer // Valeria Lazzetta (Benevento, IT)

17:15 Poster Session

TUESDAY, MARCH 31, 2026

8:30 Plenary Lecture III – From DNA Nanotechnology to Biomedical Insight: Towards Single-Molecule Spatial Omics // Ralf Jungmann (Munich, DE) // Chair: Jürgen Popp – Ernst-Abbe-Saal

9:15 COFFEE BREAK

9:45 Luminescence, Fluorescence, and FRET-Based Sensors I – Ernst-Abbe-Saal
Chair: Tobias Meyer-Zedler

9:45 Invited Lecture – How do we Create Robust Optical Chemosensors for Complex Analytes in Condensed Phases? // Thomas Sørensen (Copenhagen, DK)

10:15 Luminescent Nanoparticles for Reversible Optical Sensing of Oxygen and pH Gradients at Sub-second Temporal and µm Spatial Resolution // Michael Wind-Hansen (Aarhus, DK)

10:30 Low-cost CMOS-based System for Luminescence Lifetime Imaging of Oxygen, Temperature and pH // Sergey Borisov (Vienna, AT)

9:45 Multimodal and Nonlinear Biophotonic Imaging Methods I – Raum Otto Schott
Chair: Jer-Shing Huang

9:45 Invited Lecture – Shedding New Light on Cells with Coherent Nonlinear Optical Nanoscopy // Paola Borri (Cardiff, UK)

10:15 Advancing Ultrafast Spectral Histopathology with Broadband Coherent Raman Scattering // Carl Messerschmidt (Jena, DE)

10:30 Event-Based Structured Illumination Microscopy with Improved Optical Sectioning // Gabriel Baum (Jena, DE)

10:45 Event-Driven Spectroscopy for Dynamic Optical Sensing Applications // Pedro Jorge (Porto, PT)

9:45 AI and Data Analytics in Sensor Applications II – Raum Grete Unrein
Chair: Ivo Raimundo Jr.

9:45 Invited Lecture – Automated Image Quality Assessment Methods for Optical Microscopy // Thomas Bocklitz (Jena, DE)

10:15 Field Deployment of Planar Optodes in Soils: Capturing Event-Driven Anoxic Hotspot Formation // Martin Reinhard Rasmussen (Aarhus, DK)

10:30 AI-Driven Modular Optical Microresonator Architecture for Multiplexed Biosensing // Anton Saetchnikov (Bochum, DE)

10:45 Advancing Lung Cancer Diagnosis with AI-Driven Raman Spectroscopy // Concetta Esposito (Benevento, IT)

11:15 SHORT COFFEE BREAK

11:30 Molecular and Single-Molecule Detection Methods III – Ernst-Abbe-Saal
Junior Chair: Timea Frosch

11:30 Multiplexed Ultra-Rapid High-Resolution Genotyping Using Fluorescence-Encoded Nanoreactor Beads // Stephan Hubold (Jena, DE)

11:45 Sulfate-Directed Silver Dendrites with Long-Term Stability for SERS-Based Biomolecular Analysis in Complex Matrices // Aradhana Dwivedi (Jena, DE)

12:00 Advancing Polymer Characterization with Simultaneous Optical Photothermal IR and Raman Micro-Spectroscopy // Miriam Unger (Mülheim, DE), Heinz W. Siesler (Essen, DE)

12:15 Implantable and Bioresorbable Sensors for Precision In-vivo Detection of Therapeutic and Clinical Markers // Martina Corsi (Pisa, IT)

11:30 Fiber- and Waveguide-based Optical Sensors II – Raum Otto Schott
Chair: Carl Messerschmidt

11:30 An Optical Label-free Sensor for Characterising Cell-material-interactions // Johanna Hutterer (Tübingen, DE)

11:45 Laminated Multi-layer Optical Waveguides Enabled by Floating Film Transfer // Patrick Görrn (Wuppertal, DE)

12:00 Photonic Biosensor for Rapid, Urine-based Screening of Sexually Transmitted Infections // Celia Galindo-Martin (Barcelona, ES)

11:30	**Microfluidics and Lab-on-a-Chip Technologies I – Raum Grete Unrein** **Chair: Torsten Mayr**	
	11:30	Invited Lecture – Phase Imaging Flow Cytometry for Point-of-Care – Diagnostics: Methods and Clinical Validation // Oliver Hayden (Munich, DE)
	12:00	Development and Application of p-NIPAM Barriers and Repositories for Microfluidic Flow Control. A Proof of Concept // Maria Angustias Torres-Molina (Granada, ES)
	12:15	Optofluidic Microfluidic Chip for Streamlined Nucleic Acid Extraction and Isothermal Amplification for Point-of-care Detection of Klebsiella Pneumoniae // Catarina Nogueira (Braga, PT)
	12:30	Development of a Modular Bead-Based Microfluidic Fluoroimmunoassay Platform // Knut Rurack (Berlin, DE)
12:45	**LUNCH BREAK**	
14:00	Plenary Lecture IV – Novel Bio(inspired) (photo)electro chemical Sensing Strategies // Karolien De Wael (Antwerp, BE) // Chair: Guillermo Orellana – Ernst-Abbe-Saal	
14:45	**Luminescence, Fluorescence, and FRET-Based Sensors II – Ernst-Abbe-Saal** **Chair: Günter Gauglitz**	
	14:45	Invited Lecture – Measurement of the Absolute Membrane Potential Using Fluorescence Lifetime Imaging Microscopy (FLIM) // Tobias Meyer-Zedler (Jena, DE)
	15:15	Multi-Resonance Emitters: New Indicator Dyes for Self-Referenced Ratiometric Optical Sensing // Lisa Eiber (Granz, AT)
	15:30	Toward Intelligent 2D Luminescence-based Imaging for Multiparameter Chemical Mapping // A. V. Kalinichev (Aarhus, DK)
	15:45	Sensing Oxygen in Organic Solvents with Surface-Anchored Metal Organic Frameworks // Theresa Mautz (Graz, AT)
14:45	**Fiber- and Waveguide-based Optical Sensors III – Raum Otto Schott** **Chair: Ondrej Stranik**	
	14:45	Invited Lecture – Rethinking Optical Biosensors: From Integrated Photonics to Deployable Sensing Platforms // Eleni Makarona (Ag. Paraskevi, GR)

