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Abstract's title: PVA-GTA Fricke gel dosimeters exposed to clinical photons beams: Nuclear Magnetic Resonance Relaxometry and Imaging

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Abstract

Fricke Gel (FXGs) dosimetric system is based on the radiation induced oxidation of ferrousto ferric ions.

The application of Fricke 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 undergoing measurement 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 (Schreiner, 2015).

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 Relaxometry (NMR) and Magnetic Resonance Imaging (MRI) (Marrale, 2014).

The results here presented are related to an experimental investigation conducted on Fricke Gels characterized by gelatinous matrix of Polyvinyl alcohol (PVA)cross-linked with a Glutaraldehyde (GTA) (Marini, 2016).

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 times on radiation dose with varying ferrous ammonium sulfate content inside FXGs. Furthermore, signal stability was followed for several days after irradiation.

These measurements were preliminary to MRI analysis which can permit 3D dose mapping. 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.

The dose calibration curves are reported and discussed from the point of view of the dosimeter use in clinical radiotherapy. This work has highlighted that the optimization of additives inside gel matrix is fundamental for maximizing 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.

A. Marini et al., Diffusion and sensitivity characteristics of a chemically cross-linked PVA-Fricke gel dosimeter, Physica Medica (2016), 32, 41.

M. Marrale et al., Correlation between ferrous ammonium sulfate concentration, sensitivity and stability of fricke gel dosimeters exposed to clinical x-ray beams. NIM B (2014b) **335** 54–60.

J. Schreiner, MRI true 3D chemical dosimetry: development and clinical role. Jpc. (2015) **573.**