

2020 Helmholtz – OCPC – Program for the involvement of postdocs in bilateral collaboration projects

PART A

Title of the project: Laser-induced breakdown spectroscopy for in-situ gas recycling analysis during plasma exposure

Helmholtz Centre and institute: Forschungszentrum Jülich GmbH, Institute of Energy and Climate Research: Plasma Physics (IEK-4)

Project leader: Dr. Jannis Oelmann

Web-address: https://www.fz-juelich.de/iek/iek-4/DE/Home/home_node.html

Description of the project :

The development and optimization of measurement techniques for in-situ analysis of the gas content on a materials surface and the materials inventory is of great interest in various application fields. The quantitative hydrogen content is a crucial parameter in for instance sample production, in materials of fusion devices like Wendelstein 7-X (W7-X, Greifswald, Germany) or the Experimental Advanced Superconducting Tokamak (EAST, Hefei, PR China) but also in hydrogen storage for regenerative energy solutions. Laser-induced breakdown spectroscopy (LIBS) is a broadly used technique nowadays and a promising candidate for sample surface content analysis, as it can be operated fast, preparation free and in-situ. Moreover, in fusion devices this analysis can be performed in-operando, so during the plasma discharges, which is a unique feature of laser-induced analysis.

The Institute of Energy and Climate Research for Plasma Physics (IEK-4) is investigating in material development, analysis methods and interaction of materials with plasma. With the linear plasma device PSI-2, a device specially designed for plasma-wall interaction studies, the recycling of gases on the surface of different materials like tungsten, tantalum or graphite can be analyzed in-situ during plasma exposure.

The main task for this project proposal is to improve the optical arrangement of the LIBS setup at PSI-2 and establish measurement routines for 2D-surface mapping analysis during plasma exposure. One key aspect is to increase the measurement sensitivity and thus the limit of detection for different sample species, which is essential for the determination of the gas recycling during plasma exposure. In addition, a similar setup shall be designed for in-situ studies in the linear plasma device JULE-PSI, which was recently approved by the board of Forschungszentrum Jülich and will be set up in the Hot Materials Lab (HML) in a controlled area.

The optimization of the LIBS laser path and detection system require knowledge of laser physics to analyze and improve the beam profile quality. A conceptual study of suitable laser parameter like pulse energy and focal spot size for this application needs to be performed. In addition, experience in spectroscopy is required for probing the feasibility for a quantitative impurity and D recycling analysis with a calibration free laser-induced breakdown

spectroscopy (CF-LIBS) approach. Finally, in-situ studies of the recycling of hydrogen isotopes at tungsten surfaces during plasma exposure will be performed to improve the knowledge of its transient as well as permanent deuterium reservoir. All gained information are essential inputs for modelling parameters and the conceptual design of LIBS setups in devices like W7-X, EAST, PSI-2 or JULE-PSI, but also for other research fields where laser-based in-situ analysis can be implemented for hydrogen determination.

Description of existing or sought Chinese collaboration partner institute:

A possible collaboration partner based on recent cooperation and the experience of the group in the field of LIBS and deuterium content analysis in materials is the *School of Physics and Optical Engineering, Key Laboratory of Materials Modification by Laser, Ion and Electron Beams, Chinese Ministry of Education, Dalian University of Technology, Dalian, 116024, PR China.*

Required qualification of the post-doc:

- PhD in: physics
- Experience with: spectroscopy, laser physics, plasma physics
- Additional skills in: data analysis (e.g. Matlab or Python)

PART B

Documents to be provided by the post-doc, necessary for an application to OCPC via a postdoc-station in China, which is affiliated to a research institution like a university:

- Detailed description of the interest in joining the project (motivation letter)
- Curriculum vitae, copies of degrees
- List of publications
- 2 letters of recommendation
- Proof of command of English language

PART C

Additional requirements to be fulfilled by the post-doc:

- Max. age of 35 years
- PhD degree not older than 5 years
- Very good command of the English language
- Strong ability to work independently and in a team