	15:15	A Bimodal Plasmo-photonic Sensor for Label-free Biosensing // Juliana F. Giarola (Barcelona, ES)
	15:30	Photoinduced Re-writable Birefringence on Optical Fiber Tips Using an Azopolymer // Beatriz Soares (Porto, PT)
	15:45	Waveguides for Wash-Free Immunoassays: Multiplexed and Rapid Detection of Proteins in Complex Media // Stijn Jooken (Leuven, BE)
	16:00	Fiber-Enhanced & Deep-UV Raman Spectroscopy for Point-of-Care Therapeutic Drug Monitoring of Antibiotics // Torsten Frosch (Darmstadt, DE)
14:45	**Microfluidics and Lab-on-a-Chip Technologies II – Raum Grete Unrein** **Chair: Ambra Giannetti**	
	14:45	Lab-on-a-Chip Platforms for In Situ Photonic and Spectroelectrochemical Sensing // Detlev Belder (Leipzig, DE)
	15:15	Automated Multimodal Imaging of Microorganisms in Fuzzy Logic-Controlled Droplet Microfluidics // Fabian Ott (Jena, DE)
	15:30	Optofluidic Sensor for Rapid and Sensitive Detection of Faecal Pigments in Water Quality Monitoring // Swayam Prakash (Berlin, DE)
	15:45	3D Printed LOC Device for in-line Monitoring of Biofilm Growth Using Integrated Raman Spectroscopy // Casper Kunstmann (Odense, DK)
	16:00	Bead-based Microfluidic Platforms for Bacterial Separation and Detection from Complex Samples // Carla Carvalho (Braga, PT)
16:15	**COFFEE BREAK**	
16:45	**Luminescence, Fluorescence, and FRET-Based Sensors III – Ernst-Abbe-Saal** **Chair: Klaus Koren**	
	16:45	Synergistic Indicator-Dye / Nanostructure Design for Optical Sensors with Tunable Properties // Gerhard J. Mohr (Weiz, AT)
	17:00	Optical Immunodetection of Targeted Explosives Using 3D Printed Optical Elements // María A. H. García (Berlin, DE)
	17:15	Real-time Profiling of Single-cell Energy Metabolism Phenotype // Xu-dong Wang (Shanghai, CN)

17:30 Ion-sensing in Water Using Potential-Sensitive Dyes in Thin Film Optodes // Ramis Arbi (Hamilton, CA)

16:45 Plasmonics and Quantum-Enhanced Optical Sensing III – Raum Otto Schott
Chair: Tony Dib

16:45 Optimization of Silver-Coated Boehmite Nanostructures for Enhanced SERS detection of date-rape drugs // Panagiota Petrou (Ag. Paraskevi, GR)

17:00 Drug Detection and Biomarker Sensing in Complex Bio Matrices by Surface Enhanced Raman Spectroscopy // Dana Cialla-May (Jena, DE)

17:15 Low-Cost Multispot Nanoplasmonic Platform for High-sensitivity Multiplexed Biosensing // Jhonattan C. Ramirez (Barcelona, ES)

17:30 Light-Controlled Disorder-Engineering of Plasmonic Nanoparticles and Metasurfaces // Maximilian Buchmüller (Wuppertal, DE)

17:45 Surface Plasmon Resonance Biosensor Based on an Array of Diffraction Gratings with a Variable Period // Jiri Homola (Prague, CZ)

16:45 DNA Nanotechnology and Bioengineered Sensors – Raum Grete Unrein
Chair: Olesia Petrova

16:45 Invited Lecture – Engineering DNA-controlled CRISPR Systems for Enzyme Activity Monitoring // Alessandro Porchetta (Rome, IT)

17:15 Picomolar Sensing of Endocrine-disrupting Chemicals in Environmental Samples by a Soft Colloidal Probe Biosensor // Rosa Gehring (Leipzig, DE)

19:00 CONFERENCE DINNER – VOLKSBAD (DOORS OPEN AT 18:30)

WEDNESDAY, APRIL 1, 2026

8:30 Plenary Lecture V – Advancing Single-Molecule Imaging // Aleksandra Radenovic (Lausanne, CH) // Chair: Francesco Baldini – Ernst-Abbe-Saal

9:15 Plenary Lecture VI – An Integrated and Rapid Biosensors for Biomedical and Environmental Applications // Mohammed Zourob (Riyadh, SA)// Chair: Francesco Baldini – Ernst-Abbe-Saal

10:00 COFFEE BREAK

10:20 Luminescence, Fluorescence, and FRET-Based Sensors IV – Ernst-Abbe-Saal
Chair: Astrid Tannert

10:20 Redefining Mycotoxin Monitoring: A Dual BRET Biosensing Approach for Rapid, Multiplex, and Wash-Free Detection // Andrea Sánchez-Elvira (Madrid, ES)

10:35 Turning Light into Sensitivity: Leucomethylene Blue-driven Redox Photocatalysis for Food Mycotoxin Fluorescence Sensing // Guillermo Orellana (Madrid, ES)

10:50 Photoswitch-Enabled Optical Study of Ion Channel Function in Model Membranes // Jessica M. Jaramillo (Jena, DE)

11:05 Sensitive and Quantitative Point-of-care Detection of Biomarkers Using Europium-doped Vanadate Nanoparticle ($YVO_4:Eu^{3+}$) Probes // Farida Yark (Palaiseau, FR)

11:20 “Mix & Measure” Rapid Immunoassays for Food Safety Monitoring // Elena Benito Peña (Madrid, ES)

10:20 Multimodal and Nonlinear Biophotonic Imaging Methods II – Raum Otto Schott
Chair: Jiří Homola

10:20 Invited Lecture – Magnetic Control of Molecular Emissivity for New Applications in Imaging // Sergei Vinogradov (Philadelphia, US)

10:50 Enhanced Deep Tissue Imaging and Sensing using Perovskite Core-Shell Nanoprobes // Aniruddha Ray (Toledo, US)

11:05 A Closer Look at Life Science enabled by Multimodal Submicron O-PTIR Imaging // Carolin Borbeck (Mülheim a. d. Ruhr, DE)

11:20 Development of a Tethered Capsule Endoscope Integrating White Light Reflectance and Narrow Band Imaging for Esophageal Cancer Screening // Jianfeng Wang (Beijing, CN)

11:35 Closing Remarks and Announcement of the Next Europt(r)ode Conference

ABSTRACTS

of Plenary and Invited Talks

Quantum Sensor Networks

Alexey Gorshkov – NIST and University of Maryland, College Park, USA

Entangling quantum sensors – such as Mach-Zehnder interferometers, quadrature displacement sensors, or magnetometers – can dramatically increase their sensitivity. In this talk, we will discuss how entanglement in a network of quantum sensors can be used to accurately measure one or more properties of spatially varying fields, including properties of spatially correlated noise.

