Nuclear Instruments and Methods in Physics Research A 398 (1997) 343–350

ELSEVIER

NUCLEAR INSTRUMENTS & METHODS IN PHYSICS RESEARCH Section A

Further investigations on CR-39 fast neutron personal dosemeter

S. Djeffal[a,*], Z. Lounis[a], M. Allab[b], M. Izerrouken[b]

[a]*Laboratoire de Dosimétrie, Centre de Radioprotection et de Sûreté 2, Bd. Frantz Fanon, BP 399, Alger, Algérie*
[b]*Institut de Physique, Université des Sciences et de la Technologie. BP 32, Bab Ezzouar Alger, Algérie*

Received 18 June 1996; received in revised form 1 April 1997

Abstract

A fast neutron personal dosemeter based on CR-39 nuclear track detectors has been developed in as simple a form as possible to be used in routine monitoring. It has been investigated during the last joint irradiation exposures to neutrons organised by EURADOS–CENDOS committee on the application of track detectors in neutron dosimetry.

The energy response and the angle dependence of two types of CR-39 material, produced by Pershore Mouldings Ltd (as standard grade material) and American Acrylics (as dosimetry grade material), have been studied using neutron energies ranging from 144 keV up to 66 MeV and the ^{252}Cf neutron spectrum at different angles of incidence, i.e. 0°, 30°, 60° and 85°. Irradiated detectors have been processed using a conventional chemical etching (CE) and a two-step electrochemical etching at low (200 Hz) and high (2 kHz) frequencies (ECE). Under the ECE etching conditions a 80 μSv minimum dose equivalent value is achieved. The response of these detectors to the ambient dose equivalent in the range 0.4–13 mSv has also been studied for monoenergetic neutron beams of 1.2, 5.3 and 15.1 MeV. The dosimetric characteristics of the proposed dosemeter have been much improved by using the ECE conditions. The variations and values of these characteristics approach the required ones in a better way than that given till now in previous works.

Keywords: Personal neutron dosemeter; CR-39 nuclear track detector; High-energy neutrons; Energy and angle dependence of response; Ambient dose equivalent response

1. Introduction

For several years, the "Centre de Radioprotection et de Sûreté" in Algiers has undertaken intensive studies to improve the CR-39 fast neutron personal dosemeter in order to find the basis for a routine use and to provide individual monitoring service to cover neutron irradiated workers in Algeria.

With the ICRP and ICRU changes in radiation protection concepts during this last decade [1–4], the neutron dosemeters used in individual monitoring are now, more than ever, far from ideal. Research is still in progress in most of the dosimetry laboratories to develop a personal neutron dosemeter with a low detection threshold and a response independent of energy. This response, expressed in terms of directional dose equivalent, should also be independent of angle of incidence of neutrons.

Among neutron detectors used today, poly allyl diglycol carbonate has been considered as one of the most promising detectors for this purpose since its introduction in 1978 [5]. The main advantage of these track etch detectors for neutron monitoring is their insensitivity to photon irradiation and their capability of detecting low LET charged particles such as protons. Fast neutrons are thus mainly detected via recoil protons generated in the CR-39 material itself or in a converter material with high hydrogen content. The energy range of detected neutrons depends on the characteristics of various types of CR-39 track material used, the type and thickness of the converter in front of the etch layer, and the etching and track counting procedures.

The dosimetric characteristics of CR-39 track detectors have been studied extensively in the past decade [6–8]. Since 1984, different joint irradiation exposures to monoenergetic neutrons have been organised by EURADOS–CENDOS committee on the application of track detectors in neutron dosimetry. The major scope in all these joint irradiation exercises was to study the consistency of both the response and the background of CR-39 detectors [9–11]. It was only during the 1992

* Corresponding author. Tel.: +213 2 64 77 62; fax: +213 2 64 82 42; e-mail: crsnet@ist.cersit.dz

PII S0168-9002(97)00786-9