High Heat Flux Test with 80x80 Be/Cu/SS Standard Mockups for ITER First Wall Semi-prototype

Suk-Kwon Kim*, Seung-Jae Lee, Dong Won Lee, Young-Dug Bae, H.K. Jung, Y.I. Jung, J.Y. Park, Y.H Jeong
Korea Atomic Energy Research Institute, Daejeon, 305-353, Korea
**Corresponding author: skkim93@kaeri.re.kr*

1. Introduction

Standard mockups with 80 cm x 80 cm Be tile were fabricated to perform high heat flux test for ITER first wall semi-prototype, which includes the beryllium armor tiles joined to CuCrZr heat sink with stainless steel cooling tubes. These tests were performed in the Korea heat flux test facility (KoHLT-1) with the surface heat flux of 1.25 MW/m^2. These tests need to be performed with the goal to qualify the joining technologies required for the ITER First Wall. Based on the results of tests, the acceptance of the developed joining technologies will be established for the semi-prototype and first wall. The results of this test will affect the joining technology for the ITER First Wall.

2. Methods and Results

2.1 Manufacturing of mockup

The schematic diagram for the ITER first wall is in the Fig. 1. The semi-prototype is some kind of scaled-down first wall which has three double-fingered panels (right of Fig. 1). In this work, the standard mockup with 80 cm x 80 cm Be tile were fabricated to qualify our HIP (Hot Isostatic Pressing) technology.

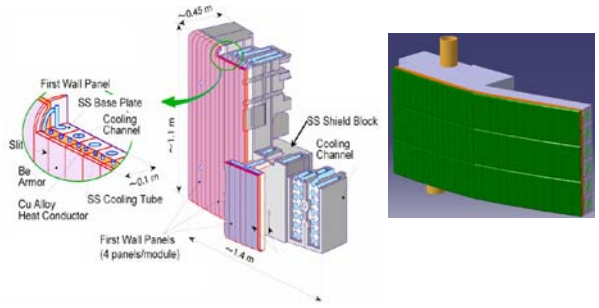

Fig. 1. Schematic diagram of ITER first wall.

The fabrication process of the standard mockups is shown in Fig. 2. The detailed procedure will be described in the following section.

For the CuCrZr and stainless steel, the canned materials are placed into the HIP furnace. HIP was conducted at 1050 °C and 100 MPa for 2 hours with the heating rate of 5 °C/min and the furnace cooling. During the heating process, the temperature was held at 900 °C for 210 min for pressure control and the homogenizing of the materials. And, in the case of Be to CuCrZr HIPping, the canned materials are placed into a HIP furnace. HIP was conducted at 580 °C and 100 MPa for 2 hours with the heating rate of 4 °C/min and the furnace cooling. The canning plates were removed by electro-discharge machining. The materials were cleaned in ethyl alcohol by using an ultrasonic cleaner. Fig. 3 shows the final mockup for installation to KoHLT-1. To simulate the manufacturing procedure of ITER first wall semi-prototype, slit-type mockups are fabricated as shown in Fig. 4, these mockups have four piece of Be tiles.

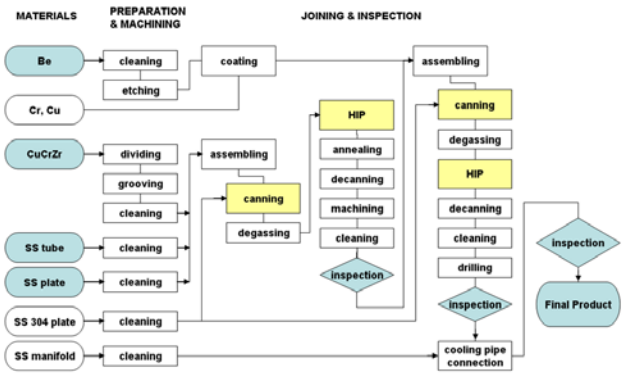

Fig. 2. Fabrication process of the standard mockups.

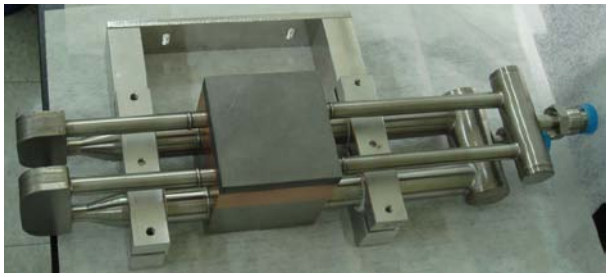

Fig. 3. The standard mockup.

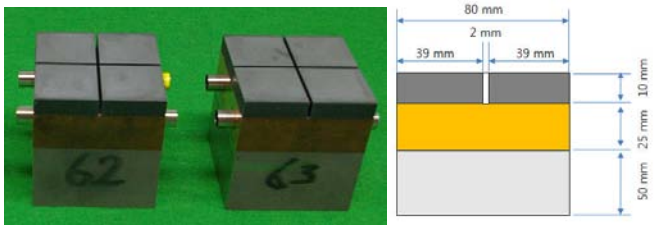

Fig. 4. Slit-type mockups.

