Materials.it 2016

Sheraton Catania Hotel Aci Castello (Catania)
December 12 - 16, 2016

Conference Chairs:
Corrado Spinella (Dipartimento di Scienze Fisiche e Tecnologie della Materia
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Materials2016 - Submission - View

Abstract's title: Phenol compounds for Electron Spin Resonance (ESR) dosimetry in gamma and neutron field

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Abstract

The use of neutrons for cancer treatments has stimulated the research for beam characterization in order to optimize the therapy procedures in Neutron Capture Therapy (Altieri, 2008). Several research laboratories have shown an increasing interest aimed at extending the applicability of Electron Spin Resonance (ESR) dosimetry to radiotherapy with different types of radiation beams. In particular, ESR spectrometry provides absorbed dose measurements through the detection of the stable free radicals produced by ionizing radiations. The ESR dosimetric method has many advantages such as simple and rapid dose evaluation, the readout procedure is non-destructive, linear response of many organic and inorganic compounds (Baffa,2014).
In this work we study the response of phenolic compounds with and without gadolinium addition for electron spin resonance (ESR) dosimetry exposed to a gamma and mixed (n, gamma) field mainly composed of thermal neutrons.
The compound IRGANOX 1076 phenol gives a phenoxy radical stabilized by the presence of two bulky groups [3]. Moreover, its high molecular weight, the low volatility and the compatibility with the dosimeter binding material (paraffin) are advantages with respect to lower molecular weight phenols.
In this work we report the ESR investigation of phenols pellets and thin films with and without Gd_2O_3 (5% by weight) exposed in the thermal column of the Triga Mark II reactor of LENA of Pavia.
Thanks to their size, the phenolic films here presented are good devices for the dosimetry of beams with high dose gradient and which require accurate knowledge of the precise dose delivered. The choice of Gd as the additive nucleus has been made because we are interested in applications for mixed field (neutrons/photons) Gd-ESR dosimetry has an high neutron capture cross section and, furthermore, the high LET secondary particles release their energy entirely in the dosimeter. The low content of gadolinium guarantees a good tradeoff between the sensitivity to thermal neutrons. However, the use of gadolinium reduces or abolishes tissue equivalence because of its high atomic number (Marrale, 2015).
The dosimetric features of these ESR dosimeters have been investigated. In particular, we analyzed the ESR spectra of these compounds and their dependence on microwave power and modulation amplitude, their response after gamma and neutron irradiations, the detection limits for both beam typologies, signal stability after irradiation.
The results of ESR experiments are compared with Monte Carlo simulations aimed at obtaining information about the total dose measured by means of ESR dosimeters.

[1] S. Altieri et al., App. Rad. Isot. (**2008**) – doi: 10.1016/j.apradiso.2008.05.007
[2] O. Baffa, A. Kinoshita, Rad. and env. Bioph. (**2014**) – doi: 10.1007/s00411-013-0509-2.
[3] M. Marrale et al., Rad. Mes. (**2015**) – doi: doi:10.1016/j.radmeas.2015.02.019.