Evaluation of Kinetic Inductance in Superconducting TiN Coplanar Waveguide Resonator

情通機構　°丘　偉，寺井　弘高
NICT　°Wei Qiu, Hirotaka Terai
E-mail: qiuwei@nict.go.jp

Experiment and results

Precision design and fabrication high quality superconducting quantum qubit (qubit) are both essential requirements for physical implantation such devices in quantum computing and quantum information applications. Among which, developing high-Q, thus low loss superconducting resonator device is to achieve long coherence time. Meanwhile, it is also crucial to know all parameters in high precision qubit circuit design. This is especially true for qubit circuit using superconducting materials. In this research report, we evaluated the kinetic inductance in superconducting TiN coplanar waveguide resonator fabricated by dc-magneton sputtering method. By measuring the resonance frequency shift in resonator device at low temperature, we evaluated the contribution of kinetic inductance of TiN films deposited at various conditions. The obtained kinetic inductance of TiN film provides useful guideline for future superconducting type qubit design and fabrication. In details, prior to the TiN film deposition, single crystal (100) Si substrate has been cleaned by hydrogen termination process by dipping the substrate into hydrofluoric (HF) acid and been transferred into main sputtering chamber with a background pressure better than 1×10^{-8} Pa. By changing the sputtering conditions, such as N_2 flow rate, bias current, and total pressure, TiN films have been deposited. The TiN films were then patterned into half-wavelength coplanar waveguide resonator before dry etched by RIE process and dicing into experimental ready size. S-parameter experiment has been conducted below 10 mK to obtain information, such as resonance frequency and resonator internal quality factor Q_i and kinetic inductance L_k (Table I).

Table I.　TiN film properties and CPWR resonance frequency and kinetic inductance under different deposition conditions.

	$N_2/(N_2+Ar)$ (%)	P (mTorr)	I (A)	Tc (K)	R@10K (Ω)	f_c (GHz)	L_m (nH/m)	L_k (nH/m)
#2	13.8	4	1.7	4.58	217.5	5.46136	711.2	292.6
#3	13.8	6	1.7	4.38	373.8	8.76620	443.1	24.5
#4	13.8	8	1.7	4.62	700.6	6.79272	571.8	153.8
#6	10.7	4	1.7	4.65	221.9	6.03676	643.4	225.3
#7	10.7	6	1.7	4.34	531.6	8.7664	443.0	24.9
#8	10.7	8	1.7	4.66	785.6	6.82103	569.4	150.7
#14	13.8	6	2.6	4.54	208.8	6.2527	621.2	203.6
#18	9.1	6	1.7	4.42	383.3	5.116473	759.1	341.2