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Erosion and redeposition patterns on divertor tiles after exposure in the first operation phase of WEST

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This contribution summarizes the results obtained from ion beam analyses (RBS and NRA) and scanning electron microscopy (SEM assisted with FIB cutting and EDX) on entire W-coated graphite divertor tiles exposed during the 1st operational phase of WEST (2017-2021) with campaigns C1 to C5.
The WEST project is devoted to test tungsten (W) divertor components for ITER and their performance in an integrated tokamak environment. During the 1st phase, the predominant fraction of the lower divertor consisted of inertially cooled graphite tiles coated with ˜13 µm W on top of ˜3 µm molybdenum (Mo) allowing to study the W erosion by measuring the remaining layer thickness, while from the 2nd phase on, the complete lower divertor is equipped with water-cooled ITER-like bulk W components. After 2018 (C3) and 2019 (C4), some tiles were removed for analyses. These tiles were selected from toroidal positions with the highest heat and particle loads. This toroidal variation in loads along the inner and outer strike line is originated by the pronounced magnetic field ripple. After 2020 (C5), a large number of coated graphite tiles got available for analyses allowing to study the effect of the ripple.
Erosion and deposition patterns for tiles exposed until the end of C5, i.e., after about 7.5 h of plasma, are compared to those for tiles removed after C3 (2.5 h of plasma) and C4 (6 h of plasma), which are published in [1-2]. Very thick deposits exceeding 50 µm after C5 are observed on the high field side of the inner strike line. These deposits peel off on the sub-millimeter length scale, probably triggered by arcing. The area fraction altered by delamination exceeds 25%.
The toroidal W erosion pattern regarding the ripple, but also on each individual tile was analyzed additional to the poloidal width of the strike lines. A maximum tungsten erosion of about 15 µm is observed on a very restricted area of several mm2. There erosion reaches on microscopic areas the graphite. The erosion follows the ripple and is stronger pronounced at the outer strike line with a variation by nearly one order of magnitude. The total erosion is only about 20% higher at the outer than at the inner strike line. This assessment of the total W erosion in the divertor will be discussed.

[1] M.Balden et al., Phys.Scripta 96, 124020 (2021)
[2] M.Diez et al., Nucl.Mater.Energy 34, 101399 (2023)