

Erosion, Screening, and Migration of Tungsten in JET Equipped with Tungsten Divertor

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W is the plasma-facing material of the JET-ILW divertor. W erosion by plasma and impurity impact determines the components lifetime as well as can influence the plasma performance by the W influx into the confined region. Certainly, the W screening by the divertor and the W transport into the plasma determines the W core content, but the W source itself impacts the process. Its quantification is essential to understand the interplay between the W impurity and the plasma.

The JET-ILW provides access to a large set of W erosion-determining parameters permitting a detailed description of the source in the divertor closest to the ITER one. (a) Effective sputtering yields and fluxes as function of impact energy of intrinsic (Be,C) and extrinsic (Ne,N) impurities as well as hydrogenic isotopes (H,D) are determined. This includes the interplay between intra- and inter-ELM W sources caused by the flux and energy distributions in these phases. The threshold behavior and the spectroscopic composition analysis provide an insight in the dominating species and phases causing the erosion. (b) The interplay between net and gross W erosion source will be elaborated considering prompt re-deposition, thus, the return of W to the surface within one Larmor radius, and surface roughness, thus, the difference between smooth bulk-W and rough W-coating components. Both effects impact the balance equation of local W erosion and deposition. (c) Post-mortem analysis reveals the campaign-integrated net migration path identifying the W transport to remote areas. The transport is related to the plasma regime, e.g. H-mode with attached divertor and high impact energies of impinging species or detached operation, as well as to the magnetic configuration, e.g. corner with geometrical screening of W or ITER-like vertical target. (d) The influence of parameters like surface temperature on the erosion, including the role of chemically assisted physical sputtering, is covered.

JET-ILW permitted access to net W erosion in one magnetic configuration within a series of 151 subsequent discharges. Comparison of spectroscopy in the intra-ELM and inter-ELM phases with post-mortem analysis of marker tiles provided a set of gross and net W erosion. ERO code simulations could reproduce the pattern as well as confirm high prompt W re-deposition factors of more than 95% for the intra-ELM phase.

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