

PHOTONIC FORGE II

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POLIPHOTONICS
STUDENT CHAPTER



Book of Abstracts

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CONTRIBUTIONS

Plenary Lectures

- **Prof. Dr. Javier Aizpurúa Iriazabal** (IKERBASQUE): *Addressing Light-Matter Interaction at the Nanoscale.*
- **Prof. Dr. Martina Delgado Pinar** (UV): *When Light Met Sound: a Review on Forward Brillouin Scattering Optomechanics in Optical Fibers.*

Invited Talks

- **Raúl López March** (iTEAM-UPV): *Analog Programmable-Photonic Computing: A Wave-Based Approach to the Future of Information.*
- **Prof. Dr. Isaac Suárez Álvarez** (UV): *Optoelectronic Devices Based on Semiconductor Perovskites: Current Development and Future Prospects.*
- **Dr. Bruno López Rodríguez** (DAS Photonics): *High-Performance Integrated Photonics with Amorphous Silicon Carbide.*
- **Dr. Iago Rodríguez Díez** (NTC-UPV): *Chiral Light-Matter Interaction on Photonic Chips for Separating Enantiomers.*
- **Prof. Dr. Ana Díaz Rubio** (NTC-UPV): *Flat Photonic Metastructures for Precise Far and Near-Field Control of Electromagnetic Waves.*

Posters

Integrated Photonics and Devices

- [P1] **Íñigo López Mulet** (NTC-UPV): *Sb₂Se₃-Based Reconfigurable 4x4 Benes Switch Matrix.*
- [P2] **Jorge Caso Prieto** (NTC-UPV): *Hydrogen-Doped Indium Oxide Thermo-Optic Phase Shifter for the Silicon-Nitride Platform.*
- [P3] **Daniela Satián Guamán** (NTC-UPV): *Experimental Optical Switching Across Resonant Wavelengths in a Gallium Phosphide Cavity.*
- [P4] **Òscar Fontelles López** (NTC-UPV): *Meta-coupler for Emission Reconfiguration in Laser Integration (MERLIN).*
- [P5] **María de la Paz García Gallego** (NTC-UPV): *Molecular Beam Epitaxy (MBE) for the Growth of III-V Materials.*

Optomechanics and Acousto-Optics

- [P6] **Dr. Raúl Ortiz Fernández** (DAS Photonics): *Experimental All-optical Up- and Down-conversion of 5G NR Signals using an Optomechanical Frequency Comb.*
- [P7] **Alberto Grau Martínez** (NTC-UPV): *Non-Suspended Silicon Optomechanical Cavity as a Mass Sensor for Nanoparticles Detection.*
- [P8] **Anna I. Garrigues Navarro** (UV): *Radial Acoustic Mode Detection Technique with an All-Fiber Ring Resonator.*
- [P9] **Xinyan Yang** (NTC-UPV): *Comparative Analysis of Optomechanical Crystal Mechanical Oscillators with Fiber Loop and Integrated Waveguide Coupling.*
- [P10] **Javier Martínez Lozano** (NTC-UPV): *Optomechanical Cavity Response Modulation by Spin-Crossover Nanoparticles.*

Nonlinear Photonics

- [P11] **Miguel A. Bosch García and Marc Pérez Safont** (UV): *Stepping Stones to Engineer Pulse Propagation Through Multifrequency Nonlinearities.*
- [P12] **José Juan Cobo Galiana** (NTC-UPV): *Pathway to Soliton Microcombs in Silicon Nitride Microrings: Nonlinear and Chaotic Kerr Comb Dynamics.*
- [P13] **Pol Molina I Grífols** (NTC-UPV): *Soliton Families in Micro-Ring Resonators with Third Order Dispersion.*

Light-Matter Interaction and Optical Characterization

- [P14] **Josep Martinez Romeu** (NTC-UPV): *Chiral Optical Forces in a Slot Waveguide for the Separation of Molecules in Gas.*
- [P15] **Jaime Gimeno Balaguer** (ETS-UPV): *From Theory to Fabrication: Circular Bragg Gratings as Optical Antennas for Single-Photon Sources.*
- [P16] **Víctor Camús Hernández** (ICMUV): *TERS Characterization of an NPoM System.*
- [P17] **José Luis Rodrigo Ramón** (UV): *Optical Probing of Matter at High Pressure.*
- [P18] **Paula Mouriño Miñambres** (NTC-UPV): *Backscattered Electron and Cathodoluminescence Microscopy for the Characterization of GaInP/InP Tandem Solar Cell Nanowires: Challenges and Opportunities.*
- [P19] **Ricardo Aguado Collazo** (NTC-UPV): *Zero-loss Energy harvesting Using nanowire solar cells in Space (ZEUS): Front Contact Deposition and Characterization and Nanowire Growth Previous Steps.*
- [P20] **Marcos Altarriba Roig** (NTC-UPV): *Design and Experimental Implementation of an Optical Vacuum Setup for the Characterization of Photonic Crystal Cavities.*
- [P21] **Lucas Mascaró Burguera** (NTC-UPV): *Spin-Crossover Compounds for Reconfigurable Photonic Integration*

Photonics for Communications and Outreach

- [P22] **Jorge Giménez Tenés, Ferran Esteve Barrera, Pablo Nicolau Monzó and Guillem Pla Borja** (UV): *Lluminària: An Outreach Magazine Crafted by Students for Students.*
- [P23] **Jaime Romero Huedo** (iTeam-UPV): *Towards 6G: Unified RoF Fronthaul for Heterogeneous Wireless Networks.*
- [P24] **Vicente Fito Estevan** (NTC-UPV): *5G Fronthaul over Fiber with Optical Conversion to Different RF Bands.*

ABSTRACTS

Invited Lectures

Prof. Dr. Javier Aizpurúa Iriazabal (DPC-UPV/EHU-Ikerbasque): *Addressing Light-Matter Interaction at the Nanoscale.*

A metallic nanogap is a superb configuration to explore the interplay between light and matter. Light scattered off, or emitted from a nanogap carries the information of the surrounding electromagnetic environment with it. This situation becomes even more appealing when a single molecule is located in such a plasmonic cavity or in its proximity, with the molecule playing an active role either in the electromagnetic coupling with the nanocavity, or even participating in processes of charge injection and transfer, as revealed through cutting-edge field-enhanced molecular spectroscopy. The process of interaction between a molecular emitter and a nanocavity will be addressed by means of different theoretical frameworks which involve aspects of condensed matter physics, quantum chemistry, and cavity-quantum electrodynamics. A battery of methodologies to address the dynamics of electrons photo-emitted in nanogaps, ultra-resolution in atomic-scale photoluminescence, or non-linear regimes in molecular optomechanics will be described, and many of the theoretical insights obtained will be interpreted in the context of state-of-the-art experimental results in nanocavity-enhanced molecular spectroscopy.

Prof. Dr. Martina Delgado Pinar (UV): *When Light Met Sound: a Review on Forward Brillouin Scattering Optomechanics in Optical Fibers.*

Electromagnetic (light) and mechanic (sound) waves interact and perturb each other when coexisting in a waveguide. Optical fibers can propagate both of them, thus they are an excellent platform to study the results of optomechanic interactions. Forward Brillouin Scattering (FBS) in fibers is a type of such phenomena, which have led to a variety of applications with outstanding features. We will present the fundamentals, and the techniques developed at the Laboratory of Fiber Optics (UV) for the all-optical control of FBS.

Contributed Talks

Raúl López March (iTEAM-UPV): *Analog Programmable-Photonic Computing: A Wave-Based Approach to the Future of Information.*

As digital electronics approach their fundamental physical limits, there is an urgent need for new computational frameworks. This talk introduces Analog Programmable-Photonic Computation (APC), a paradigm designed to harness the continuous nature of light waves rather than traditional binary logic. By leveraging Programmable Integrated Photonics (PIP), we present a wave-based approach that redefines information processing, offering a scalable and energy-efficient alternative for the future of computing. We will explore the fundamental principles of this technology and its potential to overcome the bottlenecks of current digital and quantum architectures.

Prof. Dr. Isaac Suárez Álvarez (UV): *Optoelectronic Devices Based on Semiconductor Perovskites: Current Development and Future Prospects.*

Over recent years, the family of semiconductors known as perovskites, or semiconductor perovskites (SPs), has been a hot topic in thousands of publications dedicating substantial efforts to study its basic properties and to implement a wide range of optoelectronic devices. Unlike more traditional semiconductors, such as Si or III-V, SPs are easily synthesized at low processing temperatures, making them potentially very desirable because of their fabrication under cheap equipment and low environmental impact. Moreover, SPs can be deposited as thin films by solution processing techniques (spin coating, doctor blading, inkjet printing, ...), giving rise to layers with excellent optoelectronic properties: absorption coefficients above 1 cm⁻¹, room temperature emission efficiencies close to 100 %, high electronic mobilities... Furthermore, their impressive optoelectronic properties are complemented by an enormous compositional range, so that the bandgap energy can be tuned from near infrared (NIR, up to almost 1 μm) to ultraviolet (UV, 350-400 nm), and the synthesis in different morphologies (polycrystalline thin films, nano-sheets, nano/microcrystals...) and/or dimensionalities (2D and quasi-2D semiconductors and quantum dots). This presentation will introduce the state of the art of SPs in the semiconductor technology by reviewing their physical properties and their dependence on composition/morphology. It will also describe the synthesis and fabrication methodologies, and highlight the progress in implementing optoelectronic comprising, including solar cells, photodetectors and optical sources. Particular emphasis will be placed on photonic devices, considering the presenter's group's demonstrated expertise in this domain. The talk will end with an examination of the inherent limitations in stability and processing associated with these materials, together with prospects for their advancement.

Dr. Bruno López Rodríguez (DAS Photonics): *High-Performance Integrated Photonics with Amorphous Silicon Carbide.*

Over the past decades, integrated photonic circuits have revolutionized the field of optics by enabling on-chip generation, manipulation, and detection of light with unprecedented scalability and precision. By leveraging advances in material platforms and nanofabrication tools and techniques, integrated photonics supports an ever-expanding range of applications, from high-speed optical communications and on-chip sensing to photonic quantum computing and signal. I will also address critical challenges—such as integrating active components, managing losses and achieving high thermal tunability and discuss future directions for ultra-compact, energy-efficient, and multifunctional integrated photonic devices.

Dr. Iago Rodríguez Díez (NTC-UPV): *Chiral Light-Matter Interaction on Photonic Chips for Separating Enantiomers.*

This presentation introduces two synergistic projects united by a common goal: the optical separation of enantiomers on a chip—a critical challenge in the production of safe pharmaceutical drugs and agrochemicals. CHIRALFORCE explores the fundamental interaction between polarized light and chiral matter, demonstrating how optical forces can be exploited to sort chiral molecules and nanoparticles on a photonic integrated circuit platform. Complementing this, PiES-on-chip pushes the boundaries of efficiency by applying inverse design algorithms to the photonic circuit geometry, discovering unconventional designs that optimize the separation process. Together, these initiatives illustrate the future of compact, light-based chiral technologies for safer pharmaceutical drugs and agrochemical production.

Prof. Dr. Ana Díaz-Rubio (NTC-UPV): *Flat Photonic Metastructures for Precise Far and Near-Field Control of Electromagnetic Waves.*

Photonic metastructures present a new paradigm in wave control and manipulation. The engineering of periodic artificial atoms has enabled optical responses not found in nature as well as precise manipulation in both the near and far-field regimes. Moreover, these platforms offer versatility in many applications, from photonic sensors and beam vortex generation to anomalous reflectors and nonreciprocal devices. In this presentation, a general overview of the capabilities of metastructures in photonics will be discussed with an emphasis on applications and the fabrication possibilities at the Nanophotonics Technology Center.

Posters

Integrated Photonics and Devices

Íñigo López Mulet (NTC-UPV): *Sb₂Se₃-Based Reconfigurable 4x4 Benes Switch Matrix.*

Chalcogenide phase-change materials (PCMs) stand out for their reversible and non-volatile transition between their crystalline and amorphous phase, accompanied by a large change in the refractive index. They have been leveraged in applications such as neuromorphic computing or reconfigurable photonics. Among the PCMs, antimony selenide (Sb₂Se₃) features a non-volatile refractive index change with almost negligible losses, enabling, thus, power-efficient optical phase-shifting. Hence, by developing Sb₂Se₃-based switches, data centers have the potential to drastically lower their energy usage, which is steadily increasing in response to rising demand from technologies such as artificial intelligence. In this work, we present a reconfigurable 4x4 Benes switch matrix based on Mach-Zehnder interferometers (MZIs) with 6 μm-long Sb₂Se₃/silicon waveguides in their arms.

Jorge Caso Prieto (NTC-UPV): *Hydrogen-Doped Indium Oxide Thermo-Optic Phase Shifter for the Silicon-Nitride Platform.*

In this work, we propose IHO as a CMOS-compatible microheater for realizing low-loss and high-speed thermo-optic phase shifters on the Si₃N₄ PIC platform, leveraging IHO's low absorption at near-infrared wavelengths. Our simulations demonstrate that the heater can be deposited close to the waveguide, thereby reducing both thermal loss and diffusion time. This yields a compact device with a 1.5x faster response time, lower energy consumption, and smaller footprint than TiN microheaters.

These results show an efficient approach for minimizing the trade-off between speed and power consumption in thermo-optic devices on the Si₃N₄ photonic platform with special emphasis on emerging applications requiring both fast and energy-efficient devices, such as in neuromorphic and quantum computing.

Daniela Satián Guamán (NTC-UPV): *Experimental Optical Switching Across Resonant Wavelengths in a Gallium Phosphide Cavity.*

It is possible to design gallium phosphide optomechanical cavities with two optical resonances located in the 1520–1640 nm range. Optical switching between these resonances is experimentally confirmed by observing a wavelength shift opposite to that expected from the thermo-optic effect, clearly identifying the mechanism responsible for the switching.

