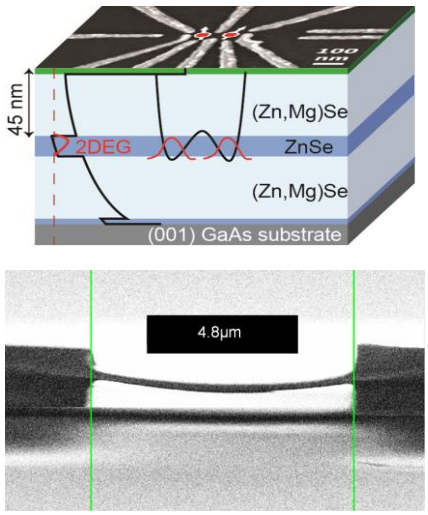
Master thesis:

Development of electron spin qubits in ZnSe using a shadow-mask technology

Background:

Many current research activities are focused on the realization of scalable spin qubits with electrostatically defined quantum dots (EDQDs). Such devices form the central part of electrical quantum nodes in a quantum network. One excellent candidate avoiding the disadvantages of presently available systems are ZnMgSe/ZnSe semiconductor quantum wells (QWs). Despite their ideal properties, not much is known about electrical contacts from outside to the 2DEG operating at 10 mK. However, these are a prerequisite for electrical manipulation and detection of the qubits. ZnMgSe/ZnSe can provide excellent spin qubits once the ohmic contacts and dielectric in the devices are in-situ (e.g. without exposure to air) deposited during the heterostructure growth. For this purpose we make use of a novel developed shadow-mask approach to fabricate the electrical contacts to ZnSe based spin qubits.



Top: Schematic drawing of a ZnMgSe/ZnSe EDQD spin qubit. Bottom: SEM images of a free-standing shadow-mask for in-situ spatial selective device processing.

Project description:

The goal of this master project is twofold: At first the shadow-mask approach shell be further developed and tailored to the device processing of ZnSe based field-effect transistors (FETs) and EDQDs. This involves the optimization of the shadow-masks with advanced nanofabrication technology and the molecular beam epitaxy (MBE) of heterostructures on these templates. Secondly, optimized shadow-masks will be used to process high-mobility ZnSe based FETs and quantum point contacts to EDQDs and analyze their electrical properties.

Your task:

You will learn the fabrication of shadow masks and ZnMgSe/ZnSe spin qubit devices by MBE, photolithography, reactive ion etching and electron beam evaporation. Characterization of the masks and as-grown devices will be performed by different structural methods (SEM, AFM, TEM). Hall bars are fabricated in order to characterize the electrical properties of the contacts and the 2DEG in a 1 K electrical transport system available in in the group of Lars Schreiber at RWTH. And finally you will participate in the fabrication of FETs and quantum point contacts to EDQDs, for which prototype devices will be characterized using advanced electronic measurement techniques.

General information:

The above master project will be conducted in the workgroup of PD Dr Alexander Pawlis at the PGI-9 institute of Forschungszentrum Jülich. Fabrication and electrical measurements will be performed in close collaboration with the group of Lars Schreiber at RWTH.

Contact:

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