**Backgrounds**

- ITER Blanket First Wall (FW) includes the Beryllium amour tiles joined to CuCrZr heat sink with stainless steel cooling tubes.
- Prequalification program needs to be performed with the goal to qualify the joining technologies required for the ITER FW.
- Based on the results of tests, the acceptance of the developed joining technologies will be established.
- The results of this qualification test will affect the final selection of the manufacturers for the ITER First Wall and the sharing between Parties.

**Introduction**

**Design for ITER FW Semi-prototype**

**ITER Blanket FW**

- Developing of the HIP bonding, fabrication methods, and high heat flux test
- To qualify the joining technologies required for the ITER blanket first wall
- Manufacturing the first wall qualification mockups for ITER 1st qualification test (2009)
- Semi-prototype qualification test due to 2012

**Fabrication of Mockups and High Heat Flux Test Facilities**

**Mockup fabrication**

A. CuCrZr joined to Stainless Steel (SS316) with HIP (1050 °C, 100 MPa, 2 hours)
B. Interlayers (1 Ti / 0.5Cr / 5Cu [μm]) were coated with Be tiles
C. Coated Be tiles and CuCrZr/SS were joined by HIP (580 °C, 100 MPa, 2 hours)

**Test facility (KoHLT; Korea Heat Load Test facilities)**

- Installed for the verification of the joining technology of the ITER blanket FW
- Radiation heating by graphite heater
- E-beam facility under construction

**Fabrication and Test of KO Preliminary Semi-Prototype for ITER First Wall Qualification**

Poster # P59A  
Fabrication and Test of KO Preliminary Semi-Prototype for ITER First Wall Qualification

2011 13th International Workshop on Plasma Facing Materials and Components for Fusion Application (PFMC-13), 9 -13 May 2011, Rosenheim, Germany

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**Facility**  
KoHLT-1 (Korea Heat Load Test Facility-1)  
KoHLT-2 (Korea Heat Load Test Facility-2)  
Electron Beam HHT Facility

<table>
<thead>
<tr>
<th>Facility</th>
<th>KoHLT-1</th>
<th>KoHLT-2</th>
<th>Electron Beam HHT Facility</th>
</tr>
</thead>
<tbody>
<tr>
<td>Major Target</td>
<td>PFCs</td>
<td>Large PFC</td>
<td>PFCs development inc. ITER blanket FW</td>
</tr>
<tr>
<td>Heat Flux (Target Area)</td>
<td>1.5 MW/m² (80 × 80 mm²)</td>
<td>0.46 MW/m² (700 × 100 mm²)</td>
<td>5 MW/m² (300 × 200 mm²)</td>
</tr>
<tr>
<td>Heat Source</td>
<td>Graphite Panel (0.25 μm)</td>
<td>Graphite Panel (~0.3 μm)</td>
<td>Electron Beam (MAX 60 keV)</td>
</tr>
<tr>
<td>Power Supply</td>
<td>40 kW (DC 100V, 400 A)</td>
<td>80 kW (DC 200V, 400 A)</td>
<td>300 kW (DC 80 kV)</td>
</tr>
<tr>
<td>Test Chamber</td>
<td>Box-type chamber (0.3 × 0.3 × 1.2 m³)</td>
<td>Box-type chamber (1.2 × 1.2 × 2.4 m³)</td>
<td>Cylindrical chamber (Φ1.2m × D2m)</td>
</tr>
<tr>
<td>Filling Gas</td>
<td>He</td>
<td>He</td>
<td>Vacuum</td>
</tr>
<tr>
<td>Cooling Water</td>
<td>300 K, 0.1 MPa, 1 m/sec</td>
<td>~373 K, 3 MPa</td>
<td>300-373 K, 10 MPa</td>
</tr>
<tr>
<td>Beryllium Compatible</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
</tbody>
</table>
High heat flux test facility with E-gun system

Electron beam facility for high heat flux tests (under construction, 2011-2012)
- Power: max. 300 kW, acc. voltage max. 60 kV
- Beam scanning area: max. 70 x 50 cm² (about 4.7 MW/m² @30 x 20 cm²)
- Super deflection system (Beam guidance system): max. 10 kHz
- Continuous and pulsed operation
- Cyclic heat flux test
- PFCS development inc. ITER TBM FW
- EU FZJ (JUDITH-2 200 kW), US SNL (EB1200), RF Efremov (IDTF 800 kW), India (under construction)

Preliminary Analysis

Preliminary analysis with ANSYS-CFX
(1) 50 mm x 300 mm (12 Be tiles) mockup
- 25 mm x 25 mm, 12 Be tiles
- Temperature evolution at each mock-up
  ⇒ no temp. increase according to the accumulated cycles
- 1.5 MW/m² heat flux with outlet region heating
- Be surface temp. reaches to 548 °C at heating phase

(2) 80 mm x 80 mm Slit mockup
- Case: single finger, transient 15s ON/15s OFF
- 5.0 MW/m²
- Far region heating with 3 Be-tiles column
- T distribution at 20, 50, 80 sec
- T evolution for 95 sec

UT examination (Ultrasonic Test)
(1) Probe (Panametrics)
- Freq.: 10 MHz, Probe Diameter: 0.25 inch, Probe type: Flat (Non-focused), Water Distance: 20 µs
(2) UT instrument (Panametrics 5800)
- PRF=160Hz, Sensitivity Gain = 74 dB, LF=20MHz, HF=1MHz, Energy=50uJ, Damping=50 ohm
(3) DAS settings
- Scan Parameters: Res. 0.5mm, Speed 15 mm/s, 80 x 80 mm, Gate 1 & 2: TOF1, TOF2, Amp, WF
- Sampling Rate=100 MHz, Average =4

Non-Destructive Test

C-scan Image

Fabrication of preliminary semi-prototype

Fabrication of small scale mockups
- Objective: Setting up key manufacturing technologies
- Applied technologies: HIP of multiple tiles, HIP of complex parts, slitting, grooving, EB welding
- Two times of HIP and EB welding was performed for the fabrication
- High joining strength of Be/CuCrZr was obtained as 115 MPa in the shear test
- The fabricated small SP mockups will be HHFT tested

Fabrication of preliminary SP (on going)
- Manufacturing of CuCrZr/SS part was completed
- Cover plates for the HIP pressure boundary will be machined and EB welded in this year
- Bending of SS and HIP joining of Be, CuCrZr/SS with SS are planned in this year