Semiconductor spin qubits: Playing the long game

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Today's noisy intermediate-scale quantum (NISQ) processors support of order 1000 qubits, yet resource estimates suggest that more than one million physical qubits will be required to achieve fault-tolerant quantum computation with the surface code [1]. Of all of the qubit technologies being pursued, semiconductor spin qubits most closely resemble conventional transistors, which can be fabricated at scale with ~100 billion transistors on a chip. It is therefore prudent to pursue long-game approaches to fault-tolerant quantum computing with semiconductor spin qubits. In this lecture, I will describe how the international research community has addressed some of the most pressing challenges facing silicon spin qubits. Recent progress includes multi-qubit control with fidelities that are on par with competing technologies [2], as well as a variety of approaches for coupling modules of densely packed spin qubits [3,4,5]. I will also describe new device platforms that open the door to the fabrication of large two-dimensional spin qubit arrays [6,7].

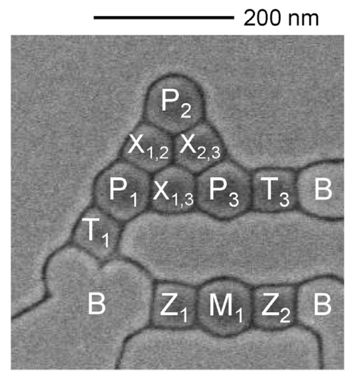

Fig.1. Scanning electron microscope image of the gate metal layer defining a close-packed triangular quantum dot array. The triangular unit cell can be repeated to form larger two-dimensional quantum dot arrays with high connectivity [7].

References

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