

**THE EFFECT OF RADIATION ON SOME PHYSICAL PROPERTIES FOR CN-85
NUCLEAR TRACK DETECTOR**

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Abstract

In this research, some properties of the nuclear tracks detectors were studied, samples of CN-85 were irradiated with an alpha particle that emitted from americium (Am241) for (3, 5, 10) minutes then etched by using chemical sodium hydroxide (NaOH), the effect of radiation on the thickness of the detectors (CN-85) and on the diameters of the tracks were described in addition to the physical properties in terms of the color of the detector and its transparency for detector, then a comparison study was conducted between the tracts for each the time of irradiation duration for samples of detectors then it was proved The nuclear track detector CN-85, lost its chemical properties when scraped at a temperature of 60°C for half an hour. The radii of the tracks produced by the irradiation were measure foe samples of CN-85 detectors, and it was found that the diameter of the trace increases with the increase of the etching time and the duration of the irradiation. It was also found that the thickness of the detector does not change with the change of the irradiation duration, but it does change with the change of the etching time.

Introduction

Solid-state nuclear track detectors, (SSNTDs), are widely used for the detection and dosimetry of several types of ionizing radiations. As such, a detailed knowledge of the physical doses such as bulk etching rate, track-etching efficiency and detector sensitivity is crucially important due to their direct relevance for the error-free detection performance. The present study brings in an easy-going experiment to test the variation of these parameters with incident alpha particle energy. The analysis indicates that the sensitivity of detector and its corresponding alpha-track size increases exponentially with an increase in the particle energy, which may represent additional evidence in favor of the use of SSNTDs as up to distinguish between low- and high-low-alpha-particle emitting radionuclides. It is well known that SSNTDs exhibit several desired properties such as high ion sensitivity over wide energy ranges, ability to record high particle fluencies without saturation and chemical/mechanical stability under vacuum conditions with nearly complete insensitivity towards photons and electrons, leading to its efficacy in precise radiation dosimeter [1]. The penetration of charged particles into the nuclear trace detectors, including the CN-85 detector, leads to any schizoprenia, long polymeric chains, which leads to the generation of free radicals at the impact of the falling particle, as the particles affect Determining the optimal skimming conditions for the nuclear trace detector. The presence of Oxygen with carbon atoms is a helping factor in breaking the bond, and this is repeated in every building in the structure. The polymer also plays an important role in decomposition and starting new decompositions, which reduces thermal stability. The polymer has thermal stability (as the free radicals formed enter into

transformations that lead to changes in Physical and chemical in the polymer It produces a polymer with broken short chains leading to a decrease in the molecular weight For the polymer, the entry of free radicals in certain reactions may lead to crosslinking of the polymer [2]. Among the different track revelation methods, chemical etching (CE) technique is still the most widely used in both nuclear track detection laboratories because of its controlled operating conditions such as etchant concentration, temperature, and exposure time [3]. The main aim of this work is to analyze the effect of ionizing radiation not only on optical coloration but also on thickness change in solid state nuclear track detectors, for a better interpretation of their physic-chemical response mechanism under irradiation. The present study brings in an easy-going experiment to test the variation of these parameters with incident alpha particle energy. The analysis indicates that the sensitivity of detector and its corresponding alpha-track size increases exponentially with an increase in the particle energy, which may represent additional evidence in favor of the use of SSNTDs as up to distinguish between low- and high-low-alpha-particle emitting radionuclides. It is well known that SSNTDs exhibit several desired properties such as high ion sensitivity over wide energy ranges, ability to record high particle fluencies without saturation and chemical/mechanical stability under vacuum conditions with nearly complete insensitivity towards photons and electrons, leading to its efficacy in precise radiation dosimeter [1].

