Research Centre for Integrated Nanophotonics

ANNUAL REPORT 2022

PUBLIC VERSION

3 OCTOBER 2023

CONTENTS

FACTS

PROGRAM	Gravitation (*Zwaartekracht*) 2013
TITLE	Research Centre for Integrated Nanophotonics
NUMBER	024.002.033
DURATION	11 years (January 1st, 2014 – December 31st, 2024)
WEBSITE	https://www.tue.nl/en/research/research-areas/integrated-photonics

CONSORTIUM

(as of July 2023)

SCIENTIFIC DIRECTOR:
Prof.dr. A. (Andrea) Fiore a.fiore@tue.nl 040 247 2118

MANAGING DIRECTOR:
Drs. J.C. (Jolie) van Wevelingen J.C.v.Wevelingen@tue.nl 040 247 5938

SECRETARY:
Dr.ir. J.M. (Jan) Vleeshouwers j.m.vleeshouwers@tue.nl 040 247 3217

ORIGINAL APPLICANTS AND CO-APPLICANTS:

NAME	FIELD OF EXPERTISE	GROUP
Prof.dr.ir. M.K. (Meint) Smit	Photonic Integration	PHI
Prof.dr. P.M. (Paul) Koenraad	III-V Semiconductor Nanophysics	PSN
Prof.ir. A.M.J. (Ton) Koonen	Optical Communication	ECO
Prof.dr.ir. W.M.M. (Erwin) Kessels	Atomic Scale Processing	PMP
Prof.dr. B. (Bert) Koopmans	Spin Dynamics	FNA
Prof.dr.ir. H.J.M. (Henk) Swagten	Spintronics	FNA
Prof.dr. K.A. (Kevin) Williams	Photonic Switching	PHI
Prof.dr. A. (Andrea) Fiore	Quantum Photonics	PSN
Prof.dr. E.P.A.M. (Erik) Bakkers	Semiconductor Nanowires	AND
Dr. A.A. (Ageeth) Bol	Nano-Electronic Materials	PMP

EXECUTIVE SUMMARY

The Gravitation program has completed its ninth year and, while some activities are coming to an end, substantial results have been obtained.

On the scientific side, within Theme 1 the exploration of new photoswitchable materials has led to the demonstration of the switching of a ring resonator with broadband light. The work on optical neural networks is producing exciting results, a photonic convolutional neural network (CNN) system with a speed of 2.56 Tera operation/s and end-to-end system energy efficiency of 3.75 pJ/operation was demonstrated. We are now working on the application of photonic CNNs to optical beam steering.

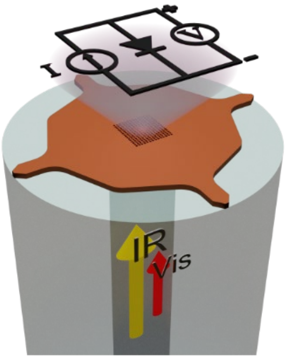
In theme 2, a double-pass configuration has been demonstrated to boost the efficiency of semiconductor optical amplifiers in the IMOS platform. Besides, modulation frequencies exceeding 100 GHz have been obtained. Our InP-membrane-on-fiber technology has been used to demonstrate a novel type of hybrid electronic-photonic sensor, namely an electrical sensor which is optically read-out through the fiber.

Within theme 3, important progress has been realized in new materials and devices. Using strong light-matter coupling, we have achieved for the first time exciton-polariton condensation from bound states in the continuum at room temperature; An ultrafast switching time of ~1 ps has been demonstrated using optospintronic magnetic tunnel junctions and multiplexing schemes for integrated optical memories have been devised; Hexagonal SiGe multishells have been developed in order to obtain quantum-well-type confinement in SiGe heterostructures.

After the end of the Covid-19-related restrictions, we have fully restarted our outreach activities, with physical demos of spectral sensing and biosensing at the NWO Teknowlogy event and at the Dutch Design Week. The annual community building event was particularly well attended and lively. On the valorization side, a new initiative, the valorization tickets, has been implemented and has encountered much interest from the community. Two new spin-offs have been founded, and have secured substantial seed funding. A spin-off from 2020 has been awarded the prestigious "Hermes Startup Award" at the Hannover Messe 2023, testifying the strong potential of the technology.

GRAVITATION HIGHLIGHTS IN IMAGES

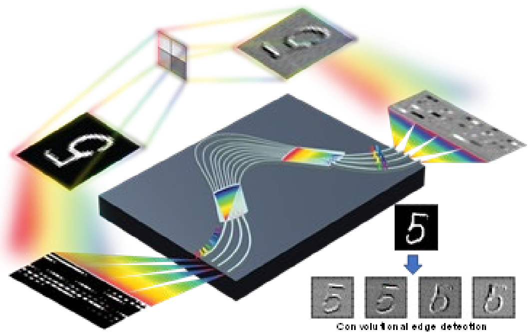
Electronic-photonic
fiber-tip sensor



Demo at the
Dutch Design Week

PhotonIP setup of
the Advisory Board

Parallel convolutional
processing



WORK PROGRESS AND ACHIEVEMENTS

THEME 1 Pervasive Optical Systems

Theme Coordinator: Oded Raz

HIGHLIGHTS

- Fabricated and published photodetector (PD) array demonstration using 7 PDs to create a large area (hexagonal shaped) array with operation speed up to 10Gb/sec.
- Demonstrated photonic convolutional neural network (CNN) system with a speed of 2.56 Tera operation/s and end-to-end system energy efficiency of 3.75 pJ/operation, using 16 weighting elements and 10 Giga sample/s inputs. The proposed parallelism improves CNN acceleration by 4-16 times with respect to state-of-the-art integrated convolutional processors.

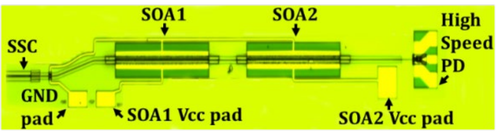
THEME 1.1 **Fiber wireless integration**

Project leader: Eduward Tangdiongga

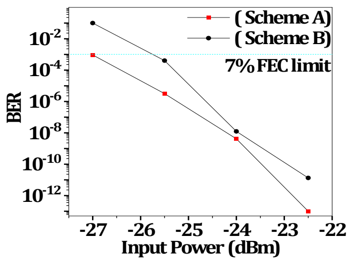
OPTICAL WIRELESS COMMUNICATION

Monolithic integrated two-stage cascaded SOA-PIN receiver for high-speed optical wireless communication

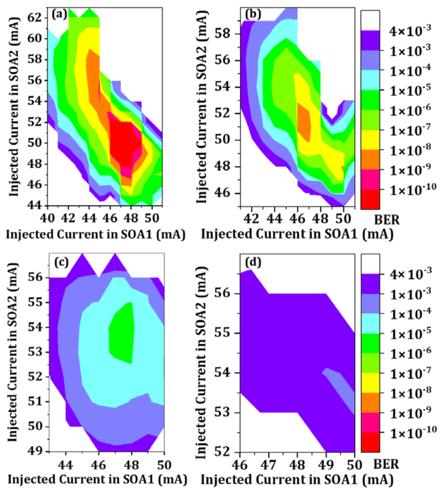
We propose to utilize a noise reduction scheme by integrating cascaded semiconductor optical amplifiers (SOAs) to build a monolithic integrated SOA-PIN receiver for a high-sensitive OWC link [LEI22]. Compared with utilizing a one-stage optical amplifier, using multiple independent SOAs as the multiple-stage amplifier offers the advantage of optimizing the noise figure of each amplifier independently by tuning their injection currents, which leads to the reduction of the total noise and the improvement of the receiver sensitivity. The designed receiver consists of one waveguide PIN photodetector integrated with two SOAs, as shown in Figure 1.



a) Monolithic integrated two-stage SOA-PIN receiver



c) BER performance versus input optical power at different injection schemes. Scheme A: two-stage pre-amplifier with different injection currents; Scheme B: two-stage pre-amplifier with the same injection current, regarding as one-stage.



b) BER performance of 10 Gb/s OOK signal as a function of the injection currents of SOA1 and SOA2. The input optical power is set at (a) -22.5 dBm, (b) -24 dBm, (c) -25.5 dBm and (d) -27 dBm.

Figure 1. OWC receiver and the link performance.

A monolithic integrated optical wireless communication (OWC) receiver with optical pre-amplifiers is fabricated based on HHI's generic photonic integration platform. The achieved sensitivity for a 10 Gb/s OOK signal with 10 dBm launch power at 1550 nm wavelength by using the designed receiver is up to -27.5 dBm at the 7% FEC limit. Compared with the one-stage SOA-PIN receiver, the measured receiver sensitivity based on the proposed method is improved by 1.5 dB for 10 Gb/s OOK signal at the 7% FEC limit.

The project is extended to the application on the optical beam steering to establish a system that exploits photonic neural network to control the integrated optical delay line for the optical beam steering. So far, the beam pointing control is done by adjusting the voltage level of individual heaters according to a look-up table, which may be sufficient for a static and semi-mobile or nomadic user, with the control keeping the same value and possibly with some adjustments due to the inevitable thermal cross-talk between the heaters. However, if users move, then the look-up table must be updated with new values according to their speeds and direction. Therefore, an automatic, accurate, and fast beam tracking and pointing control is needed to provide seamless connectivity to mobile users. We are developing the control of thermal crosstalk on the heaters, to have a fast automatic tuning according to the target beam steering angle. The control makes use of a combination of electrical and optical signal processing employing a neural network concept with an optimized cost function regarding latency, complexity and update speeds to serve users moving at walking speeds, i.e. 1-5 m/s. The schematic of the control part is shown in Figure 2.

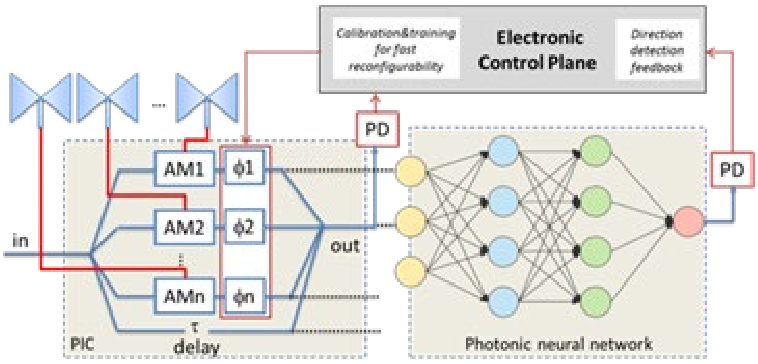


Figure 2. Schematic of a hybrid electro-optical neural network RF beam pointing controller.

TARGETS FOR 2023

- Develop the thermal compensation method for the thermo-optical phase shifter based integrated optical delay line for optical beam steering.
- Explore neural network method to control the optical steering dynamically.
- Research on photonic neural network connection for opto-electric control on the integrated beam steering chip.

THEME 1.2 **Data centers and optical interconnects**

Project leader: Oded Raz

RECONFIGURABLE CIRCUITS

Collaboration on this topic with the chemical engineering department has continued in 2022. We have been exploring the use of photoswitchable Diarletheneses (DAE) molecules who can transition between two states (open and close) via a process of photoisomerization [CAL08]. A graphic illustration of how the material behaves is shown in figure 3 below:

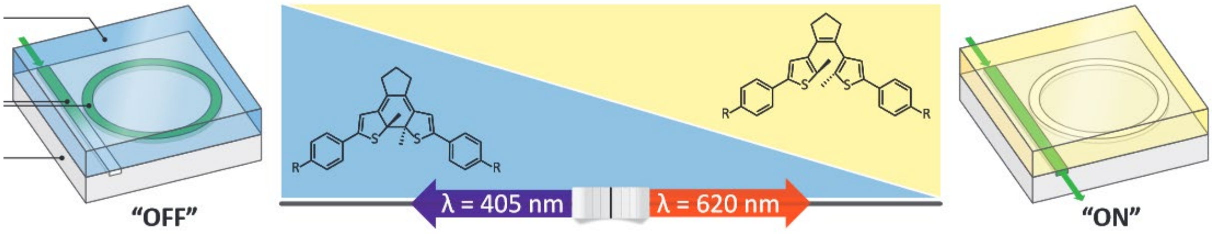


Figure 3. Reversible programming of diarletheneses based coating using two colors of light

The work has proven that the material can be easily switched with relatively low optical power flux (sources were a UV and white LED with broad illumination and a power of several watts and in relatively short time (several minutes). Initial results were published in the IEEE Photonic society Benelux chapter meeting in Eindhoven [BAH22]. In Figure 4 are the main result of switching a ring resonator between two states using illumination with UV or white light.

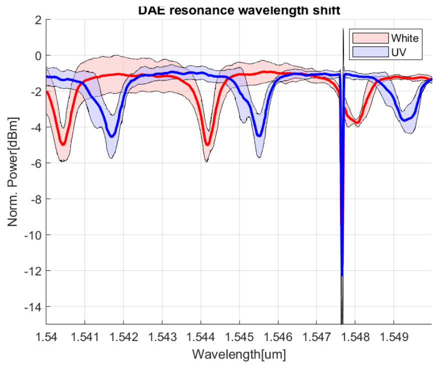


Figure 4. Resonant shifting of ORR through switching between illumination with UV and white light

NOVEL 3D AND 2.5D PACKAGING FOR OPTICS IN DATA CENTERS

Most work has shifted to use cases of packaging of surface normal devices (VCSELs and PDs) for optical wireless communication systems. In Figure 5 an image of a recently fabricated and published PD array demonstration using 7 PD to create a large area (hexagonal shaped) array with operation speed up to 10Gb/sec.

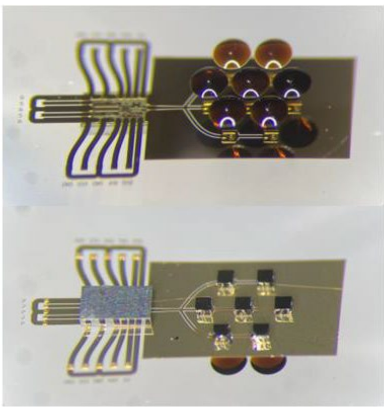


Figure 5. Assembled PD array and TIA (down) with microlens array (up).

TARGETS FOR 2023

- Co-integrate large arrays of PDs and combination of PDs and VCSELs for OWC transceivers.
- Demonstrate switching using charged nano-particles.

THEME 1.3 **Optical Switching**

Project leader: Patty Stabile

The activity on photonic neural networks has proceeded with the performance investigation of photonic integrated all-optical neurons, the result suggest an arbitrary scaling on the depth of SOA-based photonic deep neuron networks (PDNN) [SHI1]. We propose a noise model for investigating the signal degradation on the signal processing after cascades of semiconductor optical amplifiers (SOAs) in the all-optical neuron, and we experimentally demonstrate the emulation of scaling of the SOA-based integrated all-optical neural network in terms of number of input channels and layer cascade, with chromatic input to monochromatic output conversion, exploiting cross-gain-modulation effect. Both experiments and simulations shown that the all-optical neuron (AON), with wavelength conversion as non-linear function, is able to compress noise for noisy optical inputs. This suggests that the use of SOA-based AON with wavelength conversion may allow for building neural networks with arbitrary depth. In fact, an arbitrarily deep neural network, built out of seven-channel input AONs, is shown to guarantee an error minor than 0.1 when operating at input power levels of −20 dBm/channel and with a 6 dB input dynamic range. Then the simulations results, extended to an arbitrary number of input channels and layers, suggest that by cascading and interconnecting multiple of these monolithically integrated AONs, it is possible to build a neural network with 12-inputs/neuron 12 neurons/layer and arbitrary depth scaling, or an 18-inputs/neuron 18-neurons/layer for single layer implementation, to maintain an output error <0.1. Further improvement in height scalability can be obtained by optimizing the input power.

