Development of Laser-based diagnostics for surface characterisation of wall components in fusion devices *

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Plasma-facing components (PFC) in the main chamber (beryllium), the baffle region (tungsten) and the divertor (carbon) at ITER are eroded by physical and chemical sputtering and evaporation. The material is transported from net erosion areas by the edge plasma to areas with net deposition forming layers of mixed materials with co-deposition of tritium. Knowledge on the distribution, thickness and composition of these layers, which will be strongly inhomogeneous, especially in poloidal direction, is most essential for the safe operation of ITER. Therefore new methods have to be developed to monitor regularly the deposited material and the tritium inventory and to reduce it if necessary.
The FZJ team actually develops laser-based diagnostics for in situ characterisation of first wall surfaces in fusion devices. The basic idea is to heat and evaporate material at spots on the first wall by intensive laser radiation either during or between discharges. In the first case the released particles penetrate into the edge plasma where they are excited and emit a characteristic line radiation (laser induced ablation spectroscopy-LIAS). In the second case the light from the laser induced plasma is observed (laser induced breakdown spectroscopy-LIBS). In both in-situ methods the light is collected coaxially to the laser beam by an observation system, which together will be directed to different location in one poloidal cross-section.

Laser energies of 2-15 J/cm^2 are required within 10 ns pulse duration for the surface treatment. The laser light is guided from outside the biological shield by a mirror system. A mirror based beam line transfers the light from the observation system to a spectrometer outside the concrete shielding. This spectrum of the light delivers the composition of the atomic and molecular species deposited at the first layer. The absolutely calibrated signals will allow a quantitative determination of the layer components.

At TEXTOR the dependence of the release mechanism on laser energy density, the reproducibility and conversion factors (number of photons to released particle) are investigated.

Results obtained in a prototype set-up at TEXTOR are presented. A preliminary design and the main parameters for the application of these methods at ITER are discussed.

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