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Investigation of losses in eptaxially grown superconducting microwave resonators on MgO substrate

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Introduction

Dielectric loss due to TLSs in superconducting qubit circuit limit the coherence time. Coplanar waveguide resonator is a unique device to study the loss tangent as it only includes superconducting lines through on-chip coupling capacitors and therefore easier to fabricate.

Experiment and Results

Previous report of decoherence time T_1 was 400 ns for NbN qubits eptaxially grown on single-crystal MgO substrate. The recent measurement of T_1 has been improved to 1 μs on such device. Both SiO_2 from the insulation layer and the lossy MgO single-crystal have the contribution of the short qubit decoherence time. In this work, we developed the NbN resonators with resonance frequency of 10 GHz, near the typical operation freuqencies of the superconducting qubits. The resonators are fabricated with the same configuration but sputtered with amorphous SiO_2 to fill up the gap space between the coplanar waveguide central line and its grounds. The loss tangent (Fig. 1) as a function of applied microwave power was obtained by Lorentzian fit of the resonators' transmission S-parameters S_{21}. It shows that the NbN resonator without SiO_2 dielectric filling has the lowest loss tangent when compare to resonator with SiO_2 filling or resonator integrated with qubits.

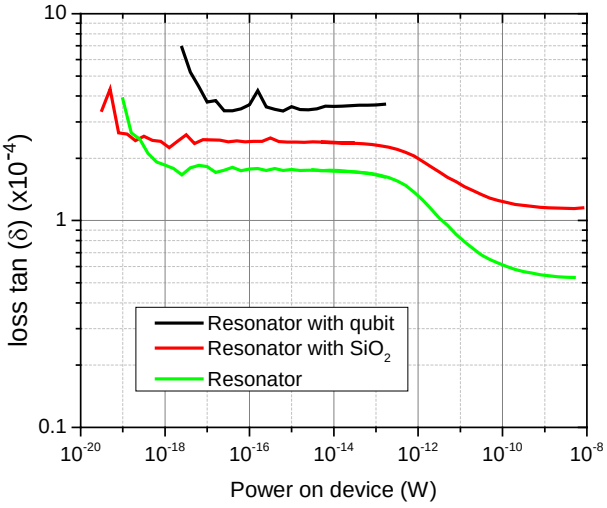

Figure 1 Dielectric loss tanδ of NbN resonator on MgO as a function of applied microwave power measured at 300 mK for three different configurations.