Characterization and calibration of SSNTD for studying rare events in cosmic rays

S.DEY [2], B.BASU[1,2], A.MAULIK[2], A.MAZUMDER[3], S.RAHA[1], S.K.SAHA[1,2] , S.SAHA[4], D. SYAM[5]
[1] *Department of Physics , Bose Institute, Kolkata ,India*
[2] *Centre for Astroparticle Physics and Space Science, Bose Institute, Kolkata, India*
[3] *GSI, Darmstadt, Germany*
[4] *Saha Institute of Nuclear Physics, Kolkata, India*
[5] *Presidency College, Kolkata, India*
swapan@bosemain.boseinst.ac.in

Abstract; Solid state nuclear track detectors (SSNTD) are useful for studying heavy ion abundance in cosmic rays. In our work we are using a particular brand over head projector transparencies, which have a very high z/β (z/β ≥150) detection threshold and so particularly suitable for rare cosmic ray events viz strangelet detection. The detector material is identified to be polyethylene terephthalate (PET).Asensitive charge response characteristic is a prerequisite for any detector. Previously we have studied the charge response of the PET detector with the exposure of light (^{16}O) and heavy (^{238}U) ions. In this paper we have added more data points on the charge response graph for ^{16}O ion, and ^{252}Cf fission source. We have constructed a calibration curve V_t/ V_g (charge response) vs dE/dx(specific energy loss).

Introduction:

Solid State Nuclear Track Detectors (SSNTD) are useful for studying heavy ion abundances in cosmic rays at high altitudes because of their light-weight and certain detection threshold values of z/β. Cr39 is a well-known and extensively used solid state detector having z/β ≥ 6. We have identified a Polyethylene Terephthelate (PET) detector, which have high z/β (z/β ≥150) detection threshold [1]. A sensitive charge response characteristic is a pre-requisite for any cosmic ray detector. We have reported earlier the charge response of that polymer detector to both light (^{16}O) and heavy (^{238}U) energetic ions from accelerator [2,3]. In this paper we have added more data points on the charge response graph for ^{16}O ion, and ^{252}Cf fission source. We have constructed a calibration curve V_t/ V_g (charge response) vs dE/dx. To improve the graph, we need more points and have proposal for S and Ni ion as exposure.

Experiment:

Pet detectors were exposed with ^{238}U-ion of energies 397 MeV, 672.7 MeV and 964.8 meV using 11.3 MeV/n ion beam at GSI, Darmstadt, Germany, ^{252}Cf fission source also used as exposure on several sheets of detector. Eight sets, each containing 22 pieces of polymers each of area 3.5x3.5 cm^2 were exposed to ^{16}O ions with eight different energies.

Detectors exposed to ions with above energies were etched in 6.25N NaOH solution at 55 +0.1° C for three hours in a constant temperature bath.

Etched plates were kept inside desiccators for a day or more to remove moisture. A reasonable area of each plate was scanned under the dry objective of magnification x100 of a Leica 500 DMR microscope for a good statistics of data. Track length (L_{obs}) and etch pit diameters, minor axis (D_b) and major axis (D_a) were measured. Bulk etch rate V_g is determined by thickness loss method after long time etching.

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Results and Discussion:

Charge response parameter which is known as reduced track etch rate (V_t/ V_g) were determined using the following formula

$$V_t / V_g = 1 + (L_{obs} / V_g\, t)$$

Where V_t = the track etch rate and, t = time of etching.

Specific energy loss (dE/dx) of ions in the detector material is determined using SRIM 2006 program. We have constructed the calibration curve (V_t/ V_g) vs dE/dx and is shown in fig 1. We need more data points in between ^{16}O ions and fission fragments also in between fission fragments and ^{238}U ions for a better calibration curve.

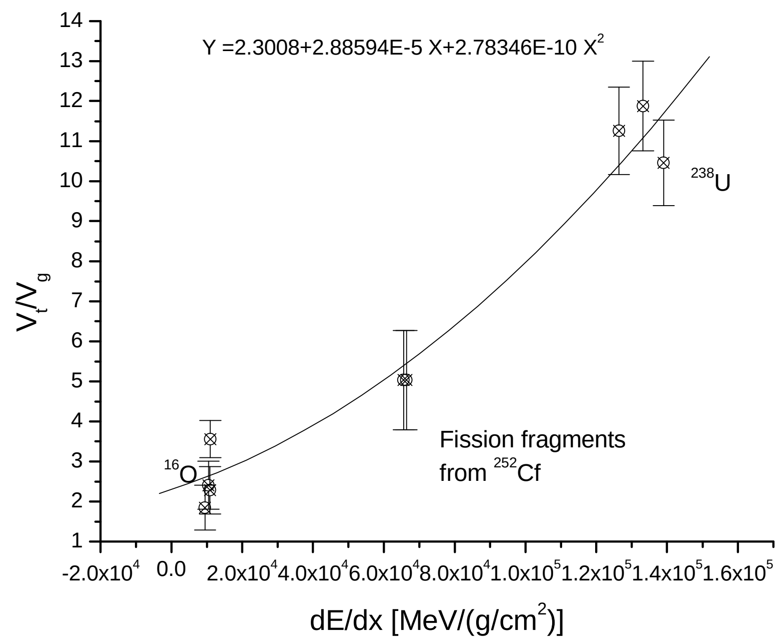

Fig.1. Calibration curve

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