Within the topic of PDNN, we propose a novel on-chip parallelism for WDM-based convolutional processing [SHI2], for implementation of photonic convolutional neural network, which is one of the best neural network structures for solving classification problems. The convolutional processing of the network dominates processing time and computing power. Parallel computing for convolutional processing is essential to accelerate the computing speed of the neural network. we introduce another domain of parallelism on top of the already demonstrated parallelisms suggested for photonic integrated processors with WDM approaches, to further accelerate the convolutional operation on chip. The operation of the novel parallelism is introduced with an updated cross-connect architecture, exploiting cyclic routing array waveguide grating, combining parallelisms in space and wavelength. The photonic CNN system is demonstrated for the handwritten digit classification problem in simulation, with a speed of 2.56 Tera operation/s and end-to-end system energy efficiency of 3.75 pJ/operation, using 16 weighting elements and 10 Giga sample/s inputs. The proposed parallelism improves CNN acceleration by 4-16 times with respect to state-of-the-art integrated convolutional processors, depending on the available weighting elements per convolutional core. Figure 6 shows the concept of the WDM-based integrated convolutional processor.

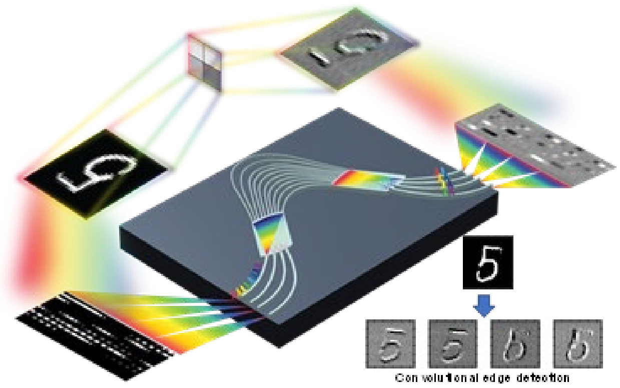


Figure 6. Parallel convolutional processing with photonic integrated cyclic grating

TARGETS FOR 2023 - This project has been completed and is now developing in a new one: ONN-controlled beam steering (connection to Theme 1.1)

THEME 1.4 **Integrated low-loss space-division-multiplexed transceivers**
Project leader: Chigo Okonkwo

In 2022, the development of space-division multiplexing (SDM) has been focused on two main aspects: The development of components and extension of the digital holography tool for loss analysis of fiber based devices [HOU22] and applications such as tapping [BRA22]. Secondly, with the increased interest on free space optical communications, and to support upcoming field-deployable FSO systems, the potential for correcting specific free-space optical channel effects on the optical wavefront such as tip-tilt, beam wander, scintillation and other effects exploiting SDM techniques has been studied [VLI22].

ALIGNMENT AND CHARACTERISATION OF FIBER-TO-FIBER COUPLING USING DIGITAL HOLOGRAPHY

Light in these fibers has a complex spatial distribution. Therefore, when coupling between SDM components optimized using total coupled power as an optimization metric, certain fiber modes may be disproportionately affected, leading to increased impairments such as mode dependent loss (MDL) and crosstalk (XT). Hence, the spatial properties of coupling should be considered, requiring characterization tools able to provide such insight. A full description of the spatial distribution of light can be obtained using digital holographic measurements. Off-axis digital holography as previously reported measures the amplitude and phase for both polarizations of a free-space optical signal by recording the interference between the signal field and a flat-phase reference. Subsequent analysis of the measured interference patterns can reveal important metrics for SDM transmission systems such as MDL and XT. In this work, we demonstrate the use of off axis DH for the alignment of free space coupling of light between a FMF and an MMF. Coupling is evaluated at various fiber positions. At each position, the total coupled optical power is measured using a free-space power meter and a transfer matrix of the SDM subsystem is measured using DH, which is used to calculate MDL and XT. It is shown that only maximizing total coupled optical power does not provide adequate coupling and severe MDL penalties of up to 20 dB are observed. Therefore, to ensure reliable results, the spatial distribution of the light must be considered when coupling is optimized in SDM systems. Off-axis DH is demonstrated to provide the necessary measurements for reliable automated alignment of SDM devices and subsystems.

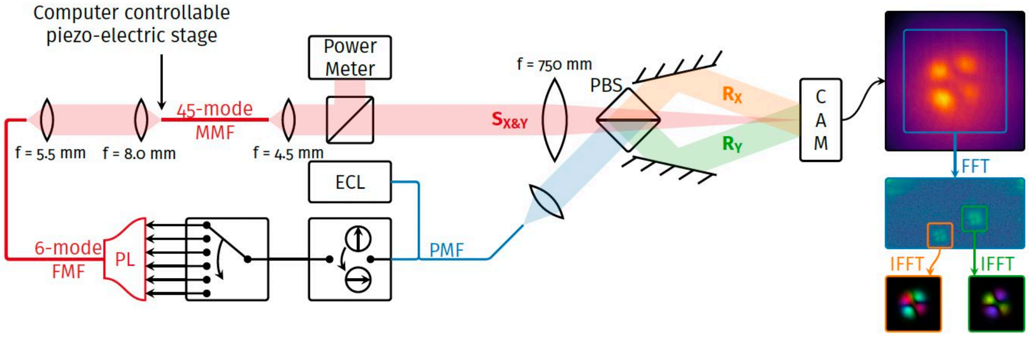


Figure 7. Experimental setup. PL: photonic lantern, SX&Y: dual-polarization signal to be characterized, RX and RY: reference beam for x- and y-polarization, FFT: fast Fourier transform, ECL: external cavity laser.

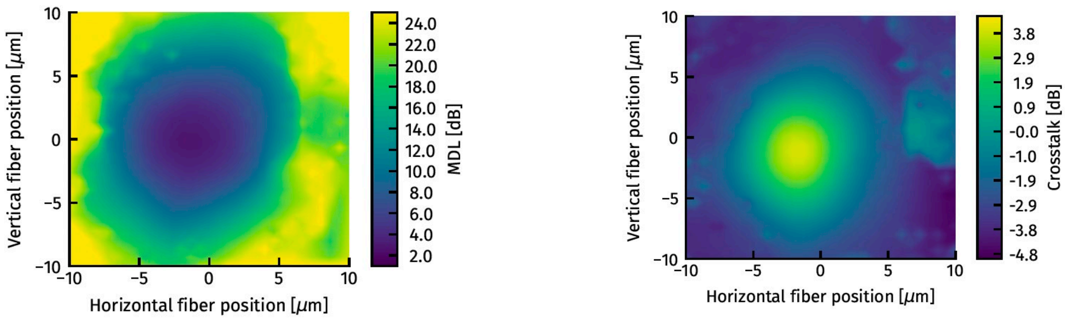


Figure 8. MDL for different offsets of the 45-mode MMF, XT for different offsets of the 45-mode MMF.

TARGETS FOR 2023

- We have improved the stability of the free space optical system but this will continue with the addition of a NIR camera to improve measurement of both polarisations
- Exploit the setup in the analysis of novel optical channels e.g., turbulent optical wireless channels
- Exploit digital demultiplexing in digital holography to evaluate coupling between fibers, fiber devices such as multi-mode amplifiers [ALV20]

THEME 2 Nanophotonic Integrated Circuits

Theme coordinator: Kevin Williams

HIGHLIGHTS

- 250% energy-efficiency advance for semiconductor optical amplifiers
- 110GHz class InP modulators demonstrated on generic platform
- Integrated self-spiking optical neuron demonstrated for the first time
- First demonstration of hybrid electronic-photonic sensing on a fiber tip (published in Nature Nanotechnology)

THEME 2.1 **Generic integration platform for photonic ICs on silicon**

Project leader: Yuqing Jiao

Energy efficiency is essential to densely integrated nanophotonic circuits. Emerging applications using optical phased arrays, neuromorphic computing, and optical switching require high efficiency SOAs. For the first time, we demonstrate that the SOA efficiency can be significantly enhanced at the circuit level, by passive mode-division (de)multiplexers that send light through the gain section twice, avoiding resonance. The experimental demonstration is realized on the InP membrane on Si (IMOS) platform, and 10 dB gain (167%) is achieved for the 2-pass SOA, compared to 6 dB for the conventional 1-pass at the same injection current and same platform design. This is a 250 % enhancement in the small-signal wall-plug efficiency.

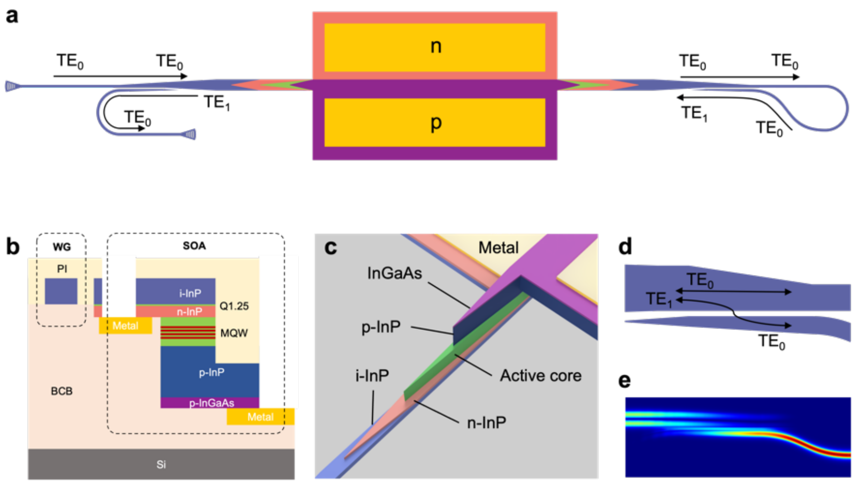


Figure 9. ***a*** *Schematic of the mode multiplexed SOAs,* ***b*** *Cross section of the active-passive IMOS platform,* ***c*** *Zoom-in illustration of the active-passive coupler that supports two transverse TE modes,* ***d*** *and* ***e*** *Illustration and field distribution of the mode division multiplexer.*

Wide-band modulation is now demonstrated on the semi-insulating indium phosphide integration platform using phase and impedance matched design. Recent measurements using a 110 GHz vector network analyser confirm the theoretical designed capability with 3dB bandwidths beyond 100 GHz. Collaborative experiments with the ECO and PhI group, and using equipment on loan from Keysight have led to the measurement of open electro-optic eye-diagrams up to 100 GBaud. On-off keying and PAM-4 configurations have been studied, and these data are confirming the modelling methods, providing confidence for even higher speed measurements in the coming year.

Photonic neuron concepts have been investigated with three different two-section laser concepts on the generic and imos platfoms. These designs include single and cascaded laser neurons, but also laser structures to investigate influencing factors for excitability and structures to extract platform parameters such as carrier lifetimes. A novel concept of an integrated randomly self-spiking neuron has been demonstrated for the first time. The spiking statistics has been measured and a novel model has been developed to describe the data accurately. This led to new understanding of how noise influences optical spiking neurons and how such devices can be used as rate encoders for spiking neural networks.

TARGETS FOR 2023

- Exploitation of IMOS technology through two semi-commercial MPW run with support from JePPIX
- Circuit level designs for fully integrated optical phased array comprising the building blocks devised in the last three years
- Electronic driver integration concepts for co-designed high speed modulators

THEME 2.2 **Ultralow-power components**

Project leader: Andrea Fiore

NANOPHOTONIC SENSORS

Following up on the work in the previous year, we have demonstrated a full electrical sensing functionality on a fiber tip, using an electro-optic photonic crystal (PhC) transferred onto the tip of a single-mode fiber (Figure 10). We use a red laser to generate carriers and produce a photovoltage in an InP p-i-n junction integrated in the PhC membrane. Due to the electro-optic effect, the voltage changes the refractive index and therefore the PhC resonance. A laser tuned to the side of the resonance, around 1550 nm, is used to read out the voltage through the wavelength shift. With this method we can optically measure the IV characteristics of the junction via the fiber. We then showed that this approach can be used to measure a parameter, e.g. temperature, from its effect on the IV characteristics of the junction, in a low temperature range T<50 K where the optical properties are temperature-independent and direct optical sensing is not possible. *This is the first demonstration of fiber-tip electrical sensing, and shows the potential of combining the high sensivity of electrical sensing with the advantages of the optical readout via the fiber [PIC23].*

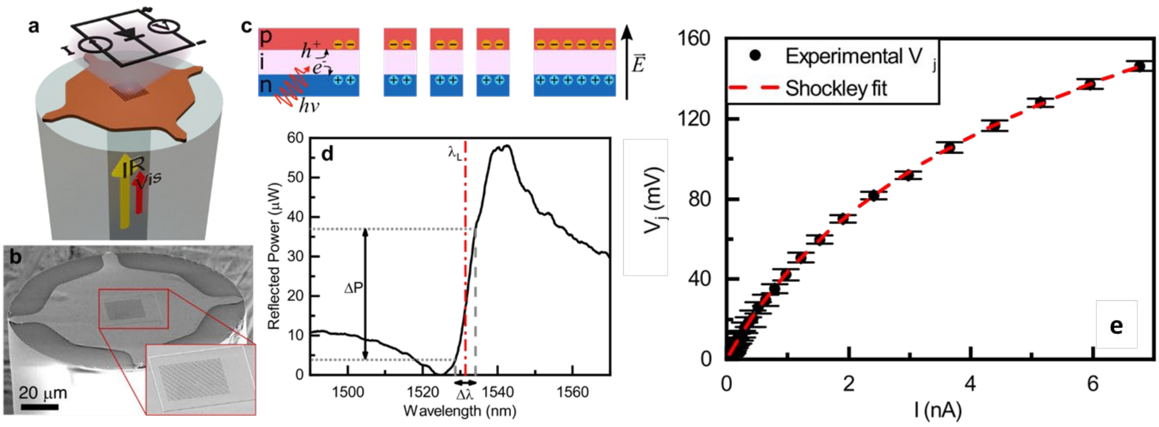


Figure 10. (a) Schematics of the electric sensor on a fiber tip; (b) SEM image of PhC transferred on the tip; (c) Schematics of the p-i-n junction under illumination with the red laser; (d) Reflectance spectrum from the fiber-tip (the wavelength of the read-out laser is indicated; (e) IV characteristics of the PhC diode measured via the fiber

TARGETS FOR 2023

- This activity has ended with the successful PhD defense of dr. Luca Picelli; it may continue in future projects.

THEME 3 Ultimate Control of Matter and Photons
Theme coordinator: Bert Koopmans

HIGHLIGHTS

- Demonstrated magnetic bits within a racetrack memory (consisting of Co/Gd/Co/Gd synthetic ferrimagnets) can be moved by current with velocities over 2000 m/s
- Demonstrated an alternative hybrid memory approach, we demonstrated successful switching of an optospintronic magnetic tunnel junction device with ~ 1 ps switching speed, 1-2 orders of magnitude beyond state-of-the-art electronic switching scenarios

THEME 3.1 **Low-threshold organic polariton lasing at room temperature from bound states in dielectric metasurfaces**
Project leader: Jaime Gómez Rivas

We have demonstrated room temperature Bose-Einstein condensation of organic exciton-polaritons in dielectric metasurfaces. Exciton-polaritons emerge from the strong coupling of excitons in organic molecules with photons in the optical cavity defined by the metasurface. At high enough densities of exciton-polaritons, they condense to the ground state forming a coherent and macroscopic quantum state. Bose-Einstein condensates decay emitting coherent radiation similar to lasers but without the need of population inversion. This characteristic opens the possibility to achieve laser-like emission at much lower thresholds than conventional (nano-)lasers.

