7P57 Characterization of Fracture behavior of W bonded F82H First Wall Components using Micro-Cantilever Bending Test

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Tungsten (W), which has high thermal conductivity, high sputtering resistance, and low tritium inventory, is considered to be the primary candidate armor material for the structural material reduced activation ferritic steel (F82H) of the fusion reactor blanket. Previous studies have been devoted to the development of a feasible method to achieve tungsten coating on F82H. To date, various available coating technologies have been developed, such as atmospheric/vacuum plasma spraying (A/VPS), solid/liquid state diffusion bonding(L/SSDB), explosive welding (EXW), etc. However, considering that the W bonded F82H has to withstand the relevant conditions of the fusion reactor, the mismatch in the physical properties between W and F82H will make the bonding area easy to suffer from certain mismatch stress, which is prone to fracture. Therefore, characterization of the fracture behavior of the W bonded F82H is essential to evaluate its bonding properties as well as the feasibility of the welding method. In this study, we are aiming to use the micro-bending test to characterize the fracture behavior of W coating and the bonding interface of W coated F82H fabricated by VPS, EXW, and SSDB coating methods.

In this study, several groups of micro bending specimens with the typical geometries as shown in Fig.1 were manufactured from interface area, tungsten coating of EXW, SSDB, VPS W coated F82H using FB2100 focused ion beam (FIB). The depth of the pre-notch depth of the cantilever was less than half of the cantilever height. The bending tests were conducted using Nanoindenter G200 with the constant displacement speed (10nm/s) compression method.

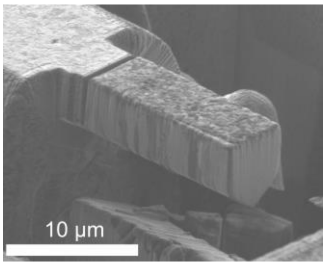

Fig. 1. SIM images of SSDB W-F82H beam

The obtained results indicated that the pre-existed flaws in the VPS tungsten coating have relatively low fracture stress and easily contribute to the catastrophic propagation of cracks. The SSDB tungsten has lots of pre-cracks distributed perpendicular to the bonding interface due to the thermal process during frication and reduced its fracture tolerance. While the EXW tungsten coating shows a different fracture behavior in two directions but are better than SSDB and VPS tungsten. In F82H substrate, the cracking tips tend to be blunting rather than propagation. Interestedly, in the interface area, the cracks that originated from F82H were finally deflected to the tungsten-F82H interface. Moreover, the interface fracture resistances of VPS & SSDB tungsten-F82H are better than their tungsten coatings. In contrast, the fracture resistance of the EXW interface was possibly weaker than its tungsten coating. Considering the difference in loading points and geometry, the fracture load will be converted into fracture stress and discussed further.

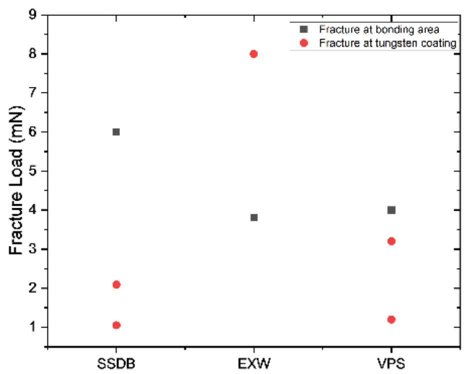

Fig. 2. Fracture Load results