§12. Analysis of Superconducting Properties of MgB_2 Superconducting Wires under Liquid H_2 Temperature

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The construction of the lower carbon society has been closed up largely as part of the restraining the warming of earth's atmosphere. The nuclear-fusion power generation is one of the clean energy sources in the lower carbon society. We have proposed that the simultaneous transport both superconducting power transmission and liquid hydrogen as the new energy sources, which is so-called "Hybrid Energy Transfer Line (HETL)". In the view points of the social restore of the fusion technology, we have developed Cu addition MgB_2 superconducting cable made in NIFS under liquid hydrogen temperature (20 K). In this study, I_c-B performances of Cu addition MgB_2 wire under various temperatures from 4.2 K to 30 K were measured to investigate high J_c around high temperature region.

We prepared Cu addition MgB_2 wire via low-temperature diffusion process [1], and it was the influential candidate material for the HETL. The feature of the Cu addition MgB_2 wire via low-temperature diffusion process is higher J_c property below magnetic field of 4 T compared with Nb-Ti alloy wire. In the large current superconducting cable such as HETL, the transport I_c performance is important factor compared with magnetic field property. We investigated the transport I_c property under high temperature region around 20 K on the Cu addition MgB_2 wire synthesized with the low-temperature diffusion process made in NIFS. In the evaluation of transport I_c property under the high temperature region, we used 15 T superconducting magnet system installed variable temperature insert (VTI) in Tsukuba magnet laboratory of National Institute for Materials Science (TML-NIMS). The schematic view of the transport I_c – magnetic field (B) measurement system under the high temperature region is shown to Fig.1. Transport I_c-B measurements were carried out at 4.2 K, 5 K, 10 K, 15 K, 20 K, 25 K and 30 K, and transport I_c criterion is defined to 1 μV/cm. The temperature control in the VTI system carried out by the cooling He gas and conductive heater and temperature sensor such as cernox put in sample probe and needle valve of VTI system.

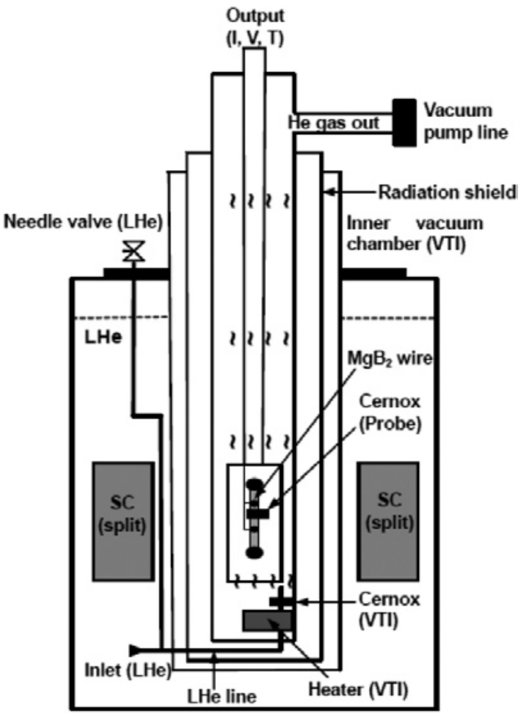

Fig.1 The schematic view of the transport I_c measurement system under the high temperature region

Fig.2 shows that transport I_c – temperature – magnetic field property of the Cu addition MgB_2/Ta/Cu multifilamentary wire. The number of sub-elements in MgB_2 multifilamentary wire is nineteen, and its diameter has also 1.04 mm. Transport I_c-B property of MgB_2 multifilametary wire was decreased with elevating temperature from 4.2 K to 30 K. However, transport I_c value over 100 A at high temperature region such as 20K, 25 K and 30 K was obtained under lower magnetic field around 1 T. Furthermore, in the conceptual design of 10 kA class HETL, the critical current density of superconducting wire was offered to 50 A/mm^2 [2]. This suggested that the results of fig.2 were satisfied with the conceptual design of 10 kA class HETL and the prospect for the 20 K operation superconducting cable observed by the applying MgB_2 wire.

[1] Y. Hishinuma et.al, SUST, **20** (2007), p.1178-1183
[2] S. Yamada et. al, 2008 *J. Phys.: Conf. Ser.* **97** 012167

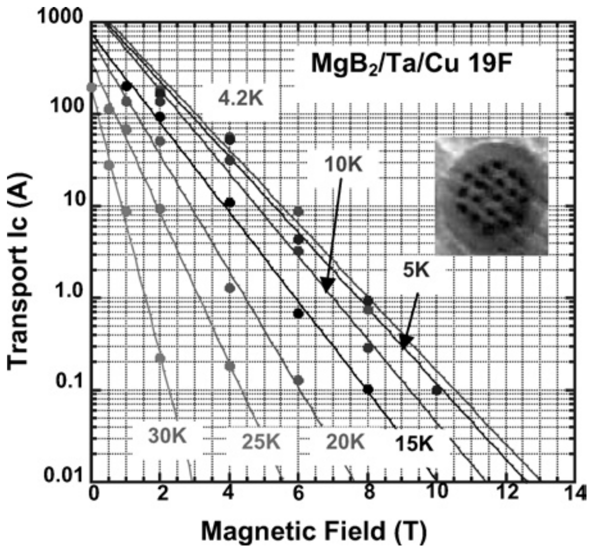

Fig.2 Transport I_c-Temperature (T)-Magnetic field (B) property of the Cu addition MgB_2/Ta/Cu multifilamentary wire.