P 15: Helmholtz Graduate School IV - Plasma Wall Interaction

Time: Wednesday 14:00–16:05 Location: A 0.112

P 15.1 Wed 14:00 A 0.112

SIESTA: a new high-current ion source for angle-dependent sputter yield measurements — •Rodrigo Arredondo Parra[1,2], Martin Oberkofler[1], Thomas Schwarz-Selinger[1], and Klaus Schmid[1] — [1]Max Planck Institut für Plasmaphysik, Boltzmannstr. 2, D-85748, Garching, Germany — [2]Technische Universität München, Boltzmannstr. 15, D-85748, Garching, Germany

SIESTA (Second Ion Experiment for Sputtering and TDS Analysis) is a newly built high current ion source used for research on plasma-wall interaction issues. The ion source can be set to an acceleration potential of up to 15 kV and can be operated with H, D, He and Ar. The beam is mass-filtered in a magnetic sector field. A monoenergetic beam of a single species (e.g. D_3^+) is used for irradiation of samples in the separate implantation chamber at a base pressure of 10^{-8} mbar. The target can be rotated to study angle-dependent effects and can be positively biased to facilitate exposure to ion energies as low as 200 eV. A magnetic suspension balance allows for in-situ sputter-yield measurements. Particle flux densities of up to $3 * 10^{19}$ D/m^2/s for 10 keV D_3^+ ions were measured. As part of ongoing research on the influence of surface roughness on the sputter yield, controlled roughness samples of Fe and W were exposed to a 6 kV D_3^+ ion beam (2 keV/D) under varying angles of incidence. The resulting sputter-yields are compared to Monte-Carlo simulations, agreeing on the dependence of the sputter-yield on the incidence angle and, in the case of Fe, also on the absolute amounts. The sputter-yields for W and Au are compared to literature data, agreeing well with previous measurements at normal incidence.

P 15.2 Wed 14:25 A 0.112

Developement of Hotspot Detection System for Protection of Plasma Facing Components in Wendelstein 7-X — •Adnan Ali[1,3], Marcin Jakubowski[1], Henri Greuner[2], Thomas Sunn Pedersen[1], Rudolf Neu[2,3], and W7-X Team[1] — [1]Max Planck Institute for Plasma Physics, Wendelsteinstrasse 1, 17491 Greifswald — [2]Max Planck Institute for Plasma Physics, Boltzmannstrasse 2, 85748 Greifswald — [3]Technical University of Munich (TUM), Boltzmannstrasse 15, 85748 Garching

One of the main aims of Wendelstein 7-X, an advanced stellarator, is to investigate the quasi steady state operation of magnetic fusion devices, for which power exhaust is an important issue. A predominant fraction of the energy lost from the confined plasma region will be removed by 10 so-called island divertors, which are designed to sustain maximum heat flux up to 10 MW/m2. A very important prerequisite for safe operation of a steady-state device is an automatic detection of the hot spots and other abnormal events. In this work, we present the experimental results obtained at the high heat flux test facility GLADIS in IPP Garching where we tested the newly developed algorithms for protection of W7-X plasma facing components. Two types of off-normal signals are detected steming either from delaminations formed at the connection between CFC and CuCrZr blocks and hydrocarbon surface layers formed on the material surface. The algorithms designed for early detection of defects was successfully tested in GLADIS and is now implemented in the new detection software for W7-X imaging diagnostic.

P 15.3 Wed 14:50 A 0.112

The influence of dislocations, vacancies, and vacancy clusters on deuterium trapping in tungsten — •Mikhail Zibrov[1], Matej Mayer[1], Armin Manhard[1], Dmitry Terentyev[2], Andrii Dubinko[2], and Werner Egger[3] — [1]Max-Planck-Institut für Plasmaphysik, Garching, Germany — [2]SCK-CEN, Mol, Belgium — [3]Universität der Bundeswehr München, Neubiberg, Germany

The hydrogen (H) isotope inventory in tungsten (W) is governed by the presence of lattice defects acting as trapping sites for H. The aim of this study is to reveal the role of individual defect types by using samples having one dominant and well-characterized defect type.

