Effect of surface roughness on erosion behaviour of tungsten divertor components on ASDEX Upgrade

A. Lahtinen¹, A. Hakola², A. Herrmann³, K. Krieger³, M. Mayer³, M. Oberkofler³, R. Neu³⁴, V. Rohde³, ASDEX Upgrade Team, and the EUROfusion MST1 Team*

¹ University of Helsinki, Department of Physics, Helsinki, Finland
² VTT Technical Research Centre of Finland Ltd., Espoo, Finland
³ Max Planck Institute for Plasma Physics, Garching, Germany
⁴ Technical University Munich, Garching, Germany

Tungsten (W) has been selected for the plasma-facing material of the ITER divertor, which sets the need to understand its erosion characteristics in this region in detail. Here, we investigate net erosion and re-deposition of W close to the low-field side (outer) strike point of the full-W ASDEX Upgrade (AUG) tokamak. Especially, we focus on the effect of surface roughness on the observed erosion and re-deposition patterns to understand how the different surfaces would respond to extended exposure in fusion reactors.

To this end, we have exposed a number of graphite samples with thin (20-30 nm) W marker coatings into low-density and high-temperature L-mode plasma discharges in deuterium on AUG using its upgraded divertor manipulator [1]. Before coating, the surfaces were either polished (smooth samples, surface roughness $R_a=0.3 \, \mu m$), milled (nominal samples, $R_a\sim1 \, \mu m$), or sandblasted (rough samples, $R_a\sim4 \, \mu m$).

The smooth samples show a large net erosion rate of $\sim0.2 \, \text{nm/s}$ close to the strike point and towards the peripheral regions, erosion gradually decreases. On the nominal and rough samples, the measured net erosion is some 2-3 times lower and the poloidal erosion profiles are almost identical. In addition, distinct regions of net re-deposition on both sides of the strike point are measured on these samples while on smooth samples, deposition is visible only in the private flux region. These observations are in line with existing campaign-integrated data from AUG [2], although now both the erosion and deposition peaks are more prominent. The results can be attributed to co-deposition of W with various impurities on microscopically shadowed areas on a rough surface and an influx of material from the AUG main chamber all the way to its divertor.

References:


*see http://www.euro-fusionscipub.org/mst1