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Few electron silicon enhancement mode nanostructures for quantum computing

Development of silicon, enhancement mode nanostructures for solid-state quantum computing will be described. A primary motivation of this research is the recent unprecedented manipulation of single electron spins in GaAs quantum dots, which has been used to demonstrate a quantum bit [1]. Long spin decoherence times are predicted possible in silicon qubits. This talk will focus on silicon enhancement mode quantum dot structures that emulate the GaAs lateral quantum dot qubit [1] but use an enhancement mode field effect transistor (FET) structure. One critical concern for silicon quantum dots that use oxides as insulators in the FET structure is that defects in the metal oxide semiconductor (MOS) stack can produce both detrimental electrostatic and paramagnetic effects on the qubit. Understanding the implications of defects in the Si MOS system is also relevant for other qubit architectures that have nearby dielectric passivated surfaces. Progress on development of top gated MOS and greater than 100,000 cm^2/V-s mobility material SiGe/sSi enhancement mode quantum dot structures will be presented. Both designs can exhibit few electron behavior. A combination of characterization of defects and modeling will be presented and if time permits, implications for the silicon enhancement mode approach for future qubits and quantum circuit micro-architecture will also be discussed.

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[1] J. Petta et al., Science 309, 2180 (2005)