Òscar Fontelles López (NTC-UPV): *Meta-coupler for Emission Reconfiguration in Laser Integration (MERLIN)*.

Dynamic reconfigurability of emission is critical for photonic devices to adapt to constantly changing environments. Current solutions for dynamic light emission rely on the combination of independent structures, in which the independent light source implies an increase in weight and footprint. The MERLIN project aims to develop the first fully integrated device for dynamic control of emissions. This integration reduces system size, power consumption and fabrication costs, while increasing performance reliability. Our group's (III-V semiconductors and graphene) responsibility in this project revolves around the design, fabrication and characterization of a GaSb-based quantum well laser, as well as maximizing light coupling and filtering the laser signal entering the meta-coupler used for laser emission, developed by the Artificial Materials and Metasurfaces group. Here, we present the advances in the deposition of SiO₂ and SiN on a GaSb layer, as well as the current numerical studies on the coupling of the laser signal to the waveguides and its spectral filtering.

María de la Paz García Gallego (NTC-UPV): *Molecular Beam Epitaxy (MBE) for the Growth of III-V Materials*.

Semiconductors constitute the foundation of a large part of modern photonics, driving the need for precise control over the properties of these materials. Achieving this level of performance requires advanced epitaxial growth techniques capable of controlling composition, thickness, and interfaces at the nanometer scale. Molecular Beam Epitaxy (MBE) enables the fabrication of high-quality heterostructures for optoelectronic devices.

MBE is an epitaxial growth technique under ultra-high vacuum that enables layer-by-layer deposition with atomic-scale precision, abrupt interfaces, and high reproducibility, together with precise doping control and the design of complex III-V heterostructures. At NTC, a newly installed MBE system provides an advanced platform for the development of high-quality III-V materials. Upcoming efforts will focus on the growth of GaSb laser structures on silicon, driving the advancement of PICs.

Optomechanics and Acousto-Optics

Dr. Raúl Ortiz Fernández (DAS Photonics): *Experimental All-optical Up- and Down-conversion of 5G NR Signals using an Optomechanical Frequency Comb*.

Optomechanical crystal cavities (OMCCs) generate optical and mechanical modes, creating a stable microwave tone and a frequency comb (OMFC) with several harmonics in the lasing regime. We demonstrate all-optical multi-frequency conversion of 5G signals using a silicon OMFC as a local oscillator. This compact, power-efficient technology is crucial for 5G and future systems and is compatible with silicon photonic circuits.

Alberto Grau Martínez (NTC-UPV): *Non-Suspended Silicon Optomechanical Cavity as a Mass Sensor for Nanoparticles Detection.*

We study the capabilities of a non-suspended optomechanical cavity to work as a nanoparticle sensor focusing on its optical response. We observe its optical response, and how it varies in the presence of a monolayer of the binding molecule and of a metallic nanoparticle. This is done by measuring the shifts of the resonance frequency and the broadening of said resonances. We also work on how to accurately deposit the nanoparticles on the optical cavities. This would allow us to easily keep track of nanoparticles when we deposit them for other applications.

Anna I. Garrigues Navarro (UV): *Radial Acoustic Mode Detection Technique with an All-Fiber Ring Resonator.*

We report a highly sensitive technique for the detection and characterization of forward stimulated Brillouin scattering (FSBS) radial acoustic modes in short optical fiber sections using an all-fiber ring resonator. In this approach, acoustic vibrations excited by pulsed optical pumping induce a time-dependent phase modulation on a co- or counter-propagating probe wave. The resonant transfer function of the fiber ring converts this phase modulation into measurable intensity oscillations, enabling efficient interrogation of mechanical resonances in millimeter-scale fiber lengths.

Radial acoustic modes up to ~900 MHz were experimentally resolved, including modes as high as R_0 ,19. Clear spectral signatures were obtained for fiber lengths down to 4 mm, with signal amplitudes several dB above the noise floor. A systematic study of the resonance linewidth as a function of fiber length reveals a substantial reduction of spectral broadening for shorter sections. For example, the linewidth of selected modes decreases by approximately 40% when reducing the fiber length from 30 cm to 1 cm, evidencing the role of longitudinal inhomogeneities in acoustic damping and resonance broadening.

The frequency-dependent response of the ring resonator is shown to shape the measured modal amplitudes, in agreement with theoretical predictions. Furthermore, comparison between co- and counter-propagating configurations experimentally confirms the expected sinc-type modulation of the phase response in the latter case.

The proposed method provides a simple, flexible, and fully fiber-integrated platform for sub-centimeter FSBS interrogation without fiber processing or long interaction lengths. It is particularly promising for point sensing and opto-mechanical characterization in compact photonic systems.

