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

Hishinuma, Y., Takeuchi, T. (NIMS)

For an advanced superconducting magnet of the fusion reactor beyond the ITER project, it is necessary to investigate various superconducting properties of candidate superconductors. In the view point of the fusion reactor, we thought that superconducting magnet also had "low activation" property as well as "high magnetic field". V-based and MgB_2 compound superconductors was non Nb-based superconductor and their decay times of induced radioactivity were shorter compared with Nb-based superconductor. 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. In this study, we studied about the critical current density (J_c) properties in high magnetic fields under the various temperatures such as 4.2, 10, 15 and 20 K.

Small amounts of Cu addition MgB_2 compound mono-cored wires were made by the PIT process using Mg (99.9%, -200 mesh), Mg_2Cu compound and amorphous B powders (99.9%,-submicron). Mg_2Cu compound was used as Cu additional source material. The cross-section image of Cu addition MgB_2 mono-cored 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 mono-cored wire. The data of 4.2 K in liquid He is also shown for comparison. The both data of 4.2 K between gas and liquid cooling was agreed well above 4 T. In the case of gas cooling, disordering of the heat balance via high transport current under the low magnetic field was caused in the measurement system. The ohmic tendency which converged on around 100 A at the transport current value was observed on the above 10 K. This is also caused by the disrupture of the heat balance. We thought that the transport I_c in the low magnetic field may be higher than that of fig. 2. From the Kramer formula of fig. 2 and T_c measurement, the critical magnetic field property of MgB_2/Ta/Cu mono-cored wire was estimated. The temperature dependence of the magnetic field in the MgB_2 wire is shown in fig.3. T_c of the sample was 36.5 K was confirmed by the four probe T_c measurement. We observed that $H_{c2}(0)$ of the sample was about 13.5 T from the fig.3. This value was lower than MgB_2 single crystal.

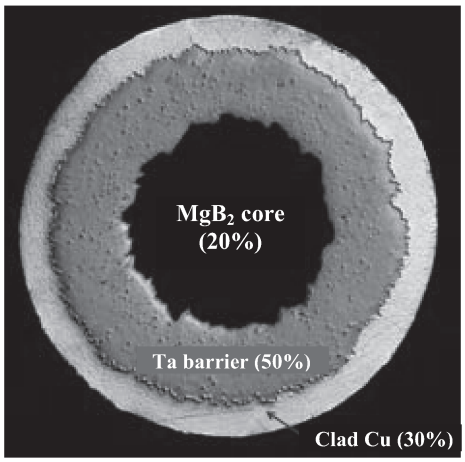

Fig. 1 Typical Optical microscopic image on the cross-section of the MgB_2/Ta/Cu PIT wire.

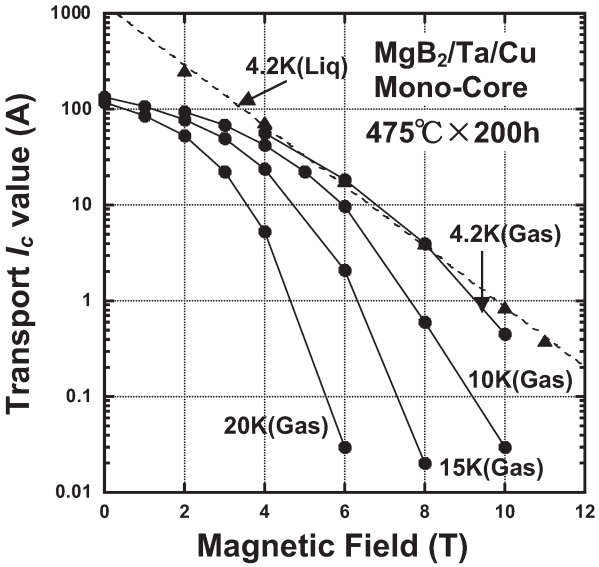

Fig. 2 I_c-B-T dependence in the MgB_2/Ta/Cu wire.

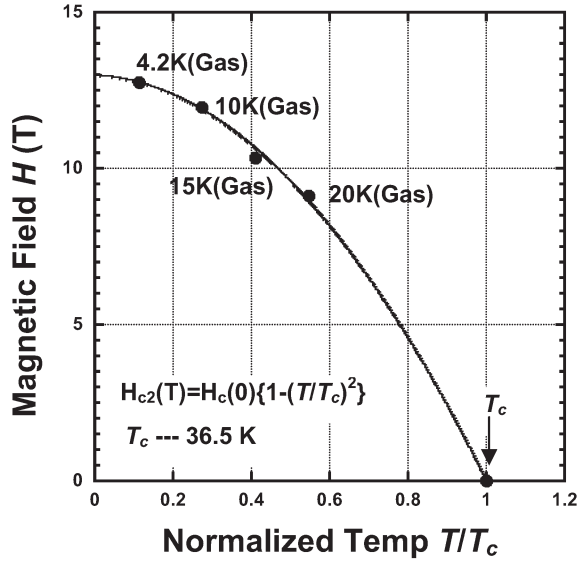

Fig. 3 Temperature dependence of the magnetic field in the MgB_2/Ta/Cu PIT wire.