

## Fabrication of small mock-ups using TIG welding for the KO HCCR TBM

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### 1. Introduction

One of the important goals of the ITER project to develop next-generation technologies is to investigate heat extraction in blanket modules in fusion reactors and tritium extraction experiments [1-7]. Korea decided to test the Helium Cooling Ceramic Reflector (HCCR) Test Blanket Module (TBM) in ITER [8]. The manufacturing technology of HCCR TBM was developed through the development of welding and joining techniques [9-13]. In addition, advanced reduction activated alloy (ARAA) materials have been developed and characterized for HCCR TBM as structural materials and used in the manufacture of TBM mock-ups. In the previous study, a small mockup of a TBM sub-module was fabricated using electron beam welding to verify the welding performance. In this study, we introduce a small mockup fabrication and performance evaluation using butt welding method without backing strip structure using TIG welding. Small-scale mock-up production for HCCR TBM and future DEMO production was verified through the fabrication procedure, fabrication and evaluation.

### 2. Fabrication procedure of the HCCR TBM sub-module and fabrication of small mock-up

#### 2.1 Design of the small mock-ups

For the small mock-up, three small mock-ups were designed and manufactured by referring to the manufacturing procedure of the HCCR TBM sub-module. Figure 1 shows the HCCR sub-module and breeding area of the sub-module and the three component components circled for manufacturing.

The small mock-ups in Figure 2 show some of the scaled-down sub-module. Part-A is part of an FW with eleven cooling channels 10 mm in diameter. Part-A processed the cooling channel by drilling and then processed it after bending. Part-B consists of two parts of the BZ component to verify the welding procedure. Part-C consists of two parts, BZ, SW with a thickness of 27mm and SW cover with a thickness of 6mm.

