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$Ti_{1-X}Al_XN$ トリチウム透過防止膜を指向したホットプレスによる Ti/V 及び Ti/Al 界面の微細組織と機械強度

Microstructure and mechanical strength of V/Ti and Ti/Al bonding by Hot-Pressing for $Ti_{1-X}Al_XN$ composite as a precursor of TPB material

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The permeation and inventory of tritium in vanadium alloy is a critical issue for the development of liquid lithium/vanadium-alloy (Li/V) blanket. TiAlN is one of the attractive candidate materials as the Tritium Permeation Barrier, because it has higher Permeation Reduce Factor and then is stable in liquid lithium.

In order to fabricate this coating, we carried out the two steps following as: 1) Prepare V/Ti/Al laminated composite coating by hot-pressing; 2) Surface nitriding to obtain the TiAlN coating. The bonding processes of these V/Ti and Ti/Al couples became the fundamental process to fabricate the V/Ti/Al composite material. In this study, the microstructure and Vickers hardness of these V/Ti and Ti/Al bonding samples were mainly discussed.

V/Ti and Ti/Al bonding experiments were carried out using the uniaxial hot-pressing process. The sandwich structured precursor samples were made to the pure V plate, Ti and Al foils. These metals were polished and cleaned before metal stacking. The uniaxial hot pressing experimental conditions for the V/Ti bonding sample are showed in Table 1.

All of the V/Ti bonding interfaces under different conditions were smooth, we found that the uniaxial hot pressing was easy and suitable process for the bonding between Ti and V. The thickness of diffusion layer between Ti and V was obtained to 105 μm (1 hr), and then this thickness was increased 190 (3 hrs), 230 (10 hrs) and 370 μm (30 hrs) with extending of the hot pressing time. Some Ti-precipitates also appeared in the middle zone in a part of the Ti/V bonding sample.

Table 1 The bonding conditions for V/Ti sample

Temperature /℃	Pressure /MPa	Time /h	Vacuum /Pa
1200	20	1	5.0×10^{-2}
1200	20	3	4.4×10^{-3}
1200	20	10	2.4×10^{-3}
1200	20	30	2.1×10^{-3}

The Vickers hardness around the interface of the V/Ti bonding sample was shown in Fig. 1. The average hardness of V base metal was estimated to about 90 Hv. This hardness was increased to 120 Hv and 150 Hv due to the hard deformation with a longer hot pressing time. Vickers hardness near the V/Ti interface was drastically increased. It suggested that V-Ti solid solution was formed around interface by the diffusion reaction between Ti and V. Furthermore, we thought that small Ti-precipitates into the reaction layer was also contributed to increase the Vickers hardness.

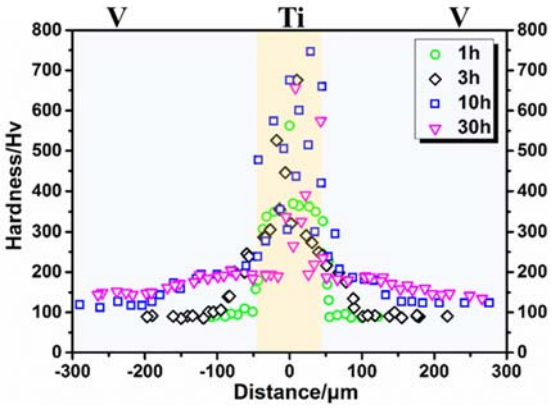

Fig.2 The Vickers hardness around the interface of the V/Ti bonding area (1/3/10/30 hours)