A strategy for development of superconducting qubits with large decoherence time

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Recently it has been successfully developed several types of superconducting qubits which allowed operation with quantum information. Nevertheless, the best decoherence time achieved for all types of qubits is not larger than several microseconds. It is clear, that any electric capacitance connected in parallel to a qubit results in decoherence due to nonideal dielectric with low loss tangent. The main idea for development of quiet qubits is the usage of high quality crystalline dielectrics in Josephson junctions and quality dielectrics in shunting capacitances, insulating layers and noise filtration systems[1].
Realization. We suggest to use tantalum ($T_c = 4.4\ K$) for the qubits with large decoherence time. It is well known that epitaxial 3-layer structures Ta-MgO-Ta are realized on r-cut sapphire. Moreover, in contrast to niobium, tantalum has the only oxide (Ta_2O_5), which could be used as low-noise crossover dielectric. We will present measurements of critical current, rectified voltage and resistance vs. magnetic field for asymmetric 1 μm diameter rings fabricated from monocrystalline Ta films with R(300K)/R(4.2K)=30 and measurements of epitaxial Ta-MgO-Ta single JJs and SQUID structures.

[1] J.M. Martinis. Quantum Inf. Process. **8**, 81 (2009).