

Gel Dosimetry – A Tool for Radiotherapeutic Planning

Filip Solář

Supervisor: Hana Bártová, Faculty of Nuclear Sciences and Physical Engineering, Czech Technical University in Prague
First Private Language Grammar School Hradec Králové, Hradec Králové, Czech Republic, solar.filip@psjg-hk.cz

Introduction

The radioactivity and the ionizing radiation have a wide range of various applications in many fields. Their use requires the detection and measurement of the radiation dose, and the dosimeters are the devices used for this purpose. There are several types of dosimeters based on different principles. A rather novel technique is gel dosimetry (GD) when the radiation induces changes in the gel containing radiosensitive substances that are subsequently quantified by spectrophotometry. The GD enables the analysis of the spatial layout of the radiation. If the GD is made of gelatine, its characteristics are similar to those of human tissues, which can be of value in radiotherapeutic planning. (Spěvák, 2012)

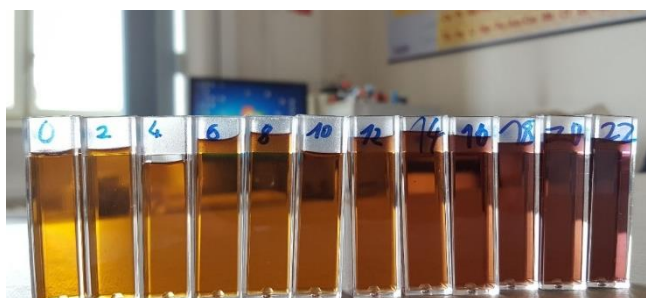
The current study focuses on modified Fricke gel dosimeter FeXo, which is composed of gelatine, Mohr's salt (FS) and xylene orange (Xo). The conversion of FS induced by radiation leads to changes with Xo, modifying the spectrophotometric characteristics of GD. (Spěvák, 2012)

The main objective of the project was to analyse how the results of radiation dose estimation are influenced by the following factors:

- 1) Aging, i.e.: the time delay from the GD preparation to the radiation exposure and spectrophotometric measurements.
- 2) The temperature during GD preparation.
- 3) The composition of GD.

Experimental setup

For each part of the project, modified Fricke gel dosimeter FeXo was prepared in series of 12 cuvettes. The GDs were irradiated on irradiator Gammacell 220 (^{60}Co) by predefined doses. Subsequently, in every single dosimeter, absorbance and transmittance for light wavelengths in the range 350 – 700 nm were measured using spectrophotometer Helios Beta.



Picture 1: Cuvettes with dosimeters after radiation of doses 0 – 22 Gy (left to right) (author)

The effects of evaluated factors on the results of radiation measurement:

- 1) GD aging: spectrophotometric analysis was performed immediately after irradiation, and the second and the fourth day after radiation exposure.
- 2) different temperatures used during GD preparation: two series of modified Fricke gel dosimeter FeXo were prepared. The first one was at 30 °C and the second one at 50 °C.
- 3) GD composition, two series of GD were compared. The first was prepared according to normal receipt, i.e. at 50 °C, and containing FS:Xo ratio 5:1. In the second series the FS:Xo ratio was 1:1.

Results

- 1) Substantial impact of time delay from GD preparation and irradiation to the spectrophotometric analysis was observed. The results obtained the second and the fourth day after preparation and irradiation of GD did not enable to accurately quantify the radiation dose.
- 2) We observed a significant effect of temperature used during GD preparation on the results. GD prepared at 50 °C showed a better correlation between administered radiation dose and observed absorbance. Moreover, the observed absorbances for the identical radiation dose significantly differed between GDs prepared at 50 °C and at 30 °C.
- 3) The GD containing a lower amount of FS (FS:Xo 1:1) exhibited lower sensitivity to the administered radiation compared to GD containing a normal amount of FS (FS:Xo 5:1).

Conclusions

The major results of our project can be summarised as follows:

- 1) GD should be prepared, exposed and evaluated at the same day. A greater time delay from preparation to evaluation can lead to the misleading results.
- 2) The temperature during GD preparation should be kept constant in order to grant reproducibility of the results when performing repeated measurements.
- 3) The decreased amount of Xo in GD decreases the sensitivity of GD.

References

Spěvák – SPĚVÁČEK, Václav. Chemie gelových dozimetřů. Praha, 2012. České vysoké učení technické v Praze fakulta jaderná a fyzikálně inženýrská.