Xinyan Yang (NTC-UPV): *Comparative Analysis of Optomechanical Crystal Mechanical Oscillators with Fiber Loop and Integrated Waveguide Coupling.*

Optomechanical crystal cavities (OMCCs) have attractive features acting as chip-integrated microwave photonic oscillators (PMOs) when operating in the phonon lasing regime. In this work, we present our experiments on the realization of OMCCs operating at 4 GHz under two different cavity excitation conditions. The first one cavity coupling through a fiber loop, where the light couples directly to the cavity through evanescent wave. The second one is using a lensed fiber, with the tip finished to couple into the cavity through an auxiliary waveguide. Both setups were compared through measurements of phase noise and frequency stability over time of the GHz tone detected in each case.

Javier Martínez Lozano (NTC-UPV): *Optomechanical Cavity Response Modulation by Spin-Crossover Nanoparticles.*

As nanophotonics advances into the quantum regime, optomechanical cavities have become essential platforms for accessing quantum properties; however, most technologies still require cryogenic temperatures. This project aims to overcome this limitation through a strain-engineered enhancement of the mechanical Q-factor at room temperature. This is achieved by integrating spin-crossover (SCO) nanomaterials, which undergo abrupt changes in their magnetic, optical, electrical, and structural properties under external triggers such as temperature, pressure, or electrical signals. Furthermore, these materials present bistability, making it possible to have highly versatile, optically controlled cavity behavior under ambient conditions.

This work thus focuses on designing and characterizing such cavities, incorporating SCO materials and studying their response under varying temperature, pressure, and SCO dispositions. Optomechanical crystal cavities are simulated in COMSOL and subsequently fabricated and measured experimentally.

By demonstrating tunable, high-performance optomechanical cavities operating near room temperature, this project lays the groundwork for compact, low-power platforms in integrated quantum photonics. Such advances have the potential to impact emerging technologies in sensing, signal processing, and reconfigurable on-chip quantum devices.

Nonlinear Photonics

Miguel A. Bosch García and Marc Pérez Safont (UV): *Stepping Stones to Engineer Pulse Propagation Through Multifrequency Nonlinearities.*

Group-velocity-dispersion (GVD) engineering plays a crucial role to control nonlinear pulse propagation in fibers, e.g., for supercontinuum (SC) generation. However, the interplay between nonlinearities and the dispersion resulting from the frequency dependence of the effective index leads to some limitations to pulse propagation. In this regard, the need of short femtosecond pulses to produce coherent SC is a paradigmatic case. If the only dispersive parameter is the effective index, then the anomalous GVD easing pulse spectral broadening also promotes instabilities and hence, a coherence loss during SC generation. As a result, demanding initial conditions, namely, relatively wideband pumping pulses, are required to mitigate the impact of instabilities. If the nonlinearity also depends on frequency significantly, then instabilities can be cancelled even under anomalous GVD, offering renewed opportunities for coherent SC even in the picosecond pulse regime. Being largely unexplored, this investigation entails major challenges that our group are steadily tackling. On the theoretical side, the generalized nonlinear Schrödinger equation (GNLSE) fails to capture the dependence on multiple frequencies of the nonlinearity and, as such, it does not suit this research track. Consequently, we had first to derive the multifrequency nonlinear Schrödinger equation (MFNLSE) to account for this feature rigorously while keeping the numerical advantages of the GNLSE. Second, using our MFNLSE, we have also analytically obtained the nonlinearity dispersion enabling coherent spectral broadening of picosecond pulses under anomalous GVD, showcasing the impact of its multifrequency nature. On the experimental side, we have collected solid evidence supporting the feasibility of a method to determine higher-order dispersion accurately, extending the approach that we had demonstrated experimentally measuring nonlinearities precisely in fibers.

José Juan Cobo Galiana (NTC-UPV): *Pathway to Soliton Microcombs in Silicon Nitride Microrings: Nonlinear and Chaotic Kerr Comb Dynamics.*

Optical frequency combs enable the generation of modern precision science, with huge impact on optical metrology, spectroscopy, and time–frequency standards. Integrated Kerr frequency combs generated in nonlinear microresonators offer a compact and scalable platform to extend these capabilities beyond laboratory. We report the observation of optical frequency comb generation in integrated silicon nitride (SiN) microring resonators using a simple experimental setup. Despite the minimal configuration, clear comb spectra are observed, highlighting the robustness of Kerr nonlinear dynamics in these devices. The measured spectral features and temporal behavior indicate that the comb formation is primarily driven by modulation instability and access to chaotic dynamical regimes. Our current efforts focus on improving the experimental setup with the goal of achieving controlled and repeatable access to soliton state. We present initial progress toward the dissipative Kerr to this regime. This work demonstrates that integrated SiN microring resonators can exhibit rich nonlinear comb dynamics even under basic experimental conditions, and outlines a clear pathway toward stabilized soliton microcombs.

