O-11

High heat flux testing of actively cooled graphite- and tungsten-armoured JT-60SA flat-tile divertor mock-ups

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JT-60SA is a fusion experiment built within the "Broader Approach Agreement" between the European Union and Japan, aiming to complement the ITER fusion reactor project [1]. The JT-60SA experiment is a superconducting tokamak, initially planned to have an operation phase with actively cooled carbon plasma-facing components followed by an operation phase with tungsten plasma-facing components [2]. Under this assumption, Fusion for Energy and EUROfusion worked on a series of actively cooled test divertor mock-ups [3]. The first test mock-ups consisted of armour tiles, which were either made of graphite (C) or tungsten (W), and an actively cooled heat sink made of a Titanium-Zirconium-Molybdenum (TZM) alloy, with Copper-Chromium-Zirconium alloy being discussed as an alternative [3].

Three actively cooled TZM-based mock-ups with C and W armour tiles were tested in the GLADIS [4] high heat flux (HHF) test facility. Following a pre-characterization, the mock-ups were exposed to a series of HHF screening tests with heat loads of up to 15 MW/m², followed by cyclic loading. The cyclic loading was performed at an incident heat flux of 10 MW/m² for a pulse length of 10 s. While the W-armoured mock-up exhibited a water leakage in the TZM heat-sink material already during the screening test series, the C-armoured mock-ups could be tested for a minimum of 150 cycles and more. After HFF testing, the mock-ups were subjected to a microscopy analysis, indicating crack formation in selected W and C armour tiles. In this contribution, we report and discuss these HHF tests and the post-exposure characterisation results in detail, also considering non-destructive thermal contact resistance SATIR tests [3].

References:
[1] JT-60SA website, www.jt60sa.org/wp/governance/, accessed 11.12.2024
[2] Y. Kamada et al., Nucl. Fusion 62 042002 (2022)
[3] S. Garitta et al., Fusion Engineering and Design 199, 114133 (2024)
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