UNIVERSITY OF TRENTO - Italy
Department of Physics

Azienda Provinciale per i Servizi Sanitari
Provincia Autonoma di Trento

Aifm
Associazione Italiana di Fisica Medica

Physics&Medicine

Toward a future of integration

Trento, November 6th – 8th, 2014

Abstract book

Editors:

Renzo Antolini
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Characterization of Fricke gel dosimeters exposed to clinical photons beams and of MRI dosimetrical applications

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The Fricke Xylenol Gel (FXG) dosimetric system is based on the radiation induced oxidation of ferrous (Fe^{2+}) to ferric (Fe^{3+}) ions [1].
The application of Fricke type gels for ionizing radiation dosimetry is continuously increasing worldwide due to their many favorable properties. However, one of their shortcomings is that ferrous and ferric ions diffuse in the gel matrix. To maintain the spatial integrity of the dose distribution, Fricke gels must be analyzed within a few hours of their irradiation, so that ferric ions remain close to their point of production. Thus, the spatial integrity of the dose distribution in the Fricke gel is maintained.
The gel matrix also contributes to the oxidation of ferrous ions during irradiation, increasing the chemical yield of ferric ions in aqueous solution and increasing the sensitivity of the dosimeter.
The oxidation of ferrous ions also causes a reduction of the longitudinal nuclear magnetic relaxation time T_1 which can be measured by means of nuclear magnetic resonance (NMR) relaxometry and magnetic resonance imaging (MRI) [2].
In this work the results of our analyses of FXG dosimeters are reported. We performed NMR relaxometry investigations which allow for direct measurements of the relaxation times in samples exposed to clinical photon beams. The main dosimetric features of the NMR signal were investigated. The gels were irradiated in the clinical dose range between 0 and 20 Gy. In order to assess the photon sensitivity we analyzed the dependence of NMR relaxation time on radiation dose with varying ferrous ammonium sulfate content (from 0.5 mM to 5 mM) inside FXGs (Fig.1). Furthermore, signal stability was followed for several days after irradiation [3].

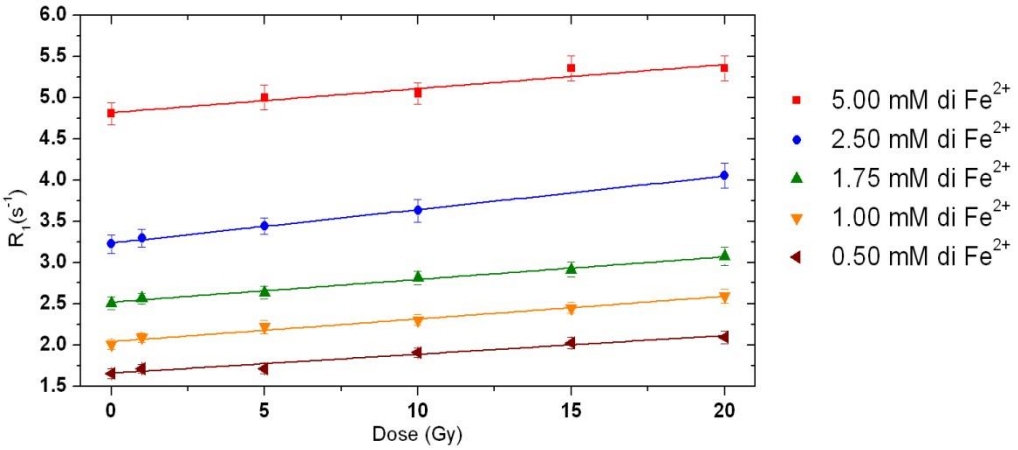

Fig.1 - FXG dose response curve for various concentrations of ferrous sulphate.

These measurements were also aided by acquisitions of magnetic resonance imaging (MRI) which can permit 3D dose mapping [4]. In order to maximize the MRI response a systematic study was performed to

optimize acquisition sequences and parameters. In particular, we analyzed for inversion recovery sequences the dependence of MRI signal on the repetition time T_R and on the inversion time T_I [3].

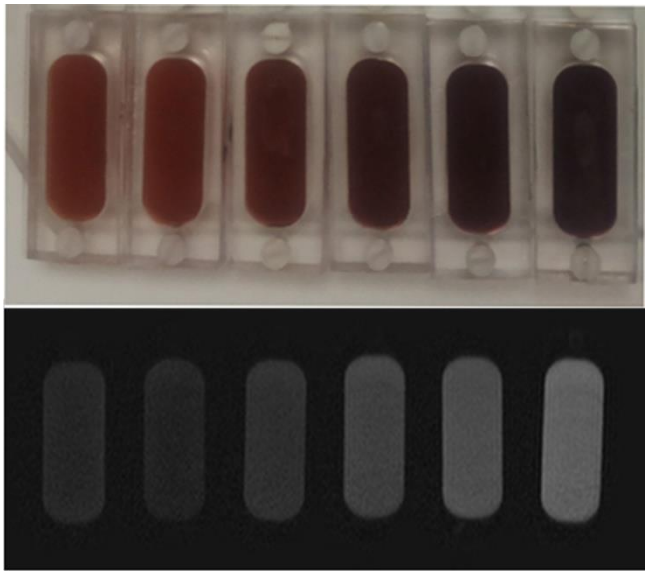

Fig.2 – (**above**) Picture of FXG irradiated in the clinical range (1.75 mM); (**below**) MRI image obtained with IR sequence (T_R=400ms and T_I=2500ms). Dose increases from left to right.

The dose calibration curves are reported and discussed from the point of view of the dosimeter use in clinical radiotherapy (Fig.2). This work has highlighted that the optimization of additives inside gel matrix is fundamental for optimizing photon sensitivity of these detectors. We can conclude that FXG dosimeters with optimal ferrous ammonium sulfate content can be regarded as a valuable dosimetric tool to achieve fast information on spatial dose distribution.

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