POST-DOC POSITION (F/M/X)

Process and Material Sciences Laboratory (LSPM), Villetaneuse, France

Implementation of ps–laser and –streak camera diagnostics in reactive plasmas

Hosting Group: Plasma/Surface Interaction and Microplasmas (IPS – MP)

The **IPS–MP** group belongs to the **Plasma, Nanostructures and Thin Films Processes (PPANAM)** research axis of the **LSPM** and is specialized on the design, implementation, and characterization of plasma processes related to novel materials and applications.

IPS–MP has undergone a quasi-reconversion in recent years, moving from the study of plasma-carbon surface interaction to plasma-metal surface interaction (W, Al). These activities are essential for the study of the behavior of materials relevant for fusion (tokamak edge plasmas). The experimental devices dedicated until now to the studies realized by **IPS–MP** in the context of "on-board plasmas" are also used for exploratory studies of synthesis of materials of interest (e.g., carbon-metal composites). Nanostructured thin films (rather oxides) are also synthesized by sol-gel processes and functionalized by plasma to test their performances for various applications (photovoltaic, …). Besides, the design of atomic sources (nitrogen in particular) is a new important axis of study using:

(a) High energy density microwave plasmas for studying dissociation processes involving excited electronic states of N_2 : *(i)* low-pressure microwave reactor (ECR among others), and *(ii)* atmospheric pressure microplasma torch.

(b) Micro-hollow cathode discharges for the synthesis of advanced material such as hexagonal boron nitride (intra-collaboration with "**Diamond and Carbon Materials**" group of **LSPM**).

Besides well-known material characterization tools (Photoluminescence, Raman spectroscopy, …), advanced optical diagnostics are implemented to better understand the behavior of the different plasmas and optimize them for the targeted applications. Among others, fast (*ns* timescales) and ultrafast (*ps* timescales) laser diagnostics, ultrafast detectors (e.g., *ps* streak camera) and high-resolution optical emission spectrometers/monochromators are installed (or under implementation) in the group. These diagnostic tools are also useful for the characterization of other plasma sources (e.g., cold plasma jets, rf plasmas, surface DBDs) available in the group in the frame of national and international projects.

Context – Duties – Skills – Allowances

1 year CDD post-doc contract with possibility of extension (+18 months) depending on candidate's performance. Collaboration between IPS–MP (Prof. G. Lombardi and Dr. K. Gazeli) of LSPM and Photonique et Nanostructures (PON) team of the Laboratory of Laser Physics (LPL; Dr. S. Forget and Prof. S. Chénais) of USPN in the frame of a *Lab of Excellence* (Labex), *Science and Engineering for Advanced Materials and devices* (SEAM) project.

Keywords
Laser diagnostics, picosecond TALIF, streak camera, reactive plasmas, atomic densities.

Duties
The post-doc will have the opportunity to perform state-of-the-art optical diagnostics at LSPM and enter a wide scientific network involving plasma physicists (experiments and models), research engineers, and material processes experts. He/She will work on the optimization of the advanced laser and detector platforms available in IPS-MP for studying low- (e.g., a microwave hydrogen plasma between 1-300 Pa) and atmospheric-pressure (microplasma jet and/or torch) plasmas by means of ns (fast) and ps (ultrafast) two-photon absorption laser induced fluorescence (TALIF). The platform consists of a fast (Sirah Lasertechnik Cobra-Stretch; 7 ns pulse width; 10 Hz repetition

frequency), and ultrafast laser (Ekspla; 10 ps pulse width; 5 Hz repetition frequency) which are coupled with a gated photomultiplier tube (Hamamatsu; few ns time resolution) and a universal streak camera (Hamamatsu; ps time resolution) respectively. He/She will particularly focus on the development of ps-TALIF for the reliable determination of reactive atom lifetimes and densities (such as H, N and O) in collisional plasmas, for which the depletion of laser-excited states becomes significant and limits the application of classic ns-TALIF. He will also contribute to the combination of ns- and ps-TALIF for probing molecular and atomic species in a microwave plasma torch for its optimization in nanomaterial synthesis.

<u>Relevant references</u>

[1] Progresses on the use of two-photon absorption laser induced fluorescence (TALIF) diagnostics for measuring absolute atomic densities in plasmas and flames, K. Gazeli, G. Lombardi, X. Aubert, C. Y. Duluard, S. Prasanna, K. Hassouni, Plasma 4 (1) 145-171 (2021) (https://doi.org/10.3390/plasma4010009).

[2] Picosecond two-photon absorption laser induced fluorescence (ps-TALIF) in krypton: the role of photoionization on the density depletion of the fluorescing state Kr 5p´[3/2]2, K. Gazeli, X. Aubert, S. Prasanna, C. Y. Duluard, G. Lombardi, K. Hassouni, Phys. Plasmas 28, 043301 (2021) (https://doi.org/10.1063/5.0041471).

[3] Investigation of N(^{4}S) kinetics during the transients of a strongly emissive pulsed ECR plasma using ns-TALIF, E. Bisceglia, S. Prasanna, K. Gazeli, X. Aubert, C. Y. Duluard, G. Lombardi, K. Hassouni, Plasma Sources Sci. Technol. 30 095001 (2021) (https://doi.org/10.1088/1361-6595/ac0da1).

[4] Absolute N atom density measurement in a Ar/N_2 Micro Hollow Cathode Discharge jet by means of ns-Two-photon Absorption Laser Induced Fluorescence, A. Remigy, X. Aubert, S. Prasanna, K. Gazeli, L. Invernizzi, G. Lombardi, C. Lazzaroni, Phys. Plasmas 2022 (Accepted; Scheduled for publication in November Issue).

Expected Skills

- PhD in Experimental Physics, Plasma Physics and Diagnostics, Physical Chemistry (combustion), or Lasers
- Strong background on laser diagnostics (ideally LIF/TALIF), laser/plasma physics and optical diagnostics
- Strong computer skills and capacity in data analysis using scientific software (Origin®, MATLAB®, Python…)
- Experience with streak cameras and LabVIEW would be an asset
- Strong organization and methodology, high autonomy, commitment, respect deadlines, flexibility, collaboration, efficient problem solving
- Supervision of PhD and Master students and cooperation with research engineers
- High efficiency in preparing research papers and conference presentations
- Communicative personality
- Fluent in English and (ideally) in French

Allowances

~2700 €/month gross salary or higher depending on candidate's experience (i.e., 1-3, 3-5 and 5-7 years after PhD).

Starting Date

Ideally from January 2023

Application Procedure

The candidate should send via e-mail to Prof. Guillaume Lombardi (guillaume.lombardi@lspm.cnrs.fr) and Dr. Kristaq Gazeli (kristaq.gazeli@lspm.cnrs.fr) the following files:

- A copy of the PhD diploma (or equivalent)
- A two-page CV
- A motivation letter (one page)
- Two recommendation letters