§9. High Magnetic Field Property of V_3Ga Compound Multifilamentary Wire Using High Ga Content Compound

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V_3Ga compound is one of the attractive low activation materials for high magnetic field superconducting magnet in the several V-based compounds because V-based superconducting materials have shorter decay time of induced radioactivity and high field property above 20 T. V_3Ga compound has not only high upper critical magnetic fields (H_{c2}) above 20 T as well as Nb_3Sn but also better mechanical property. However, the present critical current density (J_c) property of V_3Ga compound wire is insufficiency to apply for large high field magnet such as fusion application. In the previous study, V_3Ga compound wire was mainly investigated "Diffusion process" between Cu-Ga solid solution matrix within 20 at% Ga composition and V filament. Recently, we investigated the new route PIT process using high Ga content Cu-Ga compound to fabricate V_3Ga mono-cored and multifilamentary wires in order to increase a volume fraction of synthesized A15 phase. It was confirmed that the thicker V_3Ga layer formed along the boundary of Cu-Ga powder core and V matrix compared with previous diffusion processed mono-cored wire. In this paper, we fabricated the V_3Ga multifilamentary wires through the new route PIT process using various high Ga content compounds and their high magnetic field properties were reported.

The various high Ga content Cu-Ga compound ingots were made by the Tammann dissolution in Ar atmosphere using pure metal Cu foil (99.9%) and granular metal Ga (99.999%). The compositions of Cu-Ga compound ingots were 30, 40, 50 and 64 at%Ga respectively. And their ingots crushed and ground by hand-milling. The prepared Cu-Ga compound powders were packed tightly into a high pure metal V sheath tube having 10 mm outer diameter and 6 mm inner diameter. The precursor mono-cored wires were fabricated through the Powder-In-Tube (PIT) process. Wire drawings were carried out using grooved roller and cassette roller dies. The mono-cored wire was cut into short pieces, and they were stacked into a V tube. The numbers of stacked mono-cored wires were 19, 55 and 121 pieces. These stacked composites were carried out wire drawing as well as mono-cored wire, and then multifilamentary wires also finally have 1.04 mm diameter. After the heat treatments, critical current (I_c) at 4.2 K were measured by using a DC four-probe method. H_{c2} and I_c (4.2K) measurements under high magnetic fields were carried out.

The typical R (Resistance)- B (Magnetic Field) curves of samples using high Ga content Cu-Ga compound are shown to fig.1. This measurement was carried out with ramping of magnetic field. The normal state transition from superconductivity was defined as decrease of 90% in the normal state resistance. The normal transition magnetic field was improved with increase of high Ga content of filament compound. The maximum transition field was estimated to be above 22 T when used the 50 at%Ga composition powder. The H_{c2} properties of the samples using high Ga content Cu-Ga compound based on the Kramer formula are shown to fig.2. The broken lines into the fig.2 were fitting lines calculated by the transition magnetic field from the fig.1. The H_{c2} value which was estimated by the Kramer formula and R-B property was also improved with increasing of the Ga content of the filament powder. We confirmed that H_{c2} property was improved about 23 T by the high Ga content of the precursor and its value was about 2.0 T higher than that of conventional processed samples when used the 50 at%Ga composition powder.

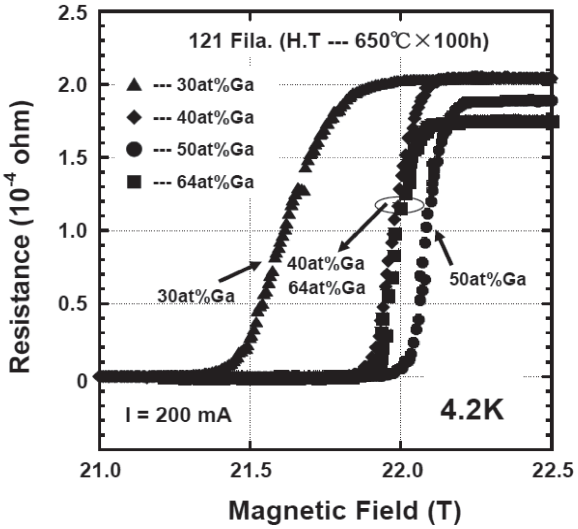

Fig.1 The typical R-B properties under the high magnetic field in the V_3Ga multifilamentary wires.

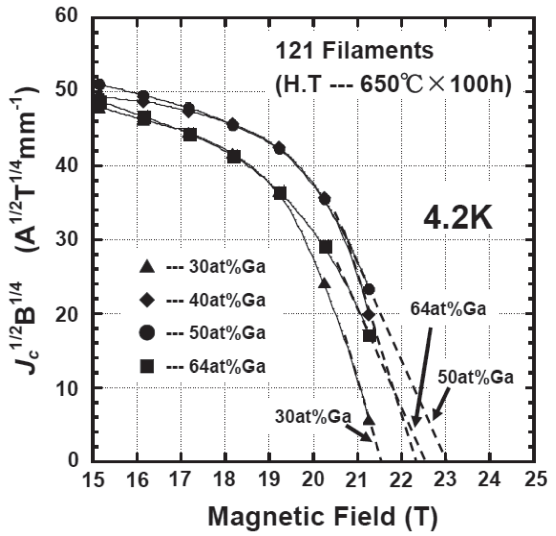

Fig.2 H_{c2} dependence of the Ga content into the Cu-Ga compound filaments on the V_3Ga multi-filamentary wires.