Characterization of Niobium Nitride Resonators at 0.1 K in Microwave SQUID Multiplexers for Readout of Transition Edge Sensors & Metallic Magnetic Calorimeters

S. Kohjio1, F. Hirayama1, H. Yamamori1, S. Nagasawa1, D. Fukuda1, A. Sato1, M. Hidaka1, T. Irimatsugawa2
1 National Institute of Advanced Industrial Science and Technology (AIST), Japan
2 The University of Tokyo, Japan

Summary

- Microwave multiplexer composed of NbN resonators and Nb dissipationless RF-SQUIDs are designed, fabricated, and characterized.
- Measured $Q_s$, unloaded $Q_s = 3 \times 10^6$ – $Q_c = 3 \times 10^7$ at 0.1 K with removal of amorphous SiO$_2$ on top.
- This $Q_s$ value is much higher than $Q_c$ of Nb ever reported in the world.
- At least, $Q_s$ of NbN is 10 times as large as $Q_c$ of Nb available in AIST.
- For readout of fast X-ray TES array with 1 MHz signal bandwidth/pixel, $Q_s \approx 10^7$ is enough from view point of the decrease of the contribution of noise originated from cryo. HEMT amplifiers.
- Shift of experimental resonant circles on the complex $S_11$ plane from theoretical ones can be quantitatively compensated by using FPGA-based readout approach through the 50-Ω feed line.
- FPGA-based 300-K electronics are developed. Flux-ramp modulation with 60-kHz saw-tooth signal linearizes the input-output characteristics. Dynamic range, linearity, and cross talk between neighboring pixels are evaluated at 4 K.

Acknowledgement

Fruitful discussion with H. Sasaki1, Y. Sato1, M. Ohno1 and H. Takahashi2.
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S. Kohjiro1, F. Hirayama1, H. Yamamori1, S. Nagasawa1, D. Fukuda1, A. Sato1, M. Hidaka1, T. Irimatsugawa2
1 National Institute of Advanced Industrial Science and Technology (AIST), Japan
2 The University of Tokyo, Japan
s-kohjiro@aist.go.jp

FPGA-based 300-K Electronics for Linearized Readout

Microwave Transmission @ 0.1 K vs. 4 K

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