HL 41: Spin Phenomena in Semiconductors

Time: Wednesday 15:45–16:30 Location: H17

HL 41.1 Wed 15:45 H17

The charge cycle of the silicon vacancy in diamond — •Joshua Claes, Bart Partoens, and Dirk Lamoen — University of Antwerp, Antwerp, Belgium

Color centers in wide bandgap semiconductors are point defects with strongly localized electrons, resembling atom-like systems that can be optically controlled. These defects hold great promise for advancing quantum technologies, including quantum sensing and quantum computing. Among them, the silicon vacancy (SiV) center in diamond stands out as a particularly promising candidate due to its narrow optical emission and long spin coherence time, lasting up to 1 second at cryogenic temperatures in its neutral state.

A key challenge for the practical use of such defects is the precise measurement of their spin state. Photoelectric detection of magnetic resonance (PDMR) is a promising technique that measures the spin state by inducing charge state transitions and capturing the released electron or hole. In this work, we employ density functional theory with the HSE06 hybrid functional to calculate the onset energies and optical cross-sections for charge state transitions of the SiV center in diamond, ranging from -2 to 0.

Using this data, we model the PDMR experiment to predict charge transitions as a function of the laser frequency applied, providing insights into the defect's behavior under experimental conditions.

HL 41.2 Wed 16:00 H17

Carrier spin coherence in inas/inalgaas quantum dots emitting in the telecom range — •Vitalie Nedelea — Technische Universität Dortmund, Dortmund, Germany

This study focuses on the carrier spin coherence in quantum dots(QDs), which are promising candidates for entanglement with an emitted photon as well as entanglement of two remote spins induced by measuring of two indistinguishable photons. The Samples, grown by molecular beam epitaxy, consist of 5.5nm InAs monolayers separated by InAlGaAs barriers. A Si δ-doped layer, at a distance of 15 nm from the QD layer, provides resident electrons. Differential transmission reveals a double exponential decay behaviour, with a short exciton(X) decay time of 0.5ns and the long indirect molecular X decay time of 2ns. The dependence of the Larmor frequencies on the transversal magnetic field (BV) gives us information about the carrier g-factor, |ge|=1.88 for the electron and |gh|=0.6 for the hole. The hole spin dephasing saturates at a higher value of T2*=1.4ns than the electron T2*=0.6ns, which could be explained by the weaker hyperfine coupling of the hole. The decay of the FR signal as a function of fm gives TS=0.3μs and extrapolating the power dependence to zero gives the spin relaxation time T1=0.5μs. The wide spread of g-factors and long spin relaxation times are promising candidates for the spin mode locking (SML) effect. In the ensemble of QDs, the sum of the multiple oscillating signals with Larmor frequencies corresponding to ωR contributes to the SML. Measured dependence of the SML on the BV reveal that the signal is related to the hole spins.

HL 41.3 Wed 16:15 H17

Optically induced spin electromotive force in ferromagnetic-semiconductor quantum well structure — •Olga Ken[1,2], Igor Rozhansky[2], Ina Kalitukha[1,2], Grigory Dimitriev[2], Mikhail Dorokhin[3], Boris Zvonkov[3], Dmitri Arteev[2], Nikita Averkiev[2], and Vladimir Korenev[2] — [1]TU Dortmund, Dortmund, Germany — [2]Ioffe Institute, St. Petersburg, Russia — [3]Lobachevsky State University of Nizhny Novgorod, Russia

We study hybrid structures which consist of ferromagnetic (FM) layer and a semiconductor quantum well (QW) and present here a systematic approach combining the optical and electrical detection of the spin-dependent electron transfer with nanoscale spatial resolution. Spin-dependent transfer is manifested in three spectacular effects: PL circular polarization under unpolarized excitation, dependence of the PL intensity from the QW on the circular polarization degree of the excitation, and spin-dependent photo-voltage across the junction. We show that in GaMnAs/GaAs/InGaAs heterostructure all the three parameters demonstrates similar non-linear magnetic field dependences with hysteresis loop saturating in ~100 mT [1]. This indicates the interaction of charge carriers in the QW with the FM, i.e. the FM proximity effect [2].

[1] I.V. Rozhansky et al. Nano Letters 23, 3994 (2023).
[2] V. L. Korenev et al. Nature Commun. 3, 959 (2012).