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► **To cite this version:**

M. Heninger, Joël Lemaire, E. Louarn, H. Mestdagh, R. Herren, et al.. Cold Plasmas for Analytical Applications. Workshop Interdisciplinaire sur la Sécurité Globale (WISG), Jan 2014, Troyes, France. CD des abstracts. hal-04218240

**HAL Id: hal-04218240**

**<https://hal.science/hal-04218240>**

Submitted on 26 Sep 2023

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## Cold Plasmas for Analytical Applications

Projet PLASPAMS, CSOSG 2013

M. Heninger<sup>1</sup>, J. Lemaire<sup>1</sup>, E. Louarn<sup>1</sup>, H. Mestdagh<sup>1</sup>, R. Herren<sup>1</sup>, F. Da Costa<sup>1</sup>  
S. Pasquiers<sup>2</sup>, J. Santos Sousa<sup>2</sup>, N. Blin-Simiand<sup>2</sup>, V. Puech<sup>2</sup>, B. Bournonville<sup>2</sup>, G. Bauville<sup>2</sup>, M. Fleury<sup>2</sup>  
J. Leprovost<sup>3</sup>, D. Robin<sup>3</sup>, P. Gremillet<sup>3</sup>

<sup>1</sup>LCP, CNRS-Université de Paris Sud 11, bat 350, Centre Universitaire d'Orsay, 91405 Orsay Cedex.

<sup>2</sup>LPGP, CNRS-Université Paris Sud 11, bât 210, Centre Universitaire d'Orsay, 91405 Orsay Cedex

<sup>3</sup>ALYXAN, Centre Hoche, 3 rue Condorcet, 91260 Juvisy sur Orge.

### Introduction

Through the PLASPAMS project we will develop an instrument dedicated to the real time detection and identification of species present in air at trace concentration or deposited on surfaces. We will combine plasma techniques and mass spectrometry in order to build a compact detector suitable for field operation.

Analytic applications in the field of security are particularly demanding:

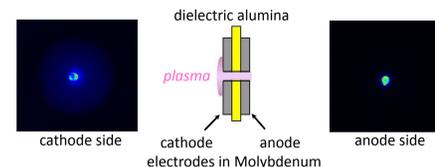
-dangerous or prohibited molecules must be identified with precision among the many species potentially present ;

-concentrations can go from the ppb range (1 molecule per billion) to % ;

-the more volatile molecules can be detected directly in air but species of low volatility will stay on surfaces and we need to desorb them efficiently in order to detect them. This will be the case for many explosives or narcotics ;

-the detector must be broadband, very sensitive and must have a fast response time.

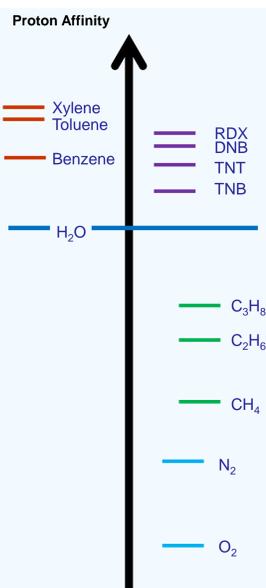
### Micro Hollow Cathode Discharge for the generation of H<sub>3</sub>O<sup>+</sup> ions



Typical diameter of the discharge hole: 1 mm.

Objective: to determine discharge parameters for the generation of H<sub>3</sub>O<sup>+</sup> ions by a MHCD working in Ar/H<sub>2</sub>O mixtures.

