Erosion of plasma facing components by arcing 
at ASDEX Upgrade

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Arc traces are observed in all major tokamak experiments, but the material released is assumed to be insignificant in comparison to sputtering and chemical erosion in the case of carbon based plasma facing components (PFCs). Recent investigations with metallic PFCs at the inner divertor baffle region of ASDEX Upgrade (AUG) show that locally the erosion by arcing can be dominant. Whereas for tungsten the arc traces show only craters up to 4 μm depth, steel as P92 is found to be eroded down to a depth of 80 μm. On average, arc erosion of P92 is about 65 times higher than the one measured for tungsten at the same location [1]. This is in contrast to laboratory data on the erosion by arcs showing only 1.9 times higher erosion of Fe compared to W [2].

Differently to the sputter process, a significant amount of material is released during arcing as droplets, i.e. spheres of a typical size of some microns. For tungsten it was found that a significant fraction of the dust collected in AUG consists out of these droplets [3]. In tokamaks a strong magnetic field almost perpendicular to the surface is present. This may influence the release of molten material, i.e. the production of droplets. To investigate further arc erosion under fusion relevant conditions, materials with different thermal properties and melting temperatures (Al, Cu, Cr, TZM and steel) have been exposed to AUG plasmas.

A first evaluation of these samples using laser profilometry yields a strong local variation of the erosion even on a single sample. Close to the surface, i.e. down to a depth of 0.5 μm, the erosion is quite similar for all materials exposed. For comparison we focus on data 1 μm below the surface. Cu and steel have melting temperature in the same range but the thermal properties (effusivity) differ strongly. This could explain the fact that the steel probe is much deeper (7 vs 25 μm) and 5 times stronger eroded. This finding is in contradiction to laboratory data [2], which report a 2 times stronger erosion for Cu. The influence of the melting temperatures is investigated by comparing Al vs Cr: an 8 times stronger erosion for Al is found. Again a discrepancy with erosion data from the literature (Al / Cr = 1.6) is observed. Data on all materials and a fit to a simple model, which will allow extrapolation to other materials, will be presented.

[1] Rohde et al., N.M.E., 9, (2016), 36