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Electrically Driven Hole Spin Resonance Detected with Charge Sensor in a Planar Si CMOS Structure

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Hole-spin qubits based on Si CMOS devices have garnered attention due to their intrinsic spin-orbit interaction (SOI), weak hyperfine interaction, and anisotropic g-tensor. The SOI allows all electrical control of qubits via electric dipole spin resonance (EDSR) which removes the need for the micro-magnets or electric spin resonance strip (ESR) lines making devices less bulky. The weak hyperfine interaction increases the coherence times. The planar Si CMOS structure is industry compatible and combined with individual spin addressability via EDSR, is apt for scaling up to a larger number of qubits. This integration has not yet been shown for a known number of holes in Silicon CMOS.

We studied a hole double quantum dot (DQD) operating in the Pauli spin blocked $(2,8) \rightarrow (1,9)$ charge transition regime. We were able to operate it as a singlet (S)-triplet (To) qubit which enabled determination of the g-factors of the dots. We performed microwave driven EDSR of the spins and coherently rotate the spins with a Rabi frequency up to 200 MHz. We also studied the in-plane g-factor anisotropy which varies by 100%. The result demonstrates the capability of industry compatible Si CMOS structure for operating hole spin qubits and allowing local EDSR spin control leading to rapidly driven spin qubits.

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