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Charge transfer and formation of complexes in the He^+ collisions with the furan molecules

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Synopsis Charge transfer and formation of the collision complexes have been studied experimentally in fragmentation of the furan molecules in collisions with He^+ cations. The excited atomic and diatomic fragments of furan have been identified using collision-induced luminescence spectroscopy. Charge transfer ionization of the furan molecules has been observed in production of helium atoms in the excited 1s4d $^1D_2$, $^3D_{1,2,3}$ states. The fragmentation yields of the excited fragments have been measured as a function of the projectile energies (velocities) in the range 5-1000 eV. Enhancement of the fragmentation yields occurring at lower velocities may indicate formation of the $[He\text{-}C_4H_4O]^+$ collision complexes prior to dissociation.

Damage induced in the living cells by impact of the charged particles, for example in hadrontherapy, is related to the modifications of the structural and chemical properties of their molecular constituents. These modifications originate from the interaction of the primary cation beams and the secondary particles generated along the track such as low energy electrons, radicals and ions [1]. Unlike electrons and radicals, interaction of ions (primary and secondary) with biological media are poorly understood despite their importance in various therapies. To determine the most sensitive part of the DNA or RNA molecular chains to the cation-induced bond rupture, ionization and fragmentation of 2-deoxy-d-ribose, uracil, thymine, adenine, thymidine and amino acids under ionic irradiation have been investigated in the gas phase and layers condensed on the surfaces (see e.g. [2-4]).

Furan, C_4H_4O, has a special significance for biology and chemistry, since its ring structure resembles that of the simple sugars, ribose and deoxyribose, in the backbone of the RNA and the DNA helix.

In this communication we present studies of charge transfer and the collision complexes formation observed in fragmentation of furan molecule in the collisions with the He^+ cations applying collision-induced luminescence spectroscopy [5]. In Figure 1 the emission spectrum obtained for the impact of the 1000 eV He^+ cations is presented. It reveals production of the excited hydrogen H(n=4,5) and carbon C($2p3s$ $^1P_1$) atoms and the diatomic CH($A^2\Delta$) and C_2($d^3\Pi_g$) fragments. It also shows formation of the excited He ($1s1d$ $^1D_2$) atoms in the electron transfer from the furan molecule. Figure 2 displays the velocity dependences of the fragmentation yields, σ_{rel}, for the excited CH($A^2\Delta$) and He ($1s4d$ $^3D_{1,2,3}$) fragments. The observed rapid increase of the CH($A^2\Delta$) fragmentation yield occurring at lower velocities may be regarded as an indication of the $[He\text{-}C_4H_4O]^+$ complex being formed prior to dissociation of furan molecules [5].

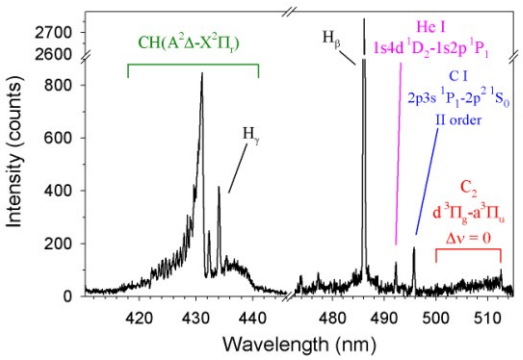

Figure 1. Emission spectrum measured at an energy of 1000 eV for He^++C_4H_4O collisions.

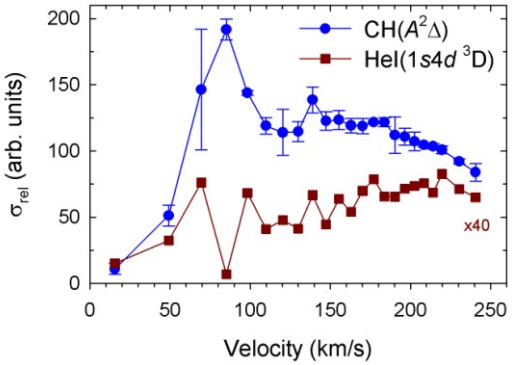

Figure 2. The CH($A^2\Delta$) and He I(1s4d ^{3}D) fragmentation yields obtained in the 15-250 km/s velocity range.

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