The MOS Interface for Singlet-Triplet Quantum Bits

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Electron spins in silicon metal-oxide-semiconductor (MOS) offer a potential path to implement quantum information science. Despite silicon's opportunity to provide a near magnetic "vacuum", fundamental doubts have been raised about the MOS interface (e.g., trap disorder and noise). In this talk, I will present characterization of the MOS interface using singlet-triplet (ST) quantum bits (qubit). The ST qubit is an excellent characterization platform. The two coupled spins can be tuned to directly probe most central properties including: valley splitting (VS), g-factor non-uniformity, charge and "magnetic" noise. Disorder is still present although an increasing number of instances from this lab and others show that design and tuning can lead regularly to single electron QDs. We will present highly tunable QDs that are fabricated without metals in the nanostructure region, minimizing potential complications of metal electrodes related to charge noise [1], stress [2], and modifications of the local magnetic field [3]. We find that the MOS interface in these QDs provides a tunable VS [4] with charge noise properties comparable to other semiconductor ST qubits [5]. We also examine the effect of introducing impurities (i.e., donors). These shallow states can be tuned in to resonance to form a useful qubit [6] or alternatively tuned out of resonance where they are undetected by other qubit's performance. For magnetic noise, we find the effective Overhauser field variation consistent with the anticipated magnitudes from the ^{29}Si concentration. We also observe a strong and tunable g-factor non-uniformity between QD locations. This particular effect is advantageously used to control a ST qubit and raises interesting future prospects.

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