§21. Investigation of Pure V/Ti Couple Diffusion Bonding by Hot-Pressing for an Advanced Breeding Blanket Fabrication

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Aluminum Nitride (AlN) is one of the promising insulator coatings for a liquid lithium (Li) breeding blanket system, because AlN has relatively good compatibility with liquid Li, high electrical resistivity and thermal conductivity and so on[1]. However, it is well known that that single-layer AlN coating easily produce various defects such as pores and cracks. Especially, the degradation of compatibility with liquid Li on AlN layer is obviously confirmed by the liquid Li penetration through these defects. This is mainly caused via the dissolution behavior of nitrogen (in AlN) into liquid Li. We approached to form the metal titanium (Ti) interlayer between the metal vanadium (V) alloy and AlN as the protective barrier material. This is due to the higher chemical potential of TiN against the metal Li at high temperature range, which is more stable than AlN.

According to the V-Ti binary equilibrium phase diagram, Ti is easily dissolved into the V at wide temperature range until 900 ^{o}C. That is to say, we think that the V/Ti bonding could be easily carried out though the hot-pressing process. In order to investigate the bonding property between pure V/Ti metals, the diffusion bonding experiment is carried out by the hot-pressing. The samples were made by pure metal V plate and Ti metal foil, and the samples were "V/Ti/V/Ti/V" sandwich structure. The original thickness of V plate and Ti foil are 0.9 mm and 0.08 mm, respectively. The raw materials were processed by conventional polishing before stacking them. This polishing process was to remove the oxidation layer on the surface of raw materials and reduce the roughness. The hot-pressing conditions for the diffusion bonding experiment between V and Ti are as follows in table 1.

Table. 1 The parameters of the Hot Pressing condition

Temp. *T* (^{o}C)	Time *t* (h)	Pressure *p* (MPa)	Vacuum *v* (Pa)
1200	1	20	5.0×10^{-2}
1200	10	20	2.4×10^{-3}

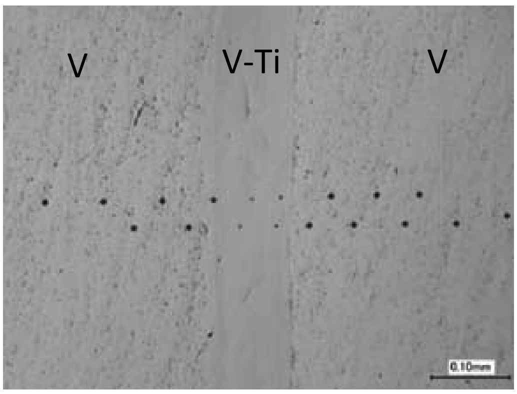

Fig. 1 Optical microstructure of the interface area of V base metal and Ti layer after the hot-pressing (1hr)

Fig.1 shows the optical image of the interface around the sandwich structured V/Ti diffusion sample via the hot-pressing for 1 hr. We found that the V plate and thin Ti foil were bonded very well by the shorter hot-pressing time, and the diffusion area between V and Ti also formed. The total width of diffusion layer was about 100 μm, and it was 20 μm wider compared with the thickness of the original Ti foil. It suggested that V atom diffused into Ti foil quickly during the hot-pressing. From the Scanning Electron Microscope (SEM) observation, we confirmed that the thickness of diffusion layer between V and Ti increased when the hot-pressing time was extended.

The comparison of the Vickers hardness around the diffusion layer after the hot-pressing was shown in fig. 2. The load and time in the Vickers hardness test are 20 gf (=196 mN) and 30 seconds. The average hardness of V base metal was about 80 Hv. In the 1 h sample, we confirmed that the Vickers hardness was drastically increased to at the narrow area around the interface area. On the other hand, the Vickers hardness of the 10 hrs sample was gently and widely increased forward to the interface area. This difference of the Vickers hardness was similar to the microstructure of the diffusion layer. We thought that the increase of the higher Vickers hardness area corresponded to the thickness of the diffusion area between V and Ti. This could be caused by the V-Ti compound formation through the hot-pressing.

The correlation comparison between the chemical composition and the Vickers hardness in the diffusion layer are also under investigated.

1) Pint, B A. et al. Journal of Nucl. Mater., **329-333** (2004) 119-124.

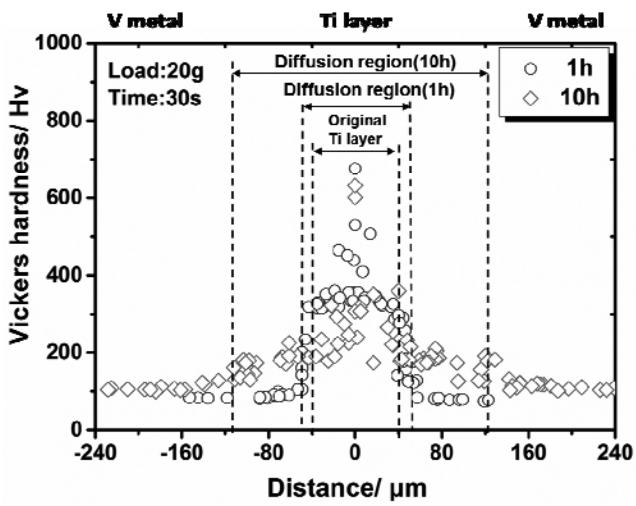

Fig. 2 Comparison of the Vickers hardness around the diffusion layer after the hot-pressing for 1 hour and 10 hours