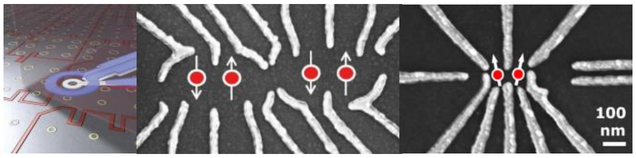
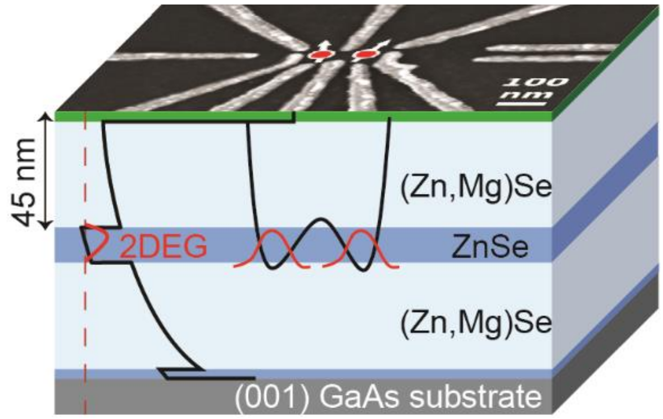


Towards electron spin quantum bits in ZnSe

Master's project starting WS 2018/19



Scientific background (Zn,Mg)Se is a II/VI semiconductor system that exhibits decisive advantages as a host material for electron spin qubits. (I) It can be used to grow high qualitative quantum wells confining a 2D electron gas. (II) It can be made nuclear spin free by isotopical purification. Thus, the electron spin coupling to an uncontrolled bath of nuclear spins is not an issue. (III) It is also a direct semiconductor without valley degeneracy in the conduction band. Thus uncontrolled valley excitation is absent and spin-to-photon conversion is possible in the future, in order to transport qubit information across a large distance.

Research goal Despite its ideal properties, not much is known about electrical contacts from outside to the 2DEG operating at 10 mK. These are a prerequisite for electrical manipulation and detection of qubits. As a first step, we characterize the 2DEG at low temperatures down to 1 K by measuring the (quantum) hall effect. Manipulation of carrier concentration in gated devices is required to control the 2DEG mobility. High 2DEG mobility is required for the next step, formation of electrically defined quantum dots within the 2DEG. Having knowledge and experience with e-beam technology on nm scale unified in our team, first devices could allow for electric transport in the single electron regime.

Top: Layer structure of the (Zn,Mg)Se sample forming a ZnSe quantum well filled by a 2D sheet of electrons. Bottom: mK dilution refrigerator for quantum dot experiments.

Your task You will characterize hall bars at low temperatures effectively becoming part of the sample fabrication feedback loop. In quantum dot formation you will learn how to control single electrons and conductivity searching for effects like *i.e.* Coulomb blockade.

- Material properties of (Zn,Mg)Se
- Cryogenic temperature physics
- Low-noise electrical measurement techniques
- Quantum dot physics

Furthermore, you will attend group seminars and journal clubs to learn about new developments in quantum computing.

Cooperation partners: Helmholtz Nano Facility in Jülich, Dr. Alex Pawlis (IBN-9)

Contact: Dr. Lars Schreiber, Physikgebäude 28A327, lars.schreiber@physik.rwth-aachen.de