Fluorescent Molecular and Nanoscale Probes for Biosensing

Andrey Klymchenko – Laboratoire de Bioimagerie et Pathologies, UMR 7021 CNRS, Université de Strasbourg, Illkirch, France

Fluorescent molecular probes are smart tools for advanced fluorescence sensing at the cellular level. Here, we explored solvatochromic dyes, which sense local polarity in biomembranes and organelles.[1] Thus, we developed a series of solvatochromic probes with organelle-targeting ligands that revealed specific signatures of membrane polarity of organelles and their response to oxidative stress.[2] By genetic targeting of a solvatochromic dye to proteins, their nanoscale environment in different organelles was monitored,[3] revealing fine changes in the organization of chromatin and cell-cell contacts.

On the other hand, nanoscale probes can provide exquisite sensitivity owing to their high brightness and high specificity to complex biologically active molecules. Thus, to go beyond the limits of brightness of organic dyes, we focused on dye-loaded polymeric nanoparticles,[4] which behave like light-harvesting nanoantennas.[5] They yielded nanoprobes for amplified sensing of DNA/RNA biomarkers of diseases, which opened the path to point-of-care diagnostics.[6] We further found that the energy transfer between two nanoantenna particles connected by DNA duplexes does not follow canonical Förster law, allowing efficient long-range FRET at distances up to 20 nm, important for construction of ultrasensitive biosensors.[7] Hybridization of ultrabright nanoparticles with magnetic beads enabled further increase in the sensitivity to RNA targets down to fM.[8] Finally, to detect neurotransmitters, which is challenging for molecular probes, we design nanoscale artificial receptors, where molecular recognition and sensing elements are assembled together within a lipid nanoreactor.[9]

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Molecular (Bio)Sensing by Plasmonic Nanoparticles

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A biosensing platform based on the localized surface plasmon resonance (LSPR) principle has been developed. 80 nm gold nanoparticles are thereby used as sensor: Any change in refractive index around the particles induces a change in resonance frequency, which is monitored using UV/VIS spectrometry. By functionalization of the nanoparticles with highly specific receptors (ss DNA for DNA, antibodies or aptamers for proteins or small molecules) a high specificity can be achieved for the respective target molecules. The principle was demonstrated for both DNA [1] as well as protein [2] detection. Compared to fluorescence array formats, the chosen principle does not require labels, resulting in a more streamlined assay, and reducing time as well as costs. The platform is capable of multiplex sensing, by using an array of immobilized nanoparticle spots all incubated simultaneously in a flow chamber with the analyte solution, which can detect the presence of multiple target molecules simultaneously in one assay.

For a multiplexed readout of the LSPR peak shift, a spectroscopic monitoring of all spots of the array is needed. Instead of a scanning approach with the required mechanical movement of beam and/or sample, imaging spectrometry is utilized. Different approaches with spectrally filtered light have been studied, using either liquid crystal tunable filter (LCTF), or just a set of 6 LEDs of different wavelength, allowing to reconstruct a spectrum resulting in a very simple and quite cost-efficient detection.

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Sensor Arrays for Complex Analytical Applications

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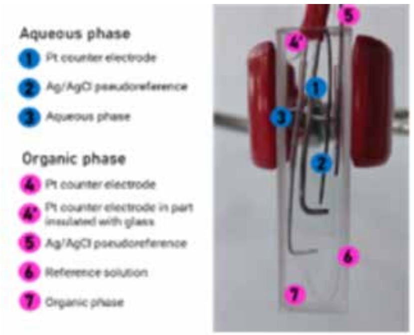
An electronic tongue system is a type of sensor array in which data from each sensor is analysed simultaneously by a multivariate algorithm, rather than separately. Once the algorithm has been trained using sufficient samples, an unknown sample can be tested and either assigned to a group (e.g. healthy or cancer patients) using classification, or assigned a value using multivariate regression.

This concept can be used to develop sensors that can be applied to complex samples containing interfering species and background signals, or analytes characterised by co-occurring signals. In the first project, we are interested in developing probes that could enable neurobiologists to quantify dopamine and serotonin simultaneously. In the second, we aim to empower potential victims of date-rape drug attacks by providing them with a sensor that can detect different drugs in real samples.

In both cases, we address the complex problem at hand by combining sensors that provide high-dimensional data. We demonstrate how the higher dimensionality of ionic species data obtained by voltammetric sensing can enhance the performance of sensor arrays, enabling the analysis of complex samples with varying background signals and interfering species. Voltammetric sensing of ionic species can be combined with spectroscopic measurements (see Fig. 1) or voltammetric sensing of electroactive species (see Fig. 2) to obtain further insights into the studied system.



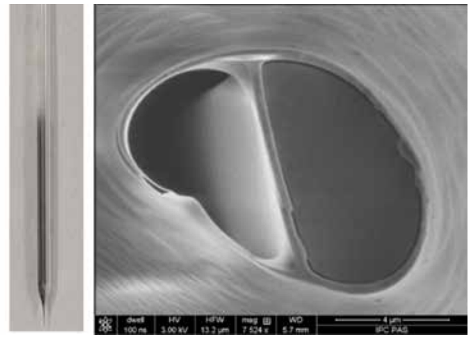


Fig.1: Miniaturized cell for spectroelectrochemical studies of ion-transfer at the liquid-liquid interface
Fig. 2: Double barrel probe for voltammetric sensing of both ionic and electroactive species.

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DNA Moiré Superlattices

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DNA nanotechnology provides a powerful route to design programmable, structurally precise architectures across multiple length scales. In this talk, I will focus on our recent development of DNA moiré superlattices, programmable, layered assemblies that bridge the structural gap between atomic-scale materials and mesoscale systems.

Using twisted DNA origami nanoseeds, we precisely control the orientation, spacing, and stacking symmetry of 2D DNA sublattices, thereby encoding moiré periodicities ranging from a few to tens of nanometres. We demonstrate seed-defined twist angles with high fidelity, the realization of gradient moiré patterns, and the integration of functional components to engineer photonic responses. Together, these advances highlight how bottom-up DNA engineering can create programmable moiré materials with unprecedented structural precision and dynamic functionality, opening new directions in nanophotonics, chiral optics, and adaptive quantum materials.

Scanning (Photo)electrochemical Probe Microscopy: Insight Into Light-driven Catalytic Processes

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Direct photocatalytic energy conversion of solar irradiation energy into chemical bond energy using molecular photosensitizers (PS) and catalysts (CAT) has attracted attention as a sustainable way of generating green fuel [1]. PS and CAT molecules are frequently embedded in soft matter matrices to stabilize them, facilitate storage of photogenerated charges and mitigate degradation of the active components, mimicking natural catalytic processes. Typically, the light-driven catalytic activity in homogeneous and heterogeneous catalysis is monitored at the bulk level. To determine possible heterogeneities in the immobilization of the active components and to determine the local efficiency of these heterogenized photoactive materials, scanning electrochemical probe microscopy (SEPM) such as scanning (photo)electrochemical microscopy (S(P)ECM) enables high-resolution mapping. We recently demonstrated that heterogeneities in the light-driven activity, of embedded hydrogen evolution reaction (HER) catalysts and water oxidation catalysts (WOC) can be evaluated and the quantitative detection of reaction products such as H_2 and O_2 can be achieved [3,4]. In addition, vibrational spectroscopy and spectroelectrochemistry, e.g., in the mid-IR region can provide mechanistic insights [4].

