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P3.121 Status and improvement of the high heat flux W monoblock type target with graded interlayer for application to DEMO divertor

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Operational reliability of the divertor target relies essentially on the structural integrity of the component, in particular, of the material interfaces, where thermal stresses tend to be concentrated. To improve bonding quality, a concept developed in the frame of the EUROfusion project WPDIV for the DEMO divertor, consists in the use of functionally graded material (FGM) as interlayer between armor material (W) and structural material (CuCrZr). Due to the reduced thermal path, the advantage to use FGM, with a thin thickness (~25 µm), is the mitigation of fatigue cracking of the armor surface due to recrystallization. Due to industrial process readiness, thin FGM was deposited (from 100% W to 100% Cu) by physical vapor deposition. In 2017, six manufactured mock-ups, equipped with tungsten blocks of 4 mm thickness, demonstrated their capability to withstand 25 MW/m² and thermal fatigue tests at 20 MW/m² (1000 cycles).
From the experience gained during mock-ups development, new optimized mock-ups are under manufacturing. Optimization consists in the fabrication time reduction and in the mock-up life-time improvement. To reduce fabrication time, the number of coated blocks is reduced and tungsten blocks with 12 mm thickness (as for the ITER-divertor) are used. Moreover, in order to improve component life time with regard to coolant induced corrosion/erosion of the CuCrZr tube, the CuCrZr tube thickness is increased by 30% to 1.5 mm (as for the ITER divertor). With finite element modeling (FEM), we show that such modifications may degrade the mock-up performance under high heat flux loading. With FEM, it is shown that augmentation of CuCrZr mechanical resistance is possible using thick FGM interlayer (~350 µm). For these improved mock-ups, rationales and required manufacturing steps will be reported in this paper. Moreover based on metallographic examinations, the recrystallization state, in comparison to the expected one, will also be presented.

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