Trade Science

Scientific Reviews and Chemical Communications

Short Communication

Direct effects of ionizing radiation on biological molecular systems

Jean-Christophe Poully

CIMAP Laboratory, France

Abstract

To understand the effects of ionizing radiation on biological molecular systems, it is crucial to control the experimental conditions, especially in terms of temperature and phase. Irradiation of a solution at room temperature mainly leads to the formation of free radicals from the solvent. These species then chemically react with biomolecules, leading to secondary processes such as bond cleavage, cross-linking and generally quenching of biological activity. All these indirect effects require diffusion of free radicals from the solvent to the biomolecule, which occurs at rates that decrease by several orders of magnitude from room to cryogenic temperatures. To study direct effects, frozen, lyophilized, crystallized, dried but also isolated molecules can be used. These last years, at the CIMAP lab, we have investigated the structure and stability of isolated collagen mimetic peptides and antibiotic/receptor non-covalent complexes of controlled mass and stoichiometry, by means of home-made experimental set-ups and through international collaborations. Our main findings are the following. First, the collagen triple helix exists in the gas phase, and its stability is not due to solvent. Second, interaction with one carbon ion at the Bragg-peak energy or ionizing photon in the VUV-X range mainly leads to ionization, vibrational energy deposition and intermolecular followed by intramolecular fragmentation (cf. figure 1). Radical-mediated mechanisms such as loss of neutral molecules from amino acid side chains have been found to play a big role. Our most recent studies on non-covalent complexes between the antibiotic vancomycin and its receptor suggest that ionizing photons trigger very different processes depending on pH: indeed, our results show that the protonated complex does not survive, and fragments mainly via glycosidic bond cleavage, whereas the deprotonated complex mainly loses CO2 after electron detachment. In a near future, we aim at probing the radiation-induced denaturation of biomolecular systems by tandem ion-mobility spectrometry.

Biography:

Jean-Christophe Poully is assistant professor at the University of Caen (France) since 2010. His research is focused on the intrinsic properties of biologically-relevant molecular systems, by means of experimental techniques such as mass and ion mobility spectrometries, but also quantum-chemical calculations. It allows shedding light on processes occurring after electron capture, photoabsorption or ion collision, but also on structural properties of biomolecules. These last years, he worked on direct effects of ionizing radiation to understand the first physical and chemical steps underlying radio- and hadrontherapy. In particular, he collaborates with radiobiologists to know more about the side-effects of irradiating cartilage, through investigations on collagen mimetic peptides. One of his future projects is going towards probing conformational changes triggered by ionizing radiation, because these processes can lead to denaturation of proteins or DNA strands.