### Selective ionization of trace compounds

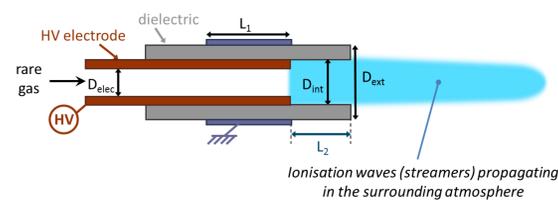
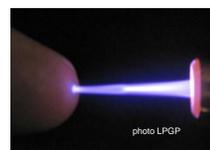


The most used ion molecule reaction for trace detection in air is the proton transfer from H<sub>3</sub>O<sup>+</sup> ions (protonated water)



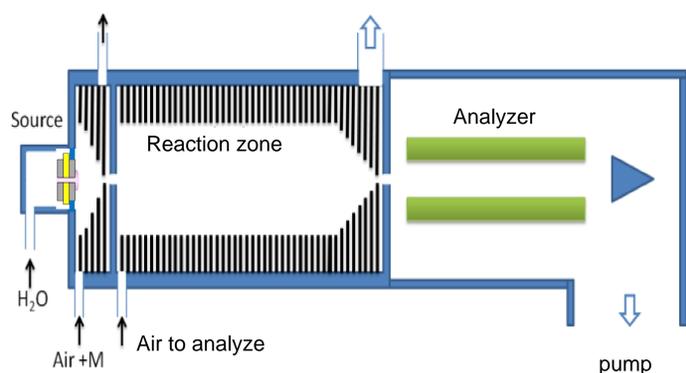
The reaction will be fast and efficient for molecules having a proton affinity higher than water (such as aromatic compounds, alcohols, aldehydes, nitrated explosives, narcotics,...) but will not occur with compounds having a proton affinity lower than water (which is the case for the main constituent of air N<sub>2</sub>, O<sub>2</sub>, Ar and also for alkanes, CFCs,...)

### Desorbing molecules deposited on surfaces with plasma jets



Typical dimensions of the discharge structure:  
D<sub>elec</sub> = 1.6 mm, D<sub>int</sub> = 2 mm, D<sub>ext</sub> = 7 mm, L<sub>1</sub> = 10 mm, L<sub>2</sub> = 5 mm

Plasma jets are used to desorb the low volatility species deposited on surfaces without heating the surface.

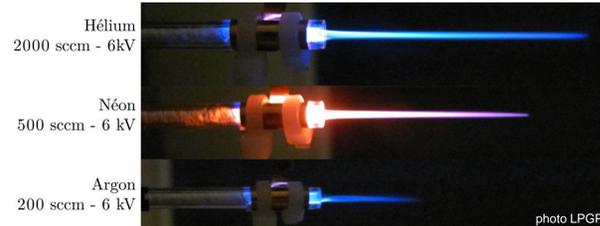
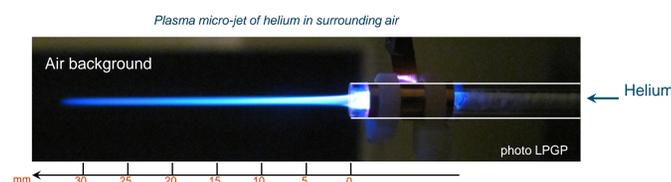


The precursor ions formed in the source will react with the sample air in a reaction zone where radiofrequency electric fields will help in guiding and transmitting the ions to the mass analyzer.

The intermediate zone can be used to break apart the cluster ions eventually formed in the source or to switch to another ionic precursor.

In a first time the analyzer will be a quadrupole. Then an ion trap will be developed in which collision induced fragmentation will help for precise identification.

### Plasma jets with different rare gases



Use of Ar allows to reduce the rare gas consumption.  
Objectives: optimisation of the discharge parameters for improving the spread of the plasma jet, optimization of the Ar metastable states density and study of the jet interaction with surfaces.

### Conclusion

The PLASPAMS project combines plasma techniques and mass spectrometry. The project team associates cold plasma specialists, physico-chemist experienced in real time trace analysis and the AlyXan company (commercializing high-resolution mass spectrometers).

The compact instrument developed will allow real-time analysis of traces present in air and of low volatility species deposited on surfaces. They will be transferred in the gas phase using cold plasma jets (without heating the surface) and detected with the very high sensitivity of mass spectrometry associated to chemical ionization.