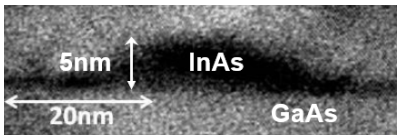
Technische Universität München

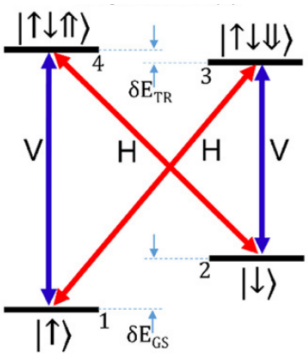
WSI
Walter Schottky Institut

Master thesis on structural and optical properties of quantum dots emitting in the telecom C-band

InAs quantum dots have been proven a valuable platform towards the implementation of quantum cryptography protocols, quantum sensing and quantum computing. Specifically, quantum dots act as reliable single-photon sources and spin-storage devices. However, silica fibers employed for long-distance propagation have their transmission widow in the telecom C-band at 1.55 μm. Therefore, it is crucial to develop quantum dots suitable for the implementation in the existing communication networks.



This thesis will first focus on the growth of InAs quantum dots emitting in the telecom C-band via molecular beam epitaxy (MBE). In order to reach this goal, you will master some of the recently developed growth techniques, such as the inclusion of an InGaAs strain relaxation layer. This layer acts on the band gap energy of the grown heterostructure, thus shifting the quantum dot's emission wavelength towards the telecom C-band[1]. Embedding the quantum dots into a diode structure allows to control of the charged states of the quantum dot via an applied voltage[2,3]. Hence you will gain experience in optical lithography and nanofabrication techniques.



The second part of the project will involve the study of the optical and spin properties of the grown quantum dots. You will optically address single quantum dots by using a resonance fluorescence excitation technique. The spin state of a charge trapped in a quantum dot at cryogenic temperatures can be controlled by the implementation of spin pumping protocols[2]. The application of an external magnetic field is required for such measurements. Therefore, you will also perform experiments using our new vector magnet.

We are looking for master students that are keen on working together with us at this project. A background in quantum optics and solid-state physics is preferable, but not secondary to your enthusiasm and curiosity in exploring the studied phenomena

If you are curious and have questions about this project, send an email including your CV to the following addresses:
kai.mueller@wsi.tum.de (Prof. Kai Müller) and bianca.scaparra@wsi.tum.de (Bianca Scaparra). Students from any gender and nationality are welcome to apply for this thesis.

[1] "*Single-photon emission at 1.55 µm from MOVPE-grown InAs quantum dots on InGaAs/GaAs metamorphic buffers*", M. Paul et al (2017), Appl. Phys. Lett.
[2] ***"****Narrow optical linewidths and spin pumping on charge-tunable close-to-surface self-assembled quantum dots in an ultrathin diode****"***, M. C. Löbl et al (2017), PRB.
[3] "*Exciton fine-structure splitting of telecom-wavelength single quantum dots: Statistics and external strain tuning*", L. Sapienza et al (2013), PRB.