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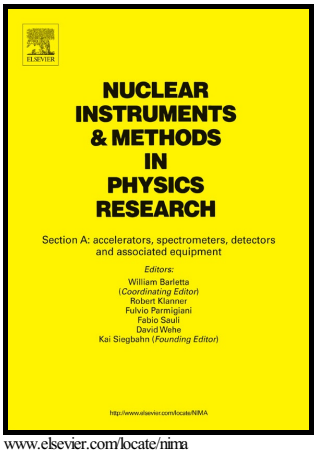

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Dosimetry Characteristics of HDPE-SWCNT Nanocomposite for Real Time Application

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Abstract

In this experimental work, different dosimetric characteristics of high density polyethylene-single wall carbon nanotube nanocomposite were investigated. The nanocomposite samples were prepared with different nanotube contents of 0.22, 0.25, and 0.39 weight percentages which were before, exactly in, and after percolation region of the nanocomposite, respectively. The samples were exposed to ^{60}Co gamma radiation source over the dose rate of 65-214 mGy/min, while the applied bias was 100 V. A linear response achieved for the sample contained 0.25 nanotube wt% verified that the percolation threshold is the optimum point for dosimetric purposes. The current-voltage characteristics curve measured for 0.25 CNT wt% nanocomposite showed that the behavior of this sample was bias polarity independent. Also, the results showed that the response of this nanocomposite was energy-independent. The maximum discrepancy of photocurrent due to angular variation within 0-90 degrees with respect to beam incidence and the reproducibility of the response were measured as 5.4 % and 0.8%, respectively. The stability study showed that this material may be suitable for protection dose level control. Therefore, this kind of nanocomposite requiring calibration can be used as a real-time dosimeter.

Keywords: HDPE-SWCNT nanocomposite, Real-time dosimetry, Dose Rate.

1. Introduction

Dosimetry and detection of ionizing radiation are the important investigation fields in the nuclear industry. Passive dosimeters, such as photographic films and thermoluminescent materials, are largely used for individual dosimetry of ionization radiation, but they do not provide a direct reading and need a further treatment after irradiation to yield any information on the dose level [1]. The high mobility of carbon nanotubes (CNTs) suggests high sensitivity in applications where charge detection is required [2]. The nano-sized, high surface area and the high aspect ratio of CNTs offer the great opportunities to enhance the electrical conductivity of the polymer nanocomposites even at a very low loading of CNTs in the polymer [3]. Electrically conductive polymer-CNT nanocomposites due to the lightness, tissue equivalent, easy processing, and low cost have great potential applications in radiation sensors, and dosimeters [4-6]. Some investigations have been done on the effect of irradiation on electrical properties of carbon allotropes with especially polymeric hosts [7-12]. The effects of ionizing radiation on the electrical resistance of PMMA-MWCNT nanocomposite were investigated recently [10]. Other researchers have investigated the interaction of radiation with functionalized CNTs that have been incorporated into various host materials, particularly polymeric ones [13]. The effects of length and critical density of CNTs on the electrical conductivity of a radiation sensor based on percolation theory were studied [7]. Adding small CNT amount to a polymeric matrix has been found to distinctly and