Our demonstration of condensation at room temperature from dielectric metasurfaces opens new possibilities in the race towards electrically driven organic integrated lasing. However, the optical losses from the metasurface are still too high. Therefore, we have also investigated the field confinement and the losses from symmetry protected optical modes (Bound States in the Continuum, BICs) in metasurfaces. These modes are characterized for the full suppression of radiation losses which, in the absence of material losses, leads to perfect optical cavities. For this investigation, we have chosen THz metasurfaces that allow us to map the electric fields using a unique double THz near-field field probe microscope that we have developed at TU/e. The measurements show an extreme electromagnetic field confinement to the surface of symmetry-protected BICs and the full suppression of optical losses.

These results have been used to design a dielectric metasurface supporting BICs in the visible and to achieve for the first time exciton-polariton condensation from BICs at room temperature. This condensation takes place at very low thresholds of less than 5 $\mu J/cm^2$. The topological character of BICs leads also to a vortex-like emission with an associated topological charge (see Figure 11).

Future research will target further reductions of the condensation threshold by investigating and optimizing the thermalization of exciton-polaritons towards the ground state. The final goal of this research is to achieve electrically driven condensation (electrical polariton lasing) at room temperature in organic systems, which are solution processable and easy to integrate in more complex devices. The realization of defect-free extended metasurfaces for condensation is an integral part of this research, which also requires from advanced metrology tools and methods. Collaborations with the TU/e start-up TeraNova B.V. on the fabrication and metrology of metasurfaces for condensation will also pave the route to future high-TRL developments.

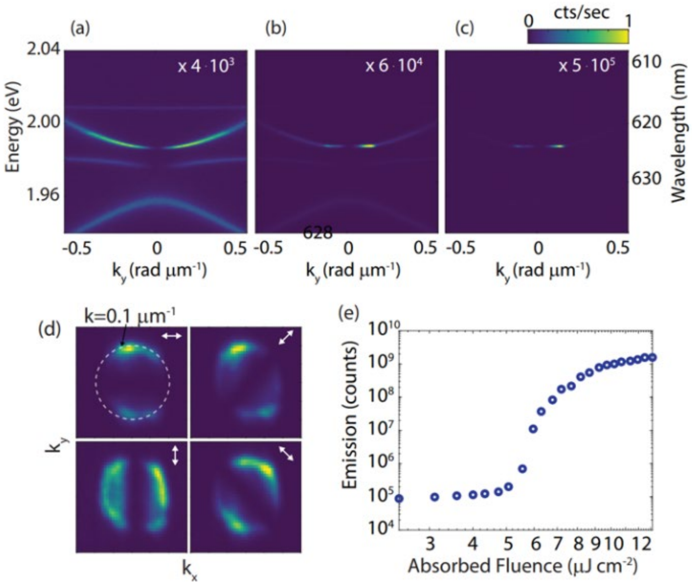


Figure 11. (a)-(c) Emission dispersion from exciton-polaritons in perylene dye molecules on top of a Si metasurface supporting BICs below (a), at (b), and above (c) the condensation threshold. (d) Polariton-laser beam profile for different polarizations showing the vortex emission from the BIC condensate. (e) Threshold curve (emission intensity vs. absorbed power) showing a condensation threshold around 5 $\mu J/cm^2$.

THEME 3.2 **Hybrid approaches combining photonics and spintronics**
Project leader: Bert Koopmans

This subproject aims to offer novel functionalities for PICs by creating MagnetoPhotonic building blocks. We envision that by combining ultrafast magnetization dynamics, spintronic phenomena, and photonics, we can create high-density magnetic memories. In a cross-strip configuration of a 'magnetic racetrack' on top of a photonic waveguide, photonic data can be stored and retrieved at high rates without the need for energy consuming high-frequency electronics.

To provide on-chip all-optical access of nanoscale magnetic bits, we developed an integrated hybrid plasmonic-photonic platform. A plasmonic nanoantenna-photonic crystal cavity (PNA-PhC) is used to access bits in a magnetic racetrack stacked on top of a waveguide. We theoretically showed that this device can enhance the switching efficiency by 30×, and enables selective detection of a targeted bit in a magnetic racetrack down to ~ 100^2 nm^2 [PEZ22a, PEZ22b]. To further increase performance, we developed a device concept based on a wavelength-division multiplexing scheme. Thus, we theoretically demonstrated parallel switching of 8 magnetic bits across the telecom C-band (see *Figure 11*b).

Following our first experimental demonstration of on-chip magneto-optical reading of 300 × 400 nm^2 memory elements implemented in IMOS [DEM22], designs in (SiN_3-based) TriPleX are presently being fabricated in a MPW run. These should enable first proof-of-concept demonstration of on-chip writing using all-optical switching of magnetization before the end-date of the Zwaartekracht program. These designs will also facilitate first experimental approaches to verify plasmonic enhancement.

In the previous year, we have demonstrated that magnetic bits within a racetrack memory (consisting of Co/Gd/Co/Gd synthetic ferrimagnets) can be moved by current with velocities over 2000 m/s [Li22] (see *Figure 11*a). This work was complemented by a systematic study of the conditions for most efficient current-induced motion, which relies on compensation of angular momentum between the Co and Gd subsystems [KOO22]. Furthermore, we explored the use of ion irradiation to control the energy requirements for writing data in a magnetic racetrack by showing that Ga^+ ion irradiation can be used to locally tune and control the energy cost of nucleating ~200 x 200 nm^2 magnetic domains [JON22].

Finally, as an alternative hybrid memory approach, we demonstrated successful switching of an optospintronic magnetic tunnel junction device with ~ 1 ps switching speed [WAN22], 1 – 2 orders of magnitude beyond state-of-the-art electronic switching scenarios. Based on comparison with competitive approaches and benchmarking of specific applications, we started up assessment of efficiency and viability of various hybrid PIC approaches, including proposals for optimal architectures.

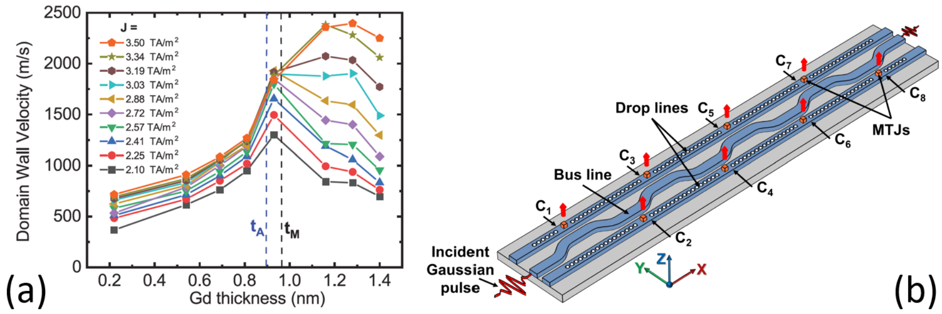


*Figure 12. (a) Current-induced domain wall velocity as afunction of Gd thickness in a Co/Gd/Co/Gd racetrack, for increasing current densities [**LiZ22**]. (b) Proposed 8-bit wavelength-division multiplexing scheme for spintronic-photonic memoy; magnetic bits are located in the photonic cavities denoted as C_1 to C_8 [Pezeshki, TU/e].*

TARGETS FOR 2023

- Processing TriPleX based devices and experimental proof of concept of all-optical switching of magnetization integrated in photonic waveguides, assessing plasmonics / cavity strategies.
- Assessment of efficiency and viability of integrated magneto-photonics technology, including proposals for optimal architectures. Benchmarking and comparison with competitive approaches.
- Final integration of ultrafast propagation of domains in magnetic racetrack (> 1000 m/s) with optical writing and detection.

THEME 3.3 **Nanomanufacturing for photonics**
Project leader: Erwin Kessels

The previous work on synthesis of 2D TMD alloys of MoS_2 and WS_2 has resulted in a publication **[SCH22].** Of particular interest is that the atomic ordering of the alloys within the 2D monolayer can be controlled by ALD. As a result, so-called core-shell flakes can be synthesized, which are expected to have interesting optical properties including luminescence and are subject of further study. Last year, the portfolio of 2D TMD alloys was extended to ALD of $Nb_xW_{1-x}S_2$ alloys (Figure 10b). Further experiments were done on the electrocatalytic activity and the electronic properties of this material. It was found that Nb-doped WS_2 grown by ALD has a very low contact resistance to Pd/Au contacts Separately, the initial growth stages of nucleation and monolayer growth during ALD of MoS_2 were studied, which are especially relevant for applications where controlled growth of monolayer MoS_2 across large areas and/or 3D nanostructures is desired. The saturation behavior of the process was characterized in detail in order to optimize the quality of the grown material. Furthermore, methods of using in-situ diagnostics (spectroscopic ellipsometry and optical emission spectroscopy) to probe the initial growth stages of ALD MoS_2 were developed.

TARGETS FOR 2023

- Wrapping up the research on the passivation of Ge and hex-SiGe surfaces

- Wrapping up the research on the nucleation and monolayer growth of MoS_2 by ALD

THEME 3.4 **Semiconductor Nanowires**
Project leader: Erik Bakkers

It has been a holy grail for several decades to demonstrate direct bandgap light emission in silicon [IYE93]. As a consequence, Si-photonics is lacking a Si-compatible light source. Based on previously published growth method [HAU15, HAU17], we recently reported efficient light emission [FAD20] from direct bandgap [ROD19] hexagonal crystal phase SiGe in Nature.

The hexagonal SiGe semiconductor material is now getting more mature since we now understand most of its fundamental properties, including a decent absorption spectrum and its ability to generate stimulated emission and optical gain. A next challenge is to grow hex-SiGe quantum well and quantum dots for opto-electronic devices as well as for single photon emitters.

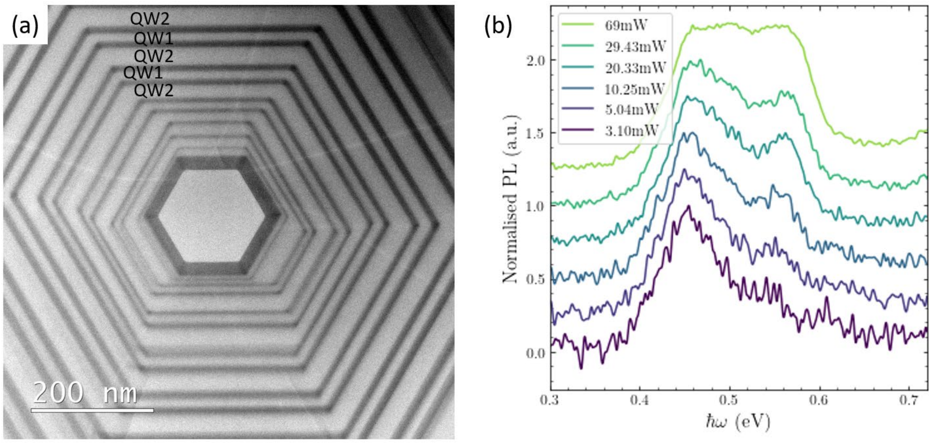


Figure 13. (a) Cross sectional transmission electron microscopy image of a hexagonal Ge/SiGe multiple quantum wells structure. The quantum wells are grown in a coaxial structure around a wurtzite GaAs nanowire core and a thick hex-SiGe buffer layer (dark hexagon). (b) Photoluminescence spectrum of a 11 nm single Ge/SiGe quantum well structure showing the quantum well emission at 0.46 eV. At high excitation, we also observe the emission of the hex-SiGe barrier at 0.55 eV.

To demonstrate hex-SiGe multishells, we employ the crystal transfer approach, in which the crystal structure is copied from a template, which is a wurtzite GaAs nanowire. The $Si_{1-x}Ge_x$ then forms a shell around the GaAs core nanowire. In this case, the core was overgrown with multiple Ge shells separated by $Si_{1-x}Ge_x$ shells. Ge sections have alternating growth times of 5 and 10 mins, while the $Si_{1-x}Ge_x$ shells all have an equal growth time. A cross-section in the middle of the nanowire is shown in Figure 13. A structure of alternating Ge (light) and $Si_{1-x}Ge_x$ (dark) rings is observed, with the GaAs core at the center. In a single quantum well sample, we observe strong photoluminescence (PL) above the bandgap of unstrained hex-Ge, located at 0.35 eV, but below the bandgap of hex-SiGe at 0.55 eV. We attribute the PL to the approximately 1% compressively strained Ge layers within the hex-Ge/SiGe nanowire shells. Our results provide strong indications for the feasibility of efficient light emission from a group IV multiple quantum well structures.

TARGETS FOR 2023

- Demonstrate lasing in hexagonal SiGe quantum wells

OUTREACH

The most relevant outreach activities in 2022 have been the "Sensing the invisible" mini-exhibit within the Dutch Design Week and a participation to the NWO Teknowlogy event. Besides these two wide audience events, our research was frequently featured in the media.

