Q 2: Nanophotonics and Integrated Photonics I

Time: Monday 11:45–13:00 Location: P 3

Q 2.1 Mon 11:45 P 3

Adaptive Molecular Systems in Coherent Nanophotonic Neural Networks — •Peter Lazarowicz[1,2,3], Ole Körner[1,2,3], Robin Conrad[1,2,3], and Carsten Schuck[1,2,3] — [1]University Of Münster, Schlossplatz 2, 48149 Münster — [2]CeNTech, Heisenbergstraße 11, 48149 Münster — [3]Center for Soft Nanoscience, Busso-Peus-Straße 10, 48149 Münster

Neuromorphic computing is a field that has seen both rapid popularisation and development in recent years, with nanophotonic neural networks showing promise in bypassing the Von Neumann bottleneck and vastly improving computational efficiency.

We investigate adaptive molecular systems as a basis for optical neural network architectures, exploiting photoisomerisation and saturable absorption mechanisms to induce the nonlinear responses that are necessary for deep learning approaches. We demonstrate integration of azobenzene photoswitches and doped phthalocyanine complexes in photonic circuits enabling fast, parallelisable photonic processing.

Q 2.2 Mon 12:00 P 3

Fabrication of LNOI Nanostructures For High Quality Quantum PICs — •Georgii Grechko[1], Tobias Feuerbach[1], Junyu Guan[1,2], Roman Kolesov[1], and Joerg Wrachtrup[1,3] — [1]3rd Institute of Physics, University of Stuttgart, Stuttgart, Germany — [2]University of Science and Technology of China, Hefei 230026, PR.China — [3]MPI for Solid State Research, Stuttgart, Germany

Lithium Niobate on Insulator (LNOI) is well established wafer-scale nanophotonic platform. Owning a unique set of properties, the material exhibits electro-optical tunability and second-order optical nonlinearity. Overall LNOI is a strong contender in the race for becoming the main platform for large-scale quantum nanophotonics, on par with silicon-on-insulator and silicon nitride. This research further enriches the technological toolkit for LNOI platform by introducing a novel nanofabrication framework based on metal hard-mask formation via lift-off and CF4 based RIE-ICP dry etching. We addressed and eliminated the key drawbacks of CF4 plasma etching that originally motivated the shift toward alternative etching methods. Key process advantages include a mask-edge smoothing effect resulting in exceptionally smooth sidewalls of fabricated structures, etch rates exceeding 60 nm/min with selectivity of 7-10 over hard mask Showcasing our fabrication approach, we demonstrate high-Q photonic crystal and Fabry-Perot cavities, manufactured using the reported method, featuring native second-harmonic generation (SHG). At submission, the highest Q-factor reached 500,000; higher values may be achieved by the time of presentation.

Q 2.3 Mon 12:15 P 3

Integrated photonics for quantum communications on a CubeSat — •Jonas Pudelko[1,2], Ömer Bayraktar[1,2], Luca Vill[1,2], Mathias Kühn[1,2], Joost Vermeer[1,2], Winfried Boxleitner[3], Stefan Petscharnig[3], Christoph Pacher[3], Gerd Leuchs[1,2], and Christoph Marquardt[1,2] — [1]Max Planck Institute for the Science of Light, Erlangen — [2]Chair of Optical Quantum Technologies, Friedrich-Alexander-Universität Erlangen-Nürnberg, Staudtstr. 7 / A3, Erlangen — [3]AIT Austrian Institute of Technology GmbH, Center for Digital Safety & Security, Vienna, Austria

Satellite based quantum key distribution enables worldwide secure communication with distinct advantages over fiber links. The profitability of commercial systems highly depends on the size, weight and power demands of the required payloads.

Our CubeSat payload demonstrates a source for weak modulated coherent states as well as a quantum random number generator based on homodyne measurements of the quantum mechanical vacuum state on a single 10 cm x 10 cm PCB with a power consumption of 4 W. The high level of integration is enabled by two Indium-Phosphide photonic integrated circuits and custom designed electronic driving circuits.

The payload was launched in 2024 as part of the QUBE mission. Here, we will present our in-orbit characterization measurements and the findings from the ongoing optical downlink campaign.

Q 2.4 Mon 12:30 P 3

Characterisation of a photonic integrated circuit-based QKD transmitter — •Joost Vermeer[1,2], Ömer Bayraktar[1,2], Jonas Pudelko[1,2], Kevin Günthner[1,2], and Christoph Marquardt[1,2] — [1]Chair of Optical Quantum Technologies, Friedrich-Alexander-Universität Erlangen-Nürnberg, Staudtstr. 7 / A3, Erlangen — [2]Max Planck Institute for the Science of Light (MPL), Staudtstr. 2, Erlangen

Quantum key distribution (QKD) offers a new way to provide secure communication. Miniaturising the required optical components allows us to implement it in many more situations, including satellites. This would allow us to overcome the range limitation of fiber-based systems and lead to worldwide secure communication.

One method of miniaturising optical systems is using photonic integrated circuits (PIC), where many optical components are integrated on a single chip. We have designed a 4×8 mm^2 indium-phosphide PIC, which can act as a transmitter for phase-based BB-84 QKD. It consists of a pulsed laser, an IQ modulator to turn each laser pulse into a pair of pulses with a phase difference determined by a quantum random number generator, and an intensity modulator containing multiple semiconductor optical amplifiers to set the required output intensity.

Integrating all of these components close together can increase the strength of unwanted interactions between them. Using both external measurement devices and detectors integrated in the PIC, we characterise the PIC to investigate how strong these effects are.

Q 2.5 Mon 12:45 P 3

Photoluminescence excitation spectroscopy of color-centers in diamond waveguides integrated in AlGaN/AlN nanophotonic circuits — •Grigory Kornilov[1], Alok Gokhale[1], Lea Rektorschek[1], Domenica Bermeo[1,2], Marco Stucki[1,2], Francesco Intravaia[1], Kurt Busch[1], Sinan Gündoğdu[1,2], Tommaso Pregnolato[1,2], and Tim Schröder[1,2] — [1]Department of Physics, Humboldt-Universität zu Berlin, Berlin, Germany — [2]Ferdinand-Braun-Institut (FBH), Berlin, Germany

Hybrid photonic integrated circuits (PICs) with embedded solid-state quantum emitters enable compact and scalable quantum devices. We have recently proposed a novel platform for integrated photonics based on AlGaN grown on AlN on sapphire. By incorporating air gaps in the structure of the circuits, diamond nanophotonic devices can subsequently be suspended across them, creating hetero-integrated waveguides which enable efficient in- and out-coupling of light. Manufacturing the nanophotonic circuits in a "racetrack" geometry allows transmission experiments to be performed in a single confocal setup. Using this approach, the coupling efficiency of diamond waveguides to the underlying AlGaN/AlN structures is investigated. In addition, photoluminescence excitation measurements are conducted to study the optical properties of individual nitrogen-vacancy centers embedded in the diamond.