INELASTIC SCATTERING OF LOW-ENERGY (1.5 – 12 eV) ELECTRONS FROM CONDENSED ADENINE

Radmila Panajotović, Marc Michaud and Léon Sanche

Radiation Sciences Group, Department of Nuclear Medicine and Radiobiology, Faculty of Medicine, University of Sherbrooke, Québec, Canada, J1H 5N4

Research on low-energy electron scattering from DNA and its constituents aims to discover the mechanisms playing an important role [1] in several applications ranging from radiotherapy to nanotechnology. In continuation to our recent measurements on thymine [2], we performed a similar experiment on its complementary base, adenine.

Adenine is a purine base consisting of two rings with the amino group (NH_2) being attached to the six-member ring (C6). Within double-stranded DNA, it forms two hydrogen bonds with thymine. Previous studies of anion desorption from physiosorbed DNA bases [3] showed that electrons of energies below 15 eV produce bond cleavage via dissociative electron attachment. The aim of the present study is to investigate the formation of electron resonances (i.e. temporary negative ions) in adenine within the same energy range.

Measurements of the vibrational and electronic excitation were performed on a high-resolution electron energy-loss (EEL) spectrometer [2], housed in a cryogenically pumped ultra-high-vacuum chamber at a base pressure of ~ 5 x 10^{-11} Torr. EEL measurements were made on a very thin (from sub-monolayer up to a monolayer) film of adenine deposited on a six-layer spacer of argon condensed on a Pt substrate held at a temperature of 18 K. An incident electron beam of energy ranging from 1.5 to 12 eV was focused on the film at an angle $\theta_o = 15^o$ with respect to the normal to the surface. The number of electrons backscattered from the film was recorded at the fixed analyzer angle of 45^o. The vibrational EEL spectra show three distinctive spectral bands among 39 normal vibrational modes of the molecule: at EEL values ranging from 0.7 to 0.12 eV, from 0.15 to 0.22 eV and from 0.38 to 0.44 eV. A particularly interesting spectral feature is that the vibrations of the amino-group (mostly in the third band) reach their maximum intensity at incident electron energies between 3 and 5 eV. Since one of two adenine-thymine bonds involves hydrogen from adenine's amino group, possible resonance in this energy range could be of importance to DNA strand break. We have also measured the EEL spectra in the range from 4.5 to 7 eV where the electronic excitation of the molecule takes place. Both vibrational excitation of the molecule in its ground electronic state and the electronic excitation, and their possible consequences on DNA damage production will be discussed at the conference.

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References

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