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Extrapolation of Be Erosion Modelling from JET and PISCES-B to ITER

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Beryllium (Be) erosion data is one of the key issues for ITER including the first wall (FW) life time predictions [1], which undergo a re-visit based on the recent studies at the existing devices: tokamak JET equipped with the ITER-like wall (ILW) and linear plasma device PISCES-B. The extrapolation of physical and chemically assisted sputtering data is based on interpretive and predictive numerical modelling by the 3D plasma-surface interaction and impurity transport ERO code. One of the key elements is the proper treatment of the sputtering ion trajectories in the magnetic sheath, determining the angle and energy distributions by impact with the surface, and, thus the effective local sputtering yield. This recent improvement has helped to resolve the discrepancy in the normal incidence part of the factorized physical sputtering yields, which were interpreted using ERO from the JET-ILW and PISCES-B measurements. The uncertainties due to plasma-facing surface temperature and fuel e.g. deuterium (D) content in the wall are considered. The D content in plasma-wetted areas was shown to be large (the yields based on the assumed 50%D surface content, which are smaller by about a factor 3-4 than for the pure Be, lead to the best agreement with experiments). This means that the most optimistic of ITER life time predictions [1] of 4200 baseline Q=10 yields discharges based on the lowest yields (50%D) is confirmed, though somewhat corrected down due to the improved sheath model. It is important, however, to emphasize that the zero order uncertainty in these FW net erosion predictions originates in the background plasma specification which remains significant for the ITER far-SOL plasma.

The advantages of the new massive-parallel ERO2.0 which allows treating the whole of JET-ILW or ITER volume, and thus providing self-consistent treatment of self-sputtering and magnetic shadowing are an additional motivation for the revisit of [1]. Furthermore, ERO2.0 enables cross-check between diagnostics, e.g. spectroscopic sightlines and filtered images from 2D cameras characterizing Be influx and plasma content, or IR images mimicking heat load distributions. Related predictive simulations of Be impurity light emission can assist in designing (sensitivity and stray light issues) the ITER visual range spectroscopy systems.

[1] D.Borodin et al., 2011 Phys. Scr. T145 14008

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