§4. Analysis of T_c, J_c and H_{c2} Properties for Low Activation Superconducting Wires

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It is necessary to investigate various superconducting properties of candidate superconductors for the realizing an advanced superconducting magnet of the fusion reactor beyond the ITER project. In the view point of the fusion reactor, low activation property, which was mentioned to reuse and recycle easily due to the short decay time of radioactivity, of the superconducting magnet was also one of the important factors as well as "high magnetic field". V-based and MgB_2 compound superconductors were non Nb-based superconductor and also corresponded to the "low activation superconductors". Especially, the superconductivity of MgB_2 compound was discovered in Japan since 2001, its superconductivity will be not understood expect the higher critical temperature (T_c) of 39 K and simple binary chemical composition. In the future applications, we think that MgB_2 wire is suitable to apply for 20 K option of nuclear fusion reactor. And we studied about the critical current density (J_c) properties of the MgB_2 wires in high magnetic fields under the various temperatures such as 4.2, 10, 15 and 20 K.

In the previous study, we investigated the small amounts of Cu addition effect using Mg_2Cu compound into the MgB_2 mono-cored wires made by the PIT process, and it was clear that Cu addition enhanced J_c-B property remarkably. For the further improvement, we tried to fabricate Cu additional MgB_2/Ta/Cu multifilamentary wires via same PIT process. The typical SEM image of the cross-sectional area of Cu addition MgB_2 19 multifilament wire is shown in Fig.1. In this study, J_c property under the high magnetic field was measured by using various High-Field Superconducting Magnet systems in Tsukuba Magnet Laboratory of National Institute for Materials Science (TML-NIMS). The temperature was controlled by the heat exchange between a liquid He and flow of cold He gas. Fig.2 shows that the transport current (I_c)- magnetic field (B) –Temperature (T) dependence in the MgB_2/Ta/Cu 19 multifilament wire. The data of 4.2 K in liquid He is also shown for comparison. The both data at 4.2 K between gas and liquid cooling was agreed well above 4 T, and temperature control by He gas was available technique in the system. Transport I_c of multifilametary wire was lower than that of mono-cored wires, however core J_c was improves drastically due to the MgB_2 core are reduction. We studied about not only T-H-J property but also bending strain effect on transport I_c in MgB_2/Ta/Cu multifilamentary wire using this system. I-V curves of the MgB_2 19 multifilamentary wire with simple bending fixture is shown in fig.3. We observed clearly the lowering of I_c value by the bending strain.

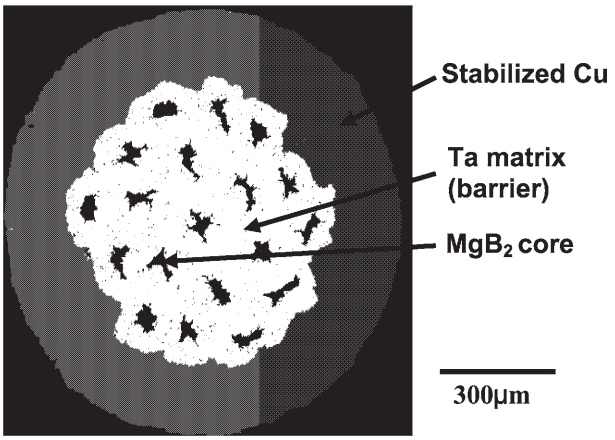

Fig.1 Typical BSE image on the cross-section of the MgB_2/Ta/Cu PIT 19 multifilament wire.

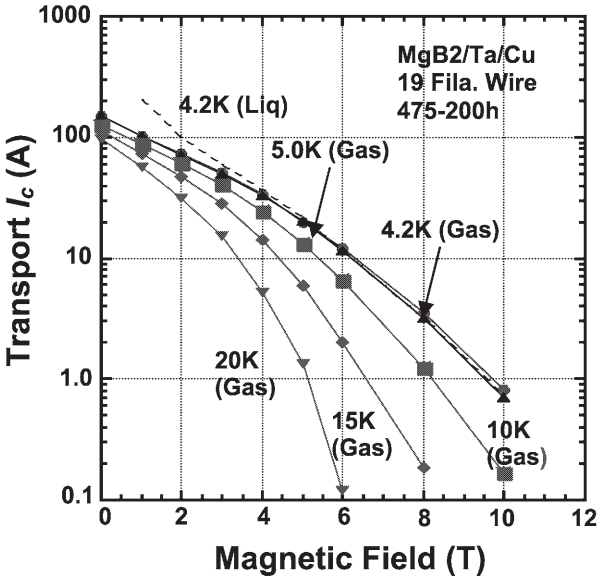

Fig.2 I_c dependence on the temperature in the MgB_2 /Ta/Cu PIT 19 multifilamentary wire.

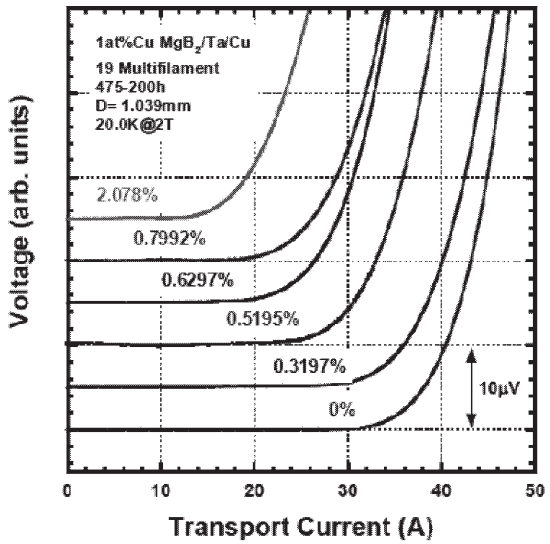

Fig.3 I-V curves of the MgB_2/Ta/Cu PIT 19 multifilament wire with simple bending fixture (20K@2T).