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FTP/P1-12: Progress of High Heat Flux Component Manufacture and Heat Load Experiments in China

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High heat flux components for first wall and divertor are the key subassembly of the present fusion experiment apparatus and fusion reactors in the future. It is requested the metallurgical bonding among the plasma facing materials (PFMs), heat sink and support materials. As to PFMs, ITER grade vacuum hot pressed beryllium CN-G01 was developed in China and has been accepted as the reference material of ITER first wall. Additionally pure tungsten and tungsten alloys, as well as chemical vapor deposition (CVD) W coating are being developed for the aims of ITER divertor application and the demand of domestic fusion devices, and significant progress has been achieved. For plasma facing components (PFCs), high heat flux components used for divertor chamber are being studied according to the development program of the fusion experiment reactor of China. Two reference joining techniques of W/Cu mockups for ITER divertor chamber are being developed, one is mono-block structure by pure copper casting of tungsten surface following by hot iso-static press (HIP), and another is flat structure by brazing.

The critical acceptance criteria of high heat flux components are their high heat load performance. A 60 kW Electron-beam Material testing Scenario (EMS-60) has been constructed at Southwestern Institute of Physics (SWIP),which adopts an electron beam welding gun with maximum energy of 150 keV and 150×150 mm2 scanning area by maximum frame rate of 30 kHz. Furthermore, an Engineering Mockup testing Scenario (EMS-400) facility with 400 kW electron-beam melting gun is under construction and will be available by the end of this year. After that, China will have the comprehensive capability of high heat load evaluation from PFMs and small-scale mockups to engineering full scale PFCs.

A brazed W/CuCrZr mockup with 25×25×40 mm3 in dimension was tested at EMS-60. The heating and cooling time are 10 seconds and 15 seconds, respectively. The experiment procedure is 3 MW/m2 by 200 cycles and then 6 MW/m2 by 1000 cycles, following by 8.5 MW/m2 for 200 cycles and 11 MW/m2 for 100 cycles. No off-normal surface temperature change and cracks were observed. The similar screening tests of small-scale mono-block W/CuCrZr mockups will be tested soon. Next large size brazed W/CuCrZr components will be manufactured and evaluated.

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