Vacancies were introduced in single crystalline W specimens by damaging with 200 keV protons to low damage levels. The samples were annealed at temperatures in the range of 500-1800 K to investigate the stages of vacancy clustering. Dislocations were introduced in recrystallized W samples via tensile plastic deformation to various strains. The resulting defects were characterized by positron annihilation lifetime spectroscopy and transmission electron microscopy. In order to fill the defects with deuterium (D), the samples were exposed to a low-flux D plasma. The D inventory in the samples was characterized by nuclear reaction analysis and thermal desorption spectroscopy. It was observed that the dislocations have a relatively small influence on the D retention, but they may facilitate the formation of blisters. Vacancies have a considerably higher D binding energy compared to dislocations. By annealing at temperatures above 600 K vacancies agglomerate in clusters, which have even higher D binding energies.

P 15.4 Wed 15:15 A 0.112

Radiation Damage Characterization in Tungsten — •Barbara Wielunska[1,2], Matej Mayer[1], Thomas Schwarz-Selinger[1], Witold Zielinski[3], Tomasz Plocinski[3], Witold Chrominski[3], and Lukasz Ciupinski[3] — [1]Max-Planck-Institut für Plasmaphysik Garching, Deutschland — [2]Fakultät für Physik TUM, Garching, Deutschland — [3]Wydzial Inzynierii Materialowej, Warszawa, Polska

Tungsten is a candidate material for the wall of future fusion reactors due to its low erosion yield and low hydrogen solubility. However, fusion neutron irradiation will induce radiation defects in the material. It is important to study the mechanism of defect creation and its influence on hydrogen retention in tungsten. Therefore tungsten samples were damaged with different ion species (p, D, He, Si, Fe, Cu, W) at energies between 0.3 and 20 MeV to different damage levels of 0.04 dpa and 0.5 dpa. For studying hydrogen retention in defects the samples were exposed to a low-temperature D plasma. The D depth distribution was obtained by nuclear reaction analysis using the D(3He, p)α reaction. Trapped D was measured by thermal desorption spectroscopy. Tungsten damaged by heavy ions (Si, Cu, Fe, W) to identical dpa values shows similar D depth profiles and D desorption spectra, i.e., the D retention is comparable. For tungsten damaged by light ions (p, D, He) the D retention shows larger differences. The damaged region was investigated by transmission electron microscopy. Differences in the dislocation structure in tungsten damaged by Si or W are visible although the D retention of those samples is almost identical.

P 15.5 Wed 15:40 A 0.112

Characterization of CVD tungsten-fibre reinforced tungsten composite: From the bulk to the interface — •Hanns Gietl[1,2], Johann Riesch[1], Jan W. Coenen[3], Till Höschen[1], Leonard Raumann[3], and Neu Rudolf[1,2] — [1]Max-Planck-Institut für Plasmaphysik, 85748 Garching — [2]Technische Universität München, 85748 Garching — [3]Forschungszentrum Jülich, IEK4, 52425 Jülich

For the use in a fusion device tungsten has unique properties such as low sputter yield, high melting point and low activation. However, the brittleness below the ductile-to-brittle transition temperature and the embrittlement during operation are the main drawbacks for the use of pure tungsten. Tungsten fibre-reinforced tungsten composites overcome this problem by utilizing extrinsic mechanisms to improve the materials* toughness. The next step in the material development is the conceptual proof for the applicability in fusion reactors by the production of larger components and for testing them under cyclic high heat flux loading. The characterization of the composites is one of the major issues to predict the material behavior within such a component. Different test methods for tungsten fibre-reinforced tungsten composites such as bending, charpy impact, and monotonic as well as cyclic tension tests were performed. The resulting fracture surfaces were examined by microstructural analysis to analyze the fracture mechanisms. In addition a single fibre pull-out test was developed to investigate the interface region between fibre and matrix which governs the overall material behavior.