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Tailoring Bond Cleavage in Gas-Phase Biomolecules by Low Energy Electrons¹

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The high energy quanta of impinging radiation can generate a large number (about 5×10^4) of secondary electrons per 1 MeV of energy deposited. When ejected in condensed phase water, the kinetic energy distribution of these free or quasi-free electrons is peaked below 10 eV. Low energy electrons also dominate in the secondary emission from biomolecular targets exposed to different energies of primary radiation. Due to the complexity of the radiation-induced processes in the condensed-phase environment, mechanisms of secondary electrons induced damage in biomolecules (BM) still need to be investigated. However, based on results from theory and different experiments accumulated within the last decade, it is now possible to determine the fundamental mechanisms that are involved in many chemical reactions induced in isolated gas-phase biomolecules by low energy electrons. The central finding of earlier research was the discovery of the bond- and site- selectivity in the dissociative electron attachment (DEA) process to biomolecules. It has been demonstrated that by tuning the energy of the incoming electron we can gain control over the location of the bond cleavage. These studies showed the selectivity in single bond cleavage reactions leading to the formation of the dehydrogenated closed shell anion $(\text{BM-H})^-$ or the complementary reaction leading to H^- . The loss of a hydrogen atom or an anion is fast compared with ring cleavage and the excision of heavier fragments and, hence, this reaction can compete efficiently with autodetachment. Moreover, site selectivity has been also observed in the metastable anion formation via the DEA process. Such delayed fragmentation was studied recently for the dehydrogenated closed-shell anion conversion into NCO^- upon DEA proceeded a few μ sec after electron attachment, indicating a rather slow unimolecular decomposition. Interestingly, site selectivity was observed in the prompt as well as the metastable NCO^- formation in DEA.

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