MEDIA COVERAGE OF GRAVITATION PROGRAM AND PEOPLE

1. Ton Koonen gave an interview for Volkskrant about Fiber-to-the-Home.
2. A radio interview with Ton Koonen in the program Villa VdB on Fiber-to-the-Home.
3. Printing optical chips as a layer cake in PhysOrg.
4. Integration of polarization converter on the IMOS platform, the thesis of Sander Reniers.
5. Patty Stabile on How to build brain-inspired neural networks based on light
6. Intrinsic currents associated with quantum states can play an important role in designing new quantum technologies: Nanoscale currents improve understanding of quantum phenomena
7. TU/e news item Advanced digital signal processing for ultra-high-capacity optical transmission
8. BNR radio interview with TU/e and PhotonDelta: Zijn we China te slim af met deze lichtinnovatie?
9. News item on the Photonics Ideation Booster Process
10. News item SMART Photonics and TU/e enter into strategic partnership.
11. TU/e news item: How the Eindhoven Hendrik Casimir Institute develops novel information and communication systems: Building the backbone of the information society
12. ‘Vakidioot’ Reinoud Lavrijsen Docent van het Jaar 2022, in ISO nl
13. NPO Radio1 Langs de Lijn En Omstreken: Reinoud Lavrijsen is verkozen tot docent van het jaar
14. Reinoud Lavrijsen in Nlf8, 19 April 2022
15. Several news item related to the granting of the PhotonDelta Growth Fund award, eg Photonics sector at Eindhoven gets major boost with €1.1B investment, in Science|Business
16. Reinoud Lavrijsen was elected “Teacher of the year in higher education NL 2022”
17. Interesting video on YouTube: https://www.youtube.com/watch?v=zibGSXuWwNE
18. Moving spins: novel methods and materials for ultrafast spintronics
19. Ultrafast writing with light
20. Theoretical methods for femtomagnetism and ultrafast spintronics

INVITED TALKS

1. Andrea Fiore, “Integrated NIR Spectral Sensing”, invited paper, Photonics Spectra Spectroscopy Conference (online, 2022)
2. Andrea Fiore et al., “Integrated Near-Infrared Spectral Sensing”, invited paper, Optical Sensors (Vancouver, Canada, 2022)

3. Jos Haverkort, Towards a hex-SiGe NW laser. Invited presentation at the Nanowire Week (Chamonix, 25-29 April 2022)
4. Paul Koenraad "Iso-electronic Doping Atoms in III/V Materials Studied at the Atomic Scale by Cross-Sectional Scanning Tunneling Microscopy", Colloquium University of Lancaster (Lancaster UK 2022)
5. Paul Koenraad "High Resolution Imaging and Characterization of Defects", Gordon Conference on Defects in Semiconductors (New London, USA, 2022)
6. Paul Koenraad "Atomic Scale Microscopy of Self-assembled dots Grown by Droplet Epitaxy", International Conference On Quantum Materials And Technologies (Bodrum, Turkey, 2022)
7. Martijn Heck, "INSPIRE: InP on SiN photonic integrated circuits realized through wafer-scale micro-transfer printing", invited paper, SPIE Photonics Europe (Strassbourg, France, 2022)
8. Martijn Heck, "The road ahead for integrated photonics (tutorial)", invited tutorial paper, IEEE Photonics Conference (IPC) (Vancouver, Canada, 2022)
9. Jaime Gómez Rivas et al., "Simple Photonics Systems", invited talk, Wave Shaping 2022 Symposium (Twente University, The Netherlands, 2022)
10. Jaime Gómez Rivas et al., "Is it possible to make a perfect optical cavity?", invited talk, Dutch Photonics Event (ASML, Veldhoven, The Netherlands, 2022)
11. Jaime Gómez Rivas et al., "Extended open cavities for polaritonic devices", invited talk, Engineer Webinar Series (Optica, on-line event, 2022)
12. Jaime Gómez Rivas et al., "Strong light-matter coupling with resonant nanophotonic structures", Invited paper, IEEE Photonics Conference (IPC) (Vancouver, Canada, 2022).
13. Jaime Gómez Rivas et al., "THz resonant structures and metasurfaces for local field enhancement and beam steering", Invited paper, 2022 Optical Fiber Communication Conference and Exhibition (OFC) (San Diego, USA, 2022)
14. Jaime Gómez Rivas et al., "Collective plasmonic resonances", invited talk, School of Plasmonics and Nano-Optics (Torino, Italy, 2022)
15. Yuqing Jiao, et al, "InP membrane technology platform for large scale photonic integration", invited paper, The European Optical Society Annual Meeting (EOSAM 2022) (Porto, Portugal, 2022)
16. Erwin Kessels, "Atomic Layer Deposition as an enabling nanotechnology", Invited presentation, Raith Expert Workshop & Skill Day, (Dortmund, Germany, 2022)
17. Erwin Kessels, "Plasma-based (spatial) ALD for low-cost, high-volume, low-temperature applications", Invited presentation, Materials Research Society, Spring Meeting (Honolulu, Hawaii, USA, 2022)
18. Erwin Kessels et al., "Thermal, plasma-enhanced and spatial ALD as an enabling nanotechnology for electronic devices", Invited presentation, 48th International Conference on Metallurgical Coatings & Thin Films (San Diego, California, USA, 2022)
19. Erwin Kessels, "ALD: materials, process technologies and applications", Invited presentation, 5th Workshop ALD for Industry (Dresden, Germany, 2022)
20. Erwin Kessels, "Plasma-enhanced atomic layer deposition (PEALD) for processing at the nanoscale", Invited presentation, DGPT Colloquium (online, 2022)
21. Erwin Kessels, "Atomic Layer Deposition from an Applications Perspective", AVS Webinar (online, 2022)
22. Erwin Kessels, chair of the 9th International Atomic Layer Etching Workshop (Ghent, Belgium, 2022)

23. Weiming Yao et al., “Bringing photonics and electronics together”, invited talk, Bristol Quantum Information Technologies Workshop 2023 (Bristol, UK, 2023)
24. Bert Koopmans, “Ultrafast Spin Dynamics”, Kick-off meeting, Berlin, March 9 – 10, 2022
25. Bert Koopmans, “Femtosecond laser-induced transfer of spin-angular momentum” - Opening lecture (invited), MORRIS 2022, Magnetics and Optics Research International Symposium (Shimane, Japan, 2022)
26. Bert Koopmans, “Towards Spintronic-Photonic Integration”, Invited (online), JEMS 2022, The Joint Magnetic Symposia (Warsaw, Poland, 2022)
27. Bert Koopmans, “Femto-magnetism meets Spintronics”, Invited, UMC 2022, Ultrafast Magnetism Conference (Nancy, France, 2022)
28. Bert Koopmans, “Ultrafast laser-induced spin currents & all-optical switching”, Invited, Workshop “Theory meets XFELs” (Hamburg, Germany, 2022)

WIDE-AUDIENCE PUBLICATIONS

A. Fiore, F. Ou and A. van Klinken, "Integrated Spectral Sensors", Optics and Photonics News, November 2022

SPOT ON INTEGRATED PHOTONICS

We continued to publish a wide-audience magazine reporting the most significant results of the Gravitation program and relevant developments in the TU/e integrated photonics community. This is now the third edition of the magazine. The digital version is available here. It has been broadcasted on social media, and printed copy has been sent to over 500 colleagues and relations.

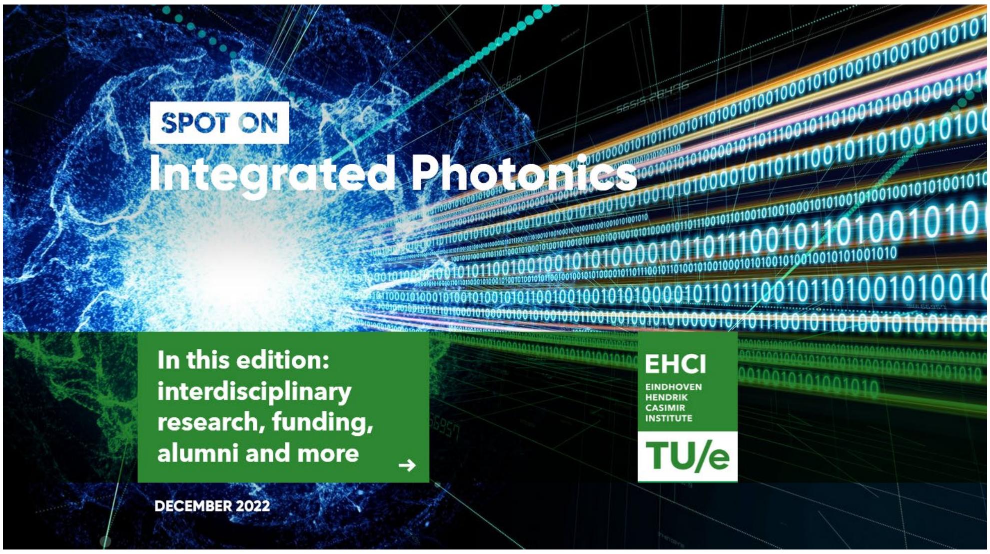


Figure 14. Cover page of the SPOT ON Integrated Photonics magazine – third edition.

NWO TEKNOWLOGY EVENT 2022

The annual NWO Teknowlogy event is an annual innovation festival featuring the latest technology emerging from NWO-funded research. In 2022 we were invited to present the TU/e-MantiSpectra spectral sensing technology with a demo and a "duo-talk".

Figure 15. Photos from the NWO Teknowlogy event 2022: (left) Spectral sensing demo; (right) M. Petruzzella and A. Fiore in a "duo-talk"

DUTCH DESIGN WEEK 2022

Dutch Design Week (DDW) is an annual highlight in Eindhoven, where designers, companies and educational institutions showcase what they have to offer. The TU/e exhibit within the 2022 DDW took place in the central Ketelhuisplein at Strijp-S. As one the five major themes showcased by the TU/e, *Sensing the invisible* featured two optical sensing exhibitions: Spectral sensing for plastic classification and Biosensing for Point-of-Care diagnostics. During the 10 days of the exhibit, thousands of people visited the demo and were introduced to the power of nanophotonics-enabled sensing.

Figure 16. Photo of the Spectral Sensing demo at the DDW 2022, with PhD student Don van Elst demonstrating the plastic classification application.

LINKEDIN

The Linkedin page is continuously sharing the news related to integrated photonics research, as one of the core pillars of the Eindhoven Hendrik Casimir Institute. The page has gained over 2,200 followers almost 1,000 more compared to the year before. This channel serves to disseminate the research results sharing the publications, media coverage, as well as to promote new open positions to attract talent.

EDUCATING AND ATTRACTING TALENT

Photonics is present in the TU/e education curriculum through a number of Bachelor and Master courses in both the Applied Physics (AP) and in Electrical Engineering (EE) Master programs.

Initiatives aimed at providing specific training programs in Photonics have been initiated by the members of this program, in collaboration with the Graduate Program Directors of the two departments.

PHOTONICS IN THE MASTER PROGRAM

Photonics is very well represented in both Master programs with a total of eight photonics-related electives. The number of Master students choosing for a photonics specialization has been boosted via the establishment of the PhotonDelta Fast Career Track Program (an informal sub-track within the AP and EE programs). In 2022, >20 of students carried out an internship and/or a Master project in photonics, many of them within our spin-offs (SMART Photonics, MantiSpectra). Discussions are presently ongoing regarding a possible initiative to further increase the number of Master students in photonics.

CHALLENGE-BASED LEARNING

We actively contribute to the TU/e education strategy aimed at embedding challenge-based learning (CBL) in the curriculum. In one of the photonics courses in the AP/EE Master, "Optical sensing and metrology", small teams of 2-3 students take up a real sensing challenge proposed by the industry and analyzes potential technical solutions within an 8-weeks course. The challenges are gathered through an annual open call "Optical sensing challenge". Challenges from ASML, ThermoFisher, Marelli Motorsport, DEMCON, Tarucca, Prodrive, PhotonFirst, SKF Seals, Nostics, VitalWear, Spectrik have been proposed so far.

Since 2021-22, photonics-related projects are proposed to interdisciplinary student teams within CBL courses. PhD student Bernat Molero Argudo (PhI group) has initiated this participation and has been the main coach for the teams. We are presently discussing our participation to a new TU/e wide initiative aimed at creating an open environment for learning and innovation, where integrated photonics would be featured as one of the key technologies.

PHOTONICS SOCIETY EINDHOVEN

The Optica Student Chapter *Photonics Society Eindhoven*, founded in 2019, has been very active in the last year, with the organisation of several workshops, activities and career events - some of them co-organized and/or cofunded by this Gravitation program. The student chapter presently counts 38 members.

BUILDING A COMMUNITY

On 26-27 September 2022 we organized the annual gathering of the Gravitation community, with over 100 participants and a very lively scientific and social program. This was co-hosted with the annual meeting of the Scientific Advisory Board.

Figure 17. Physical gathering of the gravitation community with various activities over 2 days.

PUBLICATION OUTPUT

In 2022 we published 156 papers on topics related to the Gravitation project, out of which 100 as journal publications, and 56 as conference contributions available in conference proceedings. The full list per theme is listed below.

Theme 1: Pervasive Optical Systems

Journal publications

Publication
Bravo Ospina, R. S., van den Hout, M., van der Heide, S., van Weerdenburg, J., Ryf, R., Fontaine, N. K., Chen, H., Amezcua Correa, R., Okonkwo, C. M., & Mello, D. A. A. (2022). MDG and SNR Estimation in SDM Transmission Based on Artificial Neural Networks. Journal of Lightwave Technology, 40(15), 5021-5030. [9773992]. **https://doi.org/10.1109/JLT.2022.3174778**
Chen, L., Zhao, M., Ye, H., Hang, Z. H., Li, Y., & Cao, Z. (2022). Efficient light coupling between conventional silicon photonic waveguides and quantum valley-Hall topological interfaces. Optics Express, 30(2), 2517-2527. **https://doi.org/10.1364/OE.445851**
Chen, L., Li, C., Oh, C. W., & Koonen, A. M. J. (2022). A low-latency real-time PAM-4 receiver enabled by deep-parallel technique. Optics Communications, 508, [127836]. **https://doi.org/10.1016/j.optcom.2021.127836**
Feyisa, D. W., Shi, B., Kraemer, R., Calabretta, N., & Stabile, R. (2022). Compact 8×8 SOA-Based Optical WDM Space Switch in Generic InP Technology. Journal of Lightwave Technology, 40(19), 6331-6338. [9852300]. **https://doi.org/10.1109/JLT.2022.3197292**
Graaf, J. D., Zhao, X., Konstantinou, D., van den Hout, M., Reniers, S., Shen, L., van der Heide, S., Rommel, S., Tafur Monroy, I., Okonkwo, C. M., Cao, Z., Koonen, T., Williams, K., & Jiao, Y. (2022). Beyond 110 GHz uni-traveling carrier photodiodes on an InP-membrane-on-silicon platform. IEEE Journal of Selected Topics in Quantum Electronics, 28(2), [3802010]. **https://doi.org/10.1109/JSTQE.2021.3110411**
Gültekin, Y. C., Alvarado, A., Vassilieva, O., Kim, I., Palacharla, P., Okonkwo, C. M., & Willems, F. M. J. (2022). Kurtosis-limited Sphere Shaping for Nonlinear Interference Noise Reduction in Optical Channels. Journal of Lightwave Technology, 40(1), 101-112. [9580735]. **https://doi.org/10.1109/JLT.2021.3120915**
Guo, X., Xue, X., Yan, F., Pan, B., Exarchakos, G., & Calabretta, N. (2022). DACON: A reconfigurable application-centric optical network for disaggregated data center infrastructures [Invited]. Journal of Optical Communications and Networking, 14(1), A69-A80. **https://doi.org/10.1364/JOCN.438950**
Lei, Y., Yan, X., Li, C., Bente, E., Yao, W., Cao, Z., & Koonen, T. (2022). Monolithic integrated two-stage cascaded SOA-PIN receiver for high-speed optical wireless communication. Optics Letters, 47(10), 2578-2581. **https://doi.org/10.1364/OL.457785**
Li, J., Li, C., Henneken, V., Louwerse, M., Van Rens, J., Dijkstra, P., Raz, O., & Dekker, R. (2022). 25.8 Gb/s Submillimeter Optical Data Link Module for Smart Catheters. Journal of Lightwave Technology, 40(8), 2456-2464. [9662251]. **https://doi.org/10.1109/JLT.2021.3137981**
Li, C., Chen, H., Fontaine, N. K., Farah, B., Bolle, C., Ryf, R., Mazur, M., Raz, O., Neumeyr, C., Alvarado-Zacarias, J. C., Amezcua Correa, R., Bigot-Astruc, M., Sillard, P., & Neilson, D. (2022). Co-Packaged Optics with Multimode Fiber Interface Employing 2-D VCSEL Matrix. Journal of Lightwave Technology, 40(10), 3325-3330. **https://doi.org/10.1109/JLT.2022.3160128**
Li, C., Bhat, S., Stabile, R., Song, Y., Neumeyr, C., & Raz, O. (2022). Hybrid Integration of VCSEL and 3-µm Silicon Waveguide Based on a Monolithic Lens System. IEEE Transactions on Components, Packaging and Manufacturing Technology, 12(5), 883-886. [9736950]. **https://doi.org/10.1109/TCPMT.2022.3160149**
Linnartz, J. P., Ribeiro Barbio Correa, C., Bitencourt Cunha, T., Tangdiongga, E., Koonen, A. M. J., Deng, X., Abbo, A. A., Polak, P., Müller, M., Behnke, D., Vicent Colonques, S., Metin, T., Emmelmann, M., Kouhini, S. M., Bober, K. L., Kottke, C., & Jugnickel, V. (2022). ELIoT: enhancing LiFi for next-generation Internet of things. EURASIP Journal on Wireless Communications and Networking, 2022(1), [89]. **https://doi.org/10.1186/s13638-022-02168-6**
Pan, B., Xue, X., Guo, X., & Calabretta, N. (2022). Precise Time Distribution and Synchronization for Low Latency Slotted Optical Metro-Access Networks. Journal of Lightwave Technology, 40(8), 2244-2253. **https://doi.org/10.1109/JLT.2021.3138456**
Pham, N. Q., Mekonnen, K. A., Mefleh, A., Koonen, T., & Tangdiongga, E. (2022). Automatic Gbps Receiver for Mobile Device in Beam-Steered Infrared Light Communication System. Journal of Lightwave Technology, 40(20), 6852-6859. **https://doi.org/10.1109/JLT.2022.3188156**
Rasoulzadehzali, A., Kleijn, S., Augustin, L., Tessema, N. M., Prifti, K., Stabile, R., & Calabretta, N. (2022). Design and Fabrication of Low Polarization Dependent Bulk SOA Co-Integrated with Passive Waveguides for Optical Network Systems. Journal of Lightwave Technology, 40(4), 1083-1091. [9616381]. **https://doi.org/10.1109/JLT.2021.3128426**

