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Referance code: COST-STSM-CM0601-05237

Dates of visit: 19.09.09 – 10.10.09 (3 weeks)

Purpose of the visit:

For almost a decade low energy electron interactions with a biological molecules have been intensively studied. It has been shown that electrons with sub-excitation energies can cause single and double strand breaks in the DNA [1,2]. Since low energy electrons are produced in the biological environment in large quantities (~10^5/MeV) upon high energy particles and radiation, obtaining a full description of these electron-induced processes is an important goal of radiobiology. Therefore, the building blocks of DNA, like for example a deoxyribose ($C_5H_{10}O_4$) and its analogues have been studied using theoretical and experimental methods. Tetrahydrofuran (C_4H_8O) is a model of the deoxyribose carbon ring. There is quite a substantial number of papers on electron interactions with tetrahydrofuran [e.g. 3] including dissociative electron attachment [4,5]. This process is the most interesting since it is the most important mechanism which could cause damage in DNA when electron energy is lower then the ionisation threshold.

Recent results [5] indicate that after electron attachment the temporary negative butanolate ion is created. Possessing high internal energy the anion undergoes dissociation, after which the excess energy is carried away by the fragments. Such short-living ions can not be observed in most mass spectrometers. This mechanism is well known, since long-living parent anions are rarely observed unless they are formed by thermal electrons and the molecule can accommodate the electron affinity that is released upon the attachment reaction and the kinetic energy of the electron in the vibrational degrees of freedom. However, anions can also be stabilised if placed inside a superfluid helium droplet or other cold matrix [6]. This

technique has been described in the literature for the suppression of fragmentation of molecules by electron impact ionisation [e.g. 7].

Description of the work carried out during the visit:

Due to the technical problems on both cluster source spectrometers it was impossible to perform measurements in superfluid helium envirnoment (it was caused by serious cryostat malfunction). Therefore I decided to run measurement in neon clusters which provides an other convinient cold matrix and can be obtained at higher temperatures then helium. After few experimental setup changes the electron impact ionization and fragmentation of tetrahydrofuran was performed using the electron gun with hemispherical electron monochromator. The resulting data was compared with electron impact gas phase measurement.

Description of the main results obtained:

Mass spectrum of pure neon clusters is presented on fig.1. It was obtained with incident electron energy of 72 eV, at the temperature of 75K. Neon under the pressure of 5 bars was expanding into the vacuum chamber where the pressure of 1.6×10^{-4} mbar was maintained. Ionized clusters of neon are clearly visible, up to $Ne_{27.}$ Sudden drop in the cluster intensity after Ne_{14} indicates shell closure. Poor mass resolution in this spectra was increased during the further measurements.

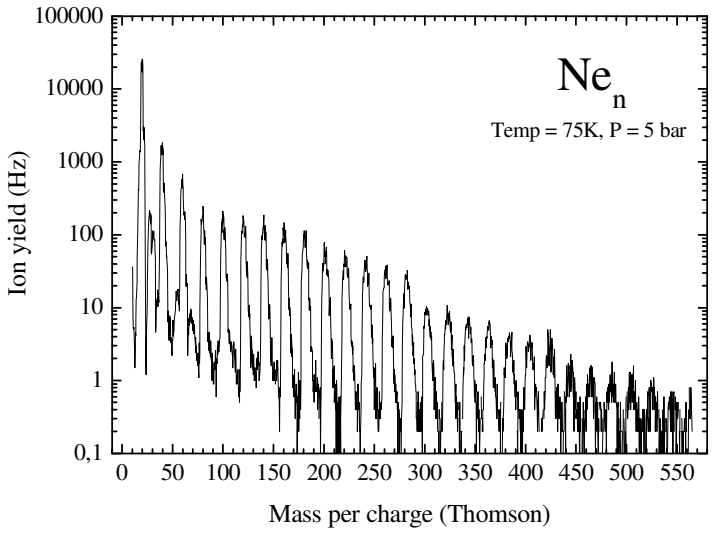

Fig. 1. Mass spectrum of neon clusters

The mass spectrum resulting from electron ionization and fragmentation of tetrahydrofuran embedded in neon clusters is presented on fig 2. The results (upper, black line) are compared with gas phase measurements (lower, red line). The parent ion (mass 72 amu) as well as $C_4H_7O^+$ are clearly visible. The molecule undergoes rich fragmentation giving rise to a group of ions with masses from 39 amu up to 44 amu. There most probable assignment based on [8] is presented on fig. 2. Surprisingly there is not much difference in parent ion relative intensities in neon cluster environment and gas phase measurement. This may suggest that the molecules are situated on the surface of the cluster or that Ne clusters are a rather soft matrix, loosing doped molecule in an ejection mechanism. On the other hand there is a significant increase in the mass 41 signal and the other ions intensities differ as well.

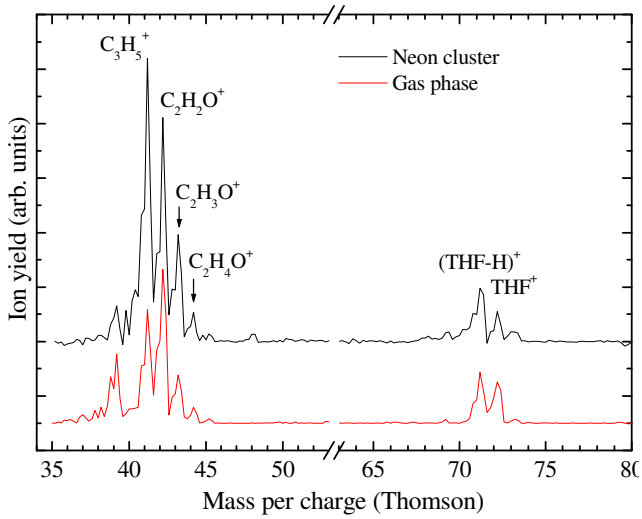

Fig. 2. Fragments resulting from electron impact ionization of tetrahydrofuran.

Literature:

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Future collaboration with host institution:

Future collaboration may include measurements of negative ions produced by electron attachment inside the helium and neon clusters.

Projected publications/articles resulting or to result from grant: