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Integration of silicon spin qubits with buried nanomagnet: a trial to design integration structure with quantum device simulator

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Abstract

Silicon spin qubit is a promising candidate as the building block for large-scale quantum computers because of their compatibility with conventional LSI fabrication technology. In the actual device fabrication, the device characteristics vary due to process variation, causing unexpected performance degradation. For example, the qubit fidelity degrades due to the quantum dot size variation. Therefore, toward large-scale integration, it is essential to consider the integration structure realizing high variation tolerance. The device simulation technology helps the situation because we can test the variation tolerance quickly. In this talk, I will discuss a case study, taking advantage of a house-made quantum device simulator, about the co-integration of the qubits and nanomagnets, proposing a high variation tolerant integration structure. That is with buried nanomagnets, which enable qubit operation with high-speed and suppressed fidelity variation. The high-speed operation results from closely placed nanomagnets near the qubits, enabling about ten times faster operation than the conventional case. Also, the proposed structure suppresses the fidelity variation due to process variation thanks to the self-aligned fabrication process. This work demonstrates that a device simulator is a powerful tool in the integration structure design toward the practical realization of large-scale quantum computers.