In this contribution, approaches for local readout of photocatalytic products using miniaturized sensors [5,6]. Using the glass sheath of the nano- or microelectrode as the waveguide for local illumination, minimizes the possibility of photobleaching of the photosensitizer (PS) during bulk illumination can be [7]. We present an enhanced local illumination method involving a high-reflective coating applied to the glass sheath of the microelectrode. We present in situ measurements of photocatalytically active supramolecular nanostructures composed solely of PS and a cobaloxime salt, CAT, as well as of Langmuir-Blodgett and Langmuir-Schaefer films consisting of phospholipidic double layers modified with ruthenium-based photosensitizers and molybdenum-based catalysts. These measurements are discussed in terms of H_2 evolution rates and apparent quantum yield (AQY). We will further discuss the potential and challenges of such measurements.

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Plasmonic Fiber Grating Biosensors: From Early Concepts to Prospects for Industrial Deployment

Prof. Christophe Caucheteur – University of Mons, Mons, Belgium

Tilted fiber Bragg gratings (TFBGs) photo-inscribed in single-mode optical fibers belong to a distinct category of fiber core index modulations in which the grating planes are inclined by a small angle (typically below 10°) relative to the fiber axis. This controlled tilt enables efficient coupling between the guided core mode and multiple cladding modes, resulting in an enhanced response to changes in the refractive index of the surrounding medium.

By merging the wavelength-selective behavior of TFBGs with plasmonic phenomena, plasmonic optical fiber grating biosensors have become a compelling solution for ultra-sensitive and selective biomolecular sensing. These hybrid devices support real-time, label-free interrogation of biochemical processes, leveraging surface plasmon resonances to amplify spectral signatures associated with molecular binding events. Since their initial demonstration, extensive efforts have focused on improving sensor performance through optimized grating design, advanced plasmonic coatings, and tailored surface chemistries.

This review surveys the development of plasmonic TFBG-based biosensors, from foundational principles to recent technological milestones. Particular attention is given to materials, fabrication approaches, and functionalization techniques that have driven significant gains in sensitivity and reliability. Despite these advances, translating laboratory prototypes into commercially viable products remains nontrivial. Key hurdles include ensuring reproducibility at scale, achieving long-term stability in realistic operating conditions, and meeting cost constraints compatible with mass production. Possible routes toward industrial adoption are examined, encompassing scalable manufacturing processes, robust biofunctional interfaces, and target applications in medical diagnostics, environmental analysis, and food quality control. Overcoming these challenges will be essential for moving plasmonic fiber grating biosensors from the lab to widespread real-world use.

Automation Meets Analytics: Smart Detection in Laboratory and Chemical Workflows

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The increasing complexity of analytical laboratory processes demands innovative automation solutions that combine precise measurements, real-time evaluation, and data-driven decision-making. Many laboratory workflows involve visual steps and assessments that are labor-intensive, prone to errors, and hinder full automation of lab processes. This presentation introduces a newly developed, multimodal automation system that integrates optical techniques, image analysis, and AI-based evaluation to efficiently address a wide range of analytical applications. The system enables, among other capabilities, the detection and quantification of crystallization processes [1], analysis of bacterial colonies via absorption and fluorescence signals [2], monitoring of dissolution behavior of substances in different solvents [3], and automated determination of buffy coats.

A key advantage of the system lies in its seamless integration into complex automation setups, supporting the full automation of laboratory and production workflows. Data from diverse measurement modules can be centrally processed, intelligent real-time decisions can be made, and processes can be managed without manual intervention. This not only significantly enhances throughput, reproducibility, and data quality but also lays the foundation for fully automated analytical and industrial workflows.

Furthermore, the system demonstrates versatility in industrial contexts: it can be applied for quality control of polishing processes in the glass industry, providing a reliable basis for subsequent analytical assessment of glass quality. The presentation will cover both the technical implementation and integration into complex automation systems, highlight the wide range of applications, and provide a perspective on future developments in intelligent laboratory and process automation.

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From DNA Nanotechnology to Biomedical Insight: Towards Single-Molecule Spatial Omics

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Super-resolution fluorescence microscopy is a powerful tool for biophysical and biological research. The transient binding of short fluorescently labeled oligonucleotides (DNA-PAINT) can be leveraged for easy-to-implement multiplexed super-resolution imaging that achieves molecular-scale resolution across large fields of view. This seminar will introduce recent technical advancements in DNA-PAINT including approaches that achieve sub-10-nm spatial resolution and spectrally unlimited multiplexing in whole cells followed by recent developments in novel protein labeling probes that have the potential to facilitate DNA-barcoded labeling of much of the proteome within intact cellular environments.

Applications of these new approaches will be discussed in cell surface receptor imaging and neuroscience. Visualization and quantification of cell surface receptors at thus far elusive spatial resolutions and levels of multiplexing yield fundamental insights into the molecular architecture of surface receptor interactions thus enabling the future development of more refined “pattern”-based therapeutics. A key approach in implementing these methods has been to leverage standard off-the-shelf fluorescence microscopy hardware as a tool for spatial omics, thus democratizing the ability to visualize most biomolecules and probe their network-wide interactions in single cells, tissues, and beyond with single-molecule-based "Localizomics”.

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How do we Create Robust Optical Chemosensors for Complex Analytes in Condensed Phases?

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Chemosensing – understood as the continues readout of a chemical parameter in a dedicated device – has not been revolutionized since the invention of the pH meter.[1] Which still requires frequent calibration and only has a limited linear range, even in its best embodiment. Optical sensors relying on collisional quenching of oxygen, has proven that potential for chemosensors, even beyond this planet. But we are not seeing a revolution in chemosensing in general. Even though dye chemistry, optical engineering, and photonic – all the enabling technologies, are now exceedingly sophisticated.

We developed an optical pH sensor about a decade ago,[2] however the complexity of the materials chemistry has prevented it to reach the market at this point. Thus, we explored other approaches to chemosensing. Taking a page from well-established bioassyas,[3,4] we are considering small volume sensing, that is chemosensing in stirred multiwell plates. This eliminates issues like mass transport, but is not really sensing, as we are determining chemical parameter in a sample. However, it is a place to start, provides a technology platform, and eliminates most of the issues with materials chemistry. The design space has proven less simple than anticipated,[5] but it has allowed us to return to the lab and design robust nanooptodes.[4] In this presentation I will give an overview of our design criteria,[6] and why we expect nanoptodes to be the first step towards robust optical chemosensors.