Rasoulzadehzali, A., Stabile, R., & Calabretta, N. (2022). Design and Analysis of Novel O-Band Low Polarization Sensitive SOA Co-Integrated With Passive Waveguides for Optical Systems. IEEE Photonics Journal, 14(5), [8451110]. **https://doi.org/10.1109/JPHOT.2022.3200639**
Ribeiro Barbio Correa, C., Mekonnen, K. A., Huijskens, F., Koonen, T., & Tangdiongga, E. (2022). Passive OFE multi-Gbps VLC transmission using POF as a feeder line. Microwave and Optical Technology Letters, 64(9), 1657-1665. **https://doi.org/10.1002/mop.33280**
Ribeiro Barbio Correa, C., Mekonnen, K. A., Huijskens, F. M., Koonen, A. M. J., & Tangdiongga, E. (2022). Bidirectional Gigabits Per Second Spatial Diversity Link Using POF for Passive Optical Front-Ends. Journal of Lightwave Technology, 40(20), 6753-6761. [9844244]. **https://doi.org/10.1109/JLT.2022.3194649**
Santos, C., Oliari, V., de Rocha, H. R. O., Pontes, M. J., Segatto, M. E. V., Okonkwo, C. M., Alvarado, A., & Silva, J. A. L. (2022). Experimental Demonstration of Constant-Envelope OFDM to Reduce Intermodulation Impairments and Increase Robustness Against Fiber Nonlinearities. Journal of Lightwave Technology, 40(15), 4983-4989. **https://doi.org/10.1109/JLT.2022.3170864**
Shi, B., Calabretta, N., & Stabile, R. (2022). InP photonic integrated multi-layer neural networks: Architecture and performance analysis. APL Photonics, 7(1), [010801]. https://doi.org/10.1063/5.0066350
Shi, B., Calabretta, N., & Stabile, R. (2022). Emulation and modelling of semiconductor optical amplifier-based all-optical photonic integrated deep neural network with arbitrary depth. Neuromorphic Computing and Engineering, 2(3), [034010]. **https://doi.org/10.1088/2634-4386/ac8827**
van den Hout, M., van der Heide, S., & Okonkwo, C. M. (2022). Kramers-Kronig Receiver with Digitally Added Carrier Combined with Digital Resolution Enhancer. Journal of Lightwave Technology, 40(5), 1400-1406. **https://doi.org/10.1109/JLT.2022.3142353**
van der Heide, S., Luis, R. S., Goossens, S., Puttnam, B. J., Rademacher, G., Koonen, T., Shinada, S., Awaji, Y., Alvarado, A., Furukawa, H., & Okonkwo, C. (2022). Real-time transmission of geometrically-shaped signals using a software-defined GPU-based optical receiver. Optics Express, 30(15), 27171-27179. **https://doi.org/10.1364/OE.450514**
van Vliet, V., van der Heide, S., van den Hout, M., & Okonkwo, C. (2022). Turbulence Characterisation for Free Space Optical Communication Using Off-Axis Digital Holography. OSA Technical Digest Series, 2022, [SpTu3G.1]. https://doi.org/10.36227/techrxiv.20072948.v1, **https://doi.org/10.1364/SPPCOM.2022.SpTu3G.1**
Wang, Y., Bhat, S. P., Tessema, N. M., Kraemer, R., Napoli, A., Delrosso, G., & Calabretta, N. (2022). Ultrawide-band Low Polarization Sensitivity 3-µm SOI Arrayed Waveguide Gratings. Journal of Lightwave Technology, 40(11), 3432-3441. [9760169]. **https://doi.org/10.1109/JLT.2022.3167829**
Wang, Y., & Calabretta, N. (2022). Polarization-insensitive 40-channel 100-GHz spacing fold-back planar echelle grating Mux/Demux for photonic integrated wavelength-selective switches. Optics Letters, 47(20), 5268-5271. **https://doi.org/10.1364/OL.470802**
Xue, X., Pan, B., Guo, X., & Calabretta, N. (2022). Flow-controlled and Clock-distributed Optical Switch and Control System. IEEE Transactions on Communications, 70(5), 3310-3319. **https://doi.org/10.1109/TCOMM.2022.3156613**
Xue, X., & Calabretta, N. (2022). Nanosecond optical switching and control system for data center networks. Nature Communications, 13(1), [2257]. **https://doi.org/10.1038/s41467-022-29913-1**
Xue, X., & Calabretta, N. (2022). Synergistic Switch Control Enabled Optical Data Center Networks. IEEE Communications Magazine, 60(3), 62-67. **https://doi.org/10.1109/MCOM.001.2100683**
Zhang, S., Xue, X., Tangdiongga, E., & Calabretta, N. (2022). Low-Latency Optical Wireless Data-Center Networks Using Nanoseconds Semiconductor-Based Wavelength Selectors and Arrayed Waveguide Grating Router. Photonics, 9(3), [203]. **https://doi.org/10.3390/photonics9030203**
Zhang, S., Tessema, N. M., Freire Santana, H., Kraemer, R., Xue, X., Tangdiongga, E., & Calabretta, N. (2022). Nanosecond photonic integrated multicast switch for low-latency optical wireless data center networks. Optics Letters, 47(16), 4247-4250. **https://doi.org/10.1364/OL.464372**

Conference publications

Publication
Bitencourt Cunha, T. E. B., Correa, C. R. B., Linnartz, J. P., Tangdiongga, E., & Huijskens, F. M. (2022). Real-time hardware G.hn LiFi infrastructure with D-MIMO and WDM over POF Fronthaul. In IECON 2022 – 48th Annual Conference of the IEEE Industrial Electronics Society [9968387] (IECON Proceedings (Industrial Electronics Conference); Vol. 2022-October). Institute of Electrical and Electronics Engineers. **https://doi.org/10.1109/IECON49645.2022.9968387**
Bradley, T., Velazquez Benitez, A., van der Heide, S., van den Hout, M., van Vliet, V., Bigot-Astruc, M., Amezcua-Correa, A., Sillard, P., Winzer, P., & Okonkwo, C. (2022). Off-axis digital holography for analysis of fibre tapping of few mode fibres. In Advanced Photonics Congress: Distributed Computing, Advanced Transport, and Security Optica Publishing Group. **https://doi.org/10.1364/NETWORKS.2022.NeTh2C.3**
Cao, Z., Yan, X., Zhang, Y., Li, C., Li, J., Hsu, C. W., & Koonen, T. (2022). Momentum Space Controlled Flexible Spatial Light Modulator for Optical Wireless Communication. In 2022 Optical Fiber Communications Conference and Exhibition, OFC 2022 - Proceedings [M4J.1] Institute of Electrical and Electronics Engineers. **https://ieeexplore.ieee.org/document/9748342**

Chen, L., Oh, C. W., Lee, J., Zhang, X., & Koonen, T. (2022). Complexity-reduction for the Digital-filtered AWGR-based 2D IR Beam-steered OWC System by using Non-integer Oversampling. In 2022 European Conference on Optical Communication, ECOC 2022 Institute of Electrical and Electronics Engineers. **https://ieeexplore.ieee.org/document/9979438**
Correa, C. R. B., Bitencourt Cunha, T. E. B., Huijskens, F. M., Linnartz, J. P., & Tangdiongga, E. (2022). Passive-OFE Spatial Multiplexing Gigabits per Second Transmission Using WDM-over-POF. In OECC/PSC 2022 - 27th OptoElectronics and Communications Conference/International Conference on Photonics in Switching and Computing 2022 [9850077] Institute of Electrical and Electronics Engineers. **https://doi.org/10.23919/OECC/PSC53152.2022.9850077**
Goossens, S., Gültekin, Y. C., Vassilieva, O., Kim, I., Palacharla, P., Okonkwo, C., & Alvarado, A. (2022). 4D Geometric Shell Shaping with Applications to 400ZR. In Signal Processing in Photonic Communications, SPPCom 2022 [SpM2I.1] Optica Publishing Group. **https://doi.org/10.1364/SPPCOM.2022.SpM2I.1**
Gültekin, Y. C., Vassilieva, O., Kim, I., Palacharla, P., Okonkwo, C., & Alvarado, A. (2022). On Optimum Enumerative Sphere Shaping Blocklength at Different Symbol Rates for the Nonlinear Fiber Channel. In 2022 27th OptoElectronics and Communications Conference (OECC) and 2022 International Conference on Photonics in Switching and Computing (PSC) [9849911] Institute of Electrical and Electronics Engineers. https://doi.org/10.23919/OECC/PSC53152.2022.9849911
Koonen, T., Mekonnen, K., Huijskens, F., & Tangdiongga, E. (2022). Bi-directional All-Optical Wireless Communication System with Optical Beam steering and Automatic Self-Alignment. In 2022 European Conference on Optical Communication, ECOC 2022 Institute of Electrical and Electronics Engineers. **https://www.scopus.com/record/display.uri?eid=2-s2.0-85146400128&origin=inward&txGid=587fc5c593d99e12f522bae69639f665**
Kraemer, R., Santana, H., Zhang, S., Pan, B., & Calabretta, N. (2022). Lossless SOA-based Multi-band OADM Nodes in Metro Networks. In OECC/PSC 2022 - 27th OptoElectronics and Communications Conference/International Conference on Photonics in Switching and Computing 2022 [9850111] Institute of Electrical and Electronics Engineers. **https://doi.org/10.23919/OECC/PSC53152.2022.9850111**
Kraemer, R., Santana, H., & Calabretta, N. (2022). O, S, C and L-band SOA-based OADM nodes in Metro Networks. In 2022 European Conference on Optical Communication, ECOC 2022 [9979358] Institute of Electrical and Electronics Engineers. **https://ieeexplore.ieee.org/document/9979358**
Pham, N. Q., Mekonnen, K. A., Mefleh, A., Koonen, A. M. J., & Tangdiongga, E. (2022). Full-Duplex Bidirectional Indoor Steerable OWC System using Orthogonal Polarization States. In 2022 European Conference on Optical Communication, ECOC 2022 Institute of Electrical and Electronics Engineers. **https://ieeexplore.ieee.org/document/9979166**
Rasoulzadehzali, A., Stabile, R., & Calabretta, N. (2022). Fabrication Tolerance Study of Polarization-Independent C-Band Bulk SOA for Active-Passive Photonic Integration. In 2022 27th OptoElectronics and Communications Conference (OECC) and 2022 International Conference on Photonics in Switching and Computing (PSC) [9850196] Institute of Electrical and Electronics Engineers. **https://doi.org/10.23919/OECC/PSC53152.2022.9850196**
Ribeiro Barbio Correa, C., Mekonnen, K. A., Huijskens, F. M., Koonen, A. M. J., & Tangdiongga, E. (2022). Multi-Gigabits per Second Spatial Multiplexing Transmission Using Passive OFE and WDM-over-POF. In 2022 European Conference on Optical Communication (ECOC) [9979618] Institute of Electrical and Electronics Engineers. **https://ieeexplore.ieee.org/document/9979618**
Santana, H., Pan, B., Kraemer, R., Prifti, K., Mefleh, A., & Calabretta, N. (2022). Transparent and Fast Reconfigurable Optical Network with Edge Computing Nodes for Beyond 5G applications. In 2022 13th International Symposium on Communication Systems, Networks and Digital Signal Processing, CSNDSP 2022 (pp. 820-825). [9907904] Institute of Electrical and Electronics Engineers. **https://doi.org/10.1109/CSNDSP54353.2022.9907904**
Santana, H., Kraemer, R., Mefleh, A., & Calabretta, N. (2022). Photonically Interconnected Federated Edge-Computing Networks Using Fast Reconfigurable SOA-based OADMs. In 2022 European Conference on Optical Communication, ECOC 2022 [9979402] Institute of Electrical and Electronics Engineers. **https://ieeexplore.ieee.org/document/9979402**
Shi, B., Calabretta, N., & Stabile, R. (2022). SOA-based All-optical Photonic Integrated Deep Neural Network with Stable Output Noise. In European Conference on Optical Communication (ECOC) 2022 Optica Publishing Group. **https://opg.optica.org/abstract.cfm?URI=ECEOC-2022-Tu4G.2**
Song, Y., Li, C., Mekonnen, K. A., Wolny, M., Ribeiro Barbio Correa, C., Spiegelberg, M., Tangdiongga, E., & Raz, O. (2022). Compact OWC Receiver Enabled by Co-integration of Micro-Lens and PD Arrays on Glass Interposer. In 2022 IEEE International Topical Meeting on Microwave Photonics, MWP 2022 - Proceedings [9997772] Institute of Electrical and Electronics Engineers. **https://doi.org/10.1109/MWP54208.2022.9997772**
van den Hout, M., van der Heide, S., Bradley, T., Velazquez Benitez, A., Mefleh, A., & Okonkwo, C. M. (2022). Improving Alignment of Free-Space Coupling of Multi-Mode Fibres using Off-Axis Digital Holography. In Proceedings of the 26th Annual Symposium of the IEEE Photonics Benelux Chapter
van der Heide, S., Albores Mejia, A., dos Reis Frazão, J., & Okonkwo, C. M. (2022). Receiver Calibration and Quantum Random Number Generation for Continuous-variable Quantum Key Distribution. In Proceedings of the 26th Annual Symposium of the IEEE Photonics Benelux Chapter
van der Heide, S., Luis, R. S., Puttnam, B. J., Rademacher, G., Koonen, T., Shinada, S., Awaji, Y., Furukawa, H., & Okonkwo, C. (2022). Real-time transmission using a GPU-based Kramers-Kronig coherent receiver. In OECC/PSC 2022 - 27th OptoElectronics and Communications Conference/International Conference on Photonics in Switching and Computing 2022 Institute of Electrical and Electronics Engineers. **https://doi.org/10.23919/OECC/PSC53152.2022.9850080**

