§8. Investigation of Cu Addition MgB_2 Superconducting Long Wire Deformation and Strain Sensitivity Evaluation System of J_c Property

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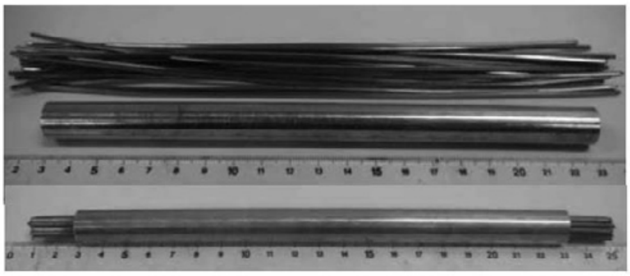
The construction of the lower carbon society has been closed up largely as part of the restraining the warming of earth's atmosphere. The nuclear-fusion power generation is one of the clean energy sources in the lower carbon society. We have proposed that the simultaneous transport both superconducting 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 proposed large power transmission cable operated under liquid hydrogen temperature (20 K). This cable will be fabricated by the Cu addition MgB_2 superconducting cable made in NIFS [1]. The conductor design will be assumed by the base design of bus-line in LHD. Recently, we succeeded to develop the 100 A class MgB_2 superconducting wire above liquid hydrogen temperature (20 K).

We tried to fabricate the 50 m long class Cu addition MgB_2 /Ta/Cu multifilamentary wire and studied about the optimum wire deformation condition on Cu addition MgB_2/Ta/Cu precursor composite. 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 Oxgen Free Cu tube (OD:14 mm, ID: 10 mm, L; 200 mm). 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 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.

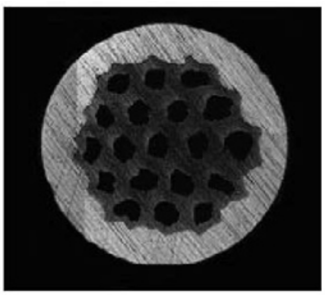
It is necessary to evaluate strain sensitivity on J_c property of MgB_2 wire in case of conductor configuration of the large current superconducting cable such as HETL. In order to evaluate strain sensitivity on J_c property, we investigated and fabricated the bending strain impressed J_c measurement probe inserted 18 T superconducting magnet Tsukuba magnet laboratory of National Institute for Materials Science (TML-NIMS). Generally, it is well known that the Walter spring method was used to evaluate the strain sensitivity in J_c property of A15 compound and high T_c superconducting wires and tapes. The schematic design of the Walter spring coil and the trial fabrication of the spring coil are shown to Fig.1. MgB_2/Ta/Cu multifilamentary wire was wrapped the Walter spring coil, and then this wire was fixed by the soldering. This spring coil was connected the measurement probe. This spring coil was twisted by the driving force of the stepping motor, and the bending strain was applied MgB_2 wire by the twisting of the spring coil. The material of spring coil was used to the beryllium copper alloy because its elastic modulus is larger compared with MgB_2 wire.

In the feature, we will investigate bending strain and flexural structure effects of MgB_2 wires using Walter spring system. This knowledge will contribute the conceptual design of 10 kA class HETL and the prospect for the 20 K operation superconducting cable.

[1] Y. Hishinuma et.al, SUST, **20** (2007), p.1178-1183



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)

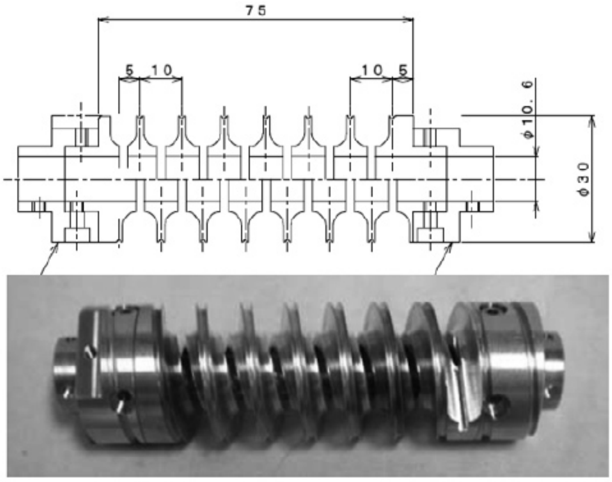


Fig.2 The schematic design of the Walter Spring coil and the trial fabrication of the spring coil.