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Shedding New Light on Cells With Coherent Nonlinear Optical Nanoscopy

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Optical microscopy is an indispensable tool that is driving progress in biology and is still the only practical means of obtaining spatial and temporal resolution within living cells and tissues. To that end, fluorescent labels provide a highly specific method of visualizing biomolecules. However, this approach has limitations including sample manipulation and staining artifacts, fluorophore photobleaching, and associated phototoxicity. Therefore, much effort has been devoted to developing non-fluorescent optical microscopy techniques which are non-perturbing, photostable, and in turn offer quantitative capabilities unavailable with fluorescent methods.

Our laboratory has been developing optical microscopy set-ups featuring innovative excitation/detection schemes which exploit coherent nonlinear light-matter interaction effects, for bioimaging and biosensing in cells and tissues. Specifically, we have demonstrated four-wave mixing (FWM) imaging of single small (10nm-sized) gold nanoparticles, detected background-free inside cells owing to their nonlinear plasmonic response, with nanoscale localisation precision in 3D [1,2]. Through polarisation-resolved detection, the technique is sensitive to the nanoparticle's shape, orientation, and chirality [3], measuring asymmetries down to 0.5% ellipticity, corresponding to a single atomic layer of gold [1]. Notably, owing to the high electron density of gold nanoparticles, the technique lends itself to correlative light-electron microscopy (CLEM) with a single probe, as demonstrated by us recently [4].

We have also developed a suite of home-built coherent Raman scattering (CRS) microscopes and associate quantitative analysis algorithms [5-8]. CRS microscopy provides chemically-specific contrast and allows us to map the spatial distribution of endogenous biomolecules, such as lipids and proteins [7,8], label-free in living cells at sub-cellular resolution.

Merging the two modalities, we are investigating the exciting area of local-field plasmonically-enhanced CRS in the vicinity of a single gold nanoparticle, for chemical sensing at the nanoscale. I will present our latest progress with these techniques and their applications to bioimaging and biosensing.

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AI and Data Analytics in Sensor Applications II – Automated Image Quality Assessment Methods for Optical Microscopy

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Optical microscopy is a vital biomedical research technique used to investigate tissues, microorganisms, and biological processes down to the subcellular scale. These investigations require reliable data pipelines to translate measured data from samples into knowledge. Quality control and robust data management are crucial for this. We have developed four open-source [1-4], machine-learning-based image quality assessment methods to address real quality evaluation problems in optical microscopy studies. The methods satisfy different requirements, with applications including classification of experimental artefacts and quality ranking. Automated quality assessment ensures objective control over the results and reduces user effort, enhancing the extraction of valuable knowledge from optical microscopy images.

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Phase Imaging Flow Cytometry for Point-of-Care Diagnostics: Methods and Clinical Validation

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Hematology analyzers are the automated, high-throughput beasts for blood cell diagnostics. With low costs per test and high statistical power for complete blood cell counts (CBC), analyzers are, due to the clinical importance of the cellular biomarkers, the most requested laboratory test in the world. However, the hidden champion of in vitro diagnostics relies on indirect assessment of single cells via scatter or impedance measurements. The indirect measurement of single blood cells limits access to the rich morphological information. This leads to a break in automation chains, as usually up to 30% of clinical samples require manual review. Functional cell information is completely missing in a CBC, as well as access to rare cell biomarkers. More recent methods, such as deformation flow cytometry, try to add functional information. However, the high shear stress requires a stand-alone solution, and thus, hematology analyzers have essentially remained unchanged over the past few decades. Most recently, point-of-care (POC) devices have been commercialized based on bright-field microscopy, but all systems use the same sample preparation methods that have been used for decades.

Our aim is to develop a next-generation hematology analyzer platform that is sample preparation-free and incorporates various hidden functional cell markers into the regular CBC, such as blood cell aggregates and neutrophil extracellular traps. For translational impact, the solution requires improving the automation level to minimize manual review and increase throughput. To achieve this ambitious goal, we utilize high-throughput quantitative phase microscopy and microfluidic workflows for stress-free flow focusing.[1-3] AI-supported image analysis allows real-time processing during acquisition, integrates seamlessly with our parallelized blood-cell imaging workflow, and delivers the spatial resolution required to distinguish individual platelets within microaggregates.[4,5] The method can also be applied to cytological flow cytometry applications, which adds more menu options for the platform.[6] With clinical diagnostic studies, we demonstrated clinical utility for prognostic biomarkers in acute care settings.[7,8]
To enhance weak cellular contrast and mitigate reliance on sparsity within the field of view, as well as to address the inherent limitations of common-path QPI, such as optical throughput loss and incomplete interference over the full pupil, we explore a telecentric interferometer utilizing near-focus interference (NFI) for quantitative phase detection.[9] A further method to enhance the phase contrast of intracellular structures is the integration of Fabry-Pérot cavities directly within the microfluidic channel geometry with partial mirrors.[10] With such consumables, a robust Weber contrast enhancement factor of nearly 20x is achieved.[11] We hope that by combining these phase-sensitive methods, we get closer to our vision of a label- and sample preparation-free high-throughput analyzer for hematology, cytology, and beyond.

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Novel Bio(inspired) (Photo)electrochemical Sensing Strategies

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Today the demand for ultra-sensitive and selective (on-site/in process) detection systems resounds from the health, food and environmental sector. These systems must be able to detect and quantify target molecules, important in point-of-care testing and for assessing the level of contamination in food, industrial and environmental samples. Bio/Photo/Electrochemistry is an inviting approach for monitoring the presence and concentration of targets as these devices are fast, portable and extremely sensitive and selective towards (non) electro-active species. Given the characteristics of the ecosystem of today, marked by electronics, we are indeed at the forefront of advancing and integrating (bio)electrochemical sensors & technologies for liquid analyses, accelerating applications in digital healthcare, monitoring and homeland security. However, despite of all optimism in the prognosis, with references to the glucose sensor as a textbook example, only a few (bio)sensors seem to go beyond an academic publication and only a handful number of examples could go beyond of its proof-of-principle stage to the real market. This contrasts sharply with the situation of physical sensors and the evolution of the internet of things, embedded in ecosystems provided by electronics. Why is the progress in developing electrochemical (bio)sensors rather slow? In this lecture, new bio(inspired) (photo)electrochemical strategies to overcome challenging aspects in this research field are presented.[1-4] Detection strategies in cancer and infectious diseases will be presented during the talk, following an integrated approach.

