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Diffused transmission of laser beam and image processing tools for alpha-particle track-etch dosimetry in PM-355 SSNTDs

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Abstract

The present study introduces an optical as well as image processing method that is effective in the study of PM-355 solid state nuclear track detector (SSNTDs) irradiated with α-particles at different times. Laser light with Gaussian extent and 635 nm wavelength is used to accomplish this goal. An imaging processing technique is utilized for the study of the nature and characteristics of a transmitted laser beam through PM-355 SSNTDs. Semi-empirical formulas are obtained which can be used as guide lines to calculate unknown dose. The present method is effective and simple and demands no sophisticated tool methods.

Keywords: laser light, Image processing, etching time, radiation dosimetry, PM-355 SSNTDs

(Some figures may appear in colour only in the online journal)

1. Introduction

Solid state nuclear track detectors (SSNTDs) of different materials are important for investigations in basic science and technology [1]. The solid state nuclear track detection (SSNTD) technique is now a well-established tool for the detection of charged particles [2]. Among such applications, SSNTDs are widely used in radiation protection and environmental radiation monitoring. Quick and accurate evaluation of track densities has prompted many attempts to construct counting systems while visual counting, or using sophisticated images analysis systems, ensures accurate determination of the number of tracks [3, 4]; other techniques are used for inexpensive and fast assessment of track density.

Since 1994 another new line has been initiated based on the measurements of optical density of a coherent laser beam [5] through the etched SSNTDs. This technique was achieved using laser light ranged from UV to IR [6–11]. A further step was accomplished by introducing the concept of scattering based on a study of tracks of coherent light from the etched detector [12].

In this article, the diffuse transmission of visible laser light from diode laser of 635 nm wavelength was study through etched PM-355 detectors (at 0° angle) irradiated with α-particles. The results obtained can be used in the determination of unknown radiation doses.

2. Instrumentation

2.1. Laser system and the experimental details

In the experimental setup (figure 1), a beam of Gaussian TEM_{00} distribution from a diode laser (SDL-635 nm-15 T) of 15 mWatt power output illuminated the PM-355 samples on its front face perpendicularly, followed by a beam splitter to send part of the incident laser beam flux to the reference detector. The beam entered and then passed through the detector. The radius of the laser beam at the sample was 1 mm. A PM-355 sample was placed between the laser output mirror and a 50 mm glass positive lens. A photodiode of an effective and sensitive area of 12.5 mm^2 was used to measure the diffused transmitted beam. The photodiode was positioned 5 cm from the glass positive lens. Both input and output signals were recorded using two digital voltmeters.

The measurements of transmission (T) at normal incidence were repeated for five samples at the laser wavelength.

