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SHORT COMMUNICATