Contribution ID: **393** Type: **Poster**

Performance of full compositional W/Cu functionally gradient materials under quasi-steady state heat load

Wednesday 7 June 2017 13:40 (2 hours)

Tungsten (W) is the most promising plasma facing material for fusion devices, while copper (Cu) has been proposed as the heat sink material behind plasma facing material[1]. Nevertheless, because of the large difference of coefficient of thermal expansion (CTE) between W and Cu, the joining of these two dissimilar materials causes the high thermal stress concentration at the interface when exposed to the high heat loads. The stress concentration leads to the interface cracking, reducing the lifetime of the components. To mitigate such damage, the W/Cu functionally graded layers between W and Cu have been proposed to provide a smooth transition of properties and thus alleviate the thermal mismatch [2].

To investigate the performance of graded structure materials under fusion relevant steady-state heat load, six-layered W/Cu functionally gradient materials (FGMs) with full compositional distributions (from 0 to 100%) prepared by resistance sintering under ultra-high pressure (RSUHP) method were tested under the electron beam material testing scenario (EMS-60) using the fusion relevant heat load in the range of 6.5˜9.8 MW/m2. The specimens were loaded for 5s, and then cooled for 30 s for indirect cooling. Meanwhile, the W/Cu mock-ups without any transition layers were also fabricated and tested for compare. In addition, the finite element simulation of the thermal-stress evolution and distribution was performed for analysis.

After 50 cycles 6.5 MW/m2 and 10 cycles 8.2 MW/m2, there are no obvious changes of the heat transition for both W/Cu FGM and W/Cu mock-up. Only a local small crack at graded interface of W/Cu FGM was founded by microscopic observation, however, the visible crack through along the sharp interface was observed. And, the residual stress distribution along the edge side for W/Cu FGM is about lower 50% than that for W/Cu mock-up. Both the experiment and simulation identified that the graded transition layers can ameliorate the stress concentration and alleviate the thermal mismatch. However, after the high heat load of 9.8 MW/m2, both the W/Cu FGM and W/Cu mock-up show the obvious deterioration of the heat transition in a few cycles, in which the W/Cu FGM shows the severe melting and infiltration of the Cu and also the cracking along graded interface, while the W/Cu mock up shows the severe crack along interface and partly exfoliation. These reveal that it is necessary to design a thicker W layer for the high temperature gradient to protect the behind gradient layers, and the W layer processed by RSUHP method needs to be improved by optimizing the fabrication parameters.

[1] Jeong-Yong Park, Yang-II Jung, Byung-Kwon Choi, et al., J. Nucl. Mater.,417 (2011) 916 - 919
[2] G. Pintsuk, S. E. Brünings, J. E. Döring, et al., Fus. Eng. Des., 66 - 68 (2003) 237 - 240

Eligible for student paper award?

No

Author: WANG, Baoguo (University of Science and Technology of China)

Co-authors: ZHU, Dahuan (Institute of Plasma Physics, Chinese Academic of Sciences); Mr LI, Changjun (Institute of Plasma Physics, Chinese Academic of Sciences); Prof. CHEN, Junling (Institute of Plasma Physics, Chinese Academic of Sciences)

Presenter: WANG, Baoguo (University of Science and Technology of China)

Session Classification: W.POS: Poster Session W

Track Classification: Plasma facing components