Improvement of the high temperature superconducting properties for the HTc SQUID current meter

T. Watanabe,[*1] I. Watanabe,[*1] and U. Widyaiswari[*1]

To measure the DC current of heavy-ion beams non-destructively at high resolution, we have developed a high critical temperature (HTc) superconducting quantum interference device (SQUID) beam current meter for use in the radioactive isotope beam factory (RIBF). Aiming at its practical use, the HTc SQUID monitor was installed at RIBF and a 1 μA heavy ion beam was successfully measuried with 100 nA resolution with this current meter.[1,2)]

Although we could measure the intensity of a sub-μA beam, a minimum current resolution of more than two orders of magnitude lower is required at the RIBF. With the aim of higher sensitivity and miniaturization of the SQUID current meter, we have started the investigation on a new method. Figure 1 shows a new scheme based on a direct coupling between an induced magnetic flux and the HTc SQUID.[3)] To fabricate an induction ring and a shielding ring, we have been investigating to coat and molten a thin layer (20–50 μm) of Bi_2-Sr_2-Ca_1-Cu_2-O_x (Bi2212) on a Ag substrate. The critical temperature of Bi2212 must be over 77 K, because it is cooled at a temperature of liquid N_2. To confirm the high critical temperature and to realize the high critical current which is related to the shielding effect of the environmental magnetic noise, we have been improving the superconducting properties. We found the properties of Bi2212 are improved by annealing it in the high purity Ar atmosphere. To obtain the better Bi2212 properties, we searched the critical temperature and critical current with a magnetic property measurement system by changing the annealing temperatures and annealing time. The measured results are shown in Fig. 2 and summarized in Table 1. The critical temperatures and critical current were greatly improved by annealing at the temperature of 723 K for 24 hours in the the high purity Ar atmosphere. Currently, the Ag substrates of the induction ring and shielding ring are being coated and molten. Furthermore, a large quartz glass container used for the annealing is also being fabricated.

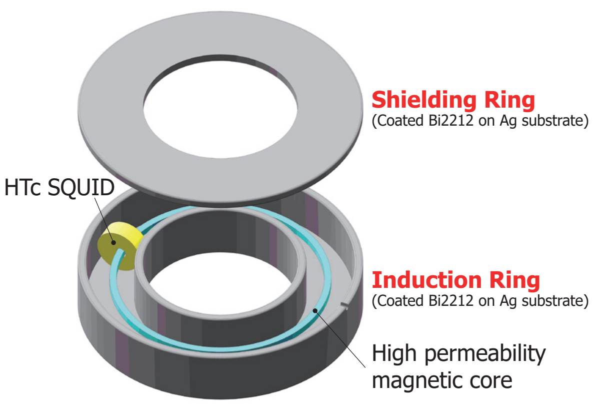

Fig. 1. A new scheme based on a direct coupling between an induced magnetic flux and the HTc SQUID.[3)]

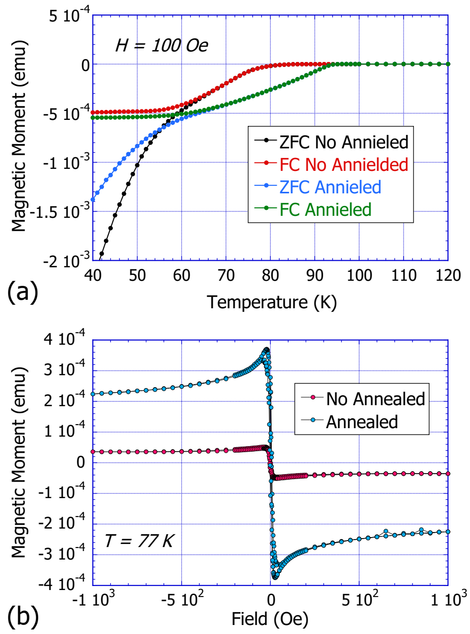

Fig. 2. Measured properties of the Bi2212 with a magnetic property measurement system.

Table 1. The obtained critical temperatures and critical currents.

	Anneiled	No anneiled
Critical temperature (K)	96	82
Critical current (A/cm^2)	422	83

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*1 RIKEN Nishina Center

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