Arc behaviour at the inner baffle of ASDEX Upgrade

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During the last years, the use of high-Z plasma facing-materials (PFCs) in fusion devices renewed the interest in arcing. Arcs are considered as source of dust particles and additional, localized erosion mechanism of the PFCs. Video observations yields that arc are mostly occur during H-mode discharges [1,2], presumably triggered by the onset of ELMs. Unfortunely, the trigger mechanisms of arcs in fusion devices are not completely understood up to now. Whereas the arc itself can be investigated using fast cameras, the local plasma conditions with the required temporal and spatial resolution are hard to measure. In this contribution the erosion by arcing for different materials is studied, which allows to investigate influence the material properties on the erosion by arcing for similar plasma conditions.
Samples were installed at the inner baffle of ASDEX Upgrade, a region which is prone for arcing in most tokamaks. As the machining grooves obscure the arc traces, polished inserts made out of W, Cr, Al, Cu, TZM, stainless steel and magnetic steel (P92) are used. The database used includes measurements from the experimental campaigns 2015 - 2019. To measure the three-dimensional topography of the surface a confocal microcope equipped with a laser profilometer is used. More details of the surface morphology was studied using scanning electron microscopy assisted by focused ion beam cutting to prepare cross-section of the material.
Arcs remove material by two different mechanisms: production of ions by sputtering and production of droplets by melting. Obviously the droplet production dominates the material removed.
The typical erosion depth measured varies from 3.5 µm for tungsten up to 17 µm for TZM. Strong variations of the occurrence of arcs are even found on these samples, i.e. some regions are almost not effected by arcs. Taking the area density at a depth of 0.4 µm the effected surface varies between 6.8 and 16.7 %. These findings and the different morphology of the traces is compared with the material properties. Unexpected results were found comparing magnetic and non-magnetic steels. Whereas the non-magnetic steel behaves similar as the other materials investigated, for magnetic steel strong erosion, with crater depth up to 80 µm is found.
The results were discussed in view of future fusion devices.

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[1] Rohde V. et al., JNM, 438 (2013) S800
[2] Rudakov D. et al., PSI 19, unpublished
[3] Rohde V. et al., N.M.E. 9 (2016) 3