Advantage of Solid-State Nuclear Track Detection (SSNTD)Technique

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Abstract

Experimental studied the range and energy loss of energetic heavy ions in different media requires heavy ions sources and uniform target for sensitivedetector systems. A large variety of heavy ions sources and detectors have been employed in many experimental techniques for long range and energy-loss measurements, it is appropriate to present a brief review on heavy ion sources and detectors generally used for measurement along with the available experimental data. The track detector method is extremely is simple and does not require any high budget equipment. The accuracy of measurement by track detector method is comparable to other method. In present review article, we have analyzed and counted on advantage of solid-state nuclear track detection ISSNTD) techniques over other detection technique.

Key words: SSNTD, Heavy ion**,** γ-ray spectroscopy, NaOH, Chemical Etching

1 Introduction

1.1 Heavy ion interaction

To understand nature has been the ultimate goal of the mankind in all the ages. Various group of scientists are working throughout the world to explore the hidden mysteries of the nature. One of the branches, in an attempt to understand such mysteries is 'Heavy Ion Physics'. Heavy nuclei consisting of quite number of nucleons, when subjected to energetic collision, nuclear matter assume the conditions which probably prevail at the time of supernova [1-3].

Heavy ion interactions are studied either with on-line experiments performed in the experimental halls of the accelerators or with off line techniques. On-line experiments require high efficiency electronics counter assisted with high speed computers and supervised by highly professional scientists. Although scientific findings made with such expensive systems are regarded as most informative and complete nevertheless, it is model dependent and detection is restricted to a narrow cone where the detectors are employed. The so-called off-line experiments can be divided into two groups; (i) heavy ion interaction with γ-ray spectroscopy and (ii) heavy ion interaction with solid state nuclear track detection (SSNTD) technique [4,5].

The γ-ray technique however is good for laboratories situated near the accelerators.

1.2 SSNTD Technique

The solid-state nuclear track detection is simple, inexpensive compared to both the techniques. The interactions will be registered as the tracks in SSNTD and it in return give the information about the charge/mass and velocity/energy of the fragments responsible for the creation of such tracks [6,7].On account of the above advantage of the SSNTD technique, it has been employed to study the behavior of the heavy ion interactions with the detectors.The material which contains latent tracks will be more intense along the latent tracks if exposed to any chemically aggressive solution.Aqueous solutions NaOH or KOH are the most consistently used as a chemical solution.During the experiments, the chemical solution etches the surface of the detector material, but this process occurs with faster rate in the damaged region. In this way, a ‘track’ of the particle is generated, which may be observed under an optical microscope. The technique based on the application of solid-statenuclear track detector has greatly expanded in range, scope and depth since its discovery in 1958 by Young [8]. In 1959, a rediscovery of Young’s work was done by Silk and Barnes [9] by irradiating mica with fission fragments. In 1960,Fleischer et al. [7] have reported the pioneered the extensive development of the method by transforming the radiation damage trails into permanent tracks. Later, many other reseachersdeveloped such tracks in thin films of different insulating materials.

The track technique is based on the principle that an energetic charged particle passing through an insulating media creates submicroscopic damage trails in solid dielectrics. Positively charged particles passing through the electrical insulator knock out the orbital electron of the atoms in and around their trajectory.It creates a positive ion that repels one another while forming a small cylindrical zone under high strain with a diameter of 3-10 nm.The charged particles break the long molecular chains by ionization and excitation along its trajectory in organic polymeric materials. The damage regions form the latent tracks which can be developed and fixed by suitable chemical etching technique. These permanent ‘tracks’ after etching can be observed under an optical microscope.

Nuclear track technology has been successfully employed in various fields such as fusion-fission, particle evaporation, nuclear reaction, detection and identification of the synthesized element 104 (Rutherfordium). Fission track dating has been successfully applied to dating of geological, archeological and cosmological samples. In the field of medicine, It has been used in the scanning of cancer cells from normal blood cells and in medical diagnosis.It has also been applied for uranium exploration, earthquake prediction, range and stopping power measurements and has found application in many more fields [6,10,11]. Taking SSNTD as a tool range and stopping power of incident heavy ion can also be find out [12]. We in our work [13,14] used the SSNTD tool to calculate the range and stopping power, also we successfully modified the existing theory of Saxena et al. (1989) where instead of assembly of detectors only a single detector was used to for range and stopping power calculations.

1.3 Advantage of SSNTDs technique over other detection technique

Some salient features of SSNTDs over other detection techniques are used:

- Simple in construction and used in easy way

- Not sensitive to ordinary light.
- Do not need much instrumentation and huge budget
- Can store information for a long time under various extreme environmental conditions of temperature, humidity, mechanical vibration, and pressure etc.
- The presence of heavy ions can easily be detected and distinguished from the light ones.
- Have very high efficiency due to the direct contact with radiation source.
- Have considerable amount of geometric flexibility and are therefore, particularly useful in angular distribution measurement
- Easily portable.

Although the SSNTDs technique has above prominent features and is being widely used in many fields of science and technology, yet it has some shortcomings like human error in scanning, counting and measuring tracks, etc which decreases the accuracy of results. The problem has been overcome to certain extent by computerized analysis of the system [15].

Conclusions

In this review article, we have conclude the overview of solid-state nuclear track detector and found these detector materials are solid substance and recorded the electrical signals of charged particles.It refers to etch the dielectric materials track detectors and this etching technique developed for many application points of view.Therefore, we can say that the concept of solid-state detector is a very useful to detector efficiency of charged particles.

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