

Ion radiation damage of biomolecules in aqueous solutions

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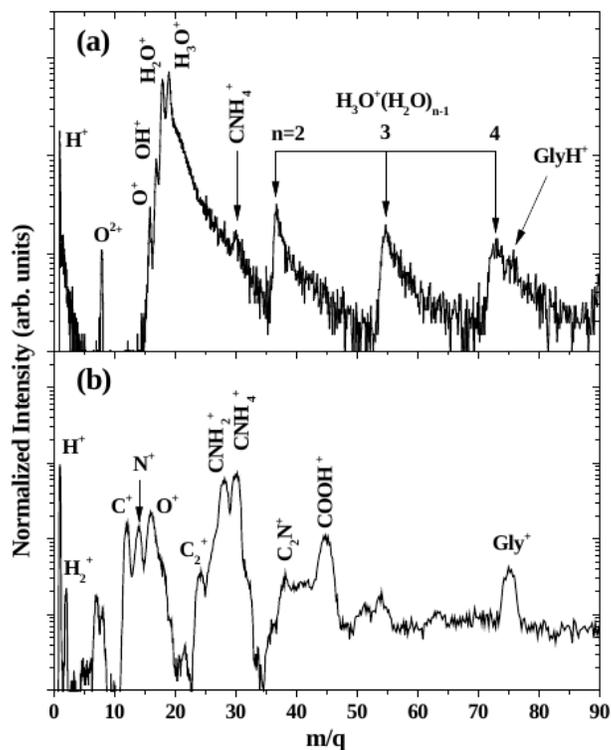
Investigations of the radiation damage to human bodies have been of longstanding interest in radiobiology and radiotherapy. The radiation damage processes of DNA are mainly divided into two categories: direct and indirect actions. The latter is closely related to radiolysis of the water molecules. Therefore, it is important for understanding of the effects of liquid water environments on radiation damage to biomaterials. To elucidate its detailed mechanism at the atomic or molecular level, basic research has been conducted on a variety of model biomaterials in the form of gas-phase targets (isolated single molecules and their cluster), as well as liquid-phase targets (aqueous solutions).

In this work, we study radiation damage of biomolecules in aqueous solutions under fast heavy-ion irradiation [1]. The purpose of this study is to understand radiolysis of biomolecules in liquid water. We performed mass spectroscopic analysis of products emitted from a biomolecule solution by ion irradiation, using the vacuum liquid microjet technique combined with a secondary ion mass spectrometry. A microjet target of aqueous solution was irradiated with 4.0-MeV carbon ions. We examined ionization and dissociation processes of the solvent molecules. We also performed the experiments with a biomolecule target in the vapor-phase.

Figure 1 shows a TOF spectrum of positively charged secondary ions emitted from (a) a 0.1-M glycine (Gly: C₂H₅NO₂) solution and (b) gas-phase target produced by sublimating a glycine powder, under 4.0-MeV C²⁺ irradiation. For the solution target, observed secondary ions from glycine molecules were protonated glycine GlyH⁺ and dissociated glycine CNH₄⁺. The former is formed via the addition reaction between neutral Gly and H⁺ generated from dissociated water molecules. The latter is formed by the cleavage of the C-C_α bond. A

comparison of the TOF spectra for the solution and gas-phase targets shows that the yield of products formed by the multifragmentation, such as CNH₂⁺ and C⁺ was significantly reduced for the solution target. The suppression of molecular multifragmentation could be an effect of the liquid water environment.

In this presentation, we will discuss the environmental effects on dissociation of biomolecules, comparing with experiments with other targets in the form of isolated single and cluster biomolecules.



References

- [1] S. Nomura et al. Nucl. Instrum. Methods Phys. Res. B 389-390 (2016) 28-3

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