

P2.1043 Investigating the role of hydrogen molecular effects on detachment using Magnum-PSI

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See full abstract here

<http://ocs.ciemat.es/EPS2019ABS/pdf/P2.1043.pdf>

In ITER and other next-generation fusion devices, divertor detachment will be crucial to limit the heat and particle fluxes to plasma-facing components to tolerable levels. This work investigates the importance of molecular effects on detachment. A type of molecular reaction of interest in this work is Molecule-Activated Recombination (MAR). MAR is a two-step process where a molecule collides with an ion and an electron, effectively resulting in recombination of the ion-electron pair and dissociation of the molecule, and could provide a recombination sink at relatively high electron temperatures of 1-3 eV where electron-ion recombination (EIR) has a negligible rate. MAR has been experimentally investigated mainly in linear devices with electron densities typically below.

The linear device Magnum-PSI can produce plasmas with electron temperatures of eV and densities, having significant overlap with the (semi-)detached ITER divertor region. This makes Magnum-PSI perfectly situated to study the effect that MAR will have on detachment in ITER. In Magnum-PSI, conditions of detachment with a high degree of plasma-neutral interactions near the target are mimicked by seeding hydrogen gas in the last of three differentially pumped vacuum chambers, raising the neutral background pressure from 0.4 Pa to up to 15 Pa in the final 80 cm in front of the target. Thomson Scattering is used to measure and in these different conditions of varying degrees of 'detachment'. Optical emission spectroscopy (OES) of the Balmer enables the determination of radial profiles of excited in the plasma beam from excited state $n=3$ up to n_{10} . The observed Balmer emissions are split into their EIR and MAR contributions to determine the relative importance of these processes, similar to [1]. OES is also used to measure the Fulcher band, which provides information about the distribution of ro-vibrationally excited, which can enhance the MAR rate by multiple orders of magnitude.

The experimental results are compared to numerical simulations of Magnum-PSI using the Eunomia-B2.5 code suite, a Monte Carlo neutral-fluid plasma model which contains a full set of molecular reactions and resolves the vibrationally excited states of.

[1] K. Verhaegh et al., Nuclear Materials and Energy 12 (2017) 11121117

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