LASER INDUCED DESORPTION AS TRITIUM RETENTION DIAGNOSTIC IN ITER *

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Measurement and control of long term tritium retention is one of the most critical issues for ITER and future fusion devices. A detailed analysis of fuel retention is needed already in the non activated phase in ITER to proof the model predictions on retention and also to qualify T-control schemes. The main goals are to identify the amount of retention, its spatial distribution and its dependence on plasma operation and wall conditions and to qualify possible T retention mitigation and control techniques.

For this purpose a new diagnostic, Laser Induced Desorption Spectroscopy (LIDS) has been developed in lab experiments and applied systematically in TEXTOR. Retained hydrogen is desorbed by rapid local laser heating and determined in TEXTOR by local spectroscopy of hydrogen Balmer lines. These results have been compared with ex-situ measurements on retention by laser desorption and quadrupole analysis.

In both methods a high energy Nd:YAG laser pulse at 1064 nm with a pulse duration of a few milliseconds heats a spot of 4-8 mm^2 up to around 2000 K. At this temperature more than 90% of the hydrogen content is desorbed from amorphous-C:H layers on carbon or tungsten samples. The heat wave penetrates up to about 100 µm into the substrate such that the hydrogen is released from these depths. The hydrogen releases mainly molecularly as H_2, HD and D_2 with some contribution from hydrocarbons.

The ex-situ method uses a quadrupole mass spectrometric detection, called LID-QMS, has a high spatial resolution and absolute accuracy. As an example, this contribution reports on the determination of the 2D pattern of hydrogen retention on a first limiter tile of TEXTOR, which has faced the plasma for 33200 s during more than two years of tokamak operation, with a corresponding hydrogen fluence of this tile of the order of 10^{26} /m^2. The tile shows a large net-erosion zone with a smaller part (about 20%) in a net-deposition zone, which led to the formation of a thick and rough a-C:H layer. The zones are separated by a sharp and macroscopically meandering border. The laser technique allows a high spatial resolution and has revealed several smaller unexpected regions of increased hydrogen inventory. It has also been applied to determine the inventory on the tile sides in between two limiter tiles (gap deposition). The laser determined hydrogen inventory is cross-checked by Nuclear Reaction Analysis (NRA) and conventional thermal Desorption Spectrometry (TDS).

The in-situ method is applied during tokamak operation. The desorbed hydrogen is excited in the tokamak plasma, its H-alpha emission is recorded by a 2D camera and the integrated amount of light is transformed into the total amount of hydrogen and deuterium via conversion factors. This spectroscopic method, called LIDS[1], has been qualified further and extended to thick a-C:H layers deposited on W substrates, and to hydrogen retention in bulk carbon and tungsten substrates. This contribution concentrates on LIDS of a pre-characterised thick a-C:H layer on tungsten under various different plasma edge conditions in TEXTOR.

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[1] B. Schweer et al., Journal of Nuclear Materials, 390–391, 2009, 576–580