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Scientific Report of Short Term Scientific Mission, COST P9
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My Short-Term Scientific Mission in laboratory of Prof. Eugen Illenberger was held from 01 October to 31 October 2007 in Institut für Physikalische und Theoretische Chemie, Freie Universität Berlin, Germany.

The main aim of my visit there was to contribute to the construction of a new experiment, namely the LIAD (Laser Induced Acoustic Desorption) experiment. The LIAD method is known to be ideal for transferring large neutral biomolecules into the gas phase and therefore should allow us to study low energy electron interaction with a complex target. Since development of this source which is held in UHV chamber requires repeated venting and evacuation of the apparatus in meantime electron attachment experiments on selected compounds, namely fluorinated isocyanol and fluorinated phenyl acetonitrile in the gas phase was performed.

DESCRIPTION OF THE MAIN RESULTS OBTAINED

1) Laser Induced Acoustic Desorption (LIAD) experiment

Films of biological relevant molecules were grown on a thin Ti foil substrate (12 μ m) at a room temperature and then inserted to UHV vacuum chamber. All molecules (i.e. monophosphate uridine, monophosphate guanosine, nitroarginine and thymidine) were purchased from Sigma-Aldrich. The studied molecules were desorbed by the pulsed output of a Nd:YAG laser to a point \sim 1 mm in back side of the Ti foil. The laser light has a wavelength of 532 nm and is delivered in a pulse of energy 12 mJ at repetition rate of 15 Hz.

Low energy electrons produced by an electron gun was set at an incident at an angle of 90 $^{\circ}$ with respect to the substrate normal. The gun was operated in a constant mode, which delivered a current of \sim 10 $^{-6}$ A. The absolute electron energy scale of the incident beam was calibrated by taking 0eV-peak observed for SF $_6^-$.

Mass spectrometry of desorbed species and ionized by electrons was achieved by means of a quadrupole mass analyzer positioned along the surface normal, at 10 mm from the sample.

During my visit following works were carried out: optimization of the electron current and the ion optics by using the SF_6^- from SF_6 , alignment of a laser beam and optimization of a power for the desorption process. Additionally, the sample holder was covered by graphite in order to avoid an excess charge on it, which could influence changes of electric field within electron exposure time.

A preliminary mass spectrum obtained from desorbed monophosphate uridine showed following fragments observed at an electron energy of 0 eV: 79 (PO_3^-), 74, 72 and 70 amu. The latter fragments have been not identified yet, however can be attributed to sugar species or salt contained in the sample. This study will be continued after further developing of this apparatus by replacing a quadrupole mass analyzer by a time-of-flight (TOF) mass spectrometer.

2) Studies on Dissociative Electron Attachment (DEA) to selected molecules.

These experiments were carried out in a crossed beam apparatus consisted of a gas inlet system, a trochoidal electron monochromator (TEM), a quadrupole mass spectrometer (QMS) and a SEM detector. An incident electron beam of well-defined energy (FWHM \approx 0.1 eV, electron current \approx 10 nA) was generated from TEM orthogonally intersected with an effusive molecular beam of studied molecules. Samples were liquid under normal conditions having sufficient vapour pressure (also due to using Ar as a carry gas) and were transferred into the collision zone by the usual gas inlet and dosage line.

Negative ions formed via electron-molecule collisions were extracted from the reaction volume towards QMS. The intensity of a particular anion as a function of the incident electron energy (assigned as the ion yield function) were then recorded. The electron energy scale was calibrated by measuring the formation of SF_6^- ions, which exhibits a sharp peak of known cross section located near 0 eV. Samples were obtained from Sigma Aldrich and used without further purification.

The DEA processes to perfluorophenyl isocyanate ($\text{C}_7\text{F}_5\text{NO}$) and pentafluorophenylacetonitrile ($\text{C}_8\text{F}_5\text{NH}_2$) have shown rich fragmentation patterns. Parent negative ions of both molecules were observed within a very narrow resonance located at 0 eV. In addition, energy dependence spectra were recorded for following ions formed from fluorinated phenyl acetonitrile: F^- (19 amu), CN^- (26 amu), CNO^- (42 amu), 112 amu, 164 amu, $[\text{M-NCO}]^-$ (168 amu) and $[\text{M-O}]^-$ (193 amu). All spectra have shown resonant peaks at common energies, namely 2, 5 and 7 eV with exception of the last one which shown a peak with a maximum at 1.5 eV. While detect anionic fragments from fluorinated isocyanol have shown peaks at different energies, i.e.: F^- (19 amu) at 5 and 7 eV, CN^- (26 amu, see Fig. 1), CH_2CN^- (40 amu) at 2 and 5 eV, C_6F_5^- (167 amu) at 4 eV, $[\text{M-CN}]^-$ (181 amu) at 7 eV and $[\text{M-F}]^-$ (188 amu) at 0.5 and 6 eV.

It is interesting to study DEA to the pseudohalogen CN^- since its electron affinity is even higher than that of the halogen atoms. In Fig. 1 ion yields of CN^- from $\text{C}_7\text{F}_5\text{NO}$ and $\text{C}_8\text{F}_5\text{NH}_2$ are presented for comparison.

Additionally, the DEA to trifluoropropene ($C_3F_3H_3$) and trifluoropropyne (C_3F_3H), however obtained results need to be repeated.

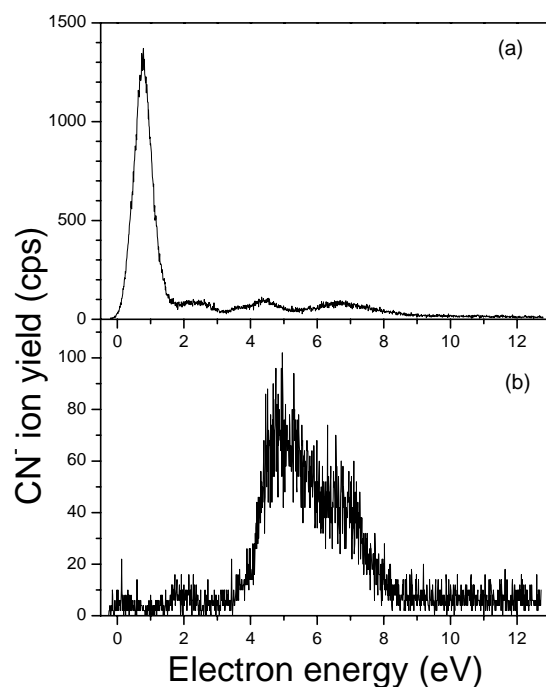


Fig. 1. Ion yields of CN^- observed from (a) pentafluorophenylacetonitrile ($C_8F_5NH_2$) and (b) perfluorophenyl isocyanate (C_7F_5NO).

FUTURE COLLABORATION

Regarding the LIAD experiment, the next visit is planned in 2008 in order to further develop this apparatus and carry out an experiment on DEA to desorbed nucleotides. In addition, a manuscript concerning DEA to pentafluorophenylacetonitrile ($C_8F_5NH_2$) and (b) perfluorophenyl isocyanate (C_7F_5NO) in the gas phase is considered to be written and submitted to one of reviewed journals.