# Material erosion, deposition and transport in the divertor region of the stellarator W7-X

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Net erosion, deposition and material transport in the stellarator W7-X were investigated on the Test Divertor Unit (TDU) using special carbon marker coatings [1] during the operational phases OP1.2a in the year 2017 and OP1.2b in 2018, and on the divertor baffles by analysis of regular wall elements after OP1.2b. While OP1.2a was characterised by high concentrations of oxygen and carbon impurities in the plasmas, OP1.2b had much smaller impurity concentrations due to regular boronizations and showed considerably better plasma performances with higher plasma densities. The samples were analysed by quantitative ion beam analysis methods, scanning electron microscopy, laser-induced breakdown spectroscopy (LIBS), and laser-induced ablation-quadrupole mass spectrometry (LIA-QMS).

Very high net erosion of carbon was observed at the strike line of all 10 TDUs in both campaigns and is attributed to sputtering and chemical erosion by C and O impurities in OP1.2a [1], while the erosion was probably dominated by impact of H ions in OP1.2b. Re-deposition of carbon in remote areas of the TDU was small, but a noticeable deposition of boron on the TDU was observed after OP1.2b. Thicker re-deposited carbon/boron layers with thicknesses of a few microns having a layered structure (carbon and oxygen in OP1.2a; carbon, boron and higher oxygen contents in OP1.2b) were found on divertor baffle tiles after OP1.2b. These tiles contained also higher H-inventories up to $10^{22}$ H-atoms/$m^2$ due to codeposition. The following inner wall showed net deposition of about 100 nm thick boron/carbon layers due to the boronizations.

The global carbon balance is currently unclear. However, carbon eroded from the TDU was not redeposited in the divertor region but was transported out of the divertor area. Some carbon was redeposited at the divertor baffles but was also pumped out as CO, $CO_2$, or $CH_4$. This is a profound difference to divertors in tokamaks, where eroded material is typically redeposited in remote divertor areas or in the inner divertor.

[1] M. Mayer et al., PFMC 2019, Phys. Scr., in press

[+]see T. Klinger et al., Nucl. Fusion **59** (2019) 112004