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Measurement of the Absolute Membrane Potential Using Fluorescence Lifetime Imaging Microscopy (FLIM)

Tobias Meyer-Zedler – Leibniz Institute of Photonic Technology, Member of Leibniz Health Technologies, Jena, Germany

The membrane potential (Vm) is crucial in electrical signaling, membrane transport, and cellular processes such as cancer progression. Optical methods enable non-invasive, high-content analysis of Vm. Among these, Genetically Encoded Voltage Indicators (GEVIs) of the ASAP family are widely used. Fluorescence intensity (F) of GEVIs shows voltage-dependent changes, but F-based measurements are limited in reporting absolute Vm due to sensor expression variability, cell movement, photobleaching, and variations in light intensity[1]. The fluorescence lifetime (τ) of excited GEVIs may offer advantages for Vm measurements by reducing intensity-related artifacts[2].

Using combined one-photon FLIM and whole-cell patch clamp, we examined ASAP1 and its successors JEDI1P, ASAP3, and rEstus[3] in HEK293T cells. From -100 to 50 mV, ASAP1 and JEDI1P showed a maximal lifetime change (Δτ) of only 250 ps whereas rEstus and ASAP3 exhibited more than twofold greater Δτ of 575 ps and 640 ps, respectively. The sensors' lifetimes displayed little dependence on light intensity, which defines an advantage over F-based V_m measurements. However, the voltage dependence of τ differed from that of intensity, indicating that the suitability of a GEVI for FLIM applications cannot be solely based on F(V). By further protein engineering we thus generated rEstus-NI with Δτ of 730 ps and a maximum sensitivity of 6.6 pS/mV at -30 mV, i.e., at a membrane voltage typical for various cancer cell lines. rEstus-NI enabled noninvasive absolute V_m measurements in individual HEK293T cells. FLIM of rEstus-NI was furthermore used to study resting Vm and spontaneously V_m fluctuations in non-excitable cancer cell lines.

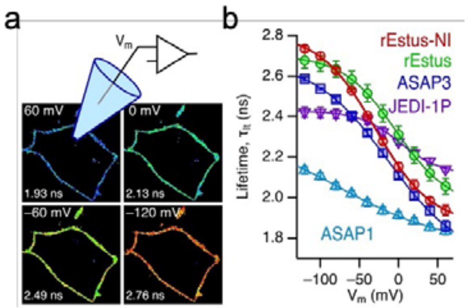

Figure 1:

a) FLIM images of HEK293T cells with rEstus-NI under patch-clamp control. b) Voltage dependence of fluorescence lifetime for various GEVIs. Adapted from Nair et al., 2025 (bioRxiv, doi: 10.1101/2025.08.08.669310).

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Rethinking Optical Biosensors: From Integrated Photonics to Deployable Sensing Platforms

Eleni Makarona – Photonic Devices and Systems Group, Institute of Nanoscience and Nanotechnology, NCSR "Demokritos", Athens, Greece

Despite decades of impressive advances, optical biosensors have largely remained confined to laboratory settings, burdened by system complexity, fragile interfaces, and operational requirements that limit their relevance outside controlled environments[1]. Achieving real-world impact therefore requires not only improved photonic device performance, but a fundamental rethinking of how biosensing platforms are conceived, engineered, and deployed.

The first part of this contribution focuses on the development of an immersible silicon photonic biosensor concept. Rather than pursuing incremental integration, this approach deliberately prioritizes radical operational simplicity while preserving the advantages of silicon photonic interferometric biosensors. By eliminating external wiring, pumps, tubing, and microfluidics, a dip-and-read sensing format is realized, challenging the prevailing assumption that high-performance photonic biosensors must rely on system-intensive architectures to be effective.

At the same time, technological dogmatism is avoided. No single optical sensing architecture can address the diversity of constraints encountered in real applications, where cost, disposability, sensitivity, selectivity, and robustness often compete. For this reason, our group develops a portfolio of complementary biosensing platforms[3-5]. Each platform is selected and engineered to address needs that cannot be met efficiently by a one-size-fits-all solution. A unifying principle across these efforts is our single-roof development model, spanning the full chain from concept creation to system-level evaluation. This end-to-end approach provides not only technical control, but enables end-user centered design and informed trade-offs, while it accelerates the transition from scientific idea to deployable sensing system. Through selected examples from health diagnostics, food safety, environmental monitoring, and public safety, it is demonstrated how platform diversity, and integrated development workflows can collectively redefine the role of optical biosensors beyond the laboratory.

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Lab-on-a-Chip Platforms for In Situ Photonic and Spectroelectrochemical Sensing

Detlev Belder – Leipzig University, Leipzig, Germany

Lab-on-a-chip technologies offer unique opportunities for miniaturized and automated optical sensing by integrating fluid handling, sample processing, photonic readout, and electrochemical control within compact microfluidic platforms. To advance these capabilities, we have developed complementary microfluidic and digital microfluidic (DMF) systems that enable in situ optical and spectroelectrochemical sensing, including surface-enhanced Raman spectroscopy (SERS) as a highly sensitive structural probe.

In one approach, we combine a pressure-stable microsensor with a silver-based SERS substrate and an integrated electrode, enabling real-time SERS detection under electrochemical control. This spectroelectrochemical modulation enhances signal strength, regulates adsorption processes, and provides additional structural information, addressing key limitations that have previously hindered the routine use of SERS in online analytical workflows.

In another approach, a DMF platform supports SERS detection via an external microspray interface or an internally implemented, potentially regenerable on-chip SERS substrate. Automated droplet handling, on-chip mixing, TLC separation, and Raman-based identification have been successfully demonstrated for various model compounds.

Together, these developments illustrate how the integration of microfluidics, photonic sensing, SERS, and spectroelectrochemical control opens new pathways toward automated, sensitive, and versatile lab-on-a-chip analysis.

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Engineering DNA-controlled CRISPR Systems for Enzyme Activity Monitoring

Alessandro Porchetta – University of Rome Tor Vergata, Rome, Italy

The use of collateral cleavage activity of type V and VI CRISPR-Cas systems hold promise for molecular diagnostics of nucleic acids, yet achieving precise non nucleic acid detection remains challenging. (1,2) Dynamic DNA nanotechnology offers unique opportunities to address this challenge by programming input responsiveness directly into nucleic acid structures. In this talk, I will present the use of DNA-based molecular transducers that provide external control over CRISPRCas12a system in response to the activity of DNA repair enzymes and topoisomerases.

I will first introduce how synthetic DNA transducers can convert a specific DNA repair activity into a measurable CRISPR-readable input. (3,4) Specifically, by transducing base excision repair events into programmable DNA triggers, we link glycosylase activities (e.g., UDG, hOGG1) to Cas12a-powered signal generation. This approach results in rapid, one-step activity-based assays that operate directly in cell lysates, providing sensitive readouts of base excision repair activity, also enabling throughput inhibitor screening.

