Modelling of tungsten erosion and deposition in the divertor of JET-ILW in comparison to experimental findings

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Tungsten (W) will be used as plasma-facing material in ITER and is under consideration for future devices like DEMO. However, the W concentration in the plasma should be minimised to limit plasma dilution and cooling. Thus, the prediction of the net W erosion is important and for this, experiments at existing fusion devices in combination with modelling are indispensable.

The present contribution focuses on the modelling of tungsten erosion and deposition in the divertor of JET. The 3D Monte-Carlo code ERO is used for this modelling and the results are compared with observations. Experimental studies at JET, mainly based on spectroscopy, can be found e.g. in [1, 2]. The tungsten gross erosion along outer divertor tiles has been measured by WI spectroscopy for intra- and inter-ELM conditions [1]. As in the experiment, the modelling shows that normally the gross erosion is dominated by the ELMs. For instance, in the example of [1], the intra-ELM sputtering is dominated by a factor of about 9 over inter-ELM sputtering. However, the modelling indicates that the inter-ELM phases can significantly contribute to the resulting net erosion as the re-deposition fraction during ELMs is larger than in-between ELMs. For the referred example, the modelled re-deposition fractions are about 84% for the inter- and 98% for the ELM-phase. This reduces the gross erosion by factors of about 6 for inter-ELM and about 50 for intra-ELM conditions leading to comparable net erosion due to inter- and intra-ELM phases. In general, the resulting contributions to the net erosion strongly depend on the inter-ELM electron temperatures – a parameter study will be presented. The modelling also shows that the W sputtering in-between ELMs is usually due to impurities (beryllium) unless the electron temperature is large enough such that sputtering due to deuterium also can contribute considerably. On the other side, the ion impact energy during ELMs is large enough (according to the free-streaming model) wherefore sputtering is dominated by deuterium ions. Finally, the effect of self-sputtering of returning W ions will be included in the modelling to study its influence on the resulting gross and net erosion.

[1] G.J. van Rooij et al., Journal of Nuclear Materials 438 (2013) S42
[2] N. Den Harder et al., Nucl. Fusion 56 (2016) 026014

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