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Development of cleaning discharges for in-vessel ITER optics

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Sputtering and subsequent redeposition of plasma facing materials in the international fusion device (ITER) will be one of the main problems for front-end optical components (windows and mirrors). The films deposition results in degradation of optical characteristics and is the challenge for optics operational stability. Different in-situ protecting/cleaning methods for in-vessel ITER optics were addressed in a number of publications. One of the techniques is exposure of deposited optical surfaces to a specially developed cleaning discharge. The initial material selection for ITER plasma facing components (PFCs), namely beryllium (Be) on the main vessel walls, tungsten (W) on the divertor upper baffle and dome, and carbon fibre composite (CFC) around the strike points on the divertor plates. The main problem of this design was the erosion of the CFC in a hydrogen plasma and redeposition of hydrocarbon films in remote parts of the reactor. The new concept involves full W divertor and Be wall for ITER project.

In the work we have presented the results of the experiments on erosion of hydrocarbon (a-C:H) films, deposited on molybdenum (Mo) foil plates, W, Mo, and Al (used as Be proxy) foils in a cleaning glow discharge on the base of hydrogen or hydrogen/reactive gas mixtures. The erosion rate, surface and optical properties of the samples were characterized before and after exposure by weighing on a microbalance with an accuracy of 0.2 µg, Reflectance Spectroscopy, Scanning Electron Microscopy, Electron Probe Microanalysis, X-ray Photoelectron Spectroscopy, and Atomic Force Microscopy.

The observed trend of increasing sputtering yield with reactive gas concentration can be interpreted as the influence of protonated ions formed in plasma.

Keywords: cleaning discharge, erosion, protonated ions, hydrocarbon films, tungsten, aluminum, molybdenum, beryllium, ITER.