High-fidelity dispersive spin readout in a scalable unit cell of silicon quantum dots

Giovanni A Oakes
Constance Laine, Jacob Chittock-Wood, Sofia M Patomäki, Michael Fogarty, Stefan Kubicek, Ross C. Leon, Fernando Gonzalez-Zalba, John Morton.

Quantum Motion, UK

giovanni@quantummotion.tech

Planar MOS multi-gate technology is one of the leading approaches for silicon-based quantum computing, especially when coupled with dispersive charge sensors, which offer scalable unit cells by reducing the need for reservoirs. So far, demonstrations of planar MOS quantum dots have been restricted to architectures where sensors are co-linear with the qubit array, limiting scalability. Achieving readout fidelity at the level of control operations has also remained challenging.

In this work, we address both limitations by demonstrating single-shot spin readout above 99.9% in 400 us within a planar MOS quantum dot array fabricated using a 300 mm wafer process. We use a single electron box (SEB) to measure the two-electron spin state of a double quantum dot via Pauli spin blockade. The sensor and qubit dots are placed in parallel channels of a bilinear array, forming a compact and scalable unit cell. The high fidelity is achieved thanks to the tunability of the structure that allows:

(i) Optimisation of the tunnelling rate of the SEB for enhanced signal.
(ii) Tuning of the coupling between the double quantum dots using a J-gate, leading to an enhancement of the singlet-triplet relaxation time from 4 us to 0.5 s.

Overall, this work demonstrates sensing in a compact unit cell with state-of-the-art fidelity, providing a path to scalable high-connectivity bilinear qubit arrays.

Figures