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Overview of the results achieved from the characterization program of the WEST plasma facing components (2018-2024)

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This contribution summarizes the main results related to fuel retention, material migration and tungsten cracking, after the first phase (2018-2020) and the start of the second phase (2022-2024) of WEST operation. The results are based on post-exposure analyses of several plasma facing components and on analysis of plasma edge conditions during operation. More specifically, the presentation will report the following findings:

- Erosion was investigated using 2 types of lower divertor components: W-coated graphite tiles installed during phase 1 of WEST and bulk W ITER-grade PFUs with fiducials on their surface installed during phase 2. For the same plasma conditions (5h of plasma in attached regime, Te=20 eV) they both follow the same erosion pattern along the ripple, e.g. the modulation of the angle of incidence. A global maximum tungsten erosion of about 8 μm is observed in both cases, which is in a good agreement with ERO simulations.
- In 2019, a dedicated helium campaign was carried out to investigate He-W interactions (45 min, He fluence > 1024 He/m2) [1]. The characterization of W-coated graphite tiles and bulk W ITER-grade PFUs shows that helium is implanted in erosion-dominant areas, with maximal concentrations of 10-12 at.% and 7-8 at.% in the outer and inner strike points respectively. A more detailed TEM analysis showed the presence of nanobubbles on the first 10 nm of the plasma-exposed surface. Similar subsurface cavities were also observed on single crystalline W samples installed on the reciprocating collector probe during this helium campaign [2].
- Thanks to the protection of the toroidal bevel, and in contrast to phase 1, no cracks were observed on the leading edges and in the magnetically shadowed part of the monoblocks. However, a crack network was observed on the top surface of the monoblocks, in plasma-exposed area around typical position of outer strike point (MB26-28). A strong correlation appears between the ripple modulation and the presence/density of these cracks. A characterization is on going to better evaluate the cracks depth and potential consequences on power exhaust capability, as well as better evaluate the role of manufacturing and machining in the crack formation.

[1] E.Tsitrone et al., Nucl. Fusion 62, 076028 (2022)
[2] B. Wirth, IAEA, 2024