Pol Molina I Grífols (NTC-UPV): *Soliton Families in Micro-Ring Resonators with Third Order Dispersion.*

Dissipative Solitons play a fundamental role in the understanding of Optical Frequency Combs. Soliton families in the context of Damped-driven Schrödinger equations influenced by third order dispersion (TOD) have been studied, especially in strong normal Group Velocity Dispersion (GVD), and around zero GVD. This is a deeper study relating the strong and weak GVD. We have discovered a menagerie of new families: unknown dark solitons, kink-like solitons and bound-state solitons, to name a few.

Light-Matter Interaction and Optical Characterization

Josep Martinez Romeu (NTC-UPV): *Chiral Optical Forces in a Slot Waveguide for the Separation of Molecules in Gas.*

Chiral optical forces present an exciting avenue into the separation of enantiomers in an all-optical fashion. Previous works have addressed the feasibility of separating nanoparticles exhibiting relatively large chirality parameter values. However, from a practical perspective, the real challenge is to separate chiral molecules that typically display extremely low chirality. In this work, we explore via numerical simulations and analytical calculations the feasibility of the separation of chiral molecules by using guided light in a dielectric slot waveguide. Our results suggest that it is possible to separate [6]helicene enantiomers suspended in gas in time scales of the order of less than a day when applying optical powers of 100 mW at a wavelength of 332 nm.

Jaime Gimeno Balaguer (ETS-UPV): *From Theory to Fabrication: Circular Bragg Gratings as Optical Antennas for Single-Photon Sources.*

Circular Bragg Gratings (CBGs) act as efficient optical antennas, confining emitter modes and directing emission vertically. We present an analytical model describing the CBG as a central defect disk coupled to a concentric grating. The field inside the disk follows a Bessel function, while the grating region supports a Bloch wave that decays exponentially. By matching these solutions at the boundary, we derive the transcendental equation governing the cavity resonance and Purcell enhancement. This analysis reveals how the radial period and disk radius determine the far-field profile, which approximates a Gaussian beam suitable for fiber coupling. To validate this design, we fabricated TiO₂ CBGs on SiO₂ substrates using electron-beam lithography and plasma dry etching. The process utilizes a chromium hard mask to achieve high-aspect-ratio gratings, finalized with a PMMA capping layer. Optical microscopy confirms the predicted vertical out-coupling, with bright emission localized at the center, demonstrating the successful realization of the theoretical design.

Víctor Camús Hernández (ICMUV): *TERS Characterization of an NPoM System.*

Tip-Enhanced Raman Scattering (TERS) is a spectroscopic technique that integrates scanning probe microscopy (SPM) with Raman spectroscopy to achieve nanoscale spatial resolution, surpassing the limitations imposed by the optical diffraction limit. This enhancement is accomplished by focusing a laser onto the apex of a metallic-coated scanning probe tip, exciting localized surface plasmons that generate a highly confined electromagnetic field. This field, in turn, amplifies the vibrational modes of molecules located beneath the tip, enabling precise molecular characterization at the nanoscale.

A Nanoparticle-on-Mirror (NPoM) sample was measured using both TERS and conventional Surface-Enhanced Raman Scattering (SERS) configurations. The sample consisted of a 24×24 array of gold disks, each with a height of 120 nm and a diameter of 12 μm. The surface of these disks was functionalized with a self-assembled monolayer (SAM) of Biphenyl-4-thiol (BPT), followed by the deposition of a single 150 nm gold nanosphere on the surface of every disk. This architecture forms an NPoM plasmonic system, where the interaction between the localized surface plasmons of the gold nanospheres and the underlying gold substrate creates a highly confined electromagnetic field. This field significantly enhances the Raman signal from the molecules underneath, enabling detailed spectroscopic analysis at the nanoscale.

By comparing the results obtained from TERS and SERS measurements, we can shed light into the differences in light confinement and Raman selection rules of the system with and without the nanoparticles, and into the molecular deformations induced by their presence. These findings not only deepen our understanding of plasmonic interactions at the nanoscale but also hold significant promise for the development of advanced sensing devices and photonic integrated circuits that make use of the unique light confinement properties of NPoM systems.

José Luis Rodrigo Ramón (UV): *Optical Probing of Matter at High Pressure Using Laser Heating and Picosecond Acoustics*

Diamond Anvil Cells (DACs) enable the exploration of matter at pressures comparable to those found deep within planetary interiors. In this poster, we present two advanced optical techniques adapted for high-pressure studies in DACs. Laser heating combined with X-ray diagnostics allows controlled temperature increases while simultaneously tracking structural and phase transformations. Picosecond acoustics uses ultrafast laser pulses to generate and detect high-frequency acoustic waves, enabling precise measurements of elastic properties and structural changes. For each method, we highlight representative results that demonstrate the information accessible under extreme conditions. Our aim is to make these optical approaches accessible to researchers beyond the high-pressure community and to illustrate how light-based techniques can reveal properties of materials at extreme pressures and temperatures.

