ERO modeling of tungsten erosion and migration from a toroidally symmetric source in DIII-D divertor

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The W gross erosion profile from a toroidally symmetric W ring in the DIII-D lower divertor is reproduced with ERO simulations taking into account the effect of ExB drifts. ExB drifts are shown to have a significant impact on impurity migration in the divertor, i.e. by carrying a large amount of C impurities onto the W surface. The flux of C impurities eroding and redepositing on the W surface is shown to be larger than the flux of C impurities originating from nearby graphite tiles. In this C deposition regime dominated by erosion-redeposition, the flux of C impurities inducing W erosion strongly depends on the C implantation into and erosion from the W surface. Modeling of these processes with the analytic homogenous mixed material (HMM) model [1,2] is shown to be valid only for large electron plasma temperature at the divertor plate (Te>25eV).

Simulations were carried out for the dedicated L-mode discharges during the Metal Rings Campaign in DIII-D. Two toroidally symmetric W rings were inserted in the lower divertor of DIII-D and exposed to ~25 repeated attached L-mode shots in the reverse-Bt configuration with additional neutral beam heating (2.8 MW). The outer strike point was placed on the outboard W ring, where the radial profiles of the W gross erosion flux were measured spectroscopically. Modeling of those L-mode plasmas with OEDGE indicates that C impurities flowing onto the W ring are eroded and migrate within the outer divertor region only. Therefore, erosion, migration and redeposition of C and W particles are modeled within the divertor region exclusively using ERO with toroidal periodic boundary conditions. Plasma background information obtained with DIVIMP suggests that the horizontal projection of the total ExB drift points inward in the common flux region, as previously observed in the UEDGE simulations of H-mode plasmas with similar input power [3]. ERO modeling predicts that such inward drifts carry large amount of C impurities onto the W surface, which are necessary to quantitatively reproduce the measured W gross erosion flux. It is also shown that ExB drifts in the far SOL may explain the large W deposition pattern observed on graphite 5 cm radially outboard from the W ring.

*Work supported by U.S. DOE under DE-FC02-04ER54698, DE-AC52-07NA27344 and DE-FG02-07ER54917.

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*Work supported by U.S. DOE under DE-FC02-04ER54698, DE-AC52-07NA27344 and DE-FG02-07ER54917.