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Flat Tungsten High Heat Flux Components Development Based On Different Technologies

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Divertor with tungsten act as plasma facing material is expected apply for future fusion reactors. How to exhaust high heat load deposit on tungsten is key issue. Tungsten monoblock structure which applied for ITER divertor is a very good solution. Is there any other tungsten bonding structure which can handling 10MW/m2 heat load or even more?
A kind of flat heat sink with special cooling channels structure, and tungsten slices bonded to it by different technologies is under developing. Analyses shows different tungsten thickness with different heat flux heat deposit surface temperature as table 1
Table 1. Analyses result of new cooling structure mock-up
Heat flux W thickness W surface temperature(℃) Cooling water velocity
15MW/m2 2mm 652 3.2m/s
5mm 798
20MW/m2 2mm 842
5mm 1101
The heat sink is CuCrZr and 316L stainless steel bonded structure by explosion welding technology. Before bond cooling channels was machining on CuCrZr side, and all the channels filled by some special metal. After CuCrZr plate and SS-316L plate explosion weld together the filled metal clean up both by higher temperature and chemical method from water inlet/outlet. Tungsten slices bond to CuCrZr plan apply braze, HIP and surface nanocrystallization + pressure under ˜400℃ with pure copper as inter layer. Braze and HIP already became mature technology, but the third technology is a new one. Compare three kinds of technology braze need high temperature (˜ 960℃) will decrease CuCrZr properties. Cost of HIP is quite high. The third one can avoid CuCrZr degradation and reduce cost.
Mock-ups with special cooling channel and 2mm tungsten brazed to CuCrZr have been made and high heat flux tested in electron beam heating facility. The results shows as table 2. Mock-ups of tungsten bonded by HIPing and the third technology is under developing. High heat flux test will be done soon. The presentation will compare advantages of different technologies.
Table 2. High heat flux test results
Heat Flux W thickness W surface temperature(℃) Cooling water velocity
15MW/m2 2mm 780 3.2m/s
20MW/m2 970

Country or International Organization

China, People's Republic

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