Paula Mouriño Miñambres (NTC-UPV): *Backscattered Electron and Cathodoluminescence Microscopy for the Characterization of GaInP/InP Tandem Solar Cell Nanowires: Challenges and Opportunities.*

Opposite to planar heterostructures, nanowires (NWs) allow heterostructures to overcome the limits regarding lattice mismatch and strain relief. However, the structural characterization of heterostructured NWs is typically done by means of transmission electron microscopy (TEM), costly and time consuming. In this work, an angular multi-segment detector in backscatter electron (BSE) configuration is employed to analyse III/V semiconductor NWs. We analyse GaInP/InP based tandem solar cells and demonstrate that by properly adjusting contrast and brightness, either the topography or the compositional contrast can be enhanced. Additionally, a cathodoluminescence analysis of the NWs' composition has been performed as a further study of the BSE results and NWs emission performance.

Ricardo Aguado Collazo (NTC-UPV): *Zero-loss Energy harvesting Using nanowire solar cells in Space (ZEUS): Front Contact Deposition and Characterization and Nanowire Growth Previous Steps.*

The ZEUS project aims to design triple junction nanowire (NW) solar cells for space applications. The triple junction present in the nanowires are properly designed to harvest most of the solar spectrum, reducing heat losses and having larger efficiencies than single junction nanowire solar cells. These triple junctions consist of three different p-i-n diodes, with different bandgaps, which enable the cell to convert different energy photons into current, instead of taking advantage of only one energy as single junction ones. In the ZEUS project, the triple junction NW solar cells are fabricated by means of metalorganic vapor phase epitaxy (MOVPE) which can achieve 47% efficiencies with the figure of merit of only using 1 g of material per square meter.

Its reduction in weight plays also a crucial aspect, not only for material consumption but also considering the importance of weight reduction in space related devices. This decrease in weight while enhancing efficiency is possible because only about 10 % of the surface needs to be covered with an active material in order to absorb as much light as a thin film covering the full area of the same material would. Also, their nanometric scale make them more resistant to radiation than bulk solar cells, improving their long-term performance in space.

Within the ZEUS project, the NTC-UPV team focuses on the up-scaling of the solar cells. This implies developments in (i) the characterisation during the fabrication in structures from sample size to 100 mm wafers; (ii) fabrication of nanostructured silicon nitride templates to be employed for the NW growth and (iii) the development of a novel structure to act as front contact. In this work, the developments in the SiN nanofabrication, together with results of the synthesis of aluminum doped zinc oxide (AZO) thin films by reactive sputtering are presented.

Marcos Altarriba Roig (NTC-UPV): *Design and Experimental Implementation of an Optical Vacuum Setup for the Characterization of Photonic Crystal Cavities.*

This Bachelor's Thesis aims at the design, assembly, and experimental validation of an optical setup integrated into a vacuum chamber for the characterization of photonic crystal optical cavities under controlled environmental conditions. The work primarily focuses on the development of the experimental setup, addressing both a conventional optical configuration operating in air and its adaptation and integration into a vacuum environment, enabling reproducible and comparable measurements in both regimes.

In the first stage, the physical principles and technical requirements for the optical characterization of photonic crystal cavities are introduced, together with the experimental constraints associated with vacuum operation. Subsequently, the optical setup is assembled, aligned, and optimized, including the components required for illumination, signal collection, and detection, as well as the integration of the vacuum chamber and its auxiliary systems.

Once the experimental system has been validated, optical characterization of nano-structured photonic crystal cavities fabricated using micro- and nanofabrication techniques is carried out. Measurements are performed both in ambient conditions and under vacuum, allowing the analysis of the cavities' optical response and the assessment of the influence of the surrounding environment on their resonant properties. This work establishes a robust experimental platform for future studies of photonic and optomechanical cavities under controlled pressure conditions.

Lucas Mascaró Burguera (NTC-UPV): *Spin-Crossover Compounds for Reconfigurable Photonic Integration*

The advance of reconfigurable photonic devices relies on the precise manipulation of light at the nanoscale. Since silicon does not present intrinsic electro-optic modulation capabilities, the integration of phase-change materials (PCMs), is essential. We introduce a new approach for designing reconfigurable photonic devices based on the integration of molecular spin-crossover (SCO) materials. These materials show a transition between two spin states with vastly different physical and optical properties which can be triggered by external stimuli. Due to their molecular nature, it is possible to chemically tailor their properties for specific applications, all while maintaining their hysteretic behavior (and therefore bistability) down to the nanoscale. In this work we present a reconfigurable optical switch based on the integration of PMMA-embedded SCO NPs into silicon racetrack micro ring resonators (MRRs), showing efficient and tunable performance.