The detector CN-85

Organic reagents, especially polymeric materials are macromolecules with repeating units which can be referred to as monomers. In synthetic polymers, the monomer units are joined together by covalent chemical bonds, usually carbon–hydrogen (C–H) linkages. Organic polymers generally are composed of carbon, hydrogen, oxygen, and nitrogen with possibly sulfur or halogens as other components. The chemical bonding between said atoms is relatively weak once exposed to ionization radiation, and thus these materials are suitable for application as radiation detectors. of which cellulose-based polymers, such as cellulose nitrate (CN-85), cellulose acetate (CA-80-15) and LR 115, are most commonly used because of their molecular makeup relevant to the radiation sensitivity. The CN-85 detector Material/Method The cellulose nitrate (CN-85) detector has the empirical formula $C_6H_8O_9N_2$ which is a nitrogen-containing material, of which the nitrogen component increases active ability for energetic charged particles. This detector also performs very well in the detection of fission fragments, heavy charged particles and α -particles. Therefore it is attractive to use it in neutron and radon detection studies [4–6]. Furthermore, cellulose-based detectors are often coated with thin layers of silicon nitride (Si_3N_4) to improve durability and optical properties; Si_3N_4 is a high-dielectric material commonly employed in microelectronics and as an antireflective coating in photovoltaic cells, further expanding the functional versatility of these polymeric detector systems.

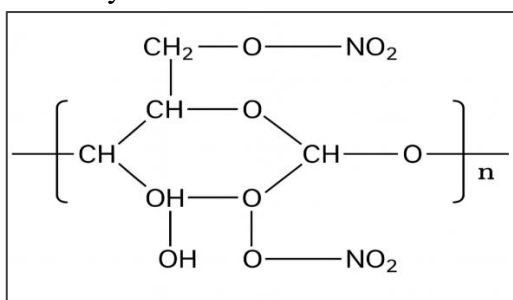


Figure 1. Chemical form of CN-85

Mechanism of formation of traces in polymers

Polymers, which are large molecules consisting of repeating units linked together, are called polymers. The monomer and these monomers are linked together in most plastics by a covalent bond that is dominated by a bond Hydrogen-carbon (C-H), and this bond is easy to break when exposed to radiation, resulting in polymeric chains. Small, ionized active ends called free radicals, which have the ability to interact with each other or with atoms other. Therefore, the main effect of radiation on polymers is their degradation, or the entanglement of their molecules with each other. Some, and these two effects represent the main changes in the properties of the polymer. The fall of radiation on these polymers It leads to irritation and ionization of these molecules, [7] and thus breaks bonds, causing damage between them, and (damage) in a substance. the polymer does not disappear under normal conditions, and this stored effect is known as the track latent effect. Areas damaged by ionizing radiation show a greater ability to interact with alkaline solutions such as hydroxide Sodium NaOH compared to the healthy regions, because the damaged regions have more energy than the regions quickly, causing sound effects, so the chemical solution penetrates the radioactive areas, its depth increases and its diameter expands with Increasing the scraping time, and the latent effect (stock) of ionizing radiation can be seen after showing it under a light microscope.

Polymeric materials have been widely used in solid-state nuclear track detectors due to its flexibility as well as sensitivity to charged particle. One of these, the polymer polyallyl diglycol carbonate (CR-39), is considered as one of the best for probing alpha particles. Its specific physicochemical features allow high resolution track recording, making such material an attractive one for several different utilization fields, including medical dosimetry, hydrogeological dating and tracing practices, solid state physics researches or in situ monitoring of radon concentration in soil [1,8,9]. Latent track formation in PADC: from one to two mechanisms The basic mechanism for latent track creation within PADC, despite its ubiquity, is still a matter of controversy. Several theoretical models have been suggested from accounts that concern complete or partial energy dissipation of incoming particles to explanations in terms of localized elastic stress generated due to ionization processes. Yet none of these models fully account for all observed experimental effects. A significant restraint in previous reports was the lack of involvement of polymer scientists that is reflected by an appreciation of the inherent macromolecular nature of PADC. Indeed, these features on the molecular scale are precisely those that are thought to underpin its excellent performance as a particle detector when compared to other solid-state and gaseous detection materials [10].

Alpha particle

Alpha particle or alpha rays, although they are called rays, are the nucleus of a helium atom and consist of two protons and two neutrons, united inside the nucleus with great nuclear force, so that it is considered the most stable and coherent intention of the elements. This is because it consists of 2 protons and 2 neutrons, and these four are characterized by the largest loss in mass when they merge to form a helium nucleus.. An alpha particle is usually represented by the symbol α , which is the Greek letter alpha for which the particle is named. It was the first type of nuclear radiation to be discovered, before beta particles and gamma rays. Discovered and named (1899) by Ernest's ford, alpha particles were used by him and coworkers in experiments to probe the structure of atoms in thin metallic foils.

Characteristics of nuclear track detectors

1. The material is readily available and can be procured with ease.
2. It features a compact design that eliminates the need for complex electronic systems or external power sources at the detection site.
3. It possesses excellent stability, allowing recorded tracks to be preserved for extended periods—spanning several years—under appropriate storage conditions (ambient temperature). However, elevated temperatures tend to degrade the tracks and reduce their count.
4. The visualization of charged-particle tracks is straightforward through chemical etching processes, wherein suitable reagents selectively remove surface layers without dissolving the detector material itself.
5. The technique provides high measurement accuracy and facilitates convenient data interpretation, making it particularly suitable for radiation dosimeter. Compared with conventional detection systems such as cloud, bubble, and spark chambers, etched-track detectors offer a remarkably simple, reliable, and cost-effective alternative.

Practical part

Samples from detectors were irradiated with alpha rays, where the americium source was used as a radiation source for irradiation times of (5, 8, 10) seconds, and those who are placed inside the water bath containing water at a temperature of 60 degrees Celsius, The etching process is done using the scraping solution, where 5M sodium hydroxide solutions are placed, which are dissolved in 20 ml of water, and the scraping solution is placed in a glass beaker As the hot water inside the bathroom will increase the speed of scraping the reagents, as the scraping process continues for 30 minutes, after which it is taken out and the specimens are washed using purified water. The reagents were dried with thin paper.

The results

The alpha-particle tracks produced in the CN-85 etched detectors were observed under an optical microscope (Model N-200M) with 100x objective lens. The microscope was connected to a computer via a digital camera replacing the ocular and linked to a laptop for high resolution image capturing and analysis. The best etching time was checked from three exposure times: 5 s, 8 s and 10 s. For every irradiation situation the track diameters with the corresponding sample thicknesses were accurately measured. These measurements led to experimental observations and quantitative data that are presented in Table (1).

Table 1. The experimental results.

T (SEC)	R (μm)	X (μm)
5	4	100
8	7.5	98
10	9	75

From the table (1), note the direct proportionality between the irradiation duration (T) and the radius, (R) and thickness (x) thus the radius of the nuclear effect increases with the increase in the period during

which the detector is known for radiation. But the detector thickness decrease with increasing for irradiation duration The illustrative relationship that confirms direct proportionality

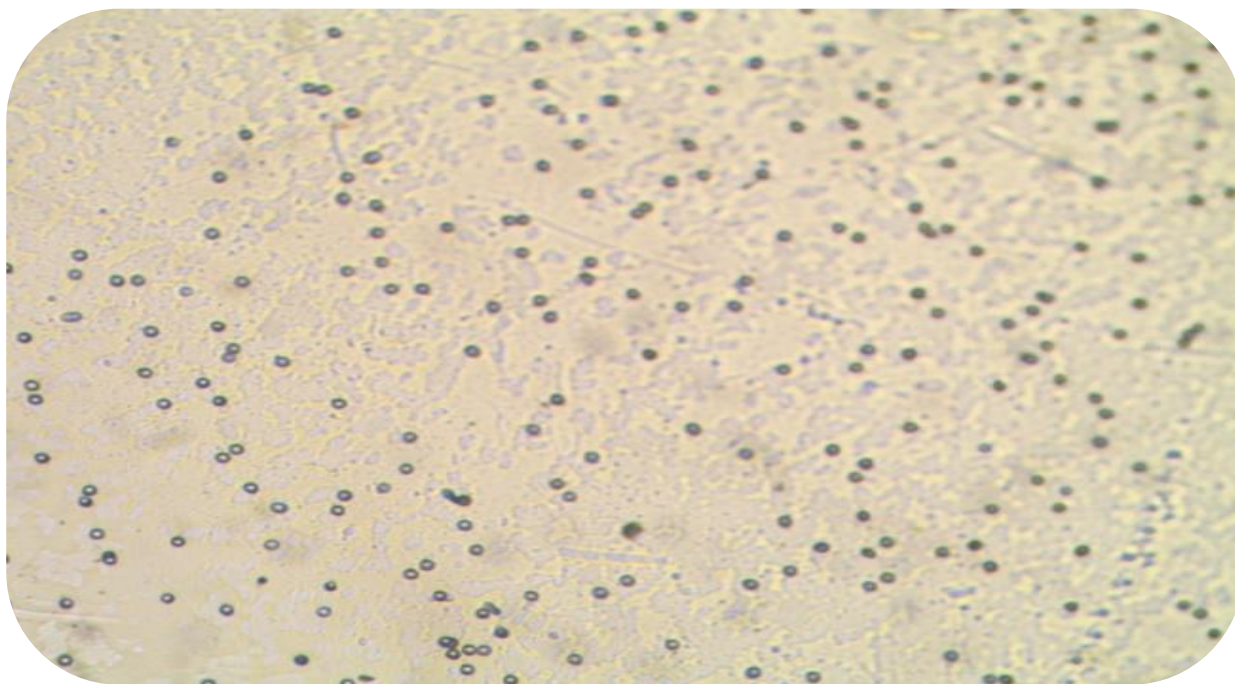


Figure 1: The Tracks at time of radiation 5min

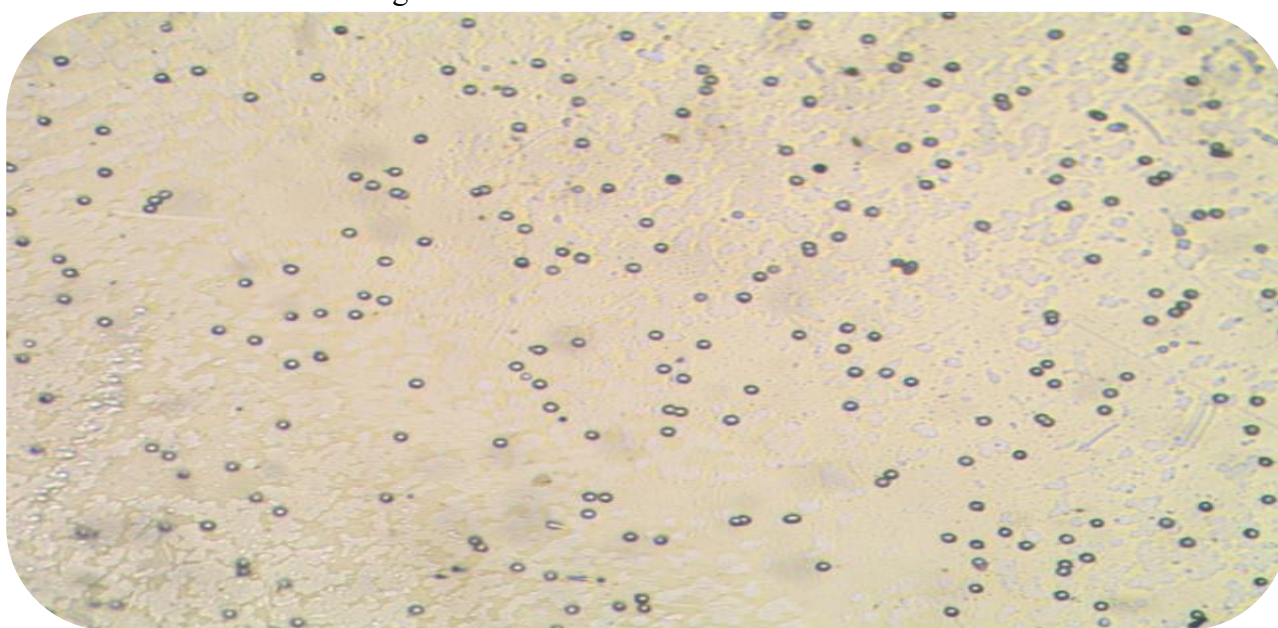


Figure 2: The Tracks at time of radiation 7 min

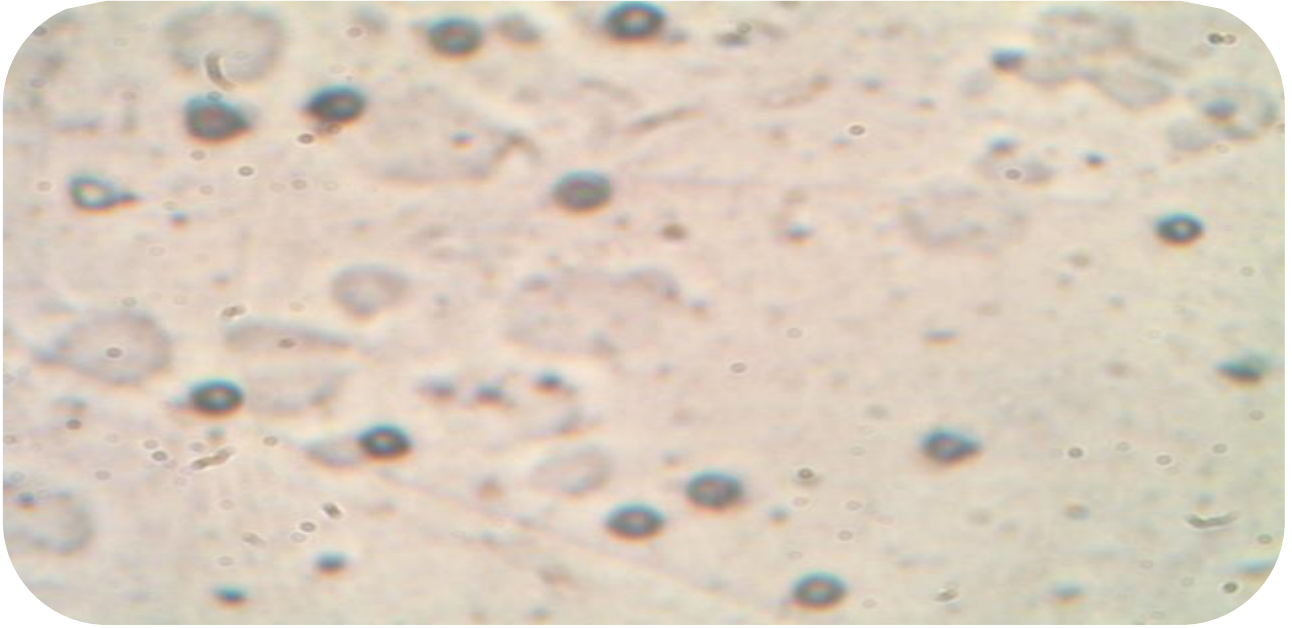


Figure 3: The Tracks at time of radiation 10 min.

تأثير الإشعاع على بعض الخواص الفيزيائية لكاشف المسار النووي CN-85

الخلاصة

في هذا البحث تمت دراسة بعض الخصائص الفيزيائية لكواشف الاثر النووية, تم تشييع عينات من كاشف الاثر النووي CN-85 بجسيمات الفا المنبعثة من مصدر الاميرشيوم Am^{241} لفترات زمنية مختلفة (3 و 5 و 8) دقيقة ثم بعد ذلك يتم قشطها باستخدام هيدروكسيد الصوديوم النقي NaOH ومن ثم دراسة تأثير الإشعاع على سمك الكاشف النووي وتأثير الإشعاع على اقطار المسارات الناتجة عن التشييع بالإضافة الى بعض الخصائص الفيزيائية المتمثلة ب سمك الكاشف النووي و لونه وشفافيته . كما تمت دراسة مقارنة للمسارات الإشعاعية وانصاف اقطارها لكل فترة تشييع , وجد ان كاشف الاثر النووي يفقد خواصه الكيميائية بعد قشطة لمدة نصف ساعة عند درجة حرارة 60 درجة سيليزية . لوحظ ان قطر الاثر يزداد مع زيادة زمن القشط ومدة التشييع كما لوحظ ان سمك الكاشف لا يتغير مع تغير مدة التشييع لكنه يتغير من تغير فترة الزمنية للقشط

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