§24. Fabrication of REBCO Coil and Application for Fusion Plasma Experimental Device Mini-RT

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Plasma confinement experiment has been conducted with Mini-RT, which has high temperature superconducting floating coil made of Bi2223 tape. Now we have designed and fabricated a new HTS coil with a next-generation REBCO tape, which is called Mini-RT/Re, so as to improve the performance of the floating coil, and to establish a fabrication technique of REBCO coil for fusion reactor development.

The technology of REBCO coil has some challenges. One of those challenging issues is a generation of a hot spot at the quench phenomenon, because of a poor heat conductivity and vulnerability to peeling for the REBCO tape. The heat treatment of the hot spot during the quench is important to prevent damage to the coil. As a countermeasure for preventing hot spots in the windings, we have pasted the 0.1mm thick copper to REBCO tape, to suppress the temperature rise when the wire rod transits to normal conducting. Furthermore, in the persistent current operation mode, when a part of winding in the coil transits to normal conducting. With the aim of improving the heat conductivity of the coil, we have sandwiched pure aluminum sheet between the coil winding and the coil frame, and designed to prevent local concentration of heat and non-uniformity of temperature rise, as shown in Fig. 1.

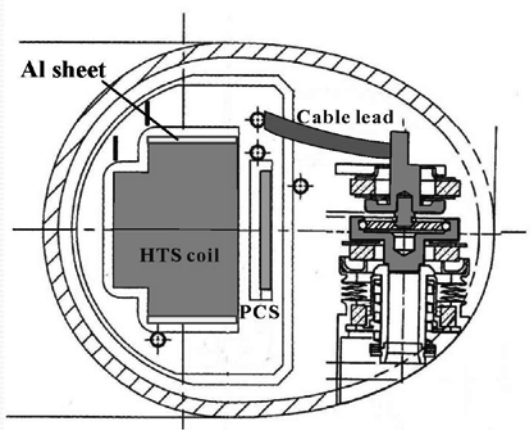

Fig. 1. Schematic drawing of Mini-RT coil

In addition, we designed the PCS coil with a REBCO tape. In the present PCS of the Mini-RT, since manganine wire heater is wound between the coil and the frame, one side of the PCS is heated, resulting in the non-uniform temperature rise, as shown in Fig. 2(a). In order to improve the ON-OFF property of PCS, a sheet-like heater made of SUS304 was introduced so as to improve the uniform heating of PCS. The PCS and heater are co-wound in the Mini-RT/Re, and it

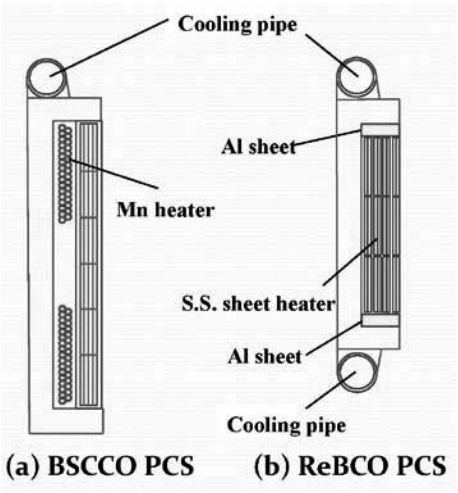

Fig. 2 Comparison of PCS between BSCCO and REBCO

has been improved so that the uniform temperature rise. To improve the cooling of the experiment, cooling channel was also changed. The cooling pipe of the PCS in the current Mini-RT is attached only to the top, while, that of the Mini-RT/Re is attached to the top and bottom, improved cooling capacity.

A typical characteristics of Mini-RT/Re is listed in Table I, in comparison with the present Mini-RT. A fabricated main coil and PCS is shown in Photo 1.

Table I. Specifications of BSCCO and REBCO coils in the Mini-RT

	BSCCO	ReBCO
Major radius	150mm	149.3mm
Minor radius	16.2mm	16.0mm
Conductor	Bi-2223	REBCO
width	4.3mm	4.32mm
thickness	0.26mm	0.2mm
Ic(A) at 77K,sf, 1μV/cm	100A	216~233A
Tc	113K	92K
Total turn	428	552
Total length	403.4m	517m
Operation current	117A	100A
Magnetomotive force	50kA	55.2kA
Inductance	0.0876H	0.144H
Stored Energy	598J	720J

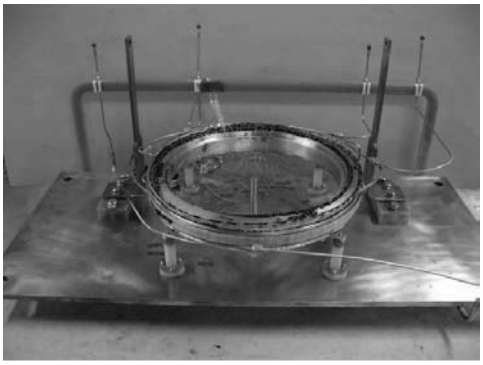

Photo 1. Photograph of REBCO coil and PCS