Photonics for Communications and Outreach

Jorge Giménez Tenés, Ferran Esteve Barrera, Pablo Nicolau Monzó and Guillem Pla Borja (UV): *Lluminària: An Outreach Magazine Crafted by Students for Students.*

“Lluminària” is a dissemination project that began in 2023, an idea of the members of the Optica (formerly OSA) student chapter PHOTONETS-UV. Students proposed to produce rigorous, peer-reviewed by senior researchers, informative texts. It consists of a collection of scientific dissemination articles spanning various realms of physics, including optics, classical dynamics, quantum physics, among others. Except for the correction of articles, which is carried out by different supervising researchers, all the content, accessibility and dissemination of the journal is done by undergraduate, graduate students and PhD researchers. Our target readership ranges from the general public to university students, encompassing both undergraduate and bachelor levels. Therefore, each article is crafted with an adequate language and scientific level, minimizing technical jargon to make complex concepts understandable to a broad audience. Moreover, to maximize accessibility, articles are presented in both Catalan and Spanish, ensuring broader engagement and dissemination of knowledge as well as reinforcing scientific dissemination in Catalan, which is still scarce.

This project is open to any undergrad and postgrad student of the Degree in Physics at the Universitat de València in a first place, but also to any other undergrad student of grades related to Physics, Optics and Photonics willing to participate as authors of the articles of their interest, as well as collaborating PhD students from other universities. Initially, the first articles have been centered around concepts elucidated by students, but we aim to broaden our scope to include sections such as explaining the functionality of everyday objects, simplifying research work for children, contributions from senior researchers offering, in an adequate level, a sneak-peek of their work to primary school students and even special features for commemorative occasions, as it was done for the Nobel Prizes 2023 & 2024.

Since its launch, Lluminària now has up to 15 published articles and several more in the process of being written. Topics have spanned through several branches of Physics and different collaborations, such as an explanation of the Physics Nobel Prize 2024, a dissemination about the inaccuracy of weather forecasts and as highlighted article, the science behind the story of Hussam Al-Attar, among others. The next goal of the project is to print a first edition on paper that compiles all the articles.

Jaime Romero Huedo (iTeam-UPV): *Towards 6G: Unified RoF Fronthaul for Heterogeneous Wireless Networks.*

The deployment of 6G heterogeneous networks demands scalable fronthaul solutions capable of supporting extreme bandwidths and ubiquitous connectivity without prohibitive hardware complexity. This work presents the design and experimental validation of a unified optical architecture based on cost-effective free-running laser schemes.

We first demonstrate a DML-based optical heterodyning technique for versatile, frequency-tunable millimeter-wave (mmW) generation, avoiding complex synchronization stages. To enhance transmission robustness, we introduce advanced modulation strategies, including PM-to-AM conversion via sideband filtering to mitigate fiber dispersion, and a hybrid DML+EOM remodulation architecture that optimizes spectral efficiency while preventing laser saturation.

Furthermore, the system enables seamless service convergence, successfully validating the simultaneous transmission of mmW (RF) and Visible Light Communication (VLC)—using both LED and Laser-based links—on a shared optical infrastructure. Finally, we experimentally demonstrate the scalability of this approach in a centralized, bidirectional Fiber-FSO-mmW network, featuring laser-free and DSP-free Remote Radio Heads (RRHs). The results confirm that free-running architectures offer a pragmatic, energy-efficient, and highly scalable solution for future ultra-dense 6G access networks.

Vicente Fito Estevan (NTC-UPV): *5G Fronthaul over Fiber with Optical Conversion to Different RF Bands.*

This work presents and experimentally evaluates a fully optical frequency conversion system for analog radio-over-fiber (ARoF) transmission of next-generation 5G radio signals according to the 3GPP New Radio (NR) standard. The proposal is based on the generation of an optical frequency comb using a dual-drive Mach-Zehnder modulator (DD-MZM), whose lines are transmitted through multi-core fiber (MCF) and mixed at the photodetector to perform frequency upconversion or downconversion to the different regulated bands for 5G transmission, without the need for digitization or complex electronic processing.

This work analyzes the impact of power imbalance between the modulated optical carrier and the carrier used for beating in the heterodyne mixing process at the detector. Performance is evaluated by measuring the error vector magnitude (EVM) and the received signal-to-noise ratio (SNR). The results show that the maximum EVM degradation after optical conversion to different bands is 1.23% compared to the original signal, provided that proper power balance between both carriers is maintained. Furthermore, it is demonstrated that simultaneous modulation of the two optical carriers improves system stability, reducing EVM variability compared to configurations in which only one carrier is modulated.