

Fast ion-induced dissociation of biomolecules in liquid water environments

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Studies on the effect of ionizing radiation on biological molecules are important for an understanding of radiation damage to normal cells during radiotherapy. Basic research has been conducted on a variety of model biomaterials such as amino acids and nucleobases in the form of gas-phase target. Radiation damage of biomolecules is caused by the direct or indirect action. In the indirect action, it is considered that the effect of water molecules surrounding a biomolecule plays an important role in radiation damage to normal cells.

In this work, we investigate fast ion-induced dissociation of biomolecules in aqueous solutions. The purpose of this study is to understand aqueous environmental effects on radiation damage of biomolecules. Three types of amino acids with different molecular structures were used as targets. These targets in aqueous solutions or in the form of gas-phase were irradiated by 4.0-MeV C^{2+} ions. Reaction products were analyzed by a time-of-flight mass spectrometry.

Secondary ions emitted from the aqueous solution targets are dissociated amino acid, protonated amino acid, and ions formed via chemical reaction with water molecules. Compared to the relative intensities of fragment ions, the fragment resulting in the cleavage of the C-C_α bond and the loss of the COOH radical is formed in the highest intensity. Interestingly, the yield of fragment ions for the solution targets is significantly low compared with that for the gas-phase targets. In particular, the yield of multi-fragment ions is reduced by approximately half. This result implies that molecular dissociation is suppressed in liquid water environments.

To see variation of the fragment ion yield, Fig. 1 shows the yield ratio between total fragment ions and multi-fragment ions as a function of

energy deposition per amino acid molecule for the gas-phase targets. The energy deposition was estimated using the core-and-bonds approach [1]. There is a clear correlation between them, and it follows the fitting result shown by dashed line. Based on this result, we deduce the amount of energy deposition for the solution targets. The energy becomes approximately half in comparison with the result of the gas-phase targets. This may result from the energy dispersion to water molecules surrounding an amino acid molecule.

In this presentation, we will discuss the effects of water molecules on dissociation of biomolecules by comparing results for solution and gas-phase targets.

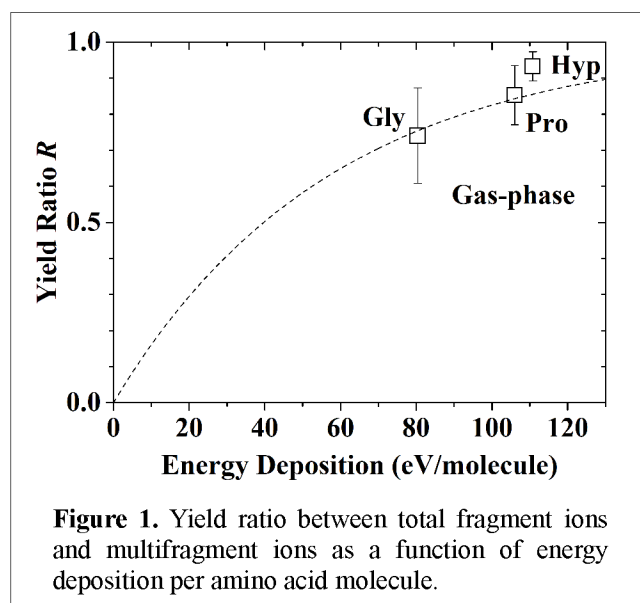


Figure 1. Yield ratio between total fragment ions and multifragment ions as a function of energy deposition per amino acid molecule.

References

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