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Silicon spin-based quantum information devices

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Abstract

Quantum information devices have been well studied because they are expected to have functionalities beyond existing information devices. A single electron spin in Si quantum dots (QDs) is one of the most promising candidates for implementing a quantum bit (qubit) as a unit of information in quantum computers. Long coherence time of electron spins is expected in Si QDs, because hyperfine coupling between electron spins and nuclear spins is small in Si.

We develop a novel device structure of lithographically-defined Si QDs toward qubits [1-3]. The Si QDs are fabricated using electron beam lithography, reactive ion etching, and oxidation, in a metal-oxide-semiconductor (MOS) structure on silicon-on-insulator (SOI) substrates. The advantage of our device is that well-defined confinement potential and small QDs (~20 nm in diameter) can be obtained.

We study both single QD and double QD devices. Charge detection of change in number of electron in QDs, one by one, has been successfully demonstrated in both devices. Few-electron regimes in QDs are also realized in both devices [2]. Using the double QD devices, we succeed in observing spin-related tunneling phenomena [3]. These achievements are the important steps for realizing qubits.

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Biography

Kodera has completed his doctorate in physics at the age of 27 years at the University of Tokyo, and research associate at Institute for Nano Quantum Information Electronics, the University of Tokyo. He is an assistant professor at Quantum Nanoelectronics Research Center, Tokyo Institute of Technology. He has published more than 40 papers in reputed journals. He served as a Program Committee Member for the Meetings of Physical Society of Japan from 2010 to 2011. He was the recipient of the Presentation Award of the Japan Society of Applied Physics, and the Tokyo Tech Young Investigator Engineering Award.