**Low-frequency spin qubit energy splitting noise in highly purified 28Si/SiGe**

**A. Schmidbauer (1), T. Struck (2), A. Hollmann (2), L. Diebel (1), R. Richter (1), M. Zoth (1),
H. Riemann (3), N. Abrosimov (3), Ł. Cywiński (4), L. Schreiber (2), and Dominique Bougeard (1)**

*(1) Institut für Experimentelle und Angewandte Physik, Universität Regensburg, Regensburg, Germany
(2) JARAFIT Institute Quantum Information, Forschungszentrum Jülich GmbH and
RWTH Aachen University, Aachen, Germany
(3) Leibniz-Institut für Kristallzüchtung, Berlin, Germany
(4) Institute of Physics, Polish Academy of Sciences, Warsaw, Poland*

Electrostatically defined quantum dots in 28Si/SiGe heterostructures have been proven to allow the robust implementation of spin qubits as long as the device-intrinsic valley splitting energy is sufficiently large to operate the qubit. Here, we present the characterization of a gate-defined single spin qubit in a quantum dot layout with an integrated nanomagnet. The qubit is hosted in a molecular-beam epitaxy-grown 28Si/SiGe heterostructure presenting 60 ppm residual 29Si[1]. We find a robust valley splitting beyond 200 𝜇eV and a well separated orbital energy beyond 1 meV. In the operation window, we observe spin relaxation times 𝑇1 > 1 s. Using electron dipole spin resonance, the manipulation of the qubit yields 𝑇2\* ∼ 20 𝜇s and 𝑇2𝑒𝑐ℎ𝑜 ∼ 127 𝜇s[2]. We investigate the detuning noise spectrum of the qubit by extracting the resonance frequency from a series of Ramsey-type measurements and compare this noise to the noise spectrum of the adjacent sensor dot. We find charge noise together with the synthetic spin-orbit interaction due to the magnetic gradient to be the dominant qubit noise source at frequencies larger than 5 mHz. Given that the SiGe barrier has natural isotope composition, we also discuss the impact of the electron wavefunction overlap with the Si/SiGe interface on the qubit dephasing time.

##### [1] A. Hollmann et al., Phys. Rev. Applied 13, 034068 (2020)[2] T. Struck et al., npj Quantum Inf. 6, 40 (2020)[3] T. Struck et al., Sci. Rep. 11, 16203 (2021)

#####

Figure 1: Left: Measurement of the spin-up probability as a function of the evolution time te for a Ramsey-fringes pulse sequence. Each point corresponds to 500 single-shot measurements[3]. Right: Spin-up probability as a function of the evolution time te after a Hahn-echo gate sequence. The dotted line marks the fitted[2] T2echo.