2.2 Non-destructive and destructive test

Visual and dimension inspections were performed whenever needed in the fabrication process. Ultrasonic Test (UT) was performed with ultrasonic probes; a 10 MHz, 0.25 inch diameter, flat type(non-focused) for the

Be/CuCrZr after a Be/(CuCrZr/SS) HIPping. The sensitivity is 74 dB for UT instrument, Panametrics 5800. There are no defects in the interfaces. Fig. 5 shows the result of the ultrasonic test for standard mockups. A pressure test was carried out by using pressurized water after a completion of the He leak test up to 5 MPa for 2 hours with each cooling path. During the test, there was no pressure drop or water leakage.

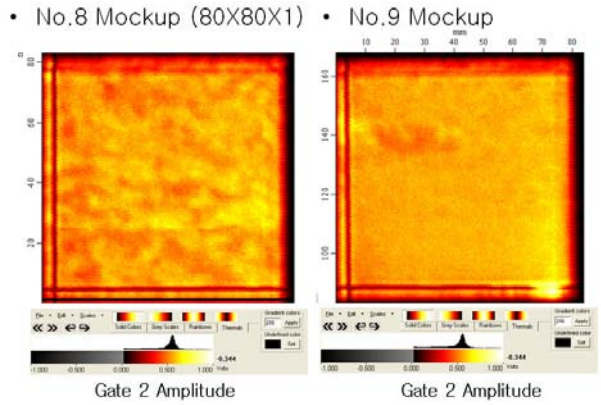

Fig. 5. The results of ultrasonic test.

2.3 High heat flux test for standard mockups

For the high heat flux test, four mockups were manufactured simultaneously in KAERI. Two mockups are the normal standard mockups, and the others are slit-type mockups, as mentioned above. In our KoHLT-1 facility, the normal cycle is based on an expected heat flux of 1.25 MW/m^2 for 300 seconds, and applied cyclic heat flux was indicated in Fig. 6.

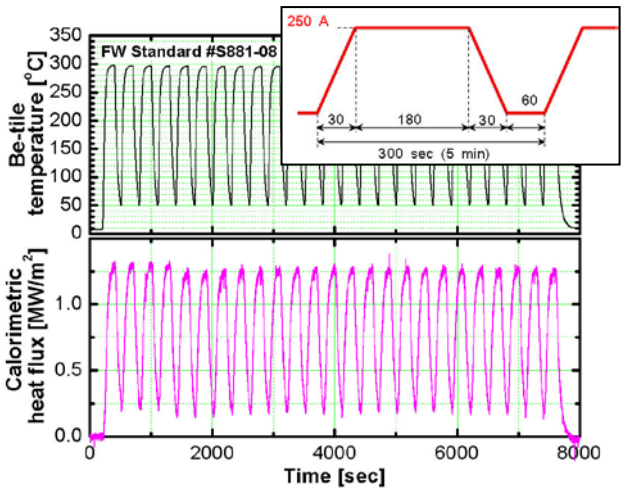

Fig. 6. The result of high heat flux test.

Fig. 6 illustrate the cyclic heat flux and surface temperature in the Be tile of standard mockups(S/N S881-08). Test facility and mockups are shown in Fig. 7, after test, change of the surface condition is also shown in this picture.

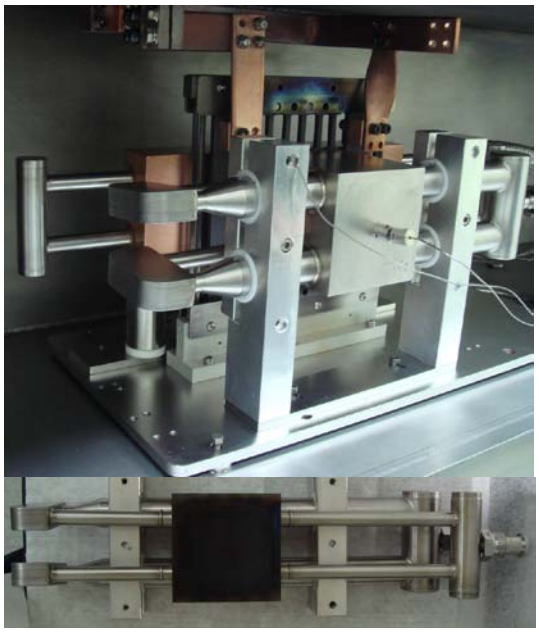

Fig. 7. The mockup installed in the KoHLT-1.

3. Conclusions

ITER first wall mockups to establish the manufacturing capability of semi-prototype were fabricated in the shape of standard mockups with single Be tile. Each mockup must be endured the 1,000 normal cycles in the heat flux of 1.25 MW/m^2 by using KoHLT-1 test facility. These tests will be performed for the purpose of qualifying the joining technologies required for the ITER first wall and semi-prototype. With the acceptance criteria of the developed joining technologies for the semi-prototype and first wall, the test results will affect the joining technology of Korea domestic for the ITER First Wall.