§8. Analysis of J_c Properties in High Magnetic Fields for Low Activation Superconducting Wires

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

It is necessary to consider the neutron irradiation effect on superconducting magnets of an advanced fusion reactor. V-based alloys and MgB_2 compound may be apply for a future fusion magnet because they have shorter decay time of induced radioactivity.

As the first trial to research V-based and MgB_2 superconducting materials for fusion application, we selected Laves phase (V_2(Hf,Zr)) and V_3Ga compounds as V-based low activation superconducting materials because they have high upper critical magnetic fields (H_{c2}) above 20 T and better mechanical property than Nb-based compound. The mechanical property of superconducting wire is very important when large scaled magnet is constructed. The advantages of MgB_2 compound for a future fusion application are not only low activation but also high T_c (39 K) and low cost. The wire fabrication process of MgB_2 is very simple compared with the other superconducting materials. However, critical current density (J_c) properties of V-based and MgB_2 compound superconductors are lower than those of Nb-based superconductors such as Nb_3Sn and Nb_3Al at present, J_c properties of them must be improved in order to apply for fusion reactor.

We have studied the new wire fabrication process of V_2(Hf,Zr), V_3Ga and MgB_2 compound wires having low activation sheath materials in order to improve J_c properties, and investigated the possibility of the application for a future fusion magnet based on J_c property under the high magnetic field. J_c measurements under the high magnetic field were carried out using 18T class High-Field Superconducting Magnet system in Tsukuba Magnet Laboratory of National Institute for Materials Science (TML-NIMS) shown in Fig.1.

The present status of J_c-B performances of V-based and MgB_2 compound superconducting wires in our researches are shown in Fig. 2. Typical present J_c values of various Nb-based and MgB_2 compound wires are also shown for the comparisons[1)-3)]. J_c properties of V-based compounds in our research are lower than those of Nb-based compounds at present, but J_c properties of new wire fabrication process in this study were improve compared with conventional process in each case. We thought that V-based superconducting materials had higher potential to J_c improvement though the progress of further process optimization and V_3Ga compound showed clear possibility of candidate materials for Nb-system superconductor, especially.

J_c properties of MgB_2 compounds in our research (Cu addition) are lower than SiC doped MgB_2 compounds under the magnetic field above 10 T. However, J_c property of Cu addition MgB_2 wire was higher than SiC doped MgB_2 under the low and middle magnetic field below 6 T. MgB_2 compound have possibility of alternative materials as Nb-Ti alloy wire for "Low activation superconducting magnet" by the progress of further J_c improvement.

Fig.1 18T class High-Field Superconducting Magnet in Tsukuba Magnet Laboratory of National Institute for Materials Science (TML-NIMS)

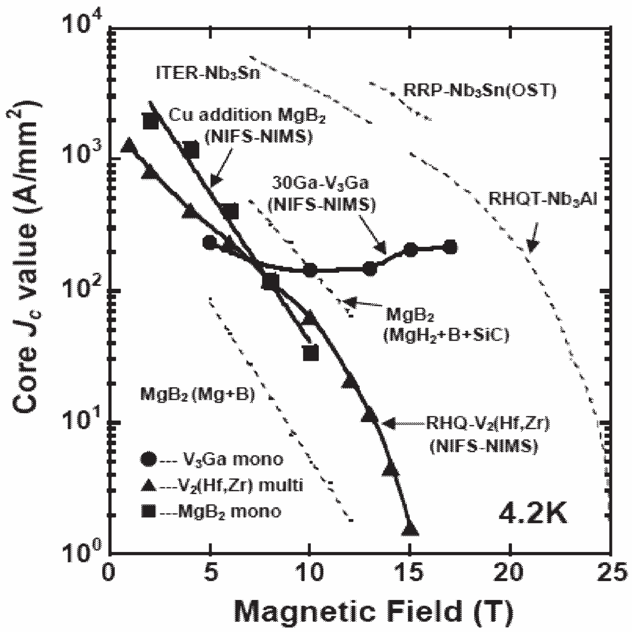

Fig.2 The present status of J_c-B performance on V-based and MgB_2 compound wires in this study.

References

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