HL 34: Quantum Dots and Wires: Telecom Wavelength

Time: Wednesday 16:30–17:45 Location: POT/0051

HL 34.1 Wed 16:30 POT/0051

All-photonic quantum teleportation at telecom wavelength with frequency converted photons from remote quantum dots — •Tim Strobel[1], Michal Vyvlecka[1], Ilenia Neureuther[1], Tobias Bauer[2], Marlon Schäfer[2], Stefan Kazmaier[1], Nand Lal Sharma[3], Raphael Joos[1], Jonas H. Weber[1], Cornelius Nawrath[1], Weijie Nie[3], Ghata Bhayani[3], Caspar Hopfmann[3], Christoph Becher[2], Peter Michler[1], and Simone Luca Portalupi[1] — [1]Institut für Halbleiteroptik und Funktionelle Grenzflächen, Center for Integrated Quantum Science and Technology (IQ^{ST}) and SCoPE, University of Stuttgart, Stuttgart, Germany — [2]Fachrichtung Physik, Universität des Saarlandes, Saarbrücken, Germany — [3]Institute for Integrative Nanosciences, Leibniz IFW Dresden, Dresden, Germany

A future terrestrial quantum internet relies on distant quantum network nodes connected via optical fiber channels. In this context, semiconductor quantum dots (QDs) are promising sources of quantum light. Here, we report on an all-photonic quantum teleportation experiment with photons from remote QDs emitting at ca. 780 nm. The polarization state of a single photon emitted by one QD is prepared and interfaced with one photon of an entangled pair from a second QD in a Bell state measurement. This process teleports the polarization state onto the second photon of the entangled pair. Polarization-preserving quantum frequency converters eliminate the frequency mismatch between photons, allowing for interference at telecom wavelengths. Teleportation succeeds with post-selected fidelities up to 0.721(33).

HL 34.2 Wed 16:45 POT/0051

Telecom C-band Quantum Dots Coupled to Gaussian-shaped Microlens Cavities — •Michelle Pfahl[1], Raphael Joos[1], Lena Engel[1], Johannes Michl[2], Katharina Dahler[1], Ponraj Vijayan[1], Tobias Huber-Loyola[2], Michael Jetter[1], Simone L. Portalupi[1], Sven Höfling[2], and Peter Michler[1] — [1]Institut für Halbleiteroptik und Funktionelle Grenzflächen (IHFG), Center for Integrated Quantum Science and Technology (IQST) and SCoPE, University of Stuttgart, Allmandring 3, 70569 Stuttgart — [2]Julius-Maximilians-Universität Würzburg, Physikalisches Institut, Lehrstuhl für Technische Physik, Am Hubland, 97074 Würzburg

Single-photon sources emitting in the telecom C-band are a key resource for applications in quantum communication and quantum cryptography, as they enable long-distance quantum networks. Semiconductor quantum dots (QDs) are particularly well suited for this since they have a high quality optical emission and can achieve high efficiency when coupled to microcavities. Here, we investigate telecom C-band InAs QDs, which are embedded in a resonator made of distributed Bragg reflectors (DBRs), with the upper dielectric DBR being shaped into Gaussian lenses using an etching process. This structure promises Purcell enhancement, which reduces the decay time of the QDs and enables efficient collection of the emitted photons. We investigate the optical modes of the resonators by an in-depth characterization of microlenses with different design parameters. Furthermore, the quantum-optical properties of the QDs coupled to cavities are analyzed by means of autocorrelation and decay time measurements.

HL 34.3 Wed 17:00 POT/0051

InGaAs/GaAs preparation at 1.55 micrometer telecom wavelengths — •Juwana Jose, André Strittmatter, Armin Dadgar, Jürgen Bläsing, and Usha Velpuri — Otto von guericke university, Magdeburg, Germany

Quantum key distribution is a secure way of generating and sharing encryption keys using photons. Single photons as qubits for key generation is an efficient method of secure data transmission. It guarantees absolute eavesdropping detection since it is impossible to copy a quantum state. Qubit transmission at telecom wavelengths of 1.55 micrometer using InGaAs quantum dots on GaAs substrates is a challenge. We explore the conventional Stranski-Krastanow growth mode to shift the wavelengths far beyond the spectral 1.3-1.4 *m region. Photoluminescence experiments on high-density QD ensembles show remarkable intensities in a wavelength range of 1.5-1.6 micrometer at room-temperature. This luminescence shifts by xx nm into the blue upon cooling down to 15 K. By tailoring the thickness of the initial InGaAs deposition to the 2D/3D transition region low QD densities of 108 cm-2 and below are achieved. Single photon emission experiments will be conducted after preparation of individual QD emitters.

HL 34.4 Wed 17:15 POT/0051

Integration of telecom C-band quantum dot-based single-photon emitters onto silicon photonic platform using micro-transfer printing — •Simon Oberle[1], Ponraj Vijayan[1], Alessandro Buzzi[2], Hugo Larocque[2], Michael Jetter[1], Simone Luca Portalupi[1], and Peter Michler[1] — [1]Institut für Halbleiteroptik und Funktionelle Grenzflächen (IHFG), University of Stuttgart — [2]Research Laboratory of Electronics (RLE), Massachusetts Institute of Technology

Silicon photonics for telecommunications applications has garnered much attention recently. The optical transparency and the large refractive index contrast of silicon at telecommunication wavelengths allow the implementation of high-density photonic integrated circuits. One disadvantage of silicon photonics is the lack of mature deterministic light sources. One potential solution is the integration of III-V material, which offers outstanding optical emission properties, on a silicon platform. The direct growth of III-V materials on silicon the most scalable and therefore desired approach. However, it is challenging because of the material polarity difference and the lattice mismatch between GaAs and silicon. An alternative approach is the hybrid integration of III-V structures using micro-transfer printing, which enables integration of prefabricated devices onto silicon. Our group has previously developed telecom C-band emitting InAs quantum dots grown on InGaAs. Here, we report our approach to designing and fabricating structures for the hybrid integration of these QDs onto a silicon platform using micro-transfer printing.

HL 34.5 Wed 17:30 POT/0051

Automated optical imaging for telecom Quantum Dot deterministic fabrication — •Eden Arbel[1], Lukas Wagner[1], Peter Gierss[1,2], Ponraj Vijayan[1], Michal Vyvlecka[1], Michael Jetter[1], Simone L. Portalupi[1], and Peter Michler[1] — [1]Institut für Halbleiteroptik und Funktionelle Grenzflächen, Center for Integrated Quantum Science and Technology (IQ^{ST}) and SCoPE, University of Stuttgart, Allmandring 3, 70569 Stuttgart, Germany — [2]Physikalisch Technische Bundesanstalt, Bundesallee 100, 38116 Braunschweig

Semiconductor quantum dots (QDs) are promising sources of single- and entangled-photon pairs. Due to its low absorption in silica fibers, operation in the telecom C-band (1530-1565nm) is desired. Integrating these QDs into Circular Bragg Grating cavities (CBGs) enhances extraction efficiency and enables Purcell enhancement. Our method employs wide-field imaging for deterministic preselection of QDs for subsequent CBG fabrication. The QD positions are referenced using e-beam-written markers. Smart preselection of suitable candidates, embedded in an automated setup, promises higher yield and efficiency, with the potential for AI integration. We demonstrate that deterministically processed CBGs exhibit significant improvements in brightness and enhance the decay time of the two-level state. With higher throughput and continually improving quality of telecom QD samples, this approach will enable to provide single-photon sources tailored to specific needs of various applications, such as quantum memories or long-distance quantum communication.