Deterministically fabricated semiconductor quantum dot-based single-photon source for on-chip and telecom applications

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Optically triggered self-assembled semiconductor quantum dots (QDs) are quasi-zero-dimensional structures that generate non-classical photon states nearly on demand. These photons, or flying qubits, are crucial for quantum photonics devices that have the potential to transform information processing and enable advancements in quantum-secured communication and computation. This presentation outlines a method for fabricating single quantum dot (QD) photon sources using a scalable and deterministic approach. The source emits photons at approximately 1550 nm, making it suitable for application in silica optical fiber networks. The device leverages the Purcell effect, necessitating precise placement of QDs in relation to a microcavity's optical mode. This arrangement enhances photon extraction efficiency, increases spontaneous emission, and improves quantum statistics. The fabrication process combines far-field optical imaging of QD emissions in the near-infrared with electron beam lithography for cavity production, resulting in a relatively high yield of devices. By employing a deterministic method for creating cavity-coupled single-photon sources, it becomes feasible to develop more complex systems. The device can be precisely integrated with a photonic platform to form a quantum-integrated photonic chip. Integration can be achieved using a pick-and-place technique through micro-transfer printing, combining various material platforms. An example of this process is the hybrid integration of a one-dimensional InP nanocavity with self-assembled InAs/InP quantum dots on SiN or Silicon-on-Insulator-based photonic platforms.

Short Bio:

Marcin Syperek completed his PhD studies at Dortmund University in Germany and Wroclaw University of Science and Technology in Poland, receiving his PhD in 2008. In 2019, he became a professor at Wroclaw University of Science and Technology, where he established the Group of Nonlinear Quantum Photonics. The group conducts research on the linear and quantum optics of low-dimensional systems interacting with light, weak and strong light-matter interactions, and excitation and spin dynamics. The group has capabilities in fabrication, measurement, and modelling of solid-state photonic systems. He has been selected (2024) as a scientific committee member for the SMARTLab facility at Sapienza University of Rome, Italy. He has co-authored more than 100 research articles, showcasing a broad and fruitful collaboration with many researchers across the globe.