



Electron Controlled Chemical Lithography 2009 Meeting



4th-9th June 2009
Istanbul, Turkey

ABSTRACT BOOKLET



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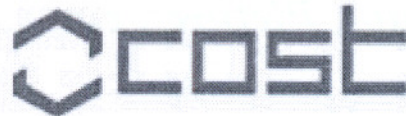
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MEASUREMENTS OF ELECTRON INTERACTIONS WITH METAL VAPOUR ATOMS

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Measurements of electron interactions with metal vapour atoms have been performed in a systematic study of fundamental interactions of atomic particles [1]. These lead toward deeper understanding of collisional dynamics and types of interaction potentials that govern the electron scattering phenomena. Electron impact spectroscopy has been accomplished for atoms from the IA (Na; Rb - in progress), IB (Ag), IIA (Mg, Ca), IIB (Zn, Cd, Hg), IIIA (In), IIIB (Yb), IVA (Pb) and VA (Sb, Bi) groups of Periodic Table of Elements. The main observable in these processes is differential cross section (DCS) that gives the probability of specific interaction at certain electron energy and scattering angle.

The experimental method used to determine DCS is based on crossed beam technique where effusive atomic beam is perpendicularly crossed by electron beam. To determine absolute DCS it is necessary to know absolute atom target density and its spatial distribution, energy and angular distribution of electron beam and its current density, as well as effective scattering volume [2] and response function of detection system. Achieving high temperatures necessary for producing effusive atomic beams of metals makes it a challenge for experimental technique. The experimental set-up consists of hemispherical monochromator and analyzer, ohmically heated crucible and a single electron multiplier [3]. A monochromatic electron beam of energies from 10 to 100 eV was elastically and inelastically scattered by an effusive beam of metal vapours and angular distributions of scattered electrons are recorded. Absolute DCS are obtained through the procedure of normalization onto the well defined, both experimentally and theoretically, optical oscillator strengths [4].

New results for some of above mentioned metal atoms will be presented and discussed in terms of agreement between experimental findings and calculation predictions.

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Studies of low energy electron interaction with furanose-structured alcohols

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Two furanose-structured alcohols related to some extent to deoxyribose molecule, 3-hydroxytetrahydrofuran (3HTHF, C₄H₈O₂) and α -tetrahydrofurfuryl alcohol (THFA, C₅H₁₀O₂), have been studied both experimentally and theoretically. Crossed electron/molecule beams technique together with quadrupole mass spectrometer has been used for electron induced positive ion formation studies. The mass spectra of 3HTHF and THFA determined at incident electron energy 70 eV were analyzed and for number of mass-charge ratios (m/q) the ionization efficiency curves have been measured. Thus, for 3HTHF 18 different m/q channels were analyzed experimentally, from which 6 were selected for deeper investigation on DFT level of theory and finally 5 for the G3MP2 method. The same was performed for THFA with 15 m/q channels experimentally, 5 on DFT and 4 on G3MP2 levels of theory. Theoretical calculations with Gaussian 03 program package led to more than 160 fragmentation reactions on B3LYP/6-311+G(2d,2p), only the energetically comparable to experimentally observed appearance energies were re-computed on G3MP2.

The experiment showed that although there were 18 and 15 m/q channels observed for 3HTHF and THFA respectively, only 10 of them for 3HTHF were abundant over 10% of the ionic yield of most intensive fragment and 6 for THFA. While the parent cation of 3HTHF occurred within its abundant ionic fragments, THFA cation had a weak signal only. Our theoretical conformational studies of neutral and cationic 3HTHF and THFA agree well with this experimental observation, for 3HTHF⁺ at least 2 stable conformers were found while for the cationic state of THFA partial dissociation the side CH₂OH chain group occurred. However the later process, dissociation of CH₂OH, seems to be a common feature for the most abundant fragmented ion of both molecules, the corresponding structures are the furanose closed ring cation with $m/q=71$ for THFA fragment and CH₂=CH-CH-OH⁺ with $m/q=57$ for 3HTHF fragment. Additionally, fragmentations to cations with $m/q=70$, 58, 43 and 31 were studied theoretically for both molecules, except the 58 for THFA that was not observed. One could expect when looking at the chemical formulas of both molecules that the fragmented cationic structures can be oxygenated, either singly (possible products found for all discussed channels) or doubly (only the C₂H₂O₂⁺ with $m/q=58$ fragmented from 3HTHF, but its second most abundant fragmented ion), or can be also cationic hydrocarbons. Only cationic hydrocarbon product found for our selected channels was the C₃H₇ cation with $m/q=43$, with corresponding neutrals COOH from 3HTHF and CH₂OH + CO from THFA, for the later the second most abundant cationic fragment.

This work was supported by the COST Action CM060, Electron Controlled Chemical Lithography (ECCL), by the Slovak Research and Development Agency, Projects No. APVV-07-365 and APVV-0310-07, as well as the Ministry of Science and Technological Development of Republic of Serbia under project 141011. Collective from Comenius University in Bratislava would like also to acknowledge to VEGA grant 1/0558/09.

MEASUREMENT OF LASER-INDUCED FLUORESCENCE OF MOLECULES USING A TIME-RESOLVED SPECTROMETER

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Measurements of laser induced fluorescence (LIF) for several known strong fluorescing molecules have been performed in order to achieve the calibration of new experimental apparatus designed for study of molecules of biological relevance. Depending on the specific application, fluorescence measuring systems strongly differ in instrumental design, i.e. use of optical components, detection systems as well as in measurement geometries including the sample cell. Proper calibration of the system that comprises excitation laser, optical cell and detection system is therefore necessary in order to obtain accurate signal interpretation. Optical emission spectroscopy represents comparative experimental technique to the optical absorption and low energy electron spectroscopy techniques in present kind of study [1].

Here, we report various approaches for the calibration of the time-resolved laser-induced fluorescence (TR-LIF) detection system. This system is based on the tunable Nd:YAG laser (320-475 nm) to excite samples and on the detection part with high spatial and temporal resolution [2]. Different methods for calibration of time domain and wavelengths are known [3-5] and the possibility of their application to our TR-LIF system has been presented. Feasibility of some methods will be tested with standard fluorescent dyes, such as fluorescein which is intended for use in establishing a reference scale for fluorescence intensity [6]. Also, rhodamine B is used as a common dye to investigate a fluorescence yields and lifetimes. The amount and wavelength of the emitted energy depend on both the fluorophore and the chemical environment. This technology has particular importance in the field of biochemistry and protein studies. Fluorescence spectroscopy is increasingly being used as a technique for probing the structure and dynamics of nucleic acids. Recently, fluorescence methods have been used to elucidate the three-dimensional arrangement of complex DNA and RNA structures [7]. The systematic errors in calibration procedure will be also discussed.

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