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Technical Preparation for Series Production of ITER Enhance Heat Flux FW Panels

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China will manufacture 10% of the ITER FW panels, all in EHF type with heat load up to 4.7MW/m2. A hypervapotron (HVT) cooling channel was applied as heat sink to enhance heat transfer. Small scale mock-ups have been manufactured in China and successfully passed the thermal fatigue test at 4.7 and 5.9MW/m2 for 7500cycles and 1500 cycles, respectively. Explosion bonding is used to make bi-metallic CuCrZr/316L(N) plates, while Be/CuCrZr is bonded by hot iso-static pressing (HIP) at 580oC and 150MPa. Laser welding with 6~15kW input power was used to close HVT cooling channel and the assembly of FW fingers to central beams. All these technologies were qualified according to specified requirements and standards, and will be used in FW series production. Finger pairs and a semi-prototype were manufactured. The pairs will be subjected to the required thermal fatigue test for qualification, which is expected to be completed by July 2016.

To ensure the quality of the products, a number of inspections are performed in the manufacture route. That includes ultra-sonic test, hydro-pressure test, helium leak test (HLT) and high heat flux test. The HLT is performed in vacuum with one temperature cycle between RT and 250oC. A hot-helium leak test system is under construction, for which the most challenges are the ultra-low vacuum background leak rate and the heating/cooling efficiency requirements. For the purpose hot nitrogen gas with temperatures up to 270oC is designed to heat and cool FW panel by flowing in the FW cooling channels. Analysis showed that the FW panel temperature can be increased to 250oC in about 15 hrs by 4MPa N2 in a flow rate of 0.4 kg/s when the maximum temperature difference of the component is kept below 55 oC. To prepare for the FW series production, a number of other large facilities have been equipped recently at SWIP, including a 16 kW YAG laser welding work station, a magneto-sputtering equipment, a 200MPa/1400oC hot iso-static pressing machine, two ultra-sonic bath lines for pickling and cleaning, two vacuum baking furnaces, a hydro- pressure test facility with the maximum pressure of 10 MPa, a phase-array ultra-sonic non-destructive test system and a 400kW electron beam scanning facility. This EB scanning system will be used to test the 1st FW prototype at 4.7MW/m2 for 1000 cycles and to test series FW fingers at 2MW/m2 for 100 cycles.

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