Experimental Studies on Low-Energy Electron Collisions with Radiosensitizers

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Various nitroimidazolic molecules have been considered as potential radiosensitizers for hypoxic tumors which are characterized by a lack of oxygen [1]. The desired benefit of radiosensitizers may also partially be ascribed to the action of low-energy secondary electrons. This species is generated in abundant amounts during the irradiation of biological tissue. The kinetic energy distribution of secondary electrons formed finds its maximum below 10 eV. Low-energy electrons may attach to molecules which leads to the formation of transient negative ions. Those states may lead to long-lived anions or they may decay by molecular dissociation or spontaneous electron emission.

In order to develop novel nitroimidazolic compounds for radiation therapy, it is important to investigate the electron attachment properties in dependence of the molecular structure. In this contribution, I will review our previous electron attachment studies with nitromidazolic compounds in the gas phase. The setup used for these studies was a high resolution electron monochromator combined with a quadrupole mass spectrometer. Measurements were also carried with a two-sector field mass spectrometer, which enabled higher electron currents than the monochromator, albeit with lower energy resolution.

The resulting negative ion mass spectra as well as anion efficiency curves showed distinct differences between the studied compounds. Hydrogen loss was observed as the most abundant reaction for the building block imidazole [1]. The DEA experiments demonstrated that the attachment of a single electron may induce the loss of all four hydrogens from imidazole. For nitroimidazoles, the presence of the NO_2 group leads to significant change of the fragmentation pattern [2,3]. For these compounds, DEA reactions are dominated by the loss of small neutral radicals like OH and NO. Finally, for larger nitromidazolic compounds like nimorazole, molecular dissociation plays a minor role and the formation of the parent radical anion is dominant [4]. This observation may point out the mechanism of radiosensitization by nitroimidazolic compounds. The results will be also compared with other DEA studies of radiosensitizers like modified pyrimidines [5].

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References

[1] A. Ribar *et al*., *PCCP*, **19**, (2017), 6406.
[2] K. Tanzer *et al*., *Angew. Chem. Int. Ed.*, **53**, (2014), 12240.
[3] A. Ribar *et al*., *Chem.- A Eur. J*, **23**, (2017), 12892.
[4] R. Meißner *et al*., *Nature Comm.,* **10**, (2019), 2388.
[5] J. Ameixa *et al*., *J.Chem. Phys*., **149**, (2018), 164307.