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Dosimetric analysis of iodine-125 seeds using the Fricke xylenol gel dosimeter

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1. Introduction

The Fricke xylenol gel (FXG) stands out as a radiochromic dosimeter of immense interest in medical dosimetry due to its properties, particularly its density, which closely mirrors that of human tissue, rendering it tissue-equivalent. Its response mechanism involves the radio oxidation of Fe^{+2} to Fe^{+3}, manifested through changes in color, enabling diverse analytical techniques such as spectrophotometry, optical computed tomography, and magnetic resonance imaging. Despite its compelling attributes, the dosimeter is notably sensitive to environmental factors, potentially leading to natural oxidation. Consequently, it finds application in rapid irradiations in teletherapy settings. This study aims to comprehensively analyze the dosimeter's response when subjected to iodine-125 brachytherapy sources over varying intervals, employing optical computed tomography techniques for precise evaluation

2. Methodology

The dosimeter was prepared using a procedure derived from that described by Del Lama [1]. Following its preparation, while still in liquid form, the dosimeter was divided into six approximately 125 ml vials and kept refrigerated for 12 hours. Subsequently, a scan was conducted using the optical CT equipment Vista™ 16.

Each of the remaining three vials was labeled and a varying number of iodine-125 brachytherapy sources [2] with an activity of 1mCi, corresponding to the vial number, were added [Figure 1]. Every 24 hours, the sources were removed from the vials, and a scan was performed using optical CT to assess the attenuation coefficient difference resulting from dosimeter oxidation caused by radiation emitted from the iodine-125 sources.

Finally, an evaluation was conducted on the irradiated vials and the control group to determine the dosimetry feasibility of these sources using this dosimeter. The samples were kept refrigerated throughout the experiment to minimize natural oxidation

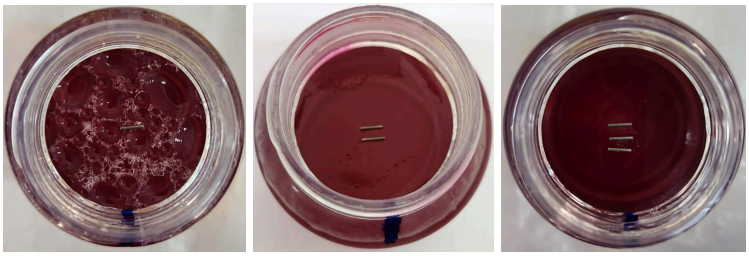

Figure 1: Vials with varying numbers of iodine-125 brachytherapy sources. Source: author

3. Results and Discussion

After the first day of irradiation, dose curves on the dosimeter became visible. Additionally, it was observed that there was no natural dosimeter oxidation in the lower region of the sample. Further analysis of the remaining samples revealed radiation doses insufficient to be distinguished from their pre-irradiation states, showing only noise [Figure 2].

a) b) c)

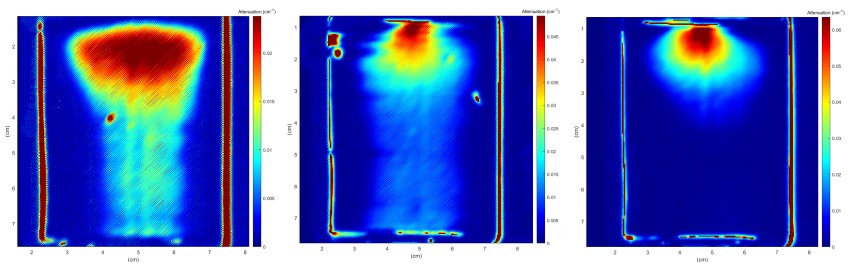

Figure 2 : Optical CT analysis after one day of irradiation of the different samples: a) Sample containing one source b) Sample containing two sources c) Sample containing three sources.

After the second day of irradiation, we observed in all samples a superficial region, near the location where the sources were positioned, where radiation action and consequent dosimeter oxidation were sufficient to be detected. However, natural oxidation was observed in the lower part of the sample [Figure 3].

a) b) c)

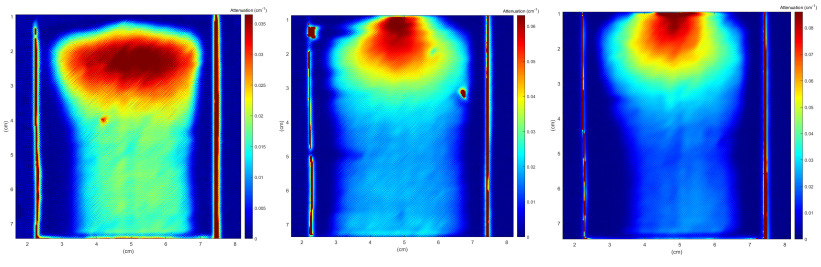

Figure 3: Optical CT analysis after two days of irradiation of the different samples. a) Sample containing one source b) Sample containing two sources c) Sample containing three sources.

On the seventh day of measurements, we observe a high level of natural oxidation in all samples, occurring throughout the vial, indicating significant natural oxidation and thus preventing the distinction between oxidation caused by radiation sources and natural oxidation due to external factors. [Figure 4].

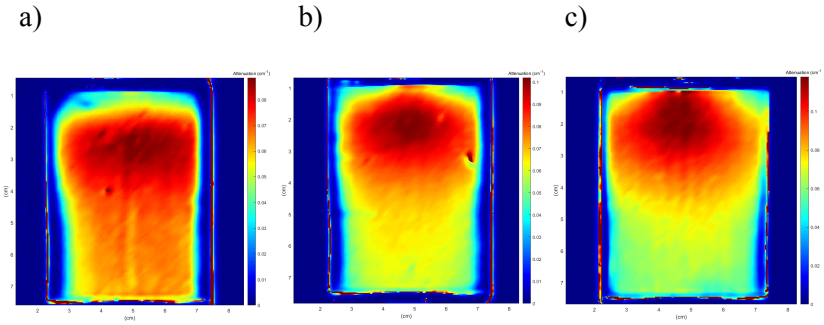

Figure 4: Optical CT analysis after seven days of irradiation of the different samples. a) Sample containing one source b) Sample containing two sources c) Sample containing three sources.

4. Conclusions

The results of the dosimetric analysis of iodine-125 seeds using the Fricke xylenol gel dosimeter proved promising with the adopted technique. However, some limitations still persist. For instance, there is a need for a minimum dose for detection, achieved only on the first day in the sample containing three sources. Furthermore, even with temperature control to reduce natural dosimeter oxidation, the analysis proved effective only within the first three days, as beyond that, natural oxidation contributes to an increase in data error

Acknowledgements

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References

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[2] “BEST MEDICAL. Best Medical Product Catalog - March 2020,”

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