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J4Or1A-04: Fundamental superconductivity of Nb films for quantum computing application

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Niobium is a widely accepted material for quantum computing device as well as superconducting radio frequency (SRF) technology. Superconducting niobium is a marginal type II superconductor which has a very narrow gap (˜20-30 mT) of the mixed state at 2K, even showing the intermediate state (IMS) at the early stage of magnetic vortex penetration. Tremendous progress has been made in understanding the impact of the Nb surface and bulk superconductivities on SRF resonator performance. However, the effect of thin superconducting Nb films for quantum computing applications requires further examination. In this study, we explore the fundamental superconducting properties of various thin Nb films and compare them with respect to the energy relaxation time, T1, measured from superconducting qubit fabricated with these films. The Nb films are fabricated both with or without a surface protective layer that prevents the formation of lossy Nb2O5. Electromagnetic properties are characterized by means of bulk magnetization, electromagnetic transport, and dynamics of surface superconductivity. In addition, analytical electron microscopy is implemented to further connect the superconducting properties to microstructure.

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