P 23: Plasma Wall Interaction II

Time: Thursday 10:30–12:00 Location: A 0.112

Invited Talk P 23.1 Thu 10:30 A 0.112

Advanced Materials for a Damage Resilient Divertor for DEMO — •Jan Willem Coenen[1], Johann Riesch[2], Hanns Gietl[2,3], Yiran Mao[1], Leonard Raumann[1], Rudolf Neu[2,3], and Christian Linsmeier[1] — [1]Forschungszentrum Jülich GmbH, Institut fuer Energie und Klimaforschung, 52425 Juelich — [2]Max-Planck-Institut für Plasmaphysik, 85748 Garching — [3]Technische Universität München, Boltzmannstrasse 15, 85748 Garching

Material issues pose a significant challenge for future fusion reactors like DEMO and highly integrated approach is required. Cracking, oxidation as well as fuel management are driving issues when deciding for new materials. Neutron induced effects e.g. transmutation adding to embrittlement are crucial to material performance. Here advanced materials e.g. Wf/W composites allow the step towards a fusion reactor. Recent developments in the area of Wf/W will be presented showing a possible path towards a component based on standard tungsten production technologies. Damage resilient materials, with an increased operational temperature range facilitate component design with higher exhaust capabilities. The maximization of operational performance can only be achieved, if improvements of material properties, mechanical and thermal, are well balanced Wf/W contributes here to advanced material strength and crack resilience even after embrittlement. Rigorous testing with respect to plasma-wall-interaction and high heat-flux performance are ongoing. Prototype components are envisioned in the ner future.

P 23.2 Thu 11:00 A 0.112

Plasma chemical studies of nitrocarburizing with an active screen made of carbon — •Alexander D. F. Puth[1], Stephan Hamann[1], Lukas Kusyn[2], Igor Burlacov[3], Anke Dalke[3], Heinz-Joachim Spies[3], Horst Biermann[3], Jürgen Röpcke[1], and Jean-Pierre H. van Helden[1] — [1]INP Greifswald, 17489 Greifswald, Germany — [2]Masaryk University, 60200 Brno, Czech Republic — [3]Institute of Materials Engineering, TU Bergakademie Freiberg, 09599 Freiberg, Germany

Active screen plasma nitrocarburizing (ASPNC) is an advanced technology for the surface treatment of steel components. A new approach of this method is the usage of an active screen made of solid carbon as a substitute for carbon-containing gas supplements. The investigations have been carried out in the laboratory scale reactor PLANIMOR.

We will present the results of spectroscopic studies of N_2-H_2 containing pulsed DC discharges. The concentrations of CH_3, CH_4, C_2H_2, C_2H_4, C_2H_6, C_2N_2, NH_3, HCN, and CO have been determined with infrared laser absorption spectroscopy (IRLAS), using tunable diode lasers (TDL) and external cavity quantum cascade lasers (EC-QCL). Futhermore, the gas temperature of the stable molecular species and of the CH_3 radical has been determined using Bolzmann plot and line profile analysis, respectivly. The concentrations being measured as a function of the plasma power at the active screen, the gas pressure and the feed gas composition, ranged between 10^{12} and 10^{16} molecules cm^{-3}.

P 23.3 Thu 11:15 A 0.112

Tungsten Smart Alloys for the First Wall Armour of Fusion Power Plants — •Felix Klein[1], Andrey Litnovsky[1], Tobias Wegener[1], Marcin Rasinski[1], Xiaoyue Tan[1,2], Janina Schmitz[1,3], Jesus Gonzalez-Julian[1], Jan Willem Coenen[1], Martin Bram[1], and Christian Linsmeier[1] — [1]Forschungszentrum Jülich, Institut für Energie- und Klimaforschung, 52425 Jülich, Germany — [2]School of Materials Science and Engineering, Hefei University of Technology, Hefei, 23009, China — [3]Department of Applied Physics, Ghent University, 9000 Ghent, Belgium

In order to operate future fusion power plants reliably and safely, tungsten (W) is considered as a prime candidate as first wall armour material. However, in accidental conditions with a loss of coolant and air ingress, the nuclear decay heat will cause the radioactive W to oxidise and volatilise, imposing a severe hazard for the environment. Smart alloys aim at preserving the properties of W during plasma operation and suppressing the release of radioactive material in case of an accident. This goal is approached by alloying with chromium (Cr) and yttrium (Y). Bulk samples for full testing were consolidated by field assissted sintering technology. A relative density of 99 % is achieved. The accident is resembled by oxidation at 1273 K in air: the Cr diffuses to the surface forming a protective Cr_2O_3 layer and stopping WO_3 formation - after 44 h the layer has a thickness of 1.3 μm. This process is supported by the Y. After oxidation times of more than two days W-containing oxides form and a sublimation rate of 10^{-6} mg cm^{-2}s^{-1} is measured. After three weeks the oxide layer has a thickness of 0.1 mm.

P 23.4 Thu 11:30 A 0.112

Extending *ab initio* plasma-surface simulations to experimentally relevant scales — •Michael Bonitz — Institut für Theoretische Physik und Astrophysik, CAU Kiel

Reliable and predictive plasma-surface modeling is crucial, both, for fundamental understanding and for many applications of low-temperature plasmas. The available approaches comprise phenomenological models of different complexity and quality as well as *ab initio* approaches that include density functional theory, quantum kinetic theory and molecular dynamics. While the former suffer from a lack of reliable input parameters, the latter often are reliable but extremely time consuming and are, therefore, typically, applicable only to very short times and/or system size. Here I present a general concept how the *ab initio* methods can be extended, both, in length and simulation time. The idea is to properly combine *ab initio* simulations with lower level models. I discuss how and when this can be done rigorously and present some examples.

P 23.5 Thu 11:45 A 0.112

Determination of the Cs distribution along a line of sight by the Zeeman splitting in an inhomogeneous magnetic field — •Christian Wimmer, Maria Lindauer, Ursel Fantz, and the NNBI Team — Max-Planck-Institut für Plasmaphysik, Boltzmannstr. 2, 85748 Garching

A Tunable Diode Laser Absorption Spectroscopy (TDLAS) is installed in a pulsed-driven (plasma pulses up to one hour) low-temperature, low-pressure hydrogen plasma, into which caesium is evaporated, for the determination of the neutral Cs density and its temperature. Permanent magnets are attached to the side walls creating an inhomogeneous magnetic field (field strength of 3–30 mT) along the chosen line of sight. The laser is tuned over the resonance transition of Cs at 852 nm in order to obtain the Doppler-broadened spectrum. A clear Zeeman-splitting appears at the high field strength, i.e. close to the side walls, whereas no significant splitting occurs at the lower B-field strength in the center. By analyzing the measured Zeeman-split spectra, it could be observed that neutral Cs is depleted in the central part of the line of sight during long plasma pulses, whereas the Cs density stays considerably high close to the side walls. Cs is used in this ion source for the surface-conversion of hydrogen atoms to negative ions, with the main conversion surface being located close to the center of the line of sight. With this new insight, the vanishing of the correlation of the Cs density with the performance of the ion source can be explained.