§3. Behavior of Rhenium Interface on Tungsten Coated Carbon by Heat Load

Tokunaga, K., Tamura, S., Miyamoto, Y., Fujiwara, T., Yoshida, N. (Res. Inst. Appl. Mech. Kyushu Univ.),
Sogabe, T. (Toyo Tanso Co., Ltd.)
Kato, T. (Nippon Plansee K.K.)
Schedler, B. (Plansee Aktiengesellschaft)
Kubota, Y., Noda, N.

The divertor plate of LHD is subjected to high heat and plasma particles with a low energy and a high flux. Tungsten seems a promising candidate material for surface material of the divertor plate because of its low sputtering yield and good thermal properties. Disadvantages of tungsten as a plasma facing material are its heavy weight and poor workability. One of the possibilities to overcome them is to coat tungsten on light carbon materials, which have shown good heat load resistance in the present plasma confinement devices. However, tungsten forms tungsten carbide and brittle carbide is produced at high temperature during use.1) Exfoliation may occur on the joint interface of tungsten and carbon tile due to the brittle carbide formation. It is known that Re is effective for carbon diffusion barrier to tungsten layer and suppress formation of the brittle tungsten carbide. The purpose of the present study is investigate structure change of Re interface in order to optimize thickness and structure of Re between the carbon tile and tungsten.

Tungsten coating (VPS-W) on CFC (CX-2002U) with a Re/W multilayer interface was made by vacuum plasma spraying (VPS). The samples were heated by focusing 20 keV electron beam on the cross section of VPS-W/CFC. After the annealing, the cross sections of the samples were mechanically polished carefully and chemically etched, and then their microstructure was observed. In addition, the compositional and structural change of joint interface after the annealing was examined with an X-ray diffractometer (XRD).

The increase of mean thickness of tungsten carbide layer in VPS-W was directly proportional to the logarithm of annealing time within 3.3 ks at 1800 °C. The logarithm increase indicates that the joint interface act as a diffusion barrier in the temperature range below 1800 °C. In contract, the samples annealed for more than 3.3 ks at 1800 °C, the thickness of tungsten carbide layer increased beyond the range of logarithmic law. It means that the effect of the joint interface as the diffusion barrier loss goes down at this annealing condition (above 3.3 ks at 1800 °C). On the other hand, the mean thickness was directly proportional to the square root of the annealing time at 2000 °C. This means that the effect as diffusion barrier has completely lost.

It was confirmed from the results of XRD, as shown in Fig. 1(a), that the layer is a compound of ReW, WC and W_2C. At the joint interface annealed for 1.8 ks at 2000 °C, the layer which has dendtite structure was broken. On the other hand, as shown in Fig. 1(b), the composition of this broken layer was confirmed from a XRD analysis, that the broken layer consists of ReW and WC. The W_2C was not observed in this layer. That is to say, this constituent W_2C changes into WC by absorbing C.

In the next fiscal year, VPS-W/CFC tiles with modified Re/W layers fabricated to optimize the interface structure will be used as test samples for the heat flux and plasma exposure experiments.

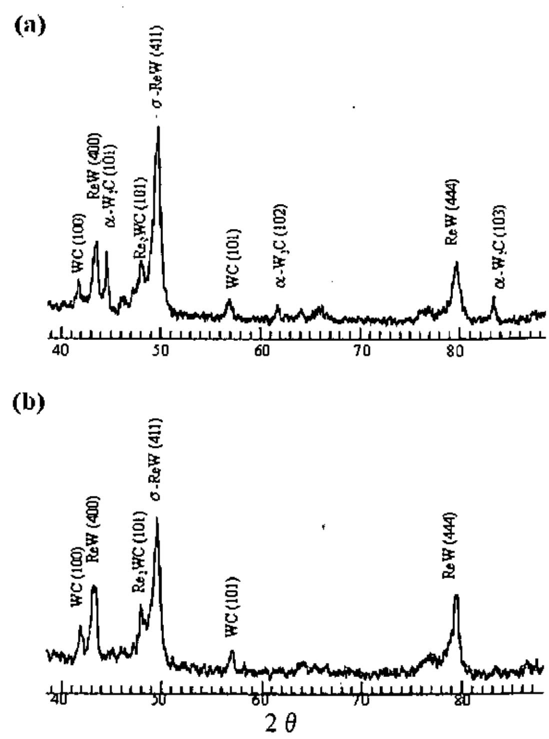

Fig. 1 X-ray diffraction analysis near joint interface annealed for 1.8 ks at 1800℃(a) and 1.8 ks at 2000℃(b).