P 22: Plasma Wall Interaction II/HEPP VII

Time: Thursday 14:00–15:50 Location: ELP 6: HS 4

Invited Talk P 22.1 Thu 14:00 ELP 6: HS 4

First Results of Laser-Induced Desorption - Quadrupole Mass Spectrometry (LID-QMS) at JET — •Miroslaw Zlobinski[1], Gennady Sergienko[1], Ionut Jepu[2,3], and et al[2] — [1]Forschungszentrum Jülich GmbH, Institut für Energie- und Klimaforschung - Plasmaphysik, Partner of the Trilateral Euregio Cluster (TEC), 52425 Jülich, Germany — [2]United Kingdom Atomic Energy Authority, Culham Centre for Fusion Energy, Culham Science Centre, OX14 3DB Abingdon, UK — [3]National Institute for Laser, Plasma and Radiation Physics, Magurele, Romania

Monitoring the tritium retention at the walls of fusion devices is important due to radiation safety, the fuel cycle and material degradation. In 2023 a new fuel retention diagnostic has been installed on JET and the first results are presented here. LID-QMS allows direct in situ measurements of the fuel inventory of plasma facing components. The diagnostic desorbs the retained gases by heating a 3 mm diameter spot on the wall using a 1 ms long laser pulse and detects them by Quadrupole Mass Spectrometry (QMS). The successful detection of tritium retention in the tritium campaign at JET has been demonstrated. Thus, this diagnostic is already foreseen as tritium monitor diagnostic for ITER.

Invited Talk P 22.2 Thu 14:30 ELP 6: HS 4

Deuterium retention analysis in pre-damaged tungsten using laser-induced breakdown spectroscopy — •Erik Wüst[1,2], Christoph Kawan[1,2], Sebastijan Brezinsek[1,2], and Thomas Schwarz-Selinger[3] — [1]Forschungszentrum Jülich GmbH, Institut für Energie und Klimaforschung - Plasmaphysik, Partner of the Trilateral Euregio Cluster (TEC), 52425 Jülich, Germany — [2]Faculty of Mathematics and Natural Sciences, Heinrich Heine University Düsseldorf, 40225 Düsseldorf, Gernany — [3]Max-Planck-Institut für Plasmaphysik, D-85748 Garching, Germany

Energetic neutrons are a product of the DT-fusion reaction and can induce material damage in Plasma-Facing Components (PFCs) in future nuclear fusion reactors. The damage increases with time and causes enhanced fuel, tritium (T) and deuterium (D), retention in tungsten (W) PFCs, which imposes issues for safety and closure of the T cycle in the fusion plant. Laser-Induced Breakdown Spectroscopy (LIBS) is a potential in-situ technique to monitor tritium inventory in W PFCs. LIBS on pre-damaged W (W-ions, 10.8 MeV, 0.23 dpa) with D contents of 0.1-1% owing to D plasma exposure in PlaQ and subsequent outgasing, was carried out to measure the depth-resolved fuel content in a laboratory set-up. LIBS was done using an Nd:YAG laser (35 ps, 355 nm, 20 mJ), ablating 15 nm per laser pulse. D was detected up to a depth of $1.3\mu m$ by observing Balmer α line from the laser-induced plasma plume. The depth profile and total amount was compared with nuclear reaction analysis (NRA) and showed good agreement. Deviations can only be observed for the first ablation cycle near the surface.

P 22.3 Thu 15:00 ELP 6: HS 4

Ion-driven deuterium permeation in tungsten-heavy-alloy-like multi-layer membranes — •Philipp Sand[1,2] and Armin Manhard[1] — [1]Max-Planck Institut für Plasmaphysik, 85748 Garching, Germany — [2]Techn. Univ. München, 85748 Garching, Germany

Tungsten heavy alloy (97W-2Ni-1Fe, %wt., THA) is a possible candidate as plasma-facing material in future nuclear fusion devices. It exhibits a similar heat conductance at high temperature and sputter yield as pure W, whilst showing an improved ductility [1]. Hydrogen isotope (HI) retention behaviour [2] was also shown to be favourable, which was attributed to the microstructure of this dual phase material: Upon plasma loading, the percolating matrix phase provides fast diffusion paths to vacuum [3], while W domains remain at low HI concentrations due to a low HI solubility. To predict HI uptake of THA under reactor relevant conditions, the parameters of HI transport across respective phase boundaries must be quantified. An ion-driven permeation experiment was benchmarked using pure W samples irradiated with of 170 eV/D at $5\text{x}10^{19}$ D/m^{2}s between 650 K and 900 K. D transport across the interface was studied at the same conditions in both directions using W substrates coated with matrix-like alloy on one side. The influence of surface oxides on permeation is investigated on both sides. It is confirmed that uptake from matrix into W is strongly suppressed while no significant barrier was observed for HI transport from W into matrix. [1] R. Neu, et al., Fusion Eng. Des. 124 (2017) 450-454, [2] H. Maier, et al., J. Nucl. Mater 18 (2019) 245-259, [3] A. Manhard, et al., Nucl. Mater 36 (2023) 101498

P 22.4 Thu 15:25 ELP 6: HS 4

Characterization of ionization pressure gauges for magnetic confinement fusion devices — •Bartholomäus Jagielski — Max Planck Institut für Plasmaphysik, Greifswald, Germany

This work describes advanced gas pressure gauges designed for use in strong magnetic fields during plasma operation in fusion devices. The performance of novel cathode designs and emitter materials, including LaB_6, ZrC, HfC, and TW, were systematically studied in terms of sensitivity and reliability in different gases. The study presents the setup of a unique laboratory featuring a high field magnet, enabling experiments with adjustable pressures and magnetic fields up to 6 T. Conditioning and stability of the emitters were explored in a magnetic field up to 6 T, revealing fluctuations in the electron and ion current, which have been studied in more detail using simulations, suggesting the existence of virtual cathodes within the potential well, affecting the potential distribution. Thermal studies using pyrometers and an infrared camera, alongside heat transfer analysis with Ansys, identified optimal LaB_6 emitter conditions. Additionally, Energy-Dispersive X-ray Surface Spectroscopy provided evidence of surface oxidation and emitter material emission under non-optimal conditions.
The optimized potential distribution and operating ranges for various cathodes were determined, achieving record values for a stable operation in a strong magnetic field. The results showcase the suitability of LaB_6 emitters in Wendelstein 7-X and for advancing fusion research, particularly in the context of large-scale projects like ITER and DEMO.