Then, I report on topoisomerase activity as the topology-writing event that controls CRISPR activation. Topoisomerases dynamically remodel DNA supercoiling, actively converting torsional stress into relaxed or reconfigured topological states. By engineering CRISPR–Cas12a systems whose activation is gated by topologically constraint DNA plasmids that are selectively resolved by topoisomerases, we transform enzymatic switch of DNA topology into a direct and amplified CRISPR readout.

Together, these strategies show how DNA molecular transducers can endow CRISPR systems with programmable input responsiveness, opening new avenues for molecular diagnostics and synthetic biology.

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Integrated and Rapid Biosensors for Biomedical and Environmental Applications

Mohammed Zourob – Alfaisal University, Riyadh, Saudi Arabia

Modern biosensing technologies face critical limitations that hinder their translation from laboratory prototypes to true point-of-care and field-deployable diagnostic systems. Many platforms struggle with real-world samples, exhibit detection limits that remain above infectious doses, require lengthy analysis times, and depend on multiple washing steps and liquid handling procedures that compromise portability and on-site applicability. An additional bottleneck lies in the stability, scalability, and integration of highly specific recognition elements capable of functioning reliably under practical conditions.

In this presentation, I will present our recent advances addressing these fundamental challenges. We have developed various optical, electrochemical, and colorimetric biosensing platforms integrated with robust aptamer-based recognition receptors. By engineering novel analyte pre-concentration and enrichment strategies directly onto sensor surfaces, we significantly enhanced target capture efficiency. The integration of these techniques with various transducers enabled substantial improvements in detection limits, reduced assay times, and minimized non-specific binding thereby lowering false-positive rates and increasing diagnostic reliability.

Furthermore, we introduce a new generation of flexible, low-cost diagnostic tools based on paper substrates, cotton swabs (Q-tips), and flexible polymeric materials. These platforms uniquely combine sample collection, analyte pre-concentration, and detection within a single device architecture. The systems have been validated against clinically relevant bacterial pathogens including Escherichia coli, Staphylococcus aureus, Campylobacter, and Brucella as well as viral targets such as influenza viruses, MERS-CoV, and HPV. Remarkably, the detection limits achieved are comparable to gold-standard PCR methods, while eliminating the need for complex instrumentation. The assays can be performed directly in the field or at the patient's bedside by minimally trained personnel, offering a transformative approach toward rapid, accessible, and decentralized diagnostics.

This work represents a significant step toward practical, scalable biosensing solutions capable of meeting the urgent global demand for rapid infectious disease detection.

Magnetic Control of Molecular Emissivity for New Applications in Imaging

Sergei A. Vinogradov – University of Pennsylvania, Philadelphia, USA

The possibility of imposing magnetic control over molecular emissivity presents interests for various fields of technology and medicine, including biomedical imaging and sensing. In this presentation, I will discuss experiments exploring magnetic field effects (MFE) on phosphorescence in donor-acceptor dyads and triads based on phosphorescent complexes of platinum porphyrins (PtP). Upon photoexcitation, the designed systems undergo reversible photoinduced electron transfer (PET), generating radical pairs (RP), whose mixed spin states exist in equilibrium with a local phosphorescent triplet states. The RPs decay either via recombination to the ground state (singlet channel) or to the triplet state of the PtP (triplet channel) and emit phosphorescence. The net distribution of the decay rate over the recombination channels, and, consequently, the phosphorescence decay time and intensity, are governed by the spin dynamics in the RPs and are sensitive to external magnetic fields. One of the designed systems was found to exhibit especially strong and positive MFE with the magnitude reaching up to ~12% in the fields as low as 200 mT. The field dependence and the sign of the MFE is characteristic of the hyperfine coupling mechanism, although at higher fields participation of the Δg mechanism was also observed. A kinetic model was developed that allowed us to accurately reproduce the observed charge and excitation dynamics in the phosphorescent MFE-sensitive systems. Overall, this work constitutes a step towards rational design of magnetically sensitive luminescent molecules, which might be exploited in construction of biological probes for new imaging modalities, such as phosphorescent probes for magneto-optical tomography or sensitizers for magneto-optical photodynamic therapy.

POSTER CONTRIBUTIONS

POSTER CONTRIBUTIONS

P_1 | Faster and Higher-Throughput Single-Molecule Fluorescence Detection using Quartz Microfluidics and Light Sheet Detection // T. Kache (Jena, DE)

P_2 |Photodynamic Therapy with Pentamethine Cyanines: Determination of the 1O2 Generation and Antimicrobial Activity // M. Puyol (Barcelona, ES)

P_3 |Automatic Microanalyzers for Monitoring the Hydrometallurgical Zinc Purification Process // M. Puyol (Barcelona, ES)

P_4 |Synthesis and Characterization of Photon-Upconversion Nanoparticles for Single-molecule Methods // J. Weisová (Brno, CZ)

P_5 |Studying the Peroxisomal Protein Import with Super-resolution Fluorescence Microscopy // D. Zakinova (Jena, DE)

P_6 |Tuning Salt Deposition on Nanostructured Biolayers for Enhanced Label-free Biosensing // A. Patrone-Garcia (Valencia, ES)

P_7 |Application of Optogenetics and Super-resolution (STED) Microscopy to Investigate Peroxisomal Morphology and Protein Import // D. Koppenhagen (Jena, DE)

P_8 |Flexible Silver-Coated Gold Nanoparticles Loaded Graphene Textiles for Direct Detection of Thiacloprid Pesticide // S. Jiao (Jena, DE)

P_9 |Plasmonic Enhancement Optical Readout to Detect Affinity Mediated Transfer for Single Molecule Detection // A. Kutová (Prague, CZ)

P_10 |Characterisation of Polymer Films for the Detection of Oil as Contaminant in Pressurized Air // P. Fels (Tübingen, DE)

P_11 |Indirect Determination of Glyphosate in Water by Ring-Oven Technique // I.M. Raimundo Jr. (Campinas, BR)

P_12 |Use of the Ring-Oven Preconcentration Technique for the Determination of Tetracyclines in Aqueous Samples // I.M. Raimundo Jr. (Campinas, BR)

P_13 |Engineering Aptameric Responsive Photonic Biosensor Based on Cholesteric Liquid Crystal Network for the Detection of Anatoxin // M. Zourob (Riyadh, SA)

P_14 |A Wearable Microneedle-Integrated Photonic Aptasensor for Real-Time, Multiplexed Detection of Illicit Drugs in Interstitial Fluid // M. Zourob (Riyadh, SA)

P_15 |Gold-palladium Core-shell Nanostructures with Tunable Shape for LSPR based Optical Sensing // O. Petrova (Jena, DE)

