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Theoretical modelling of non-hydrogenic plasma-wall interaction experiments in ASDEX-Upgrade and the GyM linear device

Plasma-wall interaction (PWI) is a key topic to be addressed for the safe operation of nuclear fusion reactors. Non-hydrogenic species, like helium (He) produced by D-T fusion reactions or argon (Ar) injected in tokamaks as a seeding impurity, need special attention. Their large mass may enhance the erosion of plasma facing components (PFCs), but they also increase radiation cooling, which instead tends to lower erosion; moreover they may induce peculiar surface modifications on the material. On the material side, tungsten (W) is the primary candidate to be investigated as a divertor and first wall material due to its low sputtering yields and high melting point. Studying full non-hydrogenic PWI may provide crucial information to understand relevant physics phenomena and for code validation purposes. Experiments of this kind have been conducted both in tokamaks and in linear plasma devices (LPDs), the latter being dedicated testbeds to investigate PWI at ITER-relevant levels of particle fluxes and fluences. In this framework, analytical and numerical models play a significant role in supporting the experimental activities, aiding their interpretation and enhancing the ability to extrapolate results to future experiments.
This work presents an overview of modelling activities related to non-hydrogenic PWI experiments, both in a full W tokamak environment and in dedicated LPD W-samples exposures, performed in ASDEX Upgrade (AUG) and in the GyM linear device [1] respectively. The erosion and impurity transport code ERO2.0 [2] is employed to simulate erosion, migration and deposition across the entire machine volume, thanks to its coupling with the boundary plasma code SOLPS-ITER [3].
Based on previous modelling works [4,5], the results presented relative to the GyM linear device focus on the recent advancements towards the validation of ERO2.0 global simulations with He and Ar plasmas. The modelling techniques adopted to support the design of the experiments are illustrated, in terms of ideal diagnostic location and different plasma-sample material configurations, in order to obtain better experimental data for validation purposes. It was shown that catchers to measure deposited layers provide higher deposition by being installed closer to the sampleholder in axial position and oriented towards it, whereas symmetric azimuthal
deposition is observed. W-samples installed in a Molybdenum (Mo) mask provided a threefold higher deposition rate than a single larger W-sample without mask. Instead, replacing W-samples with an easier to sputter material like chromium (Cr) provided the highest deposition signal, around twice the W-samples and Mo-mask configuration.
The modelling is finally validated against experimental measurements.
On the AUG tokamak side, the results aim to present the erosion modelling of H-mode He discharges, following previous work conducted on L-mode He discharges from the same campaign*. Work is ongoing to evaluate the influence of different modelling assumptions on outer divertor erosion and W transport. Moreover, a strategy for erosion modelling in intra-ELM phases is being developed to evaluate differences with the inter-ELM phase. Finally, results are compared to the L-mode modelling and to experimental outer divertor erosion measurements.

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