Improved Coherence of Superconductive Qubitsby Josephson junction optimization

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Superconducting qubits have emerged as promising platform for quantum information processing, powered by dramatic improvement of the coherence times over the past decade. In order to increase the coherence time, several strategies have been investigated [**?**, **?**]. However, Josephson junctions, a crucial nonlinear component of superconducting qubits, are still fabricated from two aluminum polycrystalline electrodes with loss amorphous aluminum oxide in between. Here we demonstrate dielectric losses decreasing by means of Josephson Junctions optimization.

Firstly, we show that optimized Josephson junction design entailed in reduced loss for planar transmon qubits at a substrate-metal interface (fig. **??**). We design and fabricate several Josephson junction constructions with similar critical dimensions, but different near-junction areas. We carry out a comparative analysis of tunable X-mon qubit lifetimes based on various Josephson Junctions construction design types, demonstrating coherence improvement up to 50 us.

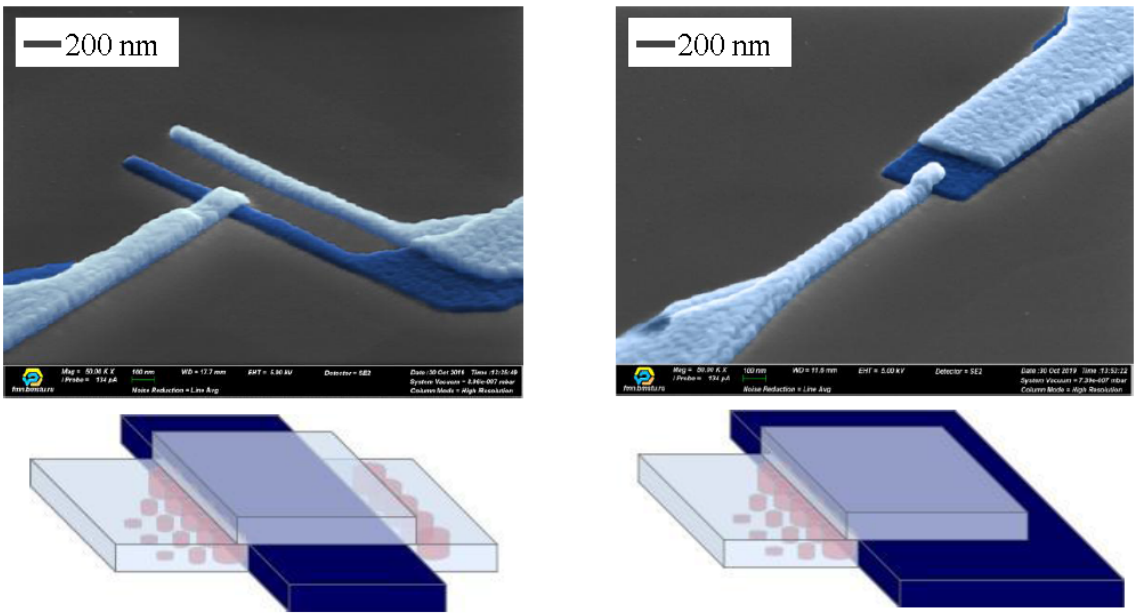

Figure 1: Josephson junction model: reference (left), modified (right).

Secondly, we propose the novel superconducting qubits fabrication technique based on Josephson junction single-crystal growth with inorganic masks. We use traditional technologies of microelectronic to fabricate epitaxial sub-um Josephson junctions (fig. **??**).

To experimentally test the proposed approaches we demonstrate tunable X-mon qubits fabrication and characterization. These discoveries are important for manufacturing stable superconducting circuits suitable for scalable quantum computing where drift and fluctuations could lead to unnecessary calibration and downtime.

All the devices were fabricated at the BMSTU Nanofabrication Facility (FMN Laboratory, FMNS REC, ID 74300).

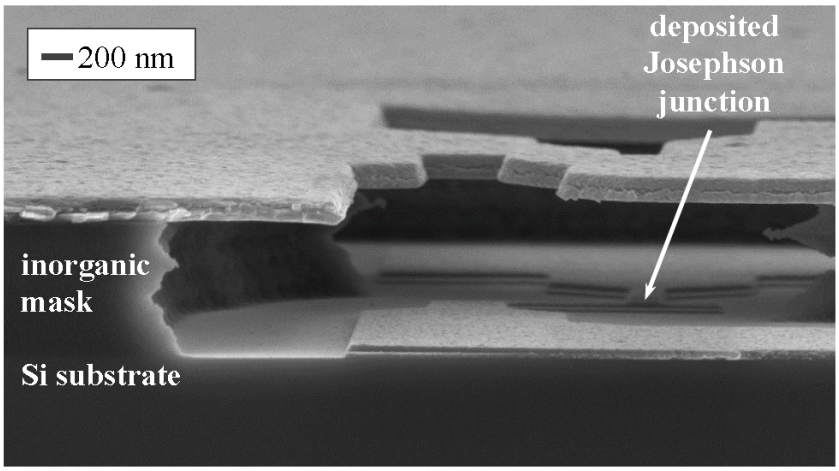

Figure 2: SEM image of deposited Josephson junction through inorganic mask.

References

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