Laser induced liquid bead desorption

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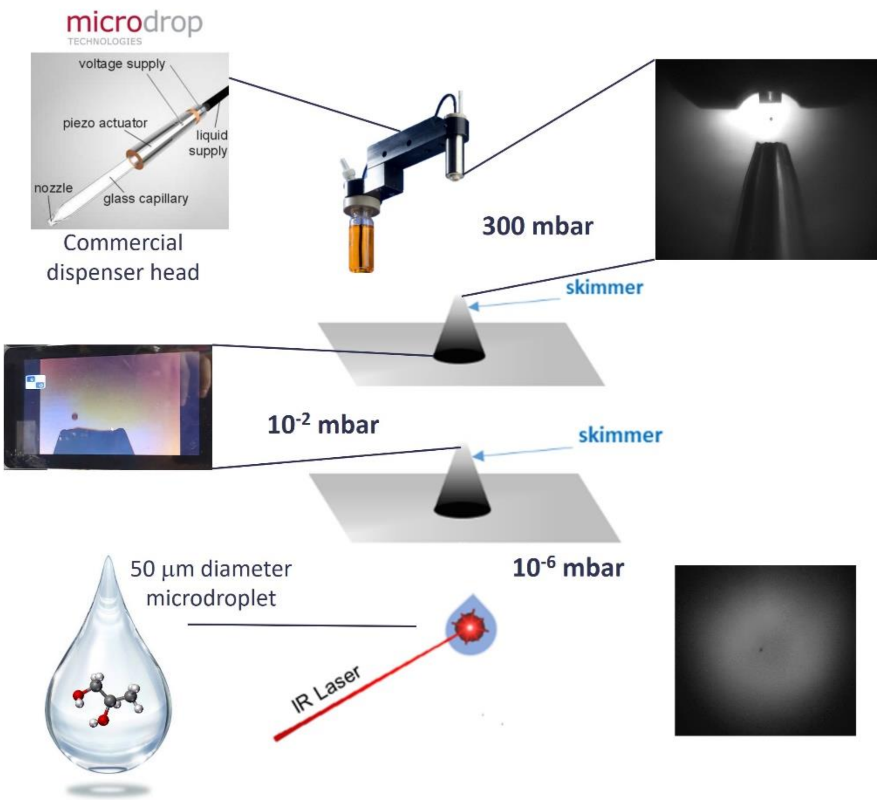
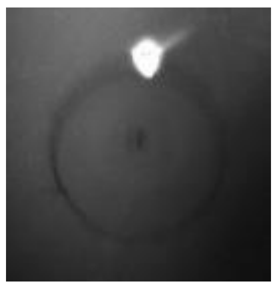
Keywords : laser desorption, microdroplets, gas phase, mass spectrometry, IR spectroscopy, biomolecules.

Context : Unravelling the structures of biomolecules to predict their function is a key process to understand their behaviour in multiple biological processes. This can be achieved using the selectivity and specificity of the gas-phase spectroscopic tools. Studies on controlled and finite size systems allow for comparison with theoretical predictions, with a high level of achievement. Nevertheless, these experiments in which the environment is removed to work on isolated species make difficult any extrapolation to the condensed phase and specially fail to take into account the ubiquitous role of water. To overcome this difficulty, our strategy is to develop an innovative gas phase ion source which will allow to interrogate micro-hydration processes. This source, unique in France, is based on laser desorption of liquid microdroplets directly under vacuum[1]. It allows to benefit from the numerous advantages of the gas phase (stoechiometric control, trapping and manipulation of ions) while preserving biomolecules native structure[2,3].





Left: scheme of the laser induced liquid bead ion desorption source. Right: explosion of a 50 µm diameter droplet under vacuum.

Objectives : The candidate will perform the experimental investigation of the desorption phenomena induced by the interaction of an infrared laser pulse (tuned to water absorption band) with a liquid water microdroplet (50 μm diameter) under vacuum. Underlying mechanisms are poorly undestood (supercritical phase transition, supersonic shock wave…) and the way energy is deposited into the microdroplpet strongly influences the nature and quantity of desorbed species (biomolecules into the droplet). Pulse energy and wavelength effects will be studied using an optical parametric oscillator with a short bandwidth and allowing to get pulse energies higher than 10 mJ. The desorbed species are analysed by time-of-flight mass spectrometry. In a second step, this ion source will be coupled to a cryogenically cooled ion trap to get structural information on the the desorbed species by performing infra-red spectroscopic studies.

[1] Morgner et al. Aust. J. Chem 59 (2006) 109.
[2] Peetz et al. *J. Am. Soc. Mass Spectrom.* 30 (2019) 181.
[3] Hellwig et al. *Biochem. Soc. Trans.* 50 (2022) 1057.

Techniques/methods in use : laser desorption, optical parametric oscillator, mass spectrometry, cryogenic ion trap, infra-red spectroscopy, vacuum techniques.

Applicant skills : experimental liking and skills, basic knowledge in physical chemistry, in laser physics or in vacuum techniques.

This M2 internship will be followed by a PhD, funded by a doctoral school allowance.