Hanle Effect in Single InAs/InP Quantum Dots Emitting in the Telecom C-band

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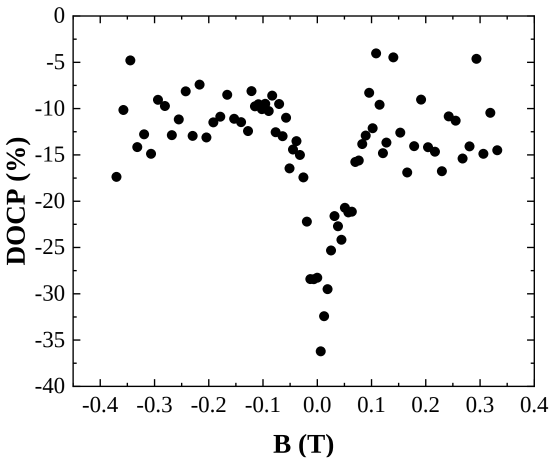
Discrete, atom-like energy structure in quantum dots (QDs) makes them ideal for applications in quantum technologies. Spin relaxation processes in QDs are greatly suppressed by the strong spatial confinement, which makes them promising candidates for quantum spin memory. However, for qubit initialization and readout, it is crucial to address and manipulate individual spins of carriers, which can be achieved with the classic techniques of optical orientation. Here, the focus lies on the spin coherence properties.

This study explores the properties of symmetric, low-density InAs/InP QDs grown using ripening process-assisted molecular beam epitaxy and emitting within the telecom spectral range (1.55 μm). The QDs were grown on a top of a distributed Bragg reflector, resulting in 6.8% photon extraction efficiency for the planar sample and 13.3% for QDs in cylindrical mesas [1]. High single-photon purity ($g^{(2)}(0) < 0.01$) [2] and low fine structure splitting shows prospects for generating non-classical light. Such a material system can be used for optically driven spintronics, compatible with telecom infrastructure.

Our investigations involved magneto-optical polarization-resolved measurements in Voigt configuration. We determined g-factors of trions within the ranges of 0.5–1.3 out-of-plane of the dots [3]. Furthermore, photoluminescence excitation measurements enabled the determination of excited states' energies in single QDs. We observed the negative circular polarization (NCP) [4] under quasi-resonant excitation for emission line identified as a trion, where the degree of circular polarization (DOCP) reaches almost ~40%. Finally, the decrease of DOCP under the influence of external magnetic field, the so called Hanle effect, reveals the spin coherence time of carriers within the QD [5]. Determining the factors causing decoherence will enable optimization of existing sources and verification of the application potential of the studied systems.



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