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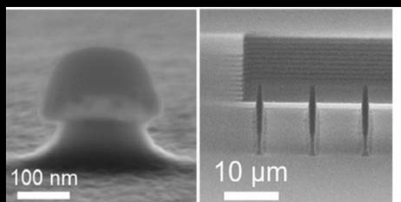
Innsbruck Physics Colloquium

Modern Device Concepts based on novel aspects in the MBE of classic wide gap II/VI semiconductors

PD Dr. Alexander Pawlis

Forschungszentrum Jülich GmbH

The classic II/VI compound semiconductors (ZnSe, MgSe, CdSe) offer enormous potential as modern quantum devices, where specific material properties are important: Homogeneous crystallo graphic properties of molecular beam epitaxy (MBE) grown heterostructures, high oscillator strength of the optical transitions, the possibility of isotope engineering and the availability of sophisticated in-situ nanofabrication techniques. Harvesting these for the realization of quantum devices requires unconventional approaches for the MBE growth and application of in-situ nanofabrication techniques. Reshaping the II/VI materials for quantum technology, I will introduce two examples, MBE growth of isotopically purified 64Zn80Se [1] and in-situ 3D-nanostructure growth with shadow mask technology. The second part of my talk is focused on the realization of single-photon sources utilizing halogenide (F, Cl)-doped ZnSe quantum wells for which we have set several benchmarking milestones over the past decade [2-4]. More recent investigations focus on ZnSe:Cl qubits: Here we demonstrated enhancement of the quantum efficiency of ZnSe:Cl single-photon sources by microlenses [5] and revealed cascaded emission from those sources [6]. Recently we verified indistinguishability of sequentially emitted photons which makes ZnSe:Cl ready for entangled-photon pair emission. Finally, I briefly present our recent success on the development of low-resistive ohmic contacts to n-type ZnSe:Cl at 4 K [7], tackling the most challenging open issue for ZnSe devices. Having solved this obstacle, we aim towards electrical devices such as field-effect transistors and electrostatically defined quantum dots. The latter represent all-electrical spin qubits, where ZnSe and related compounds can unite the main advantages of to-date established systems like the group-IV and III/V semiconductors.



SEM micrographs of a nanopillar-based single-photon source with integrated microlens on top (left) and a shadow-wall mask in-situ selective growth of 1D QW heterostructure arrays (right).

DK-ALM Pre-Talk: Tommaso Faleo

Entanglement-induced collective multiparticle interference

Time & Location: Tuesday, 07.11.2023, 16:30 h, HS C

Snacks will be provided in between the pre-talk and the colloquium.

[1] A. Pawlis, et al, MBE Growth and Optical Properties of Isotopically purified ZnSe Heterostructures, ACS Appl. Electron. Mater. 1, 44 (2019) [2] K. Sanaka, et al, Indistinguishable Photons from Independent Semiconductor Nanostructures, PRL 103, 053601 (2009) [3] K. Sanaka, et al, Entangling Single Photons from Independently Tuned Semiconductor Nanoemitters, Nano Letters 12, 4611 (2012) [4] D.J. Sleiter, et al, Optical Pumping of a Single-Electron Spin Bound to a Fluorine Donor in a ZnSe Nanostructure, Nano Letters 13, 116 (2013) [5] Y. Kutovyi, et al, Efficient Single-Photon Sources Based on Chlorine-Doped ZnSe Nanopillars with Growth Controlled Emission Energy, ACS Nano 16, 14582 (2022) [6] R. M. Pettit, et al, Correlations between Cascaded Photons from Spatially Localized Biexcitons in ZnSe, Nano Letters 22, 9457 (2022) [7] J. Janßen, et al, Low-Temperature Ohmic Contacts to n -ZnSe for all-Electrical Quantum Devices, ACS Appl. Electron. Mater. 2, 898 (2020)

Innsbruck Physics Colloquium, Organisation: K. Erath-Dulitz, H.-C. Nägerl, T. Schrabback

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