Erosion/deposition in the JET-ILW divertor measured by quartz crystal microbalance

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A set of quartz crystal microbalance (QMB) is used at JET with the ITER-like wall (ILW) with beryllium main wall and tungsten divertor to monitor material erosion/deposition rates in the remote areas of the divertor. After installation JET-ILW, a strong (factor \(\approx 10-20\)) reduction of the material deposition and accompanied fuel retention was observed in comparison with carbon wall by gas balance and with post-mortem analysis. In order to measure the reduced transport of predominately Be and residual C onto the QMB an enhancement of the sensitivity of the uncoated crystals and its electronics was required in order to measure temporally resolved erosion and deposition rates. Therefore, the QMB electronics had been modified to improve the accuracy of frequency measurements down to 0.1 Hz, which corresponds to 1.5 ng·cm\(^{-2}\) (0.04 Be monolayer). Several QMB systems consisting of sensor and reference quartz crystals, the latter used to compensate for changes due temperature variations, have been installed at the pump duct entrance to the louver below the lower vertical targets of the inner and the outer divertor leg. To prevent damage of the crystals by direct plasma impact, an automatic overheating protection electronics was introduced, which closes a shutter in front of the QMB when a temperature of 230-270\(^{\circ}\)C is reached. The frequency change immediately after the plasma exposure is estimated by fitting within the time interval of 300-1500 s using a combination of an exponential decay and a linear function. The frequency change over longer time interval was also obtained by comparing the frequencies at the beginning of subsequent plasma pulses when the system was closer to thermal equilibrium. In addition, the QMB frequencies were measured overnight when the crystals cooled down to the same steady state temperature of about 50\(^{\circ}\)C.

For many cases the QMB frequency change measured immediately after the plasma pulse is essentially smaller than measured after longer time interval. Maximum deviations were observed for additional heated plasmas with the strike point in the divertor corner where the sensor quartz crystals were exposed to the highest heat and particles fluxes. The latter could be caused by stress relaxation in the deposited layer or by oxidation of beryllium layer on the crystal. The averaged deposition rate was 1.3 - 3.8 ng·cm\(^{-2}\)·s\(^{-1}\) in inner divertor. Averaged deposition rates were higher by a factor 1.46±0.15 in deuterium plasma in comparison with hydrogen plasma. The QMB measurement will be presented and the influence of the above-mentioned effects will be discussed.

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