P_16 |Multiphoton Lithography-based Preparation of Micro/Nanostructured Thermoresponsive Hydrogel Binding Matrix for Plasmon-Enhanced Biosensing // G.I. Delgadillo (Prague, CZ)

P_17 |Experimental and Theoretical Exploration of the Gold Nanotriangle Optical Properties for Designing Detection Systems // H. Sarigul (Kaunas, LT)

P_18 |Plasmon-Enhanced Fluorescence Platforms for Sensitive Detection of Interleukin-6: A Comparative Study of Metallic Nanoparticles and Flat Films // B. Balkan-Apaydın (Prague/CZ)

P_19 |Label-Free Photonic Biosensing of SARS-CoV-2: SPR Detection of RBD–ACE2 Binding // M. Licuona (Jena, DE)

P_20 |Electrochemically-assisted SPR Sensor for the Detection of Hydrogen Peroxide // T. Liu (Prague/CZ)

P_21 |Raman-based Detection of Natural Products in Microbial Communication // T. Dib (Jena, DE)

P_22 |Exploring the 2-D Visualization of H2S and HS^- Gradients using Luminescence-based Imaging Techniques // Y.J. Knöbl (Aarhus/DK)

P_23 |Surface-Engineered Upconversion Nanoparticles for Robust Luminescence and Lifetime Sensing in Aqueous Media // L. Wetzel (Regensburg, Potsdam/DE)

P_24 |Metabolic Imaging in White Blood Cells using Fluorescence Lifetime Imaging Microscopy (FLIM) // A. Tannert (Jena, DE)

P_25 |Ratiometric pH Sensing with Dually Emissive Umbelliferone Dyes // M. Schwar (Graz, AT)

P_26 |Spectroscopic Characterization of Ruthenium Terpyridine Complexes at Cryogenic Temperatures and Application to Cryo Temperature Sensitive Paints // M. Schäferling (Münster, DE)

P_27 |Lateral Flow Test Strips for In-situ Degradation and Determination of Nitrosamines // S. de Marcos (Zaragoza, ES)

P_28 |Flexible-Linker Plasmonic Biosensors: Continuous Monitoring of Low-Molecu**lar-Weight Analyte and Endpoint Immunoassay-Based Biomarker Detection** // G. Aktug (Prague/CZ)

P_29 |Sensitive SERS Detection of Perfluorooctanoic acid (PFOA) Using Amine-Functionalized Gold Nanoparticles // M. Aghili (Kingston/CA)

P_30 |Voltammetric Ion Transfer Microscopy (VITM): Spatially Resolved Optical Ion Sensing by Electrochemical Control // J. A. Rothen (Geneva/CH)

P_31 |Polymer Fabry-Perot Resonators for Passive and Active Sensing // R. Bernini (Naples/IT)

P_32 |Paper-based Sensor for Hexamethylene Triperoxide Diamine (HMTD) Detection // A. Dybko (Warsaw/PL)

POSTER CONTRIBUTIONS

P_33 | Off-chip Acoustofluidic Particle Focusing into Single-file Motion // A. Bayramli (Jena/DE)

P_34 | Surface Modification of Thermoplastic Lab-on-a-Chip Devices with Polymer Brushes via SI-ARGET ATRP // V. Cirik (Prague/CZ)

P_35 | Microscope-based Multi-Analyte-Reflectance-Spectroscopy Biosensor: Application for Multiplexed Label-free Immunoassays // I. Raptis (Athens/GR)

P_36 | White Light Reflectance Spectroscopy Biosensing Platform for the Simultaneous Detection of Five Uropathogenic Bacteria // I. Raptis (Athens/GR)

P_37 | In-line Monitoring of Oxygen, pH, Glucose and Lactate in Organ-on-chips with Integrated Optical Sensors // T. Mayr (Graz/AT)

P_38 | Optimisation of a Lysis-on-chip system for Gram-positive and Gram-negative Bacteria // J.C. Sousa (Braga/PT)

P_39 | Automating Bacterial DNA Purification: Boosting Laboratory Workflow Efficiency // A. Frangolho (Braga/PT)

P_40 | Artificial Intelligence for Analysis of Single Molecules and Nanoparticles by Optical Microscopy and Slitless Spectroscopy // H. Brožková (Brno/CZ)

P_41 | Machine Learning-assisted Surface Enhanced Raman Scattering (SERS) Characterization of Protein-gold Nanoparticle Interactions // S. Banerjee (Berlin/DE)

P_42 | AI Boosts FLIM for Mapping Macrophages in Influenza-Infected Human Lungs // S. Greiner (Jena/DE)

P_43 | Infrared Spectroscopic Visualization of Lipid Accumulation in Influenza-Infected Murine Lung Sections // A. Shydliukh (Jena/DE)

POSTER CONTRIBUTIONS

P_44 | 3D Reconstruction of Bulk Samples using Nonlinear Multimodal Microscopy and Photogrammetry // E. Travkina (Jena/DE)

P_45 | Projected VIS-NIR Multispectral Imaging System for Intraoperative Breast Tumor Margin Assessment // H. Wang (Beijing/CN)

P_46 | Wide-field near Infrared Autofluorescence Imaging Guided Needle-type Raman Spectroscopy for Breast Tumor Margin Assessment // J. Wang (Beijing/CN, Jena/DE)

P_48 | LPG-based Sensor for FKBP12 Detection // A. Giannetti (Sesto Fiorentino/IT)

P_49 | Development of a PMMA-Coated HC-PCF Optical Fiber Fabry–Perot Interferometric Sensor for Ethanol Sensing // J.M. Leça (Aveiro/PT)

P_50 | Evaluation of a 1064 nm Fiber-Based Raman System for Fluorescence-Suppressed Optical Sensing of Biological and Textile Samples // D. Lilek (Tulln/AT)

P_51 | Light Absorption of Tandem III-V Nanowires // E. Makarona (Athens/GR)

P_52 | Combining Multimodal Nonlinear Endoscopy // T. Meyer-Zedler (Jena/DE)

P_53 | Smaller Plastics, Bigger Risks: Unveiling the Unseen Using Multimodal Submicron IR (O-PTIR), Raman and Fluorescence // C. Borbeck (Mülheim/DE)

P_54 | SERS Detection of Benzotriazole in Complex Water Matrices // A. Ghosh (Jena/DE)

P_55 | High-Speed Laser-Scanning Photothermal Infrared and Stimulated Raman Platform for Real-Time Label-Free Chemical Imaging // M. Unger (Mülheim/DE)

P_56 | Development of a Phosphorescent Quantum Dots–Hydrogel Hybrid Material as a Potential Platform for Wearable Sensing // H. Yilmaz (Zagreb/HR)