The effect of Beryllium Oxide on retention in JET ITER-like wall tiles

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Fuel retention in the JET-ITER like wall (JET-ILW) has decreased by a factor of 20 compared to operation with a carbon wall [1]. This reduction occurred due to a decrease in chemical erosion of the beryllium main chamber. A reduction in co-deposition of fuel with beryllium has been reported in the divertor [2]. However, 24% (8.8×10^{22} D atoms) of fuel remains as long-term retention in beryllium dump plates and limiter tiles [1]. This contribution studies the Be limiter tiles exposed in JET, with the aim of understanding how the microstructure influences fuel retention. Dump plate, inner, and outer wall limiters tiles have been investigated, encompassing deposited, eroded and melted regions of the vessel. A wide range of techniques have been used to study these phenomena at different length and depth scales. Focused Ion Beam (FIB) 'serial milling' studies were used for compositional understanding of 20μm^3 beryllium cut outs. TEM studies were undertaken of 20μm^2 lift-outs. SEM and EDX studies were undertaken of the surface morphology and composition at different energies. Raman Spectroscopy was applied for the first time to JET tiles, to investigate the chemical bonding of surface layers up to 50nm depth. Raman investigations have uncovered the presence of BeO bonded to deuterium in BeO_xD_y, for the first time, on melted surface regions in upper dump plate tiles. It is proposed that this bonding is important in the retention mechanisms present for beryllium in JET. Preliminary Density Functional Theory (DFT) modelling was undertaken, which confirms the Raman band for the wurtzite BeO crystal structure. The literature supports the formation of BeO bonding even under Ultra High Vacuum (UHV) conditions above temperatures of ~630°C [3-4]. SEM-EDX studies of the samples support the presence of oxide island formation. Both oxide island size and number density decrease between co-deposited wing tiles and eroded central regions. A thorough investigation of Thermal Desorption Spectroscopy (TDS) was undertaken toroidally across the midplane of the outer limiter, inner limiter and dump plates. The initial trends in the TDS data, support the presence of a different desorption peak behaviour in the central eroded regions. This suggests a different retention trap behaviour. Some toroidal asymmetry is present on a first review of the TDS data. Peak behaviour differs between the left and right wing co-deposited positions. TMAP7 analysis will be applied to these TDS spectra in greater detail, utilizing the microstructural features found with the techniques above in the code.

[1] K. Heinola, et al., *Phys. Scr.*, 1–7 (2016) T167
[2] A. Widdowson, et al., *Phys. Scr.*, 1–9 (2014) T159
[3] M. Reinelt et al., *J. Nucl. Mater.*, 568–571 (2009) 390
[4] M. Reinelt, et al., *New J. Phys.*, 8233-8239 (2009) 11

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