§23. Investigation of the Phase Transition in \( V_3Ga \) PIT Wires Using High Ga Content Cu-Ga Compounds

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\( V_3Ga \) compound superconducting wire will be desirable as a candidate material to realize “low activation and high magnetic field superconducting magnet” for an advanced fusion reactor. Recently, we succeeded in developing new \( V_3Ga \) mono-cored and multifilametary wires, fabricated via the Powder In-Tube (PIT) process using the high Ga content compounds including above 50at\%Ga composition with the aim of the \( J_c \) enhancement by the increase of \( V_3Ga \) volume fraction [1-2].

For the further \( J_c \) improvement, we have investigated the phase transition of \( V_3Ga \) phase via the high Ga content Cu-Ga compound/V matrix diffusion composite. In order to study about \( V_3Ga \) phase transition during diffusion reaction between high Ga content Cu-Ga compound and metal V, we constructed the in-situ phase transition observation system using the High-Temperature X-ray diffraction (HT-XRD).

The photographs of the sample holder and set-up of the HT-XRD system are shown in fig. 1. The sample holder was made from pure metal V plate having 8 mm of width, 90 mm of length and 2 mm of thickness. Sample holder had three pockets to pack the high Ga content Cu-Ga compound. The thermo couple was also attached by spot welding, and its signal was transmitted into the sample temperature controller of HT-XRD system. The sample holder was set up the goniometer having the two electrodes at both ends shown in fig.1 (b). The sample was heated by the electrical resistance, and the sample temperature was controlled by the output of transport current. The sample was heated in vacuum using turbo molecular pumping. We confirmed that the sample temperature in this system was able to elevate from room temperature to 1200 ℃.

Fig.2 shows that typical XRD patterns of Cu-64at\%Ga/V sample according to the sample temperature. It was clear that the Cu-64at\%Ga compound mainly consisted of the CuGa2 compound. Increasing of sample temperature at 400℃, the diffraction peak of CuGa2 was decreased. It suggested that decomposition of CuGa2 and release of liquid Ga were started because of the melting point of CuGa2 compound was around 250℃. After that, \( V_6Ga_5 \) and \( V_3Ga \) phases were appeared above 600℃. The released liquid Ga component would be reacted with metal V plate passively, and \( V_3Ga \) phase was formed via the \( V_6Ga_5 \) phase. We succeeded to construct the in-situ phase transition observation system using HT-XRD.

In the future, we tried to observe the other compound powders, and optimum heat treatment condition on the high Ga content compound diffusion process will be investigated.