van der Heide, S., Luis, R. S., Puttnam, B. J., Rademacher, G., Koonen, T., Shinada, S., Awaji, Y., Furukawa, H., & Okonkwo, C. (2022). Real-Time Optical Transmission with GPU-Based DSP. In Signal Processing in Photonic Communications, SPPCom 2022 [SpTh2J.1] Optica Publishing Group. https://www.scopus.com/record/display.uri?eid=2-s2.0-85146663850&origin=inward&txGid=eab5db498e739c9ba4cac2664381769f
van Vliet, V., van den Hout, M., van der Heide, S., & Okonkwo, C. (2022). Experimental Investigation of Mode Diversity Reception Using an Optical Turbulence Generator and Digital Holography. We5.56. Paper presented at 48th European Conference on Optical Communication, ECOC 2022, Basel, Switzerland. https://opg.optica.org/abstract.cfm?URI=ECEOC-2022-We5.56
van Vliet, V., van den Hout, M., van der Heide, S., & Okonkwo, C. M. (2022). Design, Characterisation, and Demonstration of a Hot-Air-Based Optical Turbulence Generator. In Proceedings of the 26th Annual Symposium of the IEEE Photonics Benelux Chapter
Wang, Y., & Calabretta, N. (2022). Novel Polarization Insensitive Fold-back 40-channels 100 GHz Spacing Planar Echelle Grating for Wavelength Selective Switches. In 2022 27th OptoElectronics and Communications Conference (OECC) and 2022 International Conference on Photonics in Switching and Computing (PSC) [9850180] Institute of Electrical and Electronics Engineers. https://doi.org/10.23919/OECC/PSC53152.2022.9850180
Wang, Y., & Calabretta, N. (2022). Novel fold-back 1×20 100 GHz mux/demux planar Echelle grating for low loss photonic switches. In 2022 Conference on Lasers and Electro-Optics (CLEO) [9890954] Institute of Electrical and Electronics Engineers. https://ieeexplore.ieee.org/document/9890954
Wang, Y., Kraemer, R., & Calabretta, N. (2022). Ultra-wide band polarization insensitive photonic integrated filters and switches. In 2022 IEEE Photonics Society Summer Topicals Meeting Series (SUM) [9858312] Institute of Electrical and Electronics Engineers. https://doi.org/10.1109/SUM53465.2022.9858312
Zhang, S., Tessema, N., Xue, X., Kraemer, R., Santana, H., Tangdiongga, E., & Calabretta, N. (2022). Lossless Photonic Integrated Multicast Switch for Optical Wireless Data Center Network. In 2022 27th OptoElectronics and Communications Conference (OECC) and 2022 International Conference on Photonics in Switching and Computing (PSC) (pp. 1-3). [9850188] Institute of Electrical and Electronics Engineers. https://doi.org/10.23919/OECC/PSC53152.2022.9850188
Zhang, S., Tessema, N. M., Kraemer, R., Xue, X., Freire Santana, H., Tangdiongga, E., & Calabretta, N. (2022). System Performance Assessment of an Optical Wireless Data Center Network based on Photonic Integrated Multicast Switch. In 2022 European Conference on Optical Communication (ECOC) [9979284] Institute of Electrical and Electronics Engineers. https://ieeexplore.ieee.org/document/9979284

Theme 2: Nanophotonic Integrated Circuits

Journal publications

Publication
Demirer, F. E., Baron, Y., Reniers, S., Pustakhod, D., Lavrijsen, R., van der Tol, J., & Koopmans, B. (2022). An integrated photonic device for on-chip magneto-optical memory reading. Nanophotonics, 11(14), 3319-3329. https://doi.org/10.1515/nanoph-2022-0165
Gagino, M., van Rijn, M. B. J., Bente, E. A. J. M., Smit, M. K., & Dolores-Calzadilla, V. (2022). Broadband operation of an InP optical phased array. IEEE Photonics Technology Letters, 34(10), 541-544. https://doi.org/10.1109/LPT.2022.3171979
Graaf, J. D., Zhao, X., Konstantinou, D., van den Hout, M., Reniers, S., Shen, L., van der Heide, S., Rommel, S., Tafur Monroy, I., Okonkwo, C. M., Cao, Z., Koonen, T., Williams, K., & Jiao, Y. (2022). Beyond 110 GHz uni-traveling carrier photodiodes on an InP-membrane-on-silicon platform. IEEE Journal of Selected Topics in Quantum Electronics, 28(2), [3802010]. https://doi.org/10.1109/JSTQE.2021.3110411
Hazan, J., Andreou, S., Pustakhod, D., Kleijn, S., Williams, K. A., & Bente, E. A. J. M. (2022). 1300 nm Semiconductor Optical Amplifier Compatible With an InP Monolithic Active/Passive Integration Technology. IEEE Photonics Journal, 14(3), [1532311]. https://doi.org/10.1109/JPHOT.2022.3175373
Kashi, A., van der Tol, J. J. G. M., Williams, K. A., & Jiao, Y. (2022). Efficient and fabrication error tolerant grating couplers on the InP membrane on silicon platform. Applied Optics, 61(33), 9926-9936. https://doi.org/10.1364/AO.473271
Lei, Y., Yan, X., Li, C., Bente, E., Yao, W., Cao, Z., & Koonen, T. (2022). Monolithic integrated two-stage cascaded SOA-PIN receiver for high-speed optical wireless communication. Optics Letters, 47(10), 2578-2581. https://doi.org/10.1364/OL.457785
Lenstra, D., Fischer, A. P. A., Ouirimi, A., Chime, A., Loganathan, N., & Chakaroun, M. (2022). Ultra-short optical pulse generation in micro OLEDs and the perspective of lasing. Journal of Optics, 24(3), [034007]. https://doi.org/10.1088/2040-8986/ac4cd1
Lenstra, D., Puts, L., & Yao, W. (2022). First-Passage-Time Analysis of the Pulse-Timing Statistics in a Two-Section Semiconductor Laser under Excitable and Noisy Conditions. Photonics, 9(11), [860]. https://doi.org/10.3390/photonics9110860
Lu, L., Reniers, S., Wang, Y., Jiao, Y., & Simpson, R. (2022). Reconfigurable InP waveguide components using the Sb2S3 phase change material. Journal of Optics, 24(9), [094001]. https://doi.org/10.1088/2040-8986/ac7e5a

Wang, Y., Wei, Y., Dolores Calzadilla, V., Williams, K. A., Smit, M., Dai, D., & Jiao, Y. (2022). Mode division multiplexing on an InP membrane on silicon. Optics Letters, 47(16), 4004-4007. **https://doi.org/10.1364/OL.464407**
Gajjela, R., van Venrooij, N. R. S., Rodrigues Da Cruz, A., Skiba-Szymanska, J., Stevenson, R. M., Shields, A. J., Pryor, C. E., & Koenraad, P. M. (2022). Study of Size, Shape, and Etch pit formation in InAs/InP Droplet Epitaxy Quantum Dots. Nanotechnology, 33(30), [305705]. **https://doi.org/10.1088/1361-6528/ac659e**
Godiksen, R. H., Wang, S., Raziman, T. V., Gómez Rivas, J., & Curto, A. G. (2022). Impact of indirect transitions on valley polarization in WS2 and WSe2. Nanoscale, 14(47), 17761-17769. **https://doi.org/10.1039/d2nr04800k**
Hakkel, K. D., van Elst, D. M. J., Petruzzella, M., Ebermann, M., Pagliano, F., van Klinken, A., & Fiore, A. (2022). High-performance integrated mid-infrared filter arrays. Electronics Letters, 58(23), 884-886. https://doi.org/10.1049/ell2.12626
Hakkel, K. D., Petruzzella, M., Ou, F., van Klinken, A., Pagliano, F., Liu, T., van Veldhoven, P. J., & Fiore, A. (2022). Integrated near-infrared spectral sensing. Nature Communications, 13, [103]. **https://doi.org/10.1038/s41467-021-27662-1**
Kranenburg, R. F., Ou, F., Ševo, P., Petruzzella, M., de Ridder, R., van Klinken, A., Hakkel, K. D., van Elst, D. M. J., van Veldhoven, P. J., Pagliano, F., van Asten, A. C., & Fiore, A. (2022). On-site illicit-drug detection with an integrated near-infrared spectral sensor: A proof of concept. Talanta, 245, [123441]. **https://doi.org/10.1016/j.talanta.2022.123441**
Ou, F., Sevo, P., Petruzzella, M., van Klinken, A., Hakkel, K., van Elst, D. M. J., Li, C., Pagliano, F., van Veldhoven, R. P. J., & Fiore, A. (2022). A novel handheld NIR spectral sensor module for the monitoring of moisture content and for plastic classification. In Applied Industrial Optics: Spectroscopy, Imaging and Metrology, AIO 2022 [T1A.3] Optica Publishing Group. **https://doi.org/10.1364/AIO.2022.T1A.3**
Raziman, T. V., Visser, C. P., Wang, S., Gómez Rivas, J., & Curto, A. G. (2022). Exciton Diffusion and Annihilation in Nanophotonic Purcell Landscapes. Advanced Optical Materials, 10(17), [2200103]. **https://doi.org/10.1002/adom.202200103**
Raziman, T. V., Visser, C. P., Wang, S., Gómez Rivas, J., & Curto, A. G. (2022). Exciton Diffusion and Annihilation in Nanophotonic Purcell Landscapes. Advanced Optical Materials, 10(17), [2200103]. **https://doi.org/10.1002/adom.202200103**

Conference publications

Publication
Gagino, M., Millán Mejía, A. J., Augustin, L. M., Williams, K. A., Bente, E. A. J. M., & Dolores Calzadilla, V. (2022). InP-based optical phased array with on-chip amplification. In IEEE Benelux Chapter Annual Symposium 2022 Institute of Electrical and Electronics Engineers.
Hazan, J., Couka, T., Pajkovic, R., Williams, K., & Bente, E. (2022). Control strategy for a monolithically integrated widely tunable laser system on InP for Optical Coherence Tomography. In A. A. Belyanin, & P. M. Smowton (Eds.), Novel In-Plane Semiconductor Lasers XXI [120210A] (Proceedings of SPIE - The International Society for Optical Engineering; Vol. 12021). SPIE. **https://doi.org/10.1117/12.2610120**
Hazan, J., Nassar, A., Williams, K., & Bente, E. (2022). Monolithically integrated InP 2.5 GHz Fourier Domain Mode-Locked Laser at 1530nm. In 2022 28th International Semiconductor Laser Conference, ISLC 2022 [9943513] Institute of Electrical and Electronics Engineers. **https://doi.org/10.23919/ISLC52947.2022.9943513**
Lenstra, D., Fischer, A., Ouirimi, A., Chime, A. C., Loganathan, N., & Chakaroun, M. (2022). Ultra-short optical pulse generation and laser perspective in an Alq3 based micro OLED. In S. Reineke, K. Vandewal, & W. Maes (Eds.), Organic Electronics and Photonics: Fundamentals and Devices III (pp. 1-7). [1214902] (Proceedings of SPIE - The International Society for Optical Engineering; Vol. 12149). SPIE. **https://doi.org/10.1117/12.2621432**
Nag, D., Yao, W., van der Tol, J. J. G. M., & Williams, K. A. (2022). Investigating RC and Transit Time Limited Bandwidth of Integrated Balanced Detectors through an Equivalent Circuit Model. In Bragg Gratings, Photosensitivity and Poling in Glass Waveguides and Materials, BGPP 2022 [JTu2A.40] Optica Publishing Group. **https://doi.org/10.1364/BGPPM.2022.JTu2A.40**
Puts, L., Williams, K., Lenstra, D., & Yao, W. (2022). Demonstration of self-spiking neuron behavior in a monolithically integrated two-section laser. In ECIO 2022 23rd European Conference on Integrated Optics, Proceedings (pp. 227-229). [T.P. 20] **https://www.ecio-conference.org/wp-content/uploads/2022/05/ECIO_proceedings.pdf**
Puts, L., Lenstra, D., & Yao, W. (Accepted/In press). Noise-induced pulse-timing statistics in an integrated two-section semiconductor laser with saturable absorber. In Annual Symposium of the IEEE Photonics Society Benelux
Tian, W., Santos, R., Williams, K., & Leijtens, X. J. M. (2022). Experimental study on feedback sensitivity in a semiconductor ring laser. In 2022 Conference on Lasers and Electro-Optics (CLEO) [9891269] IEEE, OSA. **https://ieeexplore.ieee.org/document/9891269**
Tian, W., Beste, L., Khachikyan, A., Mittelstädt, C., Dekker, R., Wörhoff, K., van Kerkhof, J., Santos, R., Williams, K., & Leijtens, X. (2022). Photonic flip-chip assembly of InP on TriPleX with laser soldering. In Proceedings 2022 23rd European Conference on Integrated Optics (ECIO) (pp. 71-73). IEEE, OSA.
Torreele, M., Cuyvers, S., Reep, T., Van Gasse, K., Bente, E., & Kuyken, B. (2022). Hybrid modeling technique for on-chip extended cavity semiconductor mode-locked lasers. In 2022 28th International Semiconductor Laser Conference, ISLC 2022 [9943336] Institute of Electrical and Electronics Engineers. **https://doi.org/10.23919/ISLC52947.2022.9943336**

Wang, Y., van Engelen, J., Dolores-Calzadilla, V., Williams, K., Smit, M., & Jiao, Y. (2022). Thermal and wiring optimizations of dense SOA arrays on an adhesively bonded InP membrane. In Proceedings of 23rd European Conference on Integrated Optics Politecnico di Milano. https://www.ecio-conference.org/wp-content/uploads/2022/07/ECIO_proceedingsv3.pdf
Zozulia, A., Pogoretsky , V., van Veldhoven, P. J., Bolk, J., Williams, K. A., Rihani, S., Berry, G., Robertson, M., Rawsthorne, J., & Jiao, Y. (2022). Design of InP membrane SOA with butt-joint active passive interface. In IEEE Benelux Photonics Chapter, Annual Symposium 2022 24-25 November 2022, Eindhoven University of Technology The Netherlands
Zozulia, A., Jiao, Y., & Williams, K. (2022). A method of heat sink fabrication in InP membrane lasers by bonding on double-layer BCB. In European semiconductor laser workshop 2022, ESLW 2022
Hakkel, K. D., Petruzzella, M., Ebermann, M., Pagliano, F., van Elst, D. M. J., van Klinken, A., & Fiore, A. (2022). High-performance mid-infrared filter arrays for gas sensing. In Optical Components and Materials XIX (Proceedings of SPIE; Vol. PC11997). SPIE. https://doi.org/10.1117/12.2606043
Hendriks, A. L., Picelli, L., Lindgren, G., van Klinken, A., Hakkel, K. D., Pagliano, F., van Veldhoven, R. P. J., Verhagen, E., & Fiore, A. (2022). Optomechanical sensing on a fiber-tip. In Optical and Quantum Sensing and Precision Metrology II (Proceedings of SPIE; Vol. PC12016). SPIE. https://doi.org/10.1117/12.2606052
Hendriks, A. L., Picelli, L., van Veldhoven, P. J., Verhagen, E., & Fiore, A. (2022). Nano-optomechanics on a fiber-tip. In The 12th International Conference on Metamaterials, Photonic Crystals and Plasmonics: Proceedings META. https://metaconferences.org/META/files/meta22_proceedings.pdf
Ou, F., van Klinken, A., Ševo, P., Petruzzella, M., Li, C., van Elst, D. M. J., Hakkel, K. D., Pagliano, F., van Veldhoven, P. J., & Fiore, A. (2022). Handheld NIR Spectral Sensor Module Based on a Fully-Integrated Detector Array. Sensors (Switzerland), 22(18), [7027]. https://doi.org/10.3390/s22187027
van Elst, D. M. J., van Klinken, A., Ou, F., Petruzzella, M., Hakkel, K. D., Pagliano, F., van Veldhoven, R. P. J., & Fiore, A. (2022). High-performance near-infrared spectral sensors based on a wafer-scale fabrication process. In MOEMS and Miniaturized Systems XXI (Proceedings of SPIE; Vol. PC12013). SPIE. https://doi.org/10.1117/12.2605960
van Klinken, A., Ou, F., Li, C., van Elst, D. M. J., Petruzzella, M., Hakkel, K. D., Pagliano, F., Ševo, P., van Veldhoven, R. P. J., & Fiore, A. (2022). On-chip near-infrared spectral sensor for nondestructive material analysis. In Optical Sensing and Detection VII (Proceedings of SPIE; Vol. 12139). SPIE. https://doi.org/10.1117/12.2620290

