ERO modelling of net and gross erosion of marker samples exposed to L-mode plasmas on ASDEX Upgrade

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Understanding the erosion of tungsten (W) plasma-facing components (PFCs) is crucial for successful operation of future fusion reactors. Especially important is to identify key material migration processes in the reactor vessel, and to this end one needs to determine the balance between net and gross erosion as a function of plasma-exposure conditions. In this work, we have exposed special samples with gold (Au) marker spots (1×1 and 5×5 mm²) L-mode plasma discharges in deuterium (D) at the outer strike point (OSP) region of ASDEX Upgrade (AUG). The smaller markers were designed to quantify the gross-erosion rate while on the bigger markers local prompt re-deposition of Au at the marker area allowed obtaining data on net erosion. Here, Au was selected as a proxy for W because of the full W coverage of the AUG vessel. The experimental results will be discussed in [1] and they indicate relatively uniform erosion profiles for Au across the marker spots and very little Au re-deposition elsewhere.

The ERO 1.0 code was used for interpreting the obtained results. The simulated domain covered the entire OSP region of AUG where the samples had been mounted without assuming toroidal symmetry. The background plasma was produced by the DIVIMP code using its internal two-point model plasma solver. The prescribed impurity concentrations of the background plasma were varied within typically measured values for W and light impurities like boron (B), carbon (C), and nitrogen (N). Our results indicate, however, that impurities have a noticeable effect on net erosion only in the regions where the electron temperature drops to values below 20 eV. The simulated erosion profile is more peaked than the experimental one while the maximum net erosion of 0.8-1.0 nm/s at the OSP agrees well with the measured data. The simulations also predict a toroidal tail of re-deposited particles, downstream of the markers, but the particle density here appears to be below the experimental detection threshold.

The comparison between the 1×1 mm² and 5×5 mm² marker spots further reveals that re-deposition drops from >70% to <50% when decreasing the marker size from 5 to 1 mm. This indicates that small enough marker samples can be used for accurately determining gross erosion. The simulations further hint that Au will experience 3-4 times larger erosion than W; this is also experimentally verified on the basis of data shown in Refs. [1,2]. On the other hand, no major differences in the poloidal migration lengths of the two elements are seen, thus making Au a proper choice for studying migration of PFC materials in the divertor region.

[1] A. Lahtinen et al., this conference