Contribution ID: **1172** Type: **not specified**

P3.125 Life time estimation of ITER first wall mock ups by FEM simulations

Wednesday, 19 September 2018 11:00 (2 hours)

The ITER first wall (FW) panels consist of plasma facing Be tiles, the CuCrZr alloy as heat sink material, and the stainless steel as structural material. A copper layer of 1~2 mm is used between the Be tile and the CuCrZr for stress compensation. Cyclic high heat flux tests employing the electron beam facility results indicate that the failure/weak spot usually occurs at the joint corners between the Be tile and the copper layer. 3-D FEM thermo-mechanical analyses utilizing ANSYS software have been conducted to detect the failure mechanism. Within the ANSYS strain-life fatigue module, based on strain-life relation of copper from ITER materials handbook, the fatigue life prediction of 3 ITER FW mock up (MU) types was performed. The 'signed' equivalent stress, which reflects the real cyclic load spectrum of the material, was chosen for the stress component for the fatigue life prediction. Considering the singularity issue, the location of 50 micrometer apart from the free surface was selected as the investigation spot. The results show that, when the MU is loaded with 2 MW/m^2, the semi-prototype (Be tile size of 463610mm3), the small size MU (Be tile size of 363610mm3), and the small size MU with cassette design have the fatigue lives of 10834 cycles, 9773 cycles, and 12000 cycles, respectively. It can be seen that the size of the tile as well as the design of the MU affect the lifetime of the MU. It can also be seen that, all our predicted life times are below the design criterion for the ITER FW MUs (15000 heat load cycles). Discussions on the tile size effect, stress component selection, as well as the singularity affection on the fatigue life prediction are presented in this paper.

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Session Classification: P3