Université Lille 1 Sciences & Technologies
Laboratoire de Physique des Lasers, Atomes et Molécules (UMR CNRS 8523)
Laboratoire de Physicochimie des Processus de Combustion et de l'Atmosphère (UMR CNRS 8522)

Open PhD Position

Characterization of soot particles and their precursors in laboratory flames by on-line coupling of laser techniques

Soot formation is one of the most challenging problems associated with pollutant formation in combustion processes, implying very complex chemical pathways from the preliminary aromatic rings, up to mature soot found in the exhausts. Polycyclic Aromatic Hydrocarbons (PAH) are known to play a key role in the soot inception. The selective detection of PAHs (in gas phase and/or adsorbed on soot particles) along the complete process of soot formation (i.e. spatially resolved measurements) is clearly required to achieve a sharp understanding of the elementary mechanisms involved in soot growth. Beside this fundamental interest, other motivations for the study of chemical species adsorbed on soot particles lie in their potential impact on human health and also in the environment (aircraft soot as ice nucleation centres leading to formation of contrails and cirrus clouds). Recent advances in the field of laser desorption/laser ionisation/mass spectrometry (LD/LI/MS) have complemented conventional separation methods (e.g. gas chromatography) for the adsorbed phase analysis.

The aim of this thesis is to characterize the soot particles and their precursors in flames by on-line coupling of laser desorption/laser ionization/time-of-flight mass spectrometry (LD/LI/TOF-MS) and Laser-Induced Incandescence/Fluorescence (LII/LIF) techniques. This work is based on an interdisciplinary collaboration between two groups of the PhLAM and PC2A laboratories. The coupling of the experimental set-ups independently developed by the two groups should simultaneously provide:

- identification (by LD/LI/TOF-MS) of precursors and molecules adsorbed onto soot particles produced in laboratory flames and transferred directly under vacuum in the analysis zone;
- mapping of soot and precursors in flame by LII/LIF.

Sensitivities better than one femtomole/laser shot, already demonstrated by our groups, will allow the monitoring of the chemical composition of these species in the flame, and of their evolution with the combustion stage. This study should give deeper insight in the soot formation mechanisms in flames according to the nature of the fuel and the combustion process.

We look for a candidate motivated by experimental work and development of new instrumentation, with a solid background in Physics or Physical Chemistry. Computer skills for instrument control, data acquisition and processing (as Labview, C/C++, Maple/MathLab, Origin/Igor) are required. Applications including CV, cover letter and contacts of two referees, must be sent before May 25th to Cristian Focsa (cristian.focsa@univ-lille1.fr) and Eric Therssen (eric.therssen@univ-lille1.fr).

Related research projects: LABEX CAPPA, PIA CORAC MERMOSE

*Publications: Fuel **107**, 147 (2013), Combust. Flame **158**, 227 (2011), Fuel **89**, 3952 (2010), Atmos. Env. **43**, 2632 (2009), J. Phys.: Condens. Matter **20**, 025221 (2008), Appl. Phys. B **89**, 421 (2007).*