2021 International Nuclear Atlantic Conference – INAC 2021
Virtual meeting, Brazil, November 29 – December 2, 2021

ISBN: 978-65-594-1256-3

Study on the application of optical CT for Fricke gel dosimetry

Tavares, P V S[1], Rodrigues Jr., O[1]; Campos, L L[1]
[1]*paulo.vt09@gmail.com , Radiation Metrology Center, Instituto de Pesquisas Energéticas e Nucleares Av. Prof. Lineu Prestes,2242 – Cidade Universitária, São Paulo – SP, Brazil*

1. Introduction

Optical computed tomography was developed as an alternative for evaluating gel solutions for three-dimensional dosimetry [1]. The evaluation by optical computed tomography works by measuring the solution before irradiation and another after irradiation which an image reconstruction is performed. With the reconstructed images, it is possible to measure the attenuation variation between the two measurements and relate it to the dose deposited on the material [2]. One of the initial modes of three-dimensional dosimetry is the evaluation of gel dosimeters in magnetic resonance techniques, due to the solution's magnetic properties being altered when exposed to ionizing radiation. However, not all radiotherapy sectors are able to have a magnetic resonance equipment available solely for this application. The Fricke gel solution was modified to be a radiochromic solution, i.e, it undergoes changes in its optical density as a function of the deposited dose. The xylenol orange in the Fricke gel solution becomes an indicator of ferric ions (Fe3+), which are caused by oxidation resulting from irradiation in the solution. [3]

2. Methodology

For this work it was proposed a solution Fricke gel modified with reduce in xylenol orange concentration for specified use in optical CT. The Fricke gel solution samples were irradiated with 60Co gamma radiation in a Gammacell equipment with isotropic irradiation capacity.

An analysis is performed with the reconstructed images to obtain the attenuation coefficient values at the geometric center of the solutions. For this, regions of interest of volume 10 mm x 10 mm x 10 mm were selected, as shown in figure 1.

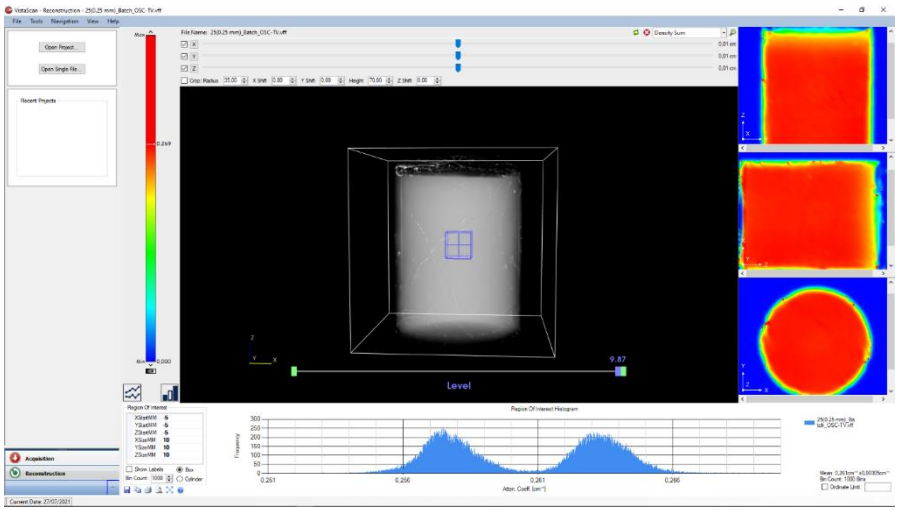

Figure 1: Region of interest selected in blue with a dimension of (10 mm x 10 mm x 10 mm) to assess dose uniformity and homogenization of the solution.

3. Results and Discussion

Figure 2 shows the coronal sections of the Fricke gel solution irradiated with doses between 3 Gy and 40 Gy evaluated 90 min after irradiation. Colors are normalized to the maximum attenuation value of 40 Gy, corresponding to the percentage of 100%.

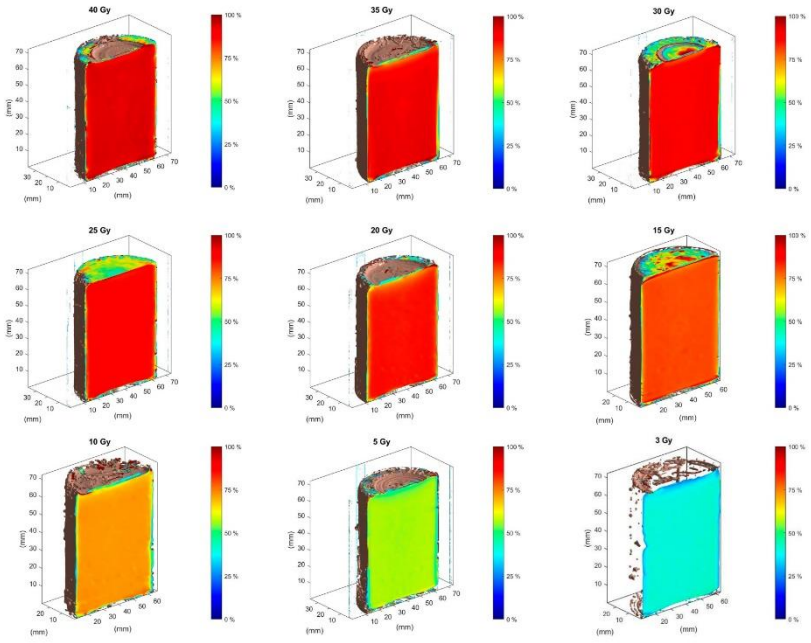

Figure 2: Coronal sections of Fricke gel solution with a concentration of 0.01 mM of xylenol orange irradiated with doses between 3 Gy and 40 Gy.

4. Conclusions

By changing the normalized attenuation values for pixel intensity, it is possible to visualize a dose gradient, an important analysis for radiotherapy planning and the evaluation of the attenuation value from a small region of interest of the Fricke Gel solution after irradiation shows the accuracy of the equipment and the homogeneity of the solution.

Acknowledgements

Thanks to FAPESP: Proc.No. 2018/05982-0 and CNPq: Proc. No. 426513/2018-5.

References

[1] DORAN, S. J.; KRSTAJIĆ, N. The history and principles of optical computed tomography for scanning 3-D radiation dosimeters. Journal of Physics: Conference Series, v. 56, n. 1, p. 45–57, 2006.

[2] BABIC, Steven; BATTISTA, Jerry; JORDAN, Kevin. Three-dimensional dose verification for intensity-modulated radiation therapy in the radiological physics centre head-and-neck phantom using optical computed tomography scans of ferrous xylenol–orange gel dosimeters. **International Journal of Radiation Oncology* Biology* Physics**, v. 70, n. 4, p. 1281-1291, 2008.

[3] MARRALE, M; D'ERRICO, F. Hydrogels for Three-Dimensional Ionizing-Radiation Dosimetry. **Gels**, v. 7, n. 2, p. 74, 2021.