# Net Versus Gross Erosion of High-Z Materials in the Divertor of DIII-D

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*We report on measurements of net and gross erosion of molybdenum and tungsten in a tokamak divertor under controlled, well-diagnosed plasma conditions allowing comparison with modeling. Net erosion of high-Z plasma-facing surfaces in a tokamak is expected to be reduced by local redeposition due to sputtered atom collisions with the impinging plasma. A series of three experiments with molybdenum and one with tungsten have been performed in DIII-D using the Divertor Material Evaluation System (DiMES). DiMES samples featured thin (few tens of nm) 1 cm diameter films of Mo and W deposited on Si disks and installed in graphite holders. The samples were exposed near the attached outer strike point of lower single-null L-mode discharges. Post-exposure net erosion of metals was measured by comparing the film thickness measured by Rutherford backscattering (RBS) before and after the exposure. Gross erosion of Mo was estimated in-situ using a filtered camera. A new, non-spectroscopic method for measuring gross erosion rates has been demonstrated, based on RBS measurement of the net erosion experienced by a very small auxilliary sample (1 mm diam.), where gross erosion is close to net erosion. RBS measurements of net erosion of the 1 cm Mo films in three consecutive experiments yielded rates of 0.4–0.7 nm/s, corresponding to about a factor of 2 reduction compared to gross erosion. For tungsten RBS measurements yield a net erosion rate of ~0.1 nm/s and gross erosion rate about a factor of 5 higher. The first experiment with Mo was modeled with the REDEP/WBC erosion/redeposition code package coupled to the ITMC-DYN mixed-material code, with plasma conditions supplied by the OEDGE code using plasma density and temperature profiles from the divertor Langmuir probes. The code-calculated net/gross erosion rate ratio of 0.46 is in good agreement with the experiment. The distribution of Mo re-deposited 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 ~20% of the net amount of Mo eroded from the sample, consistent with ITMC-DYN modeling involving mixed materials effects including a high Mo re-sputtering rate due to shallow deposition and reduced binding energy of Mo/C relative to Mo/Mo. A similar re-deposition pattern was observed in W experiment, where more detailed analysis is underway. Overall, our results confirm strong reduction of net compared to gross erosion of high-Z materials in a tokamak divertor, which is encouraging for ITER.*

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