§30. Application of Advanced High-temperature Superconductors for Fusion Plasma Experimental Devices

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Progress on a high temperature superconductor YBCO tape is quite promising, and a long tape with a few hundreds meters has been developed. However, the fabrication for coil winding seems to be premature, and there are no applications for fusion plasma devices. Here we are trying to apply a YBCO tape for a levitated superconducting coil device Mini-RT, so as to improve the plasma performance. In addition, we are exploring a feasibility of YBCO coils for a large device such as a LHD for the future application.

At first, we have introduced two following YBCO tapes.

Table I. the specification of YBCO tapes.

Provider	AMSC	ISTEC/SRL Nagoya
Critical current	70-80 A	210 A
Width	4.35 mm	10 mm
Thickness	0.20 mm	0.12 mm
Length	50 m	10 m

By using these tapes we have successfully fabricated a coil with a diameter of ~ 70 mm, in which a pancake winding is employed. The solder is used for the tape connection, and a joint resistance is measured to be ~ 24 nΩ.. The coil is cooled with a field cooling method by liquid nitrogen, and the persistent coil current is excited with an induction method. The current decay of the persistent current has been measured for these coils, and a typical data are shown in Fig. 1. It is found that the decay time is roughly consistent with the joint resistance at the solder region.

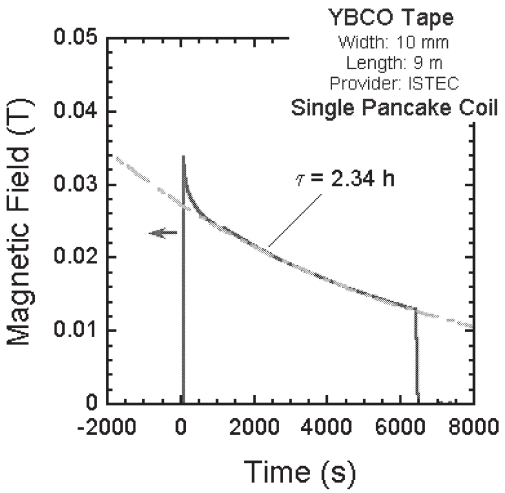

Fig. 1 A decay of a persistent current of YBCO coil with an ISTEC/SRL tape.

Next we have started a feasibility of a YBCO coil for a correction coil in the LHD. Present correction coil is made of copper, and located outside the cryostat. If the high temperature superconducting coil could be introduced for the correction coil, the flexibility of plasma experiments would be dramatically improved, because the HTS coil could be mounted inside the cryostat, and the passive and active control of the correction field would be available.

Here we have considered several cases for the winding; e.g., single tape, two tapes and five tapes cases. In Table II the specification of five tapes is summarized.

Table II. The specification of the HTS coil for the LHD correction coil, where five tapes in parallel are employed.

Superconductor	YBCO or Bi-2223
Nominal current (w. 5 tapes)	1000 A
Number of turns	400
Coil diameter (ID/OD)	690 / 910 mm
Number of double pancakes	2
Total tape length	~5 km
Stored energy	110 kJ
Max. field at the conductor	3.2 T

Figure 2 is a schematic drawing of the HTS coil, and the detailed cross section of the coil. The double pancake is adopted for the coil packing, and the stainless steel or aluminum is used for the coil casing. The maximum field is estimated to be 3.2 T at the coil region. When the persistent current switch would be introduced in this coil system, not only the passive but also the active controls of the correction coil current could be available.

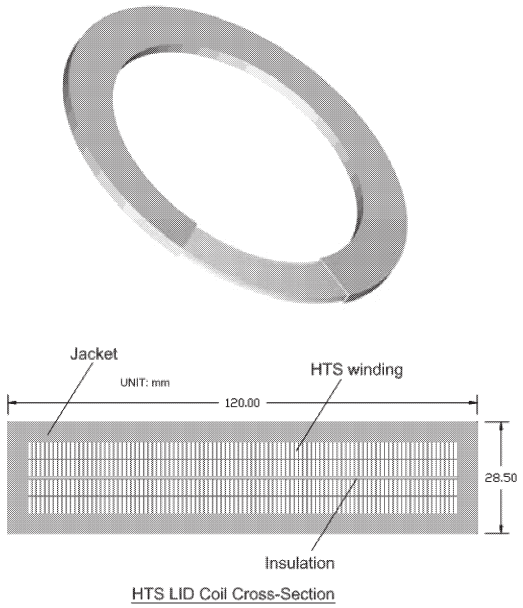

Fig. 2 A schematic drawing of the HTS coil and the cross section of the coil winding.