§27. Development of V_3Ga Superconducting Wires by Using V-Ga Compound as High Ga Source Material

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V_3Ga compound superconducting material is attractive in the several V-based compounds as high magnetic field and low activation superconducting wire materials. V_3Ga compound has high upper critical magnetic fields (H_{c2}) above 20 T as well as Nb_3Sn and then is better mechanical property than Nb_3Sn compound. Furthermore, V_3Ga compound was historically origin material to succeed development of "Bronzed process" on commercial Nb_3Sn wire. In the previous study, the wire process of V_3Ga compound was mainly investigated "Bronzed process" between Cu-Ga solid solution within 20 at%Ga composition and V filament. One of authors, Hishinuma et al., investigated that new route V_3Ga wire process synthesized by Powder In-Tube (PIT) process using high Ga content Cu-Ga compound powder above 20at%Ga. We also investigated that another PIT process using V-Ga binary system compound as the high Ga content compound.

A lot of the high Ga content phases were existed in the V-Ga binary system, and they were V_6Ga_5, V_6Ga_7, V_2Ga_5 and V_8Ga_{41}, respectively. In the view points of the wire drawing process, V_2Ga_5 phase was desirable material in these high Ga content phases due to the high melting point above 1000℃. V_2Ga_5 compound was made by arc-melting method, and arc-melting button was carried out solution heat treatment at 800℃. Typical back scattering electron microscopic image on the V_2Ga_5 compound after the solution heat treatment is shown in Fig.1. In the BSE image shown in Fig.1, two kinds of the V-Ga phases were formed. One is dark gray colored base matrix (1), another one is light gray colored dispersion precipitate into matrix (2). From the EDX and EPMA analyses, base matrix and precipitate were confirmed to the V_2Ga_5 and V_8Ga_{41} compounds. The arc-melting button after the solution heat treatment was crushed easily by hand-milling. V_2Ga_5 compound was packed into metal V tube and the composite

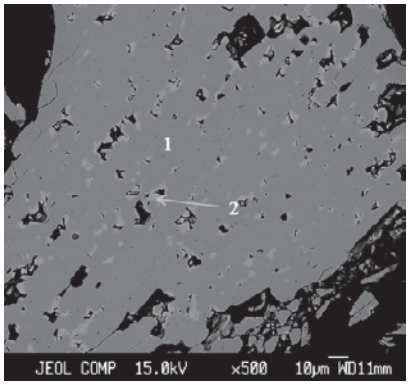

Fig. 1 Typical Back scattering Electron microscopic image on the V_2Ga_5 compound after solution treatment .

was carried our wire deformation, and then the diffusion pairs between V_2Ga_5 compound and metal V were prepared. And the other hand, Cu addition diffusion pair which was mixture of 10wt% Cu powder and V_2Ga_5compound was also prepared in order to study about Cu addition effect.

The comparions between heat treatment temperatures on the element distribution in diffusion layer by EPMA analysis are shown in Fig.2. At heat treatment of 700℃, V_3Ga phase did not form in diffusion layer, however V_6Ga_5 phase was mainly formed. Main phase into diffusion layer was changed V_3Ga from V_6Ga_5 with elevating of heat treatment. Furthermore, the volume fraction of V_3Ga phase was also increased with elevating of heat treatment. These suggested that optimum heat treatment temperature of V_2Ga_5/V precursor was higher than that of Cu-Ga/V precursor. Fig.3 shows that the element distribution into the diffusion layer on the V_2Ga_5+10wt%Cu addition /V precursor. From the comparison of Fig.2, the volume fraction of V_3Ga layer was increased remarkably by the 10wt% Cu addition. Additional Cu did not diffuse into the V_3Ga phase, and it was confirmed clearly that additional Cu promoted to form V_3Ga phase as well as conventional "Bronzed process" of Nb_3Sn and V_3Ga wire

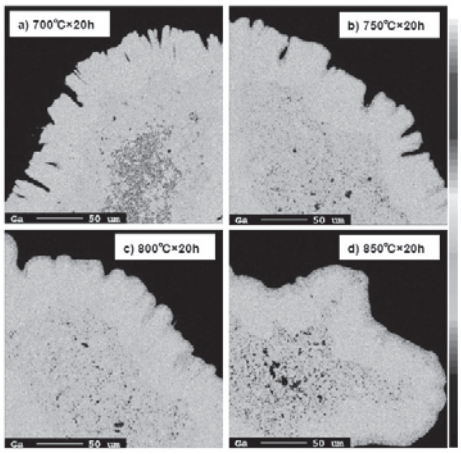

Fig.2 The heat treatment temperature effect of the Ga distribution into the diffusion layer on the V_2Ga_5/V precursor.

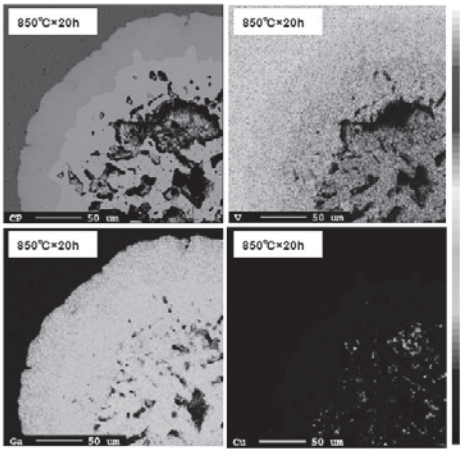

Fig.3 The element distribution into the diffusion layer on the V_2Ga_5+10wt%Cu addition /V precursor.