Abstract

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Title:	Study of excitation processes in molecules induced by electron impact
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In this thesis, we studied the formation of neutrals and positive ions of compounds of pyridine (C_5H_5N) and pyridazine ($C_4H_4N_2$) and nitrogen (N_2). We studied pyridine and pyridazine compounds using the Crossed Electron Molecular Beams Ionization Apparatus (CEMBIA). We studied pyridine and nitrogen compounds using the Electron Induced Fluorescence Apparatus (EIFA). Both devices use crossed electron and molecular beams. We studied the interactions of compounds with low energy electrons using high vacuum. We analyzed the products of these interactions by mass spectrometry and optical emission spectroscopy.

In both apparatuses, the electron beam was generated by a trochoidal electron monochromator and the molecular beam was generated by an effusive capillary. In the case of the CEMBIA apparatus, the generated ions from the interaction are directed by an electric field into a quadrupole mass analyzer (QMS). In QMS, ion separation takes place based on the ratio of charge and mass. Only a separated group of ions reaches the detector. A channeltron is used as a detector. In the case of the EIFA, the emitted photons from the interaction (during the deexcitation of the excited products) are conducted by the optical system from the vacuum chamber to the optical monochromator. Photons are detected either by a photomultiplier or a CCD camera.

Through quadrupole mass spectrometer, optical emission spectroscopy and a monochromatic electron beam, we were able to describe the processes of electron excitation, electron ionization excitation, electron dissociation excitation, electron dissociation ionization excitation, electron ionization and electron dissociation ionization.

Fragmentation of the studied compounds is characterized by sequential dissociations of carbon and hydrogen atoms. The ionization energy of the pyridine molecule was determined to be 9.37 eV. The ionization energy of the pyridazine molecule was determined to be 8.98 eV. Mass spectra were measured at an electron energy of 70 eV in the range

of 10 – 85 amu for pyridine and pyridazine. Cross-sections in the area of appearance energies were measured for selected fragments, which are compared with other publications. With electron-induced fluorescence we were probably the first to observe hydrogen migration, leading to the formation of a neutral NH radical.

The results of nitrogen´s and pyridine´s fluorescence were presented in the form of a 2D spectral map, which provides comprehensive information about the electron excitation-emission interactions with the compound. The 2D spectral map contains emission spectra and excitation-emission functions (EEF). Moreover, after the integration of the area under the spectral structures, the absolute values of the excitation-emission cross-sections can also be determined from 2D spectral map. The spectral range of the 2D map of pyridine is 200 – 700 nm and of nitrogen is 330 – 1030 nm. The energy range of the 2D spectral map of pyridine is 15 – 100 eV and of nitrogen is 6 – 100 eV. The 2D map of pyridine is in the spectral range of 200 – 700 nm and in the energy range of 15 – 100 eV.

Experiments were carried out on two devices provide new or additional data in the form of mass spectra and emission spectra. Experiments also provide data on electron-compound interactions such as cross sections for specific reactions. These data are also important for theoretical studies and modeling.

Key words: electron ionization; ionization, excitation and dissociation energy; mass spectrometry; fluorescence; optical emission spectroscopy