ED5-4

The Superconducting Flux Qubit for Prime Factorization Utilizing Low Jc Process

*Daisuke Saida[1], Shuichi Nagasawa[1], Mutsuo Hidaka[1], Kunihiro Inomata[1], Kazumasa Makise[1], Hiroki Yamamori[1], Masahiro Ukibe[1], Shiro Kawabata[1], Yuki Yamanashi[2]

The National Institute of Advanced Industrial Science and Technology[1]
Yokohama National University[2]

Specific device for prime factorization utilizing a quantum annealing has been investigated[1].In this architecture, a multiplier plays an important role because its inverse operation corresponds to the prime factorization. To demonstrate this concept, we fabricated a qubit cell, which was an element of the multiplier, utilizing multi-layered Nb/AlOx/Nb Josephson junction technology with current density of 1 μA/μm^2. The cell was consisted of a superconducting flux qubit, a quantum flux parametron (QFP) and superconducting quantum interference devices (dc-SQUID) as shown in Fig. 1(a). I_c and β_L of the qubit were 6 μA and 2.8, respectively. In order to modify an energy potential, the qubit was coupled with current paths of I_{trans} and I_{Qubit}. Prior to experiments at 4.2K, bias conditions of the QFP and readout-SQUIDs were analyzed by SPICE.

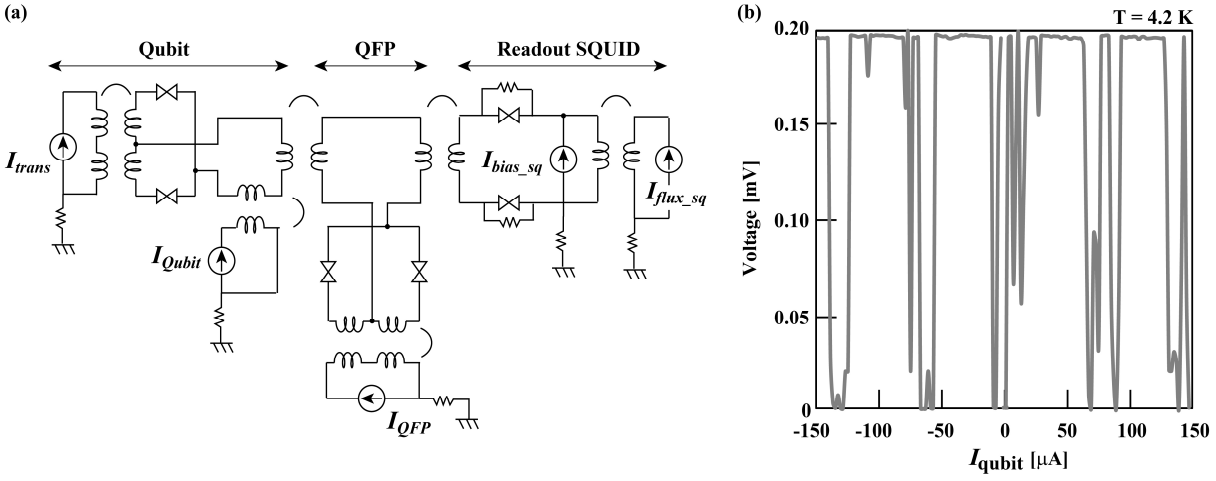
At first, bias to the readout SQUID was adjusted so as to respond zero or constant value depending on a direction of a magnetic flux. Then, a current I_{QFP}, corresponding to the flux $\Phi_0/2$, was applied to the QFP. Figure 1(b) shows output signals in the readout SQUID after applying the current I_{qubit}. Here, the signals were obtained every increment of 2 μA and averaged in 20 times. Repetitions of high and zero voltage were obtained. The feature was consistent with the SPICE analysis. This indicated successful detection of the flux in the qubit where direction of a circulating current was modified by current I_{qubit}. We consider this qubit cell has possibility of constructing the multiplier for prime factorization.

References

[1] M. Maezawa et al., *J. Phys. Soc. Jpn.* **88** (2019) 061012.

Acknowledgements

This paper is partly based on results obtained from a project commissioned by the New Energy and Industrial Technology Development Organization (NEDO), Japan. The devices were fabricated in the clean room for analog-digital superconductivity (CRAVITY) in National Institute of Advanced Industrial Science and Technology (AIST).



Keywords: superconducting flux qubit, Josephson junction, SQUID, quantum annealing