

Mutsuo Hidaka

National Institute of Advanced Industrial Science and Technology (AIST)  
Fabrication Process and Device Structure for Nb-based Quantum Annealing  
Devices

We have been developing a Nb-based fabrication process for quantum annealing devices. Qubits and peripheral circuits for a control and readout circuits of the qubits are fabricated on different chips. The qubit chips consist of planarized three Nb layers with Nb/AlOx/Nb Josephson junctions which are fabricated directly on the substrate at the first step. In the qubit chip, possible noise sources of resistors and anodized oxide layers are eliminated. The peripheral circuit chips have planarized four Nb layers, a resistor layer and Nb/AlOx/Nb Josephson junctions whose critical current density is two orders of magnitude higher compared with that of the qubit chips. The qubit chips are settled on the peripheral chip as an interposer by using flip-chip bonding method. The peripheral circuit chips are placed on a package substrate and connected to wirings on the package substrate with through silicon vias (TSVs) in the peripheral circuit chips. The adjacent peripheral circuit chips are connected with a bridge interposer. We call this device structure QUIP (Qubit chips, Interposers and a Package) structure. QUIP structure is two-dimensionally scalable and promising to realize practical-scale quantum annealing machines. This paper is based on results obtained from a project commissioned by the New Energy and Industrial Technology Development Organization (NEDO).