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An Innovative Real-Time Dosimeter for Radiation Tests

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The operational limitations of all equipment and materials used in high-radiation environments must be tested through screening procedures under all possible operating situations. These severe circumstances frequently make it impossible to repair or maintain the instrumentation, thus the devices must meet very rigorous requirements for radiation tolerance and dependability. In RHA tests, the radiation environment that the devices are designed to be subjected to over their operational lifetime is experimentally simulated. The goal of RHA tests is to find any radiation-related malfunctions and confirm that the equipment performs following specifications after receiving a certain dosage of radiation.

The determination of the precise radiation environment and its correct reproduction, careful dose monitoring, the choice of materials and components, and the design of the experimental test are only a few of the variables that affect the outcome of RHA tests. A vital and difficult challenge is the experimental simulation of the radiation environment.

Devices for space applications must function in the face of a complicated natural radiation environment that is mostly made up of protons, heavier nuclei, and electrons and protons created by powerful solar events as well as galactic and extragalactic origins. To define a device's operational limits, a precise calculation of the radiation dose it is subjected to during operation is essential.

A new dosimeter for real-time dose monitoring in RHA tests is suggested in this research. It is based on a newly created approach for reading Radio Chromic Film (RCF) spectroscopically. In particular, the RCF is positioned at the common vertex between two OFs that are fastened to aluminium support. Radiation can pass through a cylindrical hole and still reach the RCF and the DUT without appreciably altering the radiation field. The spectrometer is attached to one of the two OFs, while the light source is connected to the other. In this design, the source's light strikes the RCF, where it is reflected and collected by the second OF for spectrometer reading.

The dosimeter was successfully tested using electron and proton beams, as well as a beta source. The DUT test results show that the planned prototype dosimeter can be used for dosimetry in small experimental setup geometries with minimal radiation field disruption. The described dosimeter can also be used in hostile situations like particle accelerator facilities for nuclear and high-energy physics investigations due to its small design. The attenuation of the spectrum as a function of the dose is a known consequence of radiation damage to optical fibres. The radiation damage to optical fibres is a

scientific issue that needs to be considered as the suggested dosimeter based on optical fibres for real-time RCF measurement.

It has been designed to assess the spectral content of Radio Chromic Films (RCFs) in real-time using a spectrometer and two optical fibres as a novel dosimeter for Radiation Hardness Assurance (RHA) tests. By maintaining the relative positions of the optical fibres and the RCF fixed, the specific geometry permits, reducing the interaction of the primary radiation field with the optical fibres and improving the measurement repeatability. The creation of novel real-time dosimeters in crucial applications, such as dosimetry monitoring in radiotherapy, may be facilitated by the optimization of the design (geometry and material) of this dosimeter.

JOURNAL REFERENCE

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KEYWORDS

Radiation hardness assurance (RHA), real-time dosimetry, radiochromic film, beam monitoring