

Aleksandar Milosavljevic
Institute of Physics
Pregrevica 118
11080, Zemun (CS)
vraz@phy.bg.ac.yu

REFERENCE: Short Term Scientific Mission, COST P9
Beneficiary: Aleksandar Milosavljevic, Institute of Physics Belgrade
Host: Paul Scheier, Institute of Ion Physics, Innsbruck
Leopold-Franzens University
Period: from 1/06/2005 to 30/06/2005 Place: Innsbruck (AT)
Reference code: COST-STSM-P9-01419

SCIENTIFIC REPORT

PURPOSE OF VISIT

The purpose of visit was the exchange of experiences and joint work related to the investigation of dissociation and fragmentation of biomolecules in the gas phase upon low (medium)-energy electron impact. The emphasis was put on furan (C_4H_4O) and tetrahydrofuran (C_4H_8O) molecules, which can be considered as a simple version of the DNA sugar deoxyribose. The objective was the experimental study of molecules that are substantial parts of DNA, which should lead to better understanding of effects linked to chemical and structural changes of cellular DNA connected with radiation damage.

DESCRIPTION OF THE WORK CARRIED OUT DURING THE VISIT

The measurements have been performed at the Institut für Ionenphysik Innsbruck, using a crossed electron/molecule beam apparatus WIPPI. A monochromatized electron beam was produced by an electrostatic hemispherical selector and crossed perpendicularly to the molecular beam. The incident electron energy resolution was about 100 meV. The ions formed were extracted into a quadrupole mass spectrometer and detected by a single channel multiplier operated in the counting mode. Anhydrous both furan and tetrahydrofuran (THF) have been used after several freeze-thaw cycles under vacuum. The yield of an ion, with a mass/charge ratio defined by quadrupole filter, was recorded as a function of electron energy. In the case of negative ions, the energy scale was calibrated by measuring the ion yields of SF_6^-/SF_6 and Cl^-/CCl_4 that exhibit a narrow s-wave resonance at 0 eV. The same processes have been used for determination of the electron energy resolution, as well. In the case of positive ions, the energy scale was calibrated according to well known value for appearance energy of krypton.

DESCRIPTION OF THE MAIN RESULTS OBTAINED

- Electron attachment to furan has been investigated in the electron energy range of about 0 – 15 eV. The yield of ionic fragments: $(F-H)^-$, C_2HO^- and $C_3H_3^-$ was measured as a function of electron energy. For all three anions, a sharp resonance peak was found at about 6 eV, as well as a broad structure between 8 eV and 12 eV. Detailed measurements were performed for the $(F-H)^-$ anion, which revealed that the broad structure between 8 eV and 12 eV represents a superposition of two processes. Also, another resonance at about 3.7 eV was found (see attached figure: Furan.pdf).

- Dissociative electron attachment processes above 2 eV have not been found for THF molecule. However, preliminary measurements show resonance structures for $(\text{THF})^-$ and $(\text{THF-H})^-$ anions at about 1.2 eV.
- Positive ion formation upon electron impact ionization of both furan and THF has been studied, as well. Appearance energies (AE) were obtained for several most abundant fragments (furan: F^+ , C_3H_3^+ ; THF: THF^+ , $\text{C}_4\text{H}_7\text{O}^+$, C_3H_6^+ , C_3H_5^+) by fitting Wannier type threshold function to the measured ion efficiency. For THF, AE were measured for the first time for CH_3O^+ and CH_3^+ cations, which have been also detected upon electron impact ionization of deoxyribose.

FUTURE COLLABORATION WITH HOST INSTITUTIONS

The future collaboration with host institution will involve further investigation of binary collisions of electrons with molecules that represent analogues to DNA sugar deoxyribose. The experimental set-up in Innsbruck has facilities for measuring of a yield of mass selected both positive and negative ions as a function of incident electron energy, as well as energy distributions of a specific ionic fragment upon electron induced dissociation. The experimental set-up in Belgrade allows differential cross section measurements for a specific electron scattering process, as well as measurements of energy and angular distributions of positive ions upon electron induced dissociation of a molecule.

PROJECTED PUBLICATIONS/ARTICLES RESULTING OR TO RESULT FROM THE STSM

Most of the preliminary results that are obtained during this Short Term Scientific Mission will be presented at the LEEMI IV – NEGATIVE IONS conference, 6-9 October 2005, Smolenice, Slovakia: A. R. Milosavljević, P. Sulzer, B. Mielewska, F. Rondino, F. Zappa, B. P. Marinković, T. D. Märk and P. Scheier – poster contribution. The abstract is given in the attachment. Further work on these topics should be finalized by joint publications/articles.

Aleksandar Milosavljević
Institute of Physics, Belgrade

Belgrade, July 6th 2005

CONFIRMATION BY THE HOST INSTITUTE OF THE SUCCESSFUL EXECUTION OF THE MISSION

Herewith I confirm that Aleksandar Milosavljević, M. Sc., successfully worked in the Institute of Ion Physics from June 1st until June 30th 2005. The obtained results are interesting and this first contact between the participating institutions suggests further collaboration in the future. It was a pleasure to have Aleksandar Milosavljević working in my group.

Paul Scheier

Innsbruck, July 6th 2005