Theme 3: Ultimate Control of Matter and Photons

Journal publications

Publication
Badawy, G., Zhang, B., Rauch, T., Momand, J., Koelling, S., Jung, J., Gazibegovic, S., Moutanabbir, O., Kooi, B. J., Botti, S., Verheijen, M. A., Frolov, S. M., & Bakkers, E. P. A. M. (2022). Electronic Structure and Epitaxy of CdTe Shells on InSb Nanowires. Advanced Science, 9(12), [2105722]. https://doi.org/10.1002/advs.202105722
Jung, J., Schellingerhout, S. G., Ritter, M. F., ten Kate, S. C., van der Molen, O. A. H., de Loijer, S., Verheijen, M. A., Riel, H., Nichele, F., & Bakkers, E. P. A. M. (2022). Selective Area Growth of PbTe Nanowire Networks on InP. Advanced Functional Materials, 32(51), [2208974]. https://doi.org/10.1002/adfm.202208974
Schellingerhout, S. G., De Jong, E. J., Gomanko, M., Guan, X., Jiang, Y., Hoskam, M. S. M., Jung, J., Koelling, S., Moutanabbir, O., Verheijen, M. A., Frolov, S. M., & Bakkers, E. P. A. M. (2022). Growth of PbTe nanowires by molecular beam epitaxy. Materials for Quantum Technology, 2(1), [015001]. https://doi.org/10.1088/2633-4356/ac4fba
Tielrooij, K-J. (2022). Ultrafast light-based logic with graphene. Nature Materials, News&Views, September 2022. https://doi.org/10.1038/s41563-022-01367-2
Vincent, L., Fadaly, E. M. T., Renard, C., Peeters, W. H. J., Vettori, M., Panciera, F., Bouchier, D., Bakkers, E. P. A. M., & Verheijen, M. A. (2022). Growth-Related Formation Mechanism of I3-Type Basal Stacking Fault in Epitaxially Grown Hexagonal Ge-2H. Advanced Materials Interfaces, 9(16), [2102340]. https://doi.org/10.1002/admi.202102340
Beens, M., Duine, R. A., & Koopmans, B. (2022). Modeling ultrafast demagnetization and spin transport: The interplay of spin-polarized electrons and thermal magnons. Physical Review B, 105(14), [144420]. https://doi.org/10.1103/PhysRevB.105.144420
Blank, T. G. H., Hermanussen, S., Lichtenberg, T., Rasing, T., Kirilyuk, A., Koopmans, B., & Kimel, A. V. (2022). Laser-Induced Transient Anisotropy and Large Amplitude Magnetization Dynamics in a Gd/FeCo Multilayer. Advanced Materials Interfaces, 9(36), [2201283]. https://doi.org/10.1002/admi.202201283
de Jong, M. C. H., Meijer, M. J., Lucassen, J., van Liempt, J., Swagten, H. J. M., Koopmans, B., & Lavrijsen, R. (2022). Local control of magnetic interface effects in chiral Ir| Co| Pt multilayers using Ga+ ion irradiation. Physical Review B, 105(6), [064429]. https://doi.org/10.1103/PhysRevB.105.064429
Grzybowski, M. J., Schippers, C. F., Bal, M. E., Rubi, K., Zeitler, U., Foltyn, M., Koopmans, B., & Swagten, H. J. M. (2022). Electrical switching of antiferromagnetic CoO | Pt across the Néel temperature. Applied Physics Letters, 120(12), [122405]. https://doi.org/10.1063/5.0090484
Li, J., van Nieuwkerk, P., Verschuuren, M. A., Koopmans, B., & Lavrijsen, R. (2022). Substrate conformal imprint fabrication process of synthetic antiferromagnetic nanoplatelets. Applied Physics Letters, 121(18), [182406]. https://doi.org/10.1063/5.0100657

Lichtenberg, T., Beens, M., Jansen, M. H., Koopmans, B., & Duine, R. A. (2022). Probing optically induced spin currents using terahertz spin waves in noncollinear magnetic bilayers. Physical Review B, 105(14), [144416]. https://doi.org/10.1103/PhysRevB.105.144416

Lichtenberg, T., van Hees, Y. L. W., Beens, M., Levels, C. J., Lavrijsen, R., Duine, R. A., & Koopmans, B. (2022). Probing laser-induced spin-current generation in synthetic ferrimagnets using spin waves. Physical Review B, 106(9), [094436]. https://doi.org/10.1103/PhysRevB.106.094436

Peeters, M. J. G., van Ballegooie, Y. M., & Koopmans, B. (2022). Influence of magnetic fields on ultrafast laser-induced switching dynamics in Co/Gd bilayers. Physical Review B, 105(1), [014429]. https://doi.org/10.1103/PhysRevB.105.014429

van Hees, Y. L. W., Koopmans, B., & Lavrijsen, R. (2022). Toward high all-optical data writing rates in synthetic ferrimagnets. Applied Physics Letters, 120(25), [252401]. https://doi.org/10.1063/5.0094540

Wang, L., Cai, W., Cao, K., Shi, K., Koopmans, B., & Zhao, W. (2022). Femtosecond laser-assisted switching in perpendicular magnetic tunnel junctions with double-interface free layer. SCIENCE CHINA Information Sciences, 65(4), [142403]. https://doi.org/10.1007/s11432-020-3244-8

Arts, K., Hamaguchi, S., Ito, T., Karahashi, K., Knoops, H., Mackus, A., & Kessels, W. M. M. (2022). Foundations of atomic-level plasma processing in nanoelectronics. Plasma Sources Science and Technology, 31(10), [103002]. https://doi.org/10.1088/1361-6595/ac95bc

Beladiya, V., Faraz, T., Schmitt, P., Munser, A-S., Schröder, S., Riese, S., Mühlig, C., Schachtler, D., Steger, F., Botha, R., Otto, F., Fritz, T., van Helvoirt, C., Kessels, W. M. M., Gargouri, H., & Szeghalmi, A. (2022). Plasma-Enhanced Atomic Layer Deposition of HfO2 with Substrate Biasing: Thin Films for High-Reflective Mirrors. ACS Applied Materials & Interfaces, 14(12), 14677-14692. https://doi.org/10.1021/acsami.1c21889

Berghuis, W-J. H., Helmes, M., Melskens, J., Theeuwes, R. J., Kessels, W. M. M., & Macco, B. (2022). Extracting surface recombination parameters of germanium-dielectric interfaces by corona-lifetime experiments. Journal of Applied Physics, 131(19), [195301]. https://doi.org/10.1063/5.0091759

Bochicchio, E. A., Kolpakov, I., Korzun, K., Koolen, P. A. L. M., van Gorkom, B., Berghuis, W. J. H., Veldhoven, R., & Haverkort, J. E. M. (2022). Towards ultimate limit InP nanowire solar cells. In A. Freundlich, S. Collin, & K. Hinzer (Eds.), Physics, Simulation, and Photonic Engineering of Photovoltaic Devices XI [119960D] (Proceedings of SPIE; Vol. 11996). SPIE. https://doi.org/10.1117/12.2608084

Gerritsen, S. H., Chittock, N. J., Vandalon, V., Verheijen, M. A., Knoops, H. C. M., Kessels, W. M. M., & Mackus, A. J. M. (2022). Surface Smoothing by Atomic Layer Deposition and Etching for the Fabrication of Nanodevices. ACS Applied Nano Materials, 5(12), 18116-18126. https://doi.org/10.1021/acsanm.2c04025

Jung, J., Schellingerhout, S. G., Ritter, M. F., ten Kate, S. C., van der Molen, O. A. H., de Loijer, S., Verheijen, M. A., Riel, H., Nichele, F., & Bakkers, E. P. A. M. (2022). Selective Area Growth of PbTe Nanowire Networks on InP. Advanced Functional Materials, 32(51), [2208974]. https://doi.org/10.1002/adfm.202208974

Kolpakov, I., Bochicchio, E. A., Korzun, K., Koolen, P. A. L. M., van Gorkom, B., Berghuis, W. J. H., Veldhoven, R., & Haverkort, J. E. M. (2022). Extremely low material consumption III/V solar cell. In A. Freundlich, S. Collin, & K. Hinzer (Eds.), Physics, Simulation, and Photonic Engineering of Photovoltaic Devices XI [1199607] (Proceedings of SPIE; Vol. 11996). SPIE. https://doi.org/10.1117/12.2608529

Li, P., van der Jagt, J. W., Beens, M., Hintermayr, J., Verheijen, M. A., Bruikman, R., Barcones Campo, B., Juge, R., Lavrijsen, R., Ravelosona, D., & Koopmans, B. (2022). Enhancing All-Optical Switching of Magnetization by He Ion Irradiation. Applied Physics Letters, 121(17), [172404]. https://doi.org/10.1063/5.0111466

Li, J., Tezsevin, I., Merkx, M. J. M., Maas, J. F. W., Kessels, W. M. M., Sandoval, T. E., & Mackus, A. J. M. (2022). Packing of inhibitor molecules during area-selective atomic layer deposition studied using random sequential adsorption simulations. Journal of Vacuum Science and Technology A: Vacuum, Surfaces, and Films, 40(6), [062409]. https://doi.org/10.1116/6.0002096

Macco, B., van de Poll, M., van de Loo, B. W. H., Broekema, T. M. P., Basuvalingam, S. B., van Helvoirt, C. A. A., Berghuis, W-J. H., Theeuwes, R. J., Phung, N., & Kessels, W. M. M. (2022). Temporal and spatial atomic layer deposition of Al-doped zinc oxide as a passivating conductive contact for silicon solar cells. Solar Energy Materials and Solar Cells, 245, 1122-1125. [111869]. https://doi.org/10.1016/j.solmat.2022.111869

Macco, B. (2022). Spatial ALD in beeld. Nevac Blad, 60(2), 18-20.

Macco, B., & Kessels, W. M. M. (2022). Atomic layer deposition of conductive and semiconductive oxides. Applied Physics Reviews, 9(4), [041313]. https://doi.org/10.1063/5.0116732

Mahlouji, R., Verheijen, M. A., Zhang, Y., Hofmann, J. P., Kessels, W. M. M., & Bol, A. A. (2022). Thickness and Morphology Dependent Electrical Properties of ALD-Synthesized MoS2 FETs. Advanced Electronic Materials, 8(3), [2100781]. https://doi.org/10.1002/aelm.202100781

Mattinen, M., Gitty, F., Coleman, E., Vonk, J., Verheijen, M. A., Duffy, R., Kessels, W. M. M., & Bol, A. A. (2022). Atomic Layer Deposition of Large-Area Polycrystalline Transition Metal Dichalcogenides from 100 °C through Control of Plasma Chemistry. Chemistry of Materials, 34(16), 7280-7292. https://doi.org/10.1021/acs.chemmater.2c01154

Merkx, M. J. M., Angelidis, A., Mameli, A., Li, J., Lemaire, P. C., Sharma, K., Hausmann, D. M., Kessels, W. M. M., Sandoval, T. E., & Mackus, A. J. M. (2022). Relation between Reactive Surface Sites and Precursor Choice for Area-Selective Atomic

Layer Deposition Using Small Molecule Inhibitors. Journal of Physical Chemistry C, 126(10), 4845-4853. https://doi.org/10.1021/acs.jpcc.1c10816

Mione, M. A., Vandalon, V., Kessels, W. M. M., & Roozeboom, F. (2022). Temperature study of atmospheric-pressure plasma-enhanced spatial ALD of Al2O3 using infrared and optical emission spectroscopy. Journal of Vacuum Science and Technology A: Vacuum, Surfaces, and Films, 40(6), [062407]. https://doi.org/10.1116/6.0002158

Phung, N., van Helvoirt, C. A. A., Beyer, W., Anker, J., Naber, R. C. G., Renes, M., Kessels, W. M. M., Geerligs, L. J., Creatore, M., & Macco, B. (2022). Effective Hydrogenation of Poly-Si Passivating Contacts by Atomic-Layer-Deposited Nickel Oxide. IEEE Journal of Photovoltaics, 12(6), 1377-1385. https://doi.org/10.1109/JPHOTOV.2022.3206895

Schellingerhout, S. G., De Jong, E. J., Gomanko, M., Guan, X., Jiang, Y., Hoskam, M. S. M., Jung, J., Koelling, S., Moutanabbir, O., Verheijen, M. A., Frolov, S. M., & Bakkers, E. P. A. M. (2022). Growth of PbTe nanowires by molecular beam epitaxy. Materials for Quantum Technology, 2(1), [015001]. https://doi.org/10.1088/2633-4356/ac4fba

Schulpen, J. J. P. M., Verheijen, M. A., Kessels, W. M. M., Vandalon, V., & Bol, A. A. (2022). Controlling transition metal atomic ordering in two-dimensional Mo1- xW xS2alloys. 2D Materials, 9(2), [025016]. https://doi.org/10.1088/2053-1583/ac54ef

Theeuwes, R. J., Melskens, J., Beyer, W., Breuer, U., Black, L. E., Berghuis, W. J. H., Macco, B., & Kessels, W. M. M. (2022). POx/Al2O3 stacks for surface passivation of Si and InP. Solar Energy Materials and Solar Cells, 246, [111911]. https://doi.org/10.1016/j.solmat.2022.111911

Vandalon, V., Mackus, A. J. M., & Kessels, W. M. M. (2022). Surface chemistry during Atomic Layer Deposition of Pt studied with vibrational sum-frequency generation. Journal of Physical Chemistry C, 126(5), 2463-2474. https://doi.org/10.1021/acs.jpcc.1c06947

van Kasteren, J. G. A., Basuvalingam, S. B., Mattinen, M., Bracesco, A. E. A., Kessels, W. M. M., Bol, A. A., & Macco, B. (2022). Growth Mechanism and Film Properties of Atomic-Layer-Deposited Titanium Oxysulfide. Chemistry of Materials, 34(17), 7750-7760. https://doi.org/10.1021/acs.chemmater.2c01033

Verdelli, F., Schulpen, J. J. P. M., Baldi, A., & Rivas, J. G. (2022). Chasing Vibro-Polariton Fingerprints in Infrared and Raman Spectra Using Surface Lattice Resonances on Extended Metasurfaces. Journal of Physical Chemistry C, 126(16), 7143-7151. https://doi.org/10.1021/acs.jpcc.2c00779

