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REFERENCE:
Short Term Scientific Mission, COST P9
Beneficiary: Jan SKALNY, Department of Experimental Physics, Comenius University Bratislava
Host: Prof. Tilmann Märk, Institute for Ion Physics, University of Innsbruck
Period: from 15/05/2005 to 25/05/2005 Place: Innsbruck
Reference code: COST-STSM-P9-01440

SCIENTIFIC REPORT

PURPOSE OF VISIT

The collaboration between the Plasma physics group at Comenius University Bratislava and the Institute of Ion Physics at University of Innsbruck has been launched years ago. Several projects have been successfully accomplished in collaboration between mentioned institutions. Many scientific papers have been published by team, which consisted from researchers from Innsbruck and Bratislava, me personally too. The research was focused to the study of electron impact processes with various gaseous molecules at ambient and also at elevated gas temperatures by using the crossed electron-molecular beams apparatus constructed in Innsbruck and completed by parts designed in Bratislava.. Recently the new thermo-regulated source of molecular beam was designed and manufactured in Bratislava and finally installed on apparatus CELIA located in Innsbruck. The improved construction of the source enables to stabilize the temperature of tested gas within the temperature interval (260-650) K. he upper limit of temperature was increased. Hence the temperature dependence of cross section for various electron impacts stimulated processes can be studied over the relatively large interval of temperatures.

The aim of planned STSM is to optimize the regime of the mentioned beam source installed on CELIA apparatus for the study of reactions of low energy electrons with bio-molecules or molecules relevant to bioprocesses. The aim of STSM was to continue the experiments

investigated the process of electron attachment to molecules containing benzene base. The attention should have paid to temperature effect in case benzyl chloride, chloro-benzene a 2-chlorethyl benzene. The goal of the stay at laboratory in Innsbruck was to test the properties of molecular beam source. Experiments were planned in collaboration between teams from Bratislava and Innsbruck.

DESCRIPTION OF THE WORK CARRIED OUT DURING THE VISIT

The goal of intended experiments was to study the effect of gas temperature on the electron attachment to benzyl chloride, chloro-benzene a 2-chlorethyl benzene and to use these chemical compounds for optimisation of regime of molecular beam source. Due to some changes in research program in Innsbruck the effect of gas temperature on electron attachment to HBr and DBr has been investigated. The reason for the change of the program was the idea to use the source enabling the increase the temperature of gas reasonably for the study of structures formed due to vibrational excitation of molecules interacting with electrons, as well as the isotopic effect. The compounds selected by colleagues in Innsbruck are relatively simple hence no other effect can disturb the phenomena, which we were intended to study.

DESCRIPTION OF THE MAIN RESULTS OBTAINED

I participated on experiments performed by students PhD Juraj Fedor who finished his master studies in Bratislava.

The dominant anionic fragment Br^- was observed at ambient temperature approx. 300 K and also at elevated temperatures of molecular gas source up to 620 K. It is evident from Fig. 1 that the increase in gas temperature leads to appearance of new resonances produced from excited molecules HBr.

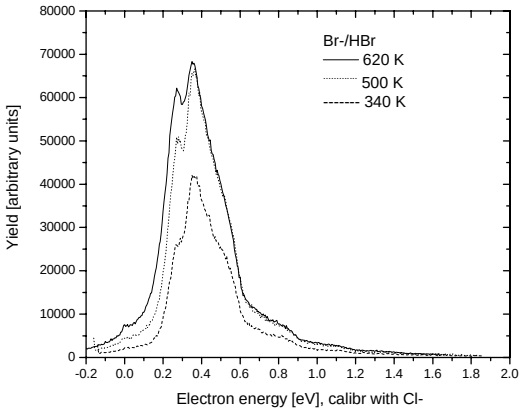

Fig. 1 Relative cross sections for attachment of electrons to HBr molecules measured at three selected temperatures.

The cross section for DBr is approximately smaller than that one in HBr. The main resonance produced in from no irrationally excited molecule DHr is evidently narrower than in HBr and is slightly shifted to higher electron energies. Also the resonances produced from excited DBr molecules exhibit the similar shift in energy at the same temperature of gas. The basic problem which aroused during experiments was the finding that the delivered DBr contains large amount of HBr as an impurity. Therefore the results obtained in DHr are only qualitative.

Besides of main experiments I have learned about measurements of electron attachment to some biomolecules, which are relevant to program COST P9. Experiments were conducted by group in which our student Michal Stano was working. The experiences obtained during my stay will be used in reseach prepared in Bratislava.

The present measurements were performed utilizing a high resolution hemispherical electron monochromator that enables the investigation of positive and negative ion formation processes with a typical energy resolution of ~100meV to ~150meV. The product ions are analyzed with a quadrupole mass filter and detected with a channeltron type secondary electron multiplier operated in the pulse counting mode (see Fig. 1). In the past this experimental setup was successfully used to investigate inelastic interactions of free electrons with gas phase molecules of biological relevance, such as DNA bases, sugar, amino acids and nucleosides.

Porphyrins are metallo-organic compounds have been studied by described techniques. These consist of a central metal core (i.e. Fe, Mg, Co, …) surrounded by a porphine molecule that has the chemical formula $C_{16}N_4H_{14}$. Each of the four nitrogen atoms can form a bond to the metal core and depending on the type of this core we speak about very important components of everyday life. Heme (a part of hemoglobin) has an iron core, chlorophyll a magnesium core and vitamin B12 a cobalt core, just to point out a few examples. Also for the human metabolism porphyrins are of great importance since some severe diseases are accompanied by an overproduction of porphyrins. Like in the previous investigations porphyrins can be vaporized in an oven without thermal decomposition at around 320-330°C.

The metal inside the porphyrins has drastic effects on its chemical properties (i.e. as heme or chlorophyll as mentioned above). Thus it is very enticing to check if the interaction of these molecules with low-energy electrons is also determined by the metal core, i.e., are there metal dependant characteristic resonances in the electron attachment cross sections of the porphyrins.

FUTURE COLLABORATION WITH HOST INSTITUTIONS

The obtained preliminary results must be completed by measurement of H^- anions from HBr and DBr molecules. The DBr chemical must be used for measurements. Experiments will be performed in Innsbruck as well as in Bratislava, where another type of source for formation of molecular beam is used. On the base of knowledge learned in Innsbruck the apparatus in Bratislava will be equipped by new source of molecular beam being able to produce the beam from solid samples.

PROJECTED PUBLICATIONS/ARTICLES RESULTING OR TO RESULT FROM THE STSM

The preliminary results must be completed in accordance with foregoing item. Then these will be appropriate for publication. Some of obtained results will be presented at conferences.

Jan Skalny

Bratislava 7 June, 2005.

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

The visit of Prof. Jan Skalny was underdone with success and in accordance with the planed activities. The use of HBr and DBr instead of halegencarbons was initiated by changes of the research plan of laboratory in Innsbruck. The studied HBr and DBr molecules are relevant to the program COST P9.

Prof. Tilmann Märk

Innsbruck, 14 June, 2005.