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TRACK ETCHING STUDIES IN PHOSPHATE GLASS DETECTORS

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ABSTRACT

The etching characteristics of some phosphate glasses viz.LG-700,LG-750,LG-760 and G-1 have been studied.The track detectors used in the study were exposed at90° and 45° with ^{208}Pb (13.6 MeV/n), ^{238}U(15 and 5.9 MeV/n), ^{132}Xe(15 and 5.9 MeV/n) and ^{197}Au (11.4 MeV/n). The relative sensitivities of these glass detectors are presented here which finds its applications in identifying heavy ionizing particles.

KEYWORDS
Phosphate;heavy ion;energy; sensitivity.

INTRODUCTION

The heavy ionizing charged particles in passing through solids are mainly losing their energy by excitation and ionization processes which result in a more or less stable radiation damage(Chadderton,1965).The nature and stabilty of this radiation damage,also called latent track of the particle,depends on the data of the particle and on thephysical and chemical properties of the solid (Fleischer et al.,1975 and Haase et al.,1977).A number of problems in nuclear physics require adetector which can identify one type of heavy ionizing particle against a background of other particles of higher and lower ionizing rate (Price et al.,1987).The family of Solid State Track Detectors constitute mainly three types of insulating solids i.e.glasses, plastics and crystals.

The plastic track detectors have been found suitable for a high charge resolution study.However,they exhibit extensively variable track revelation characteristics depending on temperature,exposure to ultraviolet radiation and storatime,(Yadav,1983 and Garg et al.,1988).Whereas,glass detectors have some advantage over polymeric detectors.They are more stable under various environmental conditions and rather insensitive to lightly ionizing particles(Bhandari and Kumar,1974).Therefore,in some applications,phosphate glass track detectors of suitable composition are proving to be much better than polymeric detectors especially in heavy ion experiments(Drach et al.,1987 and Price et al.,1987).

EXPERIMENTAL PROCEDURE

The samples of laser phosphate glasses were exposed at UNILAC, Darmstadt(West Germany). The glass samples were subjected to chemical treatment with 12 % HF at a room temperature of 30°C for time intervals varying from 1 min. to 80 min. The samples were, then, washed thoroughly in running water.

The observed projected track lengths (l') and diameter (D) of nearly 50 tracks were counted in each glass detector and the respective mean was obtained. The actual track lengths were calculated from the mean of the observed projected length using a relation $l=l'/\cos\theta$ where θ is the angle of incident beam on the detector surface.

RESULTS AND DISCUSSION

The characteristic ability of a chemical reagent to reveal the track of an ionizing particle depends on three quantities viz.

(a) The general etching rate, V_G, which is defined as a linear rate of dissolution of the surface of solid and depends on the reagent and the temperature;
(b) The track etching rate, V_T, which depends on the ratio of Z, the atomic number of the ionizing particle, to $\beta = v/c$, its velocity in terms of speed of light, and
(c) The sensitivity of the detector, $s = V_T/V_G$, which gives the shape of the conical etch pit produced at the sites of entry and exit of the ionizing particle to and from the detector. The phosphate glass(G-1) show maximum sensitivity in comparison to other phosphate glass detectors.

Fig. 1 shows the etching behaviour of tracks of ^{238}U ions having energy 15 and 5.9 MeV/n in phosphate glass detectors. The distinctly observed curves show the energy dependence of heavy ions in phosphate glasses. In order to study the charge resolution, phosphate glasses irradiated with $_{92}U^{238}$ and $_{54}Xe^{132}$ ions of energy 15 MeV/n were used. The variation of track diameter with time of etching is shown in Fig.2. The observed curves are well resolved for a charge difference of 38. Thus, phosphate glass detectors are quite useful in charge resolution studies.

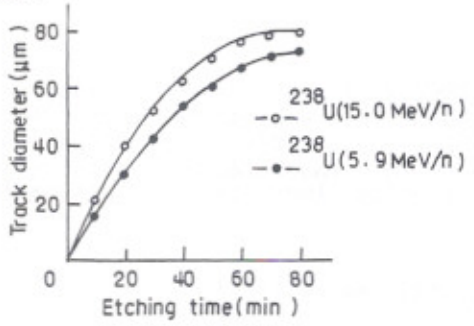

Fig. 1. Variation of track diameter with etching time for LG-700 glass irradiated with ^{238}U at 15 and 5.9 MeV/n

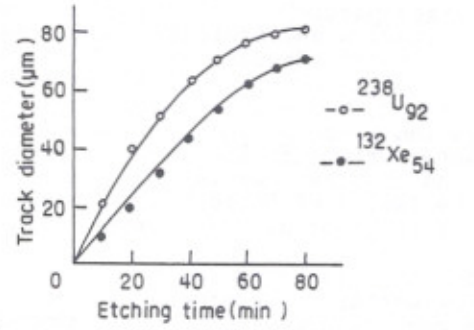

Fig. 2. Variation of track diameter with etching time for LG-700 glass irradiated with $^{238}U_{92}$ and $^{132}Xe_{54}$ at 15 MeV/n

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