ミリケルビンで動作する HFQ 回路に向けた π-π-π SQUIDs の特性評価

π-π-π SQUIDs: The Switching Element of HFQ Circuits Operating at mK

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During the 82nd JSAP Autumn Meeting 2021, we reported a new and simple fabrication process of half-flux-quantum (HFQ) circuits based on π-π-π SQUIDs, which are consisted of three superconductor/ferromagnet/insulator/superconductor (SFIS) Josephson junctions. At that time, we demonstrated the correct operation of an HFQ TFF by measuring the divide-by-two operation at 4.2 K [1]. In this work, we plan to decrease the operating temperature of HFQ circuits down to ~mK since the low-power HFQ circuit is one of the best candidates for qubit control and readout circuits in the future. We measured the modulation pattern of a π-π-π SQUID and confirmed that our SFIS junctions can still maintain their intrinsic π-phase shift at 10 mK as shown below, however, β_c increased exponentially (not shown here) with the decreasing of temperature due to the suppression of the quasiparticle current at lower temperature. Additionally, we think our fabrication process can also be adopted into the conventional single-flux-quantum (SFQ) circuits that with moderate operating speed and compatible to HFQ circuits, because a π-π SQUID shows the same behavior as that of a conventional DC SQUID, which can also be treated as the building block of SFQ circuits.

Acknowledgment

This work was supported by the JSPS KAKENHI, Grant Numbers JP18H05211, JP18H01498, JP19H05615 and 20K22412, and JST-CREST Program Grant Number JPMJCR20C5 and the Program for Promoting the Enhancement of Research University.

References

[1] Feng Li, Yuto Takeshita, Masayuki Higashi, Masamitsu Tanaka, Taro Yamashita, and Akira Fujimaki, The 82nd JSAP Autumn Meeting 2021, 12p-N403-5, 2021.

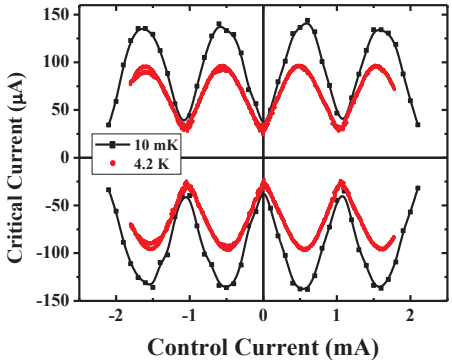

Fig.1 Modulation patterns of π-π-π SQUID measured at 4.2 K and 10 mK, respectively.

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