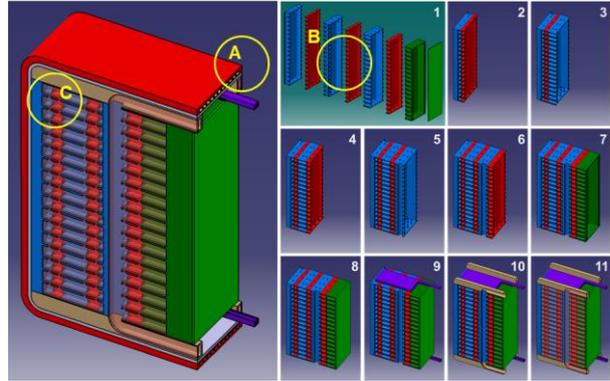


Fig. 1. Schematic diagram of HCCR TBM

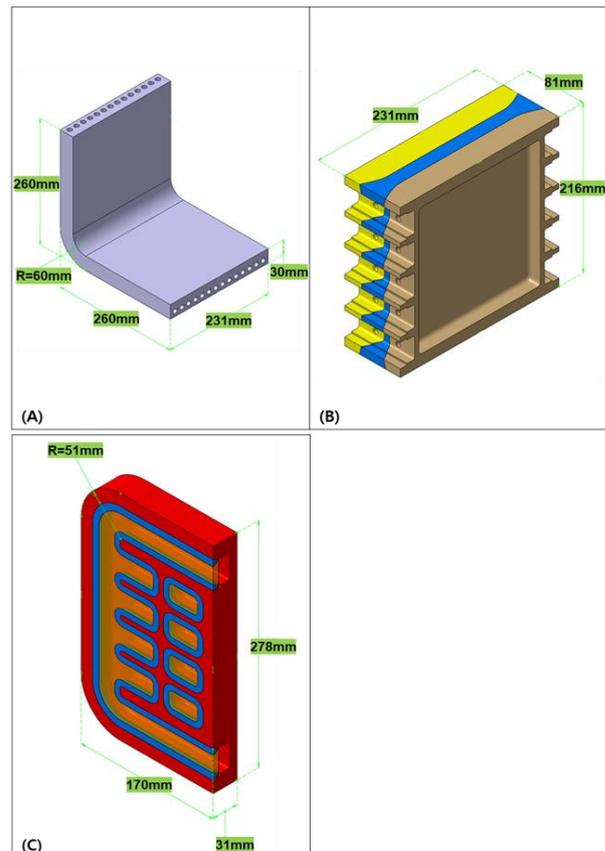


Fig. 2. Schematic diagram of the small mock-up

## 2.2 Fabrication of the small mock-ups

The manufacturing procedure for the HCCR TBM mock-up is as follows: 1) parts machining, 2) welding, 3) machining, 4) NDT test using ultrasonic test (UT) and some small mockups, helium leak test, hydraulic test, etc. were performed. Figures 3 and 4 show detailed manufacturing processes.

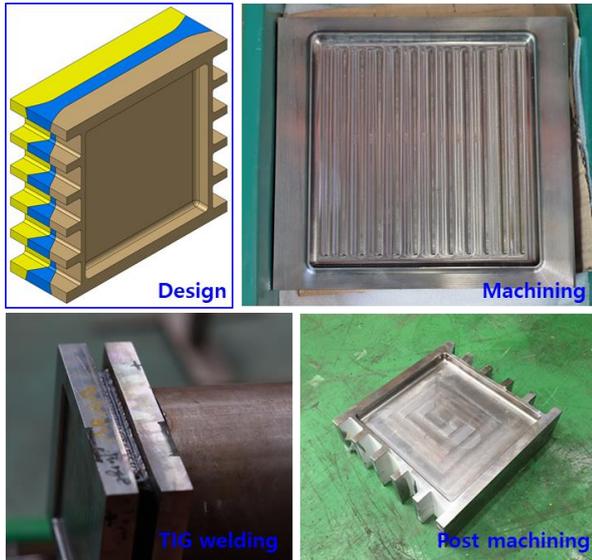


Fig. 3. Manufacturing process of the small mock-up of BZ (Part B)

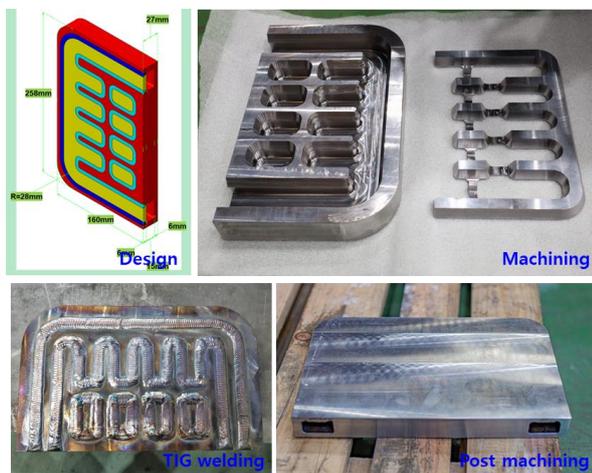


Fig. 4. Manufacturing process of the small mock-up of FW-SW-BZ (Part C)

## 2.3 Nondestructive Testing and Hydraulic Test

After TIG welding for small mock-ups, ultrasonic and hydraulic tests were performed to investigate joint integrity. Figure 5 is a photograph of the hydraulic test of a small mock-up (Part-C) of the FW-SW-BZ, and a successful test of 22Mpa at room temperature.

To verify the integrity of the weld on the welded back of the small mock-ups, the welded section was cut and the weld condition was investigated. Welding of the back of the cut small mock-ups confirmed that the back bead was formed normally. Bending and TIG welding methods verified through small mock-ups production will be applied to ITER TBM or DEMO production in the future.



Fig. 5. Water pressure test of small mock-up (Part-C).

## 3. Conclusions

Design and manufacturing procedures for the manufacture of HCCR TBM and DEMO TBM were performed, and small mock-ups were fabricated using TIG welding to validate the manufacturing procedures and methods. In order to establish and optimize the welding procedure in TIG welding of ARAA materials, ultrasonic nondestructive testing and hydraulic tests were performed. The fabricated small mock-up successfully tested 22Mpa at room temperature to verify welding performance.

## Acknowledgments

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