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Experimental study of radiolytic oxygen removal in irradiated water

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The mechanism behind the biological sparing effect with ultra-high dose rate (FLASH) still remains unknown. One possibility is that the FLASH effect is caused by oxygen removal or the reaction of radiation-induced radicals with oxygen during irradiation. In this work, before studying the oxygen removal with FLASH irradiation, we decide to irradiate the samples with conventional dose rate (CONV) to investigate experimental oxygen removal in different liquids and study the radical production and reactions that arise in this dose rate range, for reference. Water samples were exposed to 50 Gy X-ray radiation dose at the dose rate of ˜4.7 Gy/min. Each sample was irradiated for 2-3 irradiations. Dosimetry for the X-rays source was carried out using a Semiflex ionization chamber. The oxygen measurement was performed using a chemical optical sensor and observed online. The oxygen depletion was the highest in the first irradiation and then decreased in steps afterwards with the average values of 0.28, 0.25 and 0.23 μM/Gy in the first three irradiations, respectively. From the experimental results, we conclude that the decreasing behavior of oxygen removal is produced by the radical production and their reactions which compete with oxygen removal. The radicals created in previous steps might react with each other and reduce the reaction that should occur with the oxygen in the next irradiation. In addition, an increased oxygen removal was found in solutions containing organic molecules.

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