Study on the Cooper-pair transistor as a fast supercurrent switch

The University of Electro-Communications, ◦ (D) Jutarat Tanarom, Hiroshi Shimada

E-mail: tanaromj@gmail.com

The Cooper-pair transistor (CPT) is expected to perform as a fast supercurrent switch when it is operated on the supercurrent branch of the current (*I*) -voltage (*V*) characteristic near zero voltage [1-3]. However, the maximum supercurrent through the CPT is quite low (typically, < 100 nA) when compared with other superconducting electronics technologies. In order to combine them with other superconducting electronics, the difference in the current level is to be addressed.

In this study, we examined the scalability of the supercurrent that could be gate-modulated for parallel *N* CPTs having a common gate electrode, in the range $1 \leq N \leq 100$. The devices were composed of $Al/Al_xO_y/Al$ junctions of the size approximately 200 nm × 100 nm, and the common gate consisted of an Al electrode with a thick oxide layer on it lain beneath the island electrodes. The measurement was performed at 75 mK with a compact dilution refrigerator. The *I* - *V* characteristics and the gate modulation of the supercurrent of the parallel CPT's were measured. Figure 1 shows the increase in the maximum supercurrent as a function of *N*. The magnitude of the supercurrent could be scaled up with parallel multiple CPT's. However, as can be seen in Figure 2, the width of the current peak in the Coulomb oscillation of the supercurrent increased considerably with the increase in *N*. This is considered due to the random offset charges, possibly, in the gate oxide, tunnel barriers, etc. We estimated the distribution of the magnitude of the random offset charges with a simulation assuming a Gaussian distribution of it.

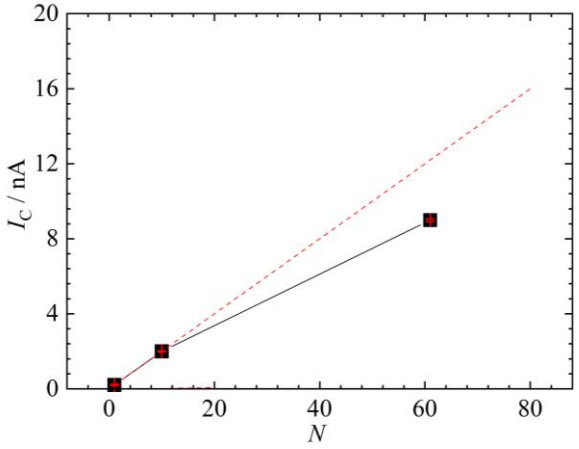

Fig. 1 Measured supercurrent I_c as a function of the effective number *N* of CPTs

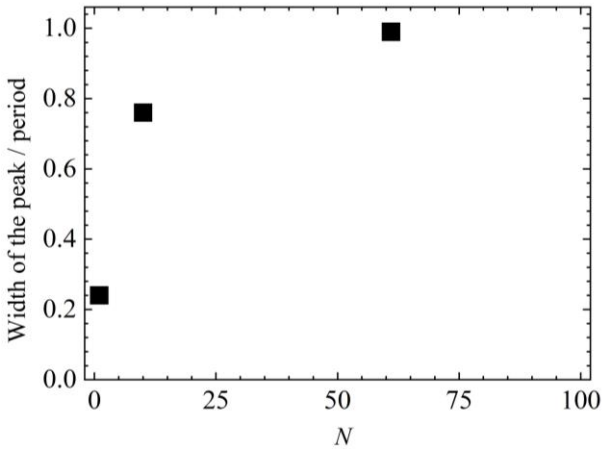

Fig. 2 The dependence of the Coulomb oscillation peak width on the effective number *N*

[1] K.A. Matveev, M. Gisselfalt, L.I. Glazman, M. Jonson, R.I. Shekhter, PRL. **70**, 2940 (1993)

[2] L.I. Glazman, F.W.J. Hekking, K.A. Matveev, R.I. Shekhter, Physica B **203**, 316 (1994)

[3] A.B. Zorin, PRL **76**, 4408 (1996)