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Track etch and thermo luminescent detectors response to high energy charged particles

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Abstract

Charged particles can be registered in a track etch detector (TED) when the linear energy transfer (LET) of a particle is higher than a threshold. Relative response of thermo luminescent detectors (TLDs) generally decreases with increasing LET of radiation depositing in them energy. The exposure of both these detectors in high energy charged particle beams permits to improve knowledge concerning the possibility of theirs use.

Two types of poly allyldiglycolcarbonate (PADC) TED and two different TLDs have been exposed since several past years to high energy charged particles with energies up to 1 GeV/amu, and LET up to 600 keV/μm in water. Some unknown ("blind") exposures were also realised.

Basic results like LET spectra, relative response of TLDs as the function of LET, etc., are presented. Particular attention is devoted to the results of evaluation of both detectors after blind exposures, theirs analysis and discussion.

Keywords: Track etch detectors; Thermoluminescent detectors; Chemical etching; Linear energy transfer (LET); LET spectrometry; Registration threshold

1. Introduction

Track etch detector (TED) as well as thermoluminescent detector (TLD) can be used to solve many specific tasks related to the detection and dosimetry of ionizing radiation. The exposure of them to high energy charged particles permits to accumulate further data on their characteristics, and, consequently, to improve knowledge of their properties and to estimate the possibilities of their application.

The contribution deals with the evaluation of some TED and TLD exposed to high energy charged particles in beams available at several accelerators.

Some of the results for both detectors type evaluation are presented, analyzed, and discussed; particular attention is devoted to the comparison of both data obtained for common blind exposures using several types of radiation.

2. Methods

2.1. Irradiations

TED and TLD have been exposed since several past years to high-energy charged particles from ^{1}H up to ^{89}Kr, with energies up to 1 GeV/amu, and linear energy transfer (LET) up to 600 keV/μm in tissue (Jadrníčková and Spurný, 2006). These beams have been available at: HIMAC accelerator in NIRS, Chiba, Japan, nuclotron accelerator in Joint Institute of Nuclear Research (JINR), Dubna, Russia (http://www.jinr.ru/facil/), at Brookhaven National Laboratory, and in proton beams at Loma Linda University Medical Centre (LLUMC). With the exception of Dubna nuclotron, all other exposures were performed in the frame of ICCHIBAN program (Uchihori and Benton, 2004). The monitoring has been in all cases assured by local staff.

2.2. Detectors used, their treatment

2.2.1. Track etch detectors

Poly allyldiglycolcarbonate (PADC) TEDs delivered by two manufacturers have been used as LET spectrometers: one is

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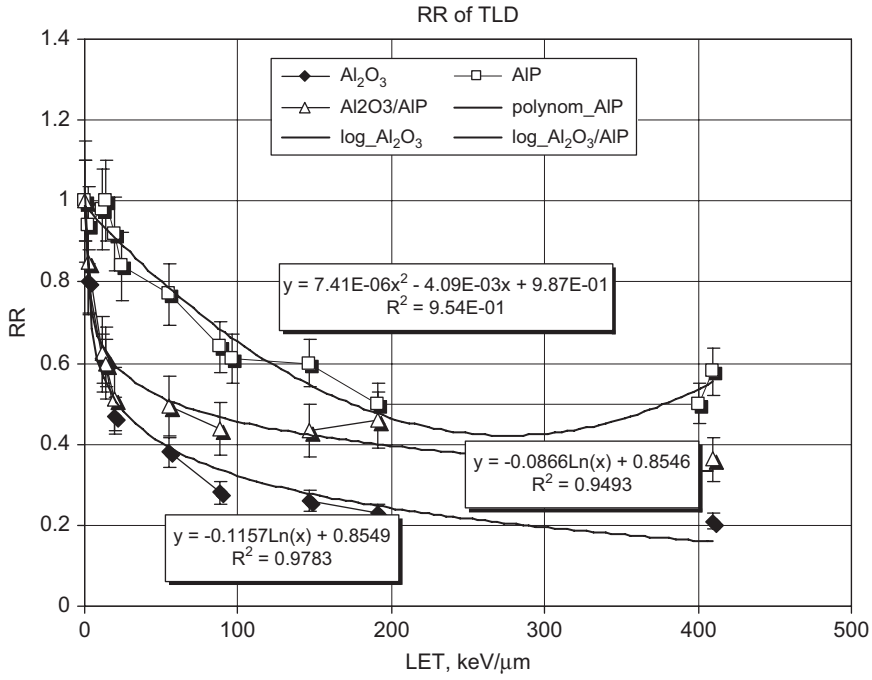

Fig. 1. LET dependences of TLDs RR and their regression functions.

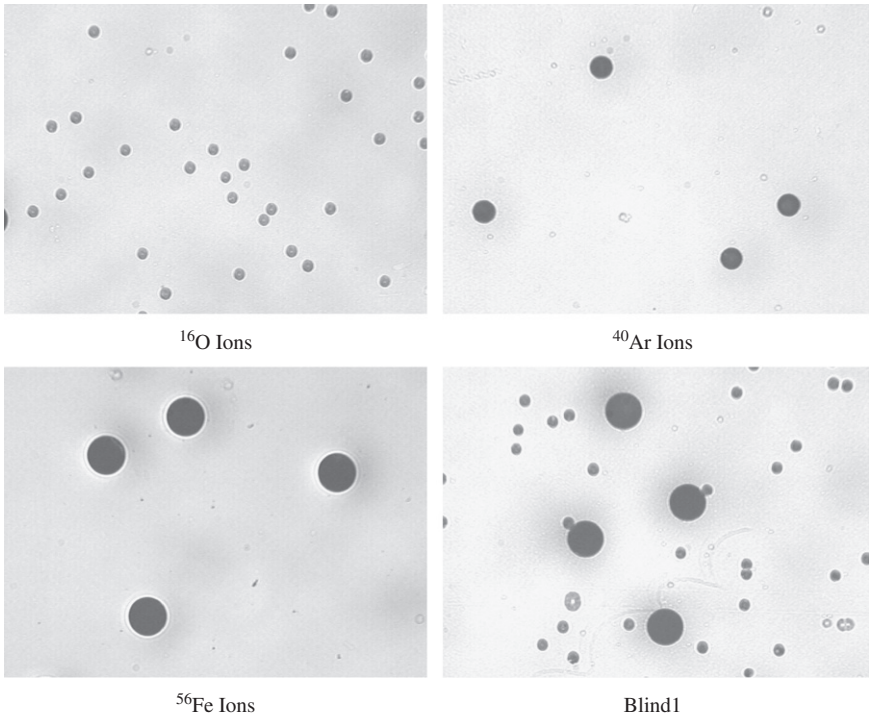

Fig. 2. Pictures of tracks etched in Page PADC-LET spectrometer and some of exposures.

Page (Pershore, Worcs, UK) in thickness of 0.5 mm, the other is Tastrak (Bristol, UK) in thickness of 0.5 and/or 1 mm. LET spectrometry method was developed in our laboratory (Spurný et al., 1996). Detector's samples are etched chemically, in 5 N NaOH at 70 °C for 18 h, it corresponds to the one-side removal layer of about 17 µm thick. To determine the LET value of a particle, the etching rate ratio $V = v_T/v_B$ (v_B is a bulk etching rate, and v_T is an inside track etch rate) was determined through the measurements of track parameters by means of an automatic optical image analyzer LUCIA G. V-spectra obtained were corrected for the critical detection angle and transformed to LET spectra using calibration curves based on the irradiation