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EX/P5-11: Measurements of Net versus Gross Erosion of Molybdenum Divertor Surface in DIII-D

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We report the first measurements of post-exposure net erosion and in-situ gross erosion of molybdenum under controlled, well-diagnosed plasma conditions in a tokamak divertor. Net erosion rate of 0.40±0.04 nm/s was measured on a molybdenum sample exposed to the divertor plasma in the DIII-D tokamak using the Divertor Material Evaluation System (DiMES). A silicon disk 1 cm in diameter coated with a 24 nm thick film of Mo and mounted in a graphite DiMES holder in the lower divertor of DIII D was exposed in a series of 7 reproducible lower single null L-mode plasma discharges. The exposure was performed near the attached outer strike point (OSP) for a total flattop time of ˜28 s. The plasma density and temperature near the OSP, measured by the divertor Langmuir probes, were n_e = 1.3–1.5x10ˆ{19} mˆ{-3}, T_e = 25–30 eV. An upper bound estimate of the average gross erosion rate of 3.75 nm/s was inferred from spectroscopic measurements using an absolutely calibrated CCD camera with MoI filter centered around 390 nm and having a bandwidth of ˜10 nm. Net erosion of Mo was measured by comparing the Mo layer thickness measured by Rutherford backscattering (RBS) before and after the exposure. The reduction of Mo thickness was 11±1 nm, corresponding to an average net erosion rate of 0.40±0.04 nm/s i.e. significantly smaller than the gross erosion rate measured by the camera. This result is consistent with theory/computational expectations of high local redeposition. The distribution of Mo redeposited on the graphite holder was measured by RBS. As expected, Mo deposits were concentrated near the Mo-coated sample edge, with an e-folding length of ˜2 mm. The total amount of Mo found on the holder was only ˜20% of the net amount of Mo eroded from the sample, possibly due to high re-sputtering and further transport of deposited Mo from the graphite surface. Plasma density and temperature profiles from divertor Langmuir probes around the radial location of the sample are used as input to detailed modeling of erosion/redeposition using the REDEP/WBC code package + OEDGE code combination, currently in progress. This work was supported in part by the US Department of Energy under DE-FG02-07ER54917, DE-FC02-04ER54698, DE-AC04-94AL85000 and DE-AC52-07NA27344.

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