Vincent, L., Fadaly, E. M. T., Renard, C., Peeters, W. H. J., Vettori, M., Panciera, F., Bouchier, D., Bakkers, E. P. A. M., & Verheijen, M. A. (2022). Growth-Related Formation Mechanism of I3-Type Basal Stacking Fault in Epitaxially Grown Hexagonal Ge-2H. Advanced Materials Interfaces, 9(16), [2102340]. https://doi.org/10.1002/admi.202102340

Yang, G., van de Loo, B., Stodolny, M., Limodio, G., Melskens, J., Macco, B., Bronsveld, P., Isabella, O., Weeber, A., Zeman, M., & Kessels, W. M. M. (2022). Passivation Enhancement of Poly-Si Carrier-Selective Contacts by Applying ALD Al_2O_3 Capping Layers. IEEE Journal of Photovoltaics, 12(1), 259-266. https://doi.org/10.1109/JPHOTOV.2021.3119595

Yu, Q., Lemmen, E., Vermulst, B., Mackus, A. J. M., Kessels, W. M. M., & Wijnands, K. (2022). Equivalent electric circuit model of accurate ion energy control with tailored waveform biasing. Plasma Sources Science and Technology, 31(3), [035012]. https://doi.org/10.1088/1361-6595/ac4c27

Alzeidan, A., Cantalice, T. F., Vallejo, K. D., Gajjela, R. S. R., Hendriks, A. L., Simmonds, P. J., Koenraad, P. M., & Quivy, A. A. (2022). Effect of As flux on InAs submonolayer quantum dot formation for infrared photodetectors. Sensors and Actuators A: Physical, 334, [113357]. https://doi.org/10.1016/j.sna.2021.113357

Bai, P., Abdelkhalik, M. S., Castanheira, D. G. A., & Gómez Rivas, J. (2022). Evolutionary optimization of the short-circuit current enhancement in organic solar cells by nanostructured electrodes. Journal of Applied Physics, 132(15), [153103]. https://doi.org/10.1063/5.0097964

Berghuis, A. M., Tichauer, R. H., de Jong, L. M. A., Sokolovskii, I., Bai, P., Ramezani, M., Murai, S., Groenhof, G., & Gómez Rivas, J. (2022). Controlling Exciton Propagation in Organic Crystals through Strong Coupling to Plasmonic Nanoparticle Arrays. ACS Photonics, 9(7), 2263-2272. https://doi.org/10.1021/acsphotonics.2c00007

Gajjela, R. S. R., Sala, E. M., Heffernan, J., & Koenraad, P. M. (2022). Control of Morphology and Substrate Etching in InAs/InP Droplet Epitaxy Quantum Dots for Single and Entangled Photon Emitters. ACS Applied Nano Materials, 5(6), 8070-8079. https://doi.org/10.1021/acsanm.2c01197

Gajjela, R., Alzeidan, A., Curbelo, V. M. O., Quivy, A. A., & Koenraad, P. M. (2022). Atomic-scale characterization of single and double layers of InAs and InAlAs Stranski-Krastanov quantum dots. Physical Review Materials, 6(11), [114604]. https://doi.org/10.1103/PhysRevMaterials.6.114604

Murai, S., Abujetas, D. R., Liu, L., Castellanos, G. W., Giannini, V., Sánchez-Gil, J. A., Tanaka, K., & Gómez Rivas, J. (2022). Engineering Bound States in the Continuum at Telecom Wavelengths with Non-Bravais Lattices. Laser and Photonics Reviews, 16(11), [2100661]. https://doi.org/10.1002/lpor.202100661

Nugroho, F. A. A., Bai, P., Darmadi, I., Castellanos, G. W., Fritzsche, J., Langhammer, C., Gómez Rivas, J., & Baldi, A. (2022). Inverse designed plasmonic metasurface with parts per billion optical hydrogen detection. Nature Communications, 13, [5737]. https://doi.org/10.1038/s41467-022-33466-8

ter Huurne, S. E. T., Rodrigues Da Cruz, A., van Hoof, N., Godiksen, R. H., Elrafei, S. A., Curto, A. G., Flatté, M. E., & Gómez Rivas, J. (2022). High-Frequency Sheet Conductance of Nanolayered WS2Crystals for Two-Dimensional Nanodevices. ACS Applied Nano Materials, 5(10), 15557-15562. https://doi.org/10.1021/acsanm.2c03517

van Heijst, E. A. P., ter Huurne, S., Sol, J. A. H. P., Castellanos Gonzalez, G., Ramezani, M., Murai, S., Debije, M. G., & Gómez Rivas, J. (2022). Electric tuning and switching of the resonant response of nanoparticle arrays with liquid crystals. Journal of Applied Physics, 131(8), [083101]. https://doi.org/10.1063/5.0079016
Verdelli, F., Schulpen, J. J. P. M., Baldi, A., & Rivas, J. G. (2022). Chasing Vibro-Polariton Fingerprints in Infrared and Raman Spectra Using Surface Lattice Resonances on Extended Metasurfaces. Journal of Physical Chemistry C, 126(16), 7143-7151. https://doi.org/10.1021/acs.jpcc.2c00779

Conference publications

As most contributed conference publications are not uploaded by the physics groups in the TU/e database, the list gives only partial information on the publications in conferences.

Publication
Bochicchio, E. A., Kolpakov, I., Korzun, K., Koolen, P. A. L. M., van Gorkom, B., Berghuis, W. J. H., Veldhoven, R., & Haverkort, J. E. M. (2022). Towards ultimate limit InP nanowire solar cells. In A. Freundlich, S. Collin, & K. Hinzer (Eds.), Physics, Simulation, and Photonic Engineering of Photovoltaic Devices XI [119960D] (Proceedings of SPIE; Vol. 11996). SPIE. https://doi.org/10.1117/12.2608084
Kolpakov, I., Bochicchio, E. A., Korzun, K., Koolen, P. A. L. M., van Gorkom, B., Berghuis, W. J. H., Veldhoven, R., & Haverkort, J. E. M. (2022). Extremely low material consumption III/V solar cell. In A. Freundlich, S. Collin, & K. Hinzer (Eds.), Physics, Simulation, and Photonic Engineering of Photovoltaic Devices XI [1199607] (Proceedings of SPIE; Vol. 11996). SPIE. https://doi.org/10.1117/12.2608529
Korzun, K., Koolen, P. A. L. M., Kolpakov, I., Bochicchio, E. A., Gómez Rivas, J., & Haverkort, J. E. M. (2022). Thermodynamics of a nanowire solar cell: Towards the ultimate limit. In A. N. Sprafke, J. C. Goldschmidt, & L. Mazzarella (Eds.), Photonics for Solar Energy Systems IX [1215005] (Proceedings of SPIE ; Vol. 12150). SPIE. https://doi.org/10.1117/12.2621372
Korzun, K., Koolen, P. A. L. M., Kolpakov, I., Bochicchio, E. A., Gómez Rivas, J., & Haverkort, J. E. M. (2022). Thermodynamics of a nanowire solar cell towards the radiative limit. In A. Freundlich, S. Collin, & K. Hinzer (Eds.), Physics, Simulation, and Photonic Engineering of Photovoltaic Devices XI [1199609] (Proceedings of SPIE ; Vol. 11996). SPIE. https://doi.org/10.1117/12.2608671
Wang, L., Cheng, H., Li, P., van Hees, Y. L. W., Liu, Y., Cao, K., Lavrijsen, R., Lin, X., Koopmans, B., & Zhao, W. S. (2022). Picosecond optospintronic tunnel junctions. Proceedings of the National Academy of Sciences of the United States of America (PNAS), 119(24), [e2204732119]. https://doi.org/10.1073/pnas.2204732119
Melskens, J., Theeuwes, R. J., Beyer, W., Steltenpool, M., Kessels, W. M. M., Weeber, A. W., & Mewe, A. (2022). Impact of Al2O3 ALD growth and properties on passivation quality of p-polySi/Al2O3 stacks. Poster session presented at 12th International Conference on Crystalline Silicon Photvoltaics 2022, Konstanz, Germany.
Korzun, K., Koolen, P. A. L. M., Kolpakov, I., Bochicchio, E. A., Gómez Rivas, J., & Haverkort, J. E. M. (2022). Thermodynamics of a nanowire solar cell: Towards the ultimate limit. In A. N. Sprafke, J. C. Goldschmidt, & L. Mazzarella (Eds.), Photonics for Solar Energy Systems IX [1215005] (Proceedings of SPIE ; Vol. 12150). SPIE. https://doi.org/10.1117/12.2621372
Korzun, K., Koolen, P. A. L. M., Kolpakov, I., Bochicchio, E. A., Gómez Rivas, J., & Haverkort, J. E. M. (2022). Thermodynamics of a nanowire solar cell towards the radiative limit. In A. Freundlich, S. Collin, & K. Hinzer (Eds.), Physics, Simulation, and Photonic Engineering of Photovoltaic Devices XI [1199609] (Proceedings of SPIE ; Vol. 11996). SPIE. https://doi.org/10.1117/12.2608671
Ter Huurne, S., Abujetas, D. R., Van Hoof, N., Sánchez-Gil, J. A., & Rivas, J. G. (2022). Electromagnetic field confinement by bound states in the continuum. In 2022 47th International Conference on Infrared, Millimeter and Terahertz Waves (IRMMW-THz) [9895585] Institute of Electrical and Electronics Engineers. https://doi.org/10.1109/IRMMW-THz50927.2022.9895585

REFERENCES

[BAH22] A. Bahari, M. Spiegelberg, D.R.D. Van Luijk, R.P. Sijbesma, O. Raz, “Optically Programmable Microring Resonator Filter”, Proc. Of the IEEE photonics society Benelux chapter meeting Nov. 2022

[BRA22] T. Bradley, et al, "Off-axis digital holography for analysis of fibre tapping of few mode fibres," in Optica Advanced Photonics Congress 2022, Technical Digest Series (Optica, 2022), paper NeTh2C.3.

[CAL08] Guido Callierotti, Andrea Bianco, Chiara Castiglioni, Chiara Bertarelli and Giuseppe Zerbi, “Modulation of the Refractive Index by Photoisomerization of Diarylethenes: Theoretical Modeling“, J. Phys. Chem. A 2008, 112, 32, 7473–7480

[DEM22] F.E. Demirer, Y. Baron, S. Reniers, D. Pustakhod, R. Lavrijsen, B. Koopmans, J. van der Tol *Integrated photonic devices for on-chip, magneto-optical memory reading*, Nanophotonics 11, 3319 (2022).

[FAD20] E.M.T. Fadaly, A. Dijkstra, J. R. Suckert, D. Ziss, M. A. J. Van Tilburg, C. Mao, Y. Ren, V. T. Van Lange, K. Korzun, S. Kölling, M. A. Verheijen, D. Busse, C. Rödl, J. Furthmüller, F. Bechstedt, J. Stangl, J. J. Finley, S. Botti, J. E. M. Haverkort, and E. P. A. M. Bakkers, “Direct-bandgap emission from hexagonal Ge and SiGe alloys,” Nature 580 (2020)

[HAU15] Hauge, H. I. T. et al. (2015). Hexagonal Silicon Realized. Nano Lett. 15, 5855–5860.

[HAU17] Hauge, I. T., et al. (2017). Single-Crystalline Hexagonal Silicon − Germanium. Nano Lett 17, 85–90.

[HOU22] M. van den Hout, et al, "Alignment of Free-Space Coupling of Few-Mode Fibre to Multi-Mode Fibre using Digital Holography," in European Conference on Optical Communication (ECOC) 2022, J. Leuthold, C. Harder, B. Offrein, and H. Limberger, eds., Technical Digest Series (Optica, 2022), paper We5.5.

[IYE93] S. S. Iyer and Y.-H. Xie. (1993). Light Emission from Silicon. Science. 260, 40–46.

[JON22] Mark C.H. de Jong, B.H.M. Smit, M.J. Meijer, J. Lucassen, H.J.M. Swagten, B. Koopmans, and R. Lavrijsen, Controlling Magnetic Skyrmion Nucleation With Ga^+ Ion Irradiation, *submitted to Physical Review B.*

[KOO22]: Kools, T. J., van Gurp, M. C., Koopmans, B., & Lavrijsen, R. (2022). Magnetostatics of room temperature compensated Co/Gd/Co/Gd-based synthetic ferrimagnets. Applied Physics Letters, 121(24), 242405. doi:10.1063/5.0127694

[LEI22] Lei, Y., Yan, X., Li, C., Bente, E., Yao, W., Cao, Z., & Koonen, T. (2022). Monolithic integrated two-stage cascaded SOA-PIN receiver for high-speed optical wireless communication. Optics Letters, 47(10), 2578-2581.

[Li22]: Li, P., Kools, T. J., Koopmans, B., & Lavrijsen, R. (2023). Ultrafast Racetrack Based on Compensated Co/Gd-Based Synthetic Ferrimagnet with All-Optical Switching. Advanced Electronic Materials, 9(1), 2200613. doi:10.1002/aelm.202200613

[PEZ22a] H. Pezeshki, P. Li, R. Lavrijsen, J. J. G. M. Van Der Tol, and B. Koopmans, Optical reading of nanoscale magnetic bits in an integrated photonic platform, IEEE J. Quantum Electron., 1 (2022).

[PEZ22b] H. Pezeshki, P. Li, R. Lavrijsen, M. Heck, E. Bente, J. van der Tol, and B. Koopmans, Design of an integrated hybrid plasmonic-photonic device for all-optical switching and reading of spintronic memory, Physical Review Applied 19, 054036 (2023)

[PIC23] L. Picelli, P.J. van Veldhoven, E. Verhagen and A. Fiore, " Hybrid electronic-photonic sensors on a fiber tip", Nature Nanotechnology, in press

[ROD19] Rödl, C. et al. Accurate electronic and optical properties of hexagonal germanium for optoelectronic applications. (2019). Phys.Rev.Materials 3, 034602.

[SCH22] Schulpen, J. J. P., Verheijen, M. A., Kessels, W. M. M., Vandalon, V. & Bol, A. A. Controlling transition metal atomic ordering in two-dimensional Mo1-xWxS2 alloys. *2D Mater.* (2022) doi:10.1088/2053-1583/ac54ef

[SHI1] Shi, Bin, Nicola Calabretta, and Ripalta Stabile. "Emulation and modelling of semiconductor optical amplifier-based all-optical photonic integrated deep neural network with arbitrary depth." Neuromorphic Computing and Engineering 2.3 (2022): 034010

[SHI2] Shi, Bin, Nicola Calabretta, and Ripalta Stabile. "Parallel Photonic Convolutional Processing On-chip with Cross-connect Architecture and Cyclic AWGs." IEEE Journal of Selected Topics in Quantum Electronics 29.2: Optical Computing (2022): 1-10.

[VLI22] V. van Vliet, et al "Turbulence Characterisation for Free Space Optical Communication Using Off-Axis Digital Holography," in Optica Advanced Photonics Congress 2022, Technical Digest Series (Optica, 2022), paper SpTu3G.1.

[WAN22] Luding Wang, Houyi Cheng, Pingzhi Li, Youri L. W. van Hees, Yang Liu, Kaihua Cao, Reinoud Lavrijsen, Xiaoyang Lin, Bert Koopmans, and Weisheng Zhao, "Picosecond optospintronic tunnel junctions," *Proc. Nat. Acad. Sci. USA*, vol. 119, no. 24, Art. no. e2204732119, Jun. 2022.