Tunable g-factors in SiGe quantum dots

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So far, most of the experimental work on semiconductor spin qubits has focused on GaAs-based single and double quantum dots (QDs) [1-5]. However, the quantum coherence of electron spins in GaAs QDs is lost on relatively short time scales due to hyperfine interaction with the nuclear spins.

Here we investigate an alternative material system: SiGe self-assembled nanocrystals. Si and Ge are attractive materials because in these materials electronic spins can have a long coherence time due to the absence of hyperfine interaction (in isotopically purified crystals) [6]. One further advantage of SiGe nanocrystals is their compatibility with CMOS technology [7].

We have recently reported the first realisation of single-hole transistors based on such individual SiGe nanocrystals [8]. A variety of low-temperature transport regimes depending on the strength of the tunnel coupling to the leads were observed. Transport spectroscopy reveals largely anisotropic hole g-factors. By changing the number of holes localized within the SiGe QDs a clear modulation of the g-factor is observed indicating that the g-factors are linked to the corresponding orbital wavefunctions.

Furthermore, in order to be able to study the effect of an external electric field on the value of the g-factor for the same orbital wave function, i.e. for the same number of holes, we have fabricated dual gate devices with both bottom and top gates. Our measurements demonstrate that the g-factor can be varied for at least a 300% when changing the value of the perpendicular electric field, as it is shown in Fig.1 [9].

The observed tunable g-factors make SiGe self-assembled QDs an interesting material system for performing all-electrical spin coherent manipulations.

Figures

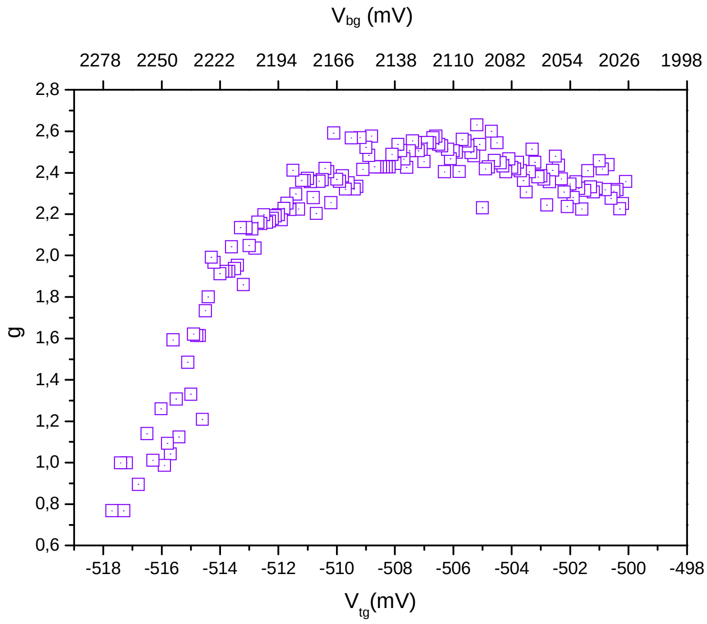

Fig.1. Measured g-factor as a function of the voltage applied to the top gate (V_{tg}) and to the back gate (V_{bg}). A big modulation in g is observed.

References

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