Radiation Damage induced by soft X-rays in the DNA molecule

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DNA is the most sensitive biological target within cells upon exposure to ionizing radiation. One of the most powerful methods of surface analysis is X-ray photoelectron spectroscopy (XPS) which can be used to perform quantitative elemental analysis of thin films and provides information about chemical transformations of functional groups.

In the present work the decomposition of the calf thymus DNA fibre under irradiation with soft X rays (magnesium Kα X-ray source) in ultra-high vacuum is studied by means of XPS. . In this experimental approach the X-ray beam both damages and probes the sample. X-ray photoelectron spectra were measured using Kratos Model XSAM 800 with dual-anode X-ray source, a hemispherical energy analyzer and multi-channeltron detector. Compositional survey and detailed scans of P 2p, P 2s, C 1s, N 1s and Na 1s are recorded using pass energy of 1000 and 20 eV, respectively. To monitor changes, the spectra were taken repeatedly over 5 h. In most cases, the spectra have complicated shapes due to contribution of several functional groups and shake-up satellites. However, a comparative analysis of changes in XPS line shapes and stochiometry indicates that the DNA molecule is decomposed during X-ray irradiation time.

It is known that radiation damage to DNA induced by X-ray comprises of contributions from (i) primary particle and (ii) low-energy secondary electrons generated by the primary particles. Therefore, in future work, the application of XPS to the characterization of the radiation damage to the DNA molecule and it components, mainly nucleotide bases induced by 100 eV electrons will be studied.