VUV spectroscopy of biological molecules produced by vaporization of nanoparticles: Bringing fragile neutrals to the gas phase

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We will present a new aerosol source implemented inside the SAPHIRS molecular beam chamber which is a versatile and permanent endstation of the DESIRS VUV beamline at SOLEIL. The very first scientific results obtained on 2 amino acids will be presented too.

It has been shown in 2006 that the thermodesorption of biological nanoparticles (containing one pure substance) is a soft vaporisation method that produces gas phase neutrals within a tiny vapour plume (few mm^3) [1]. This kind of source is ideally adapted to the brilliant light of 3rd generation synchrotron light sources. Thermally fragile neutral molecules, like amino acids, can be studied in this manner in the gas phase, for example using VUV photoionization electron spectroscopy, or mass spectrometry. The advantage of tuneable VUV light is to induce a "soft ionization", where the photon energy can be adjusted so as to avoid dissociative ionization, thus yielding fragment-free mass spectra. This method is perfectly suited to study the electronic structure and corresponding fragmentation dynamics of the thermodesorbed, unfragmented neutrals.

Here we present a newly built aerosol source where special emphasis has been laid on the design and the characterization of an aerodynamic lens system (ALS) and a thermodesorber. This system has been implemented inside the SAPHIRS chamber, which is equipped with an imaging photoelectron-photoion coincidence spectrometer that has been described earlier [2]. It combines velocity map imaging of the photoelectrons with a Wiley-McLaren TOF-MS.

The ALS is used to focus nanoparticles, produced by nebulisation of a liquid solution, into the vacuum by forming a highly collimated beam [3]. This beam is introduced into the ionization region of SAPHIRS, via a differential pumping stage chamber. An optical detection unit, which is composed of a cw solid-state laser at 532 nm (15 mW) and a photomultiplier, is used to detect scattered light of the particles at the ALS outlet in order to align the aerosol beam, and to control the stability of the source. The theoretical performances of the ALS and the characterization of the produced particle beam by nanophase threshold photoelectron spectroscopy (TPES) will be presented.

A heater is inserted between the extraction plates of the ionisation region in order to vaporise continuously the nanoparticles of the beam. The neutral molecules of the resulting vapour plume can then be ionized by the brilliant VUV radiation of the DESIRS

beamline. We will show that this heater does not perturb significantly the imaging of the photoelectrons. The temperature of the heater can be adjusted and thus one can tune the thermal energy of the gas phase neutrals produced.

Finally, we will present first results on thermally-desorbed biomolecules (tryptophane, phenylalanine) [4]. We were able to record TPEPICO energy scans, where the internal energy of the parent ion was scanned with a 25 meV resolution. To our knowledge, this has never been achieved before. The recording time of the spectra is several hours showing thereby the high stability of this new source.

[1] K.R.Wilson et al., *J. Phys. Chem. A*, vol. 110 (2006), 2106-2113.
[2] X. Wang, P. McMurry, *Aerosol Sci. Technol.*, vol. 40 (2006), 320–334.
[3] G.A. Garcia et al., *Rev. Sci. Instr.,* vol. 80 (2009), 023102.
[4] F. Gaie-Levrel, G.A. Garcia, L. Nahon, M. Schwell, to be published.