§13. Superconducting Properties of Cu Addition MgB_2 Superconducting Wires under Liquid Hydrogen Temperature

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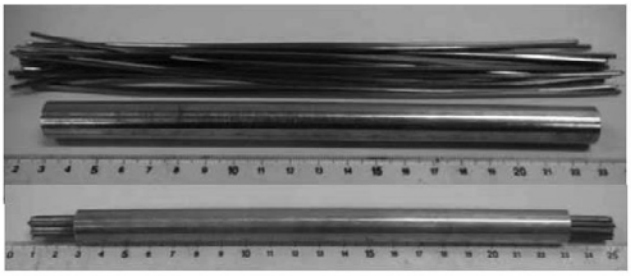
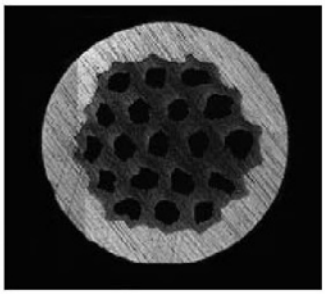
The construction of the lower carbon society has been closed up largely as part of the restraining the warming of earth's atmosphere. The nuclear-fusion power generation is one of the clean energy sources in the lower carbon society. We have proposed that the simultaneous transport both superconducting power transmission and liquid hydrogen as the new energy sources, which is so-called "Hybrid Energy Transfer Line (HETL)" [1]. 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 [2], 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.



MgB_2/Ta/Cu long precursor wire having 19 filaments

Before wire deformation



Final wire deformation

Fig.1 Photographs of the MgB_2/Ta/Cu long precursor wire having 19 filaments and cross-section of multifilamrntary long wire (d=1.04mm)

Fig.1 shows the photographs of the MgB_2/Ta/Cu long precursor long wire having 19 filaments and cross-sectional area of 50 m long multifilamentary wire. At first, we prepared Cu addition MgB_2/Ta wire mono-cored wire. MgB_2/Ta/Cu long precursor composite was made by the stacking mono-cored wire into the Oxygen Free Cu tube. The number of sub-elements in MgB_2 multifilamentary wire is nineteen. We carried out the wire deformation from 14 mm ϕ to 1.04 mm ϕ (reduction rate; 99.45 %) and succeeded to fabricate 50 m long MgB_2/Ta/Cu 19 multifilamentary wire without the wire breaking (see fig.1). A few intermediate annealing (400℃ for 2 hours) under Ar atmosphere was effective to soften the Ta matrix of MgB_2/Ta/Cu wire.

Considering of the large conductor configuration such as HETL, Cable in condit Conductor (CICC) is suitable for large current conductor type. However, J_c-B measurement using liquid hydrogen is difficult from the view point of the safety. We measured the J_c property estimated by magnetic hysteresis loop and Bean model (so called "Magnetization J_c"). Generally, magnetization J_c is calculated by the width of the M-H loop hysteresis and the volume fraction of the sample. Typical M-H loop curves of Cu addition MgB_2 multifilamentary wire under the various temperatures are shown in Fig.2. The magnetic field was applied from + 3 T to – 3 T. In the HETL design [1], applied magnetic field was estimated about 0.5 T. We confirmed that flux jumping around lower magnetic field such as 0.5 T was not appeared by the use of Ta matrix. It suggested that superconducting property of MgB_2/Ta wire was stable under the magnetic field. The magnetization J_c estimation was undergoing.

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

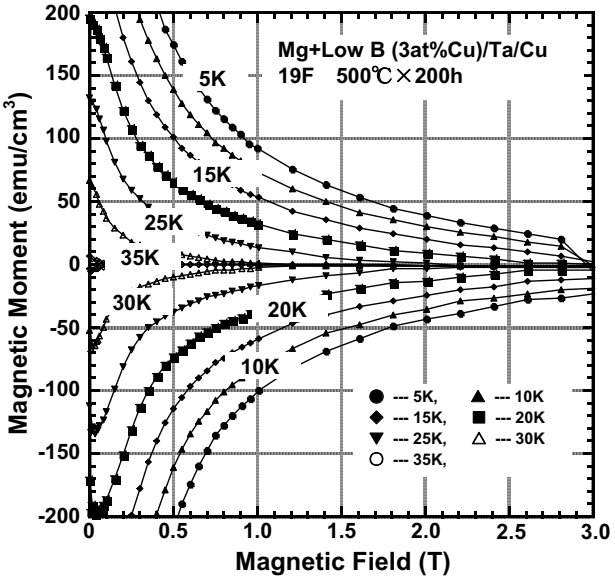


Fig.2 Typical M-H loop curves of Cu addition MgB_2/Ta/Cu multifilamentary wire under various temperatures.