

Use of Nuclear Track Detectors (NTDs) as inexpensive particle detectors for educational purpose

R. Bhattacharyya¹, S. Dey¹, Sanjay K. Ghosh^{1,2},
A. Maulik^{1,*}, S. Raha^{1,2}, and Y.P. Viyogi³

¹Centre for Astroparticle Physics and Space Science, Bose Institute, Kolkata 700 091, India

²Department of Physics, Bose Institute, Kolkata 700 009, India and

³EHEP@A Group, VECC, Kolkata 700 064, India

1. Introduction

Nuclear Track Detectors (NTDs) have been used for many decades as heavy ion detectors in fields varying from Nuclear Physics to Biology to Geology [1, 2]. The main advantages of NTDs are their relatively low cost, ease of handling and existence of thresholds of detection, which provides a natural and easy way to suppress the background (γ and β rays etc.) in many experiments. Since such detectors do not require power for their operation, they are also detectors of choice for setting up of detector arrays at remote locations as well as for balloon borne experiments [3, 4]. Also the etching facilities and microscopes required for scanning of NTDs can be setup at relatively low costs.

Advantages of NTDs, as listed above, mean that they can be an ideal choice when it comes to the setup of simple, inexpensive experiments at the undergraduate and even high school level. Such experiments can provide an opportunity to introduce interested students to the tools and techniques used in cutting edge research at a very early stage in their careers.

Currently, any experiment which gives students a taste of experimental work in Nuclear and Particle physics is virtually non-existent in undergraduate colleges and schools in India. Using NTD for detecting low energy α -particles, a typical Rutherford scattering experiment can be setup at much less cost compared to the use of silicon detectors and associ-

ated electronics and readout. The aim will be to demonstrate that one can observe scattered α -particles even at back angles. For ^{241}Am source and gold and aluminum targets, the energy of α -particles to be detected at 120° will be around 5.2 MeV and 3.6 MeV due to kinematical effects. We report here our first attempt at the detection of low energy α -particles in the above range.

2. Experiment

In this study, Lexan films of thickness $350\ \mu\text{m}$ were cut into pieces ($2\ \text{cm} \times 2\ \text{cm}$) and exposed to 5.48 MeV alpha particles from a ^{241}Am source at VECC, Kolkata. The samples were kept at a distance of 1 cm from the source and the exposure duration was 1 min. The energy of the alpha particles impinging normally on the Lexan film after traversing a distance of 1 cm in air is 4.5 MeV as obtained using the Monte Carlo code SRIM [5].

After exposure, the samples were etched for 2 h in 6.25 N NaOH solution at $70.0 \pm 2.0^\circ\text{C}$. Instead of the expensive, specialized constant temperature etching baths, a simple setup was deliberately used for this purpose as shown in Fig. 1. The solution was prepared in a beaker, the beaker was in-turn placed in a water filled saucepan and the entire arrangement was placed on a variable temperature induction heater from Tarson. This particular arrangement was found to be much better at maintaining the temperature of the etchant within a small range compared to just placing the beaker on the heater. A mercury thermometer was used to monitor the temperature of the solution inside the beaker and a magnetized stirrer was used to maintain the unifor-

*Electronic address: atanu.maulik@jcbose.ac.in

mity of temperature and concentration of the etchant and also to remove the etched material from the etch pits. The exposed samples were placed in small net bags and then they were dipped in the solution with weights attached to the bags to ensure that the samples were fully submerged in the solution.



FIG. 1: The setup used for etching.

3. Results and discussions

After etching, the samples were observed under a Leica microscope and the alpha particle tracks were clearly visible. Fig. 2 shows the tracks (diameter $\sim 6 \mu\text{m}$ after 2 h etching) under $100\times$ magnification. The size of the tracks were large enough to be visible under simple microscopes of the type found in most schools. A scale attached to eyepieces can also enable measurement of track dimensions.

That such a simple setup can perform the job of etching and reveal alpha particle tracks on Lexan is very encouraging. Further optimization to detect lower energy α -particles is in progress. With NTDs, there is also the possibility of setting up of simple experiments like measurements of branching ratios of radioactive decay or cosmic ray studies.

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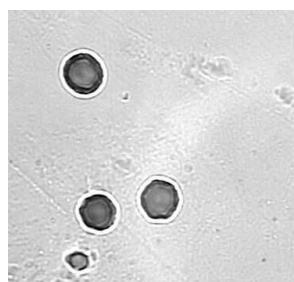


FIG. 2: Alpha tracks seen on Lexan at $100\times$ magnification after 2 h etching. Size of the image frame is $58 \mu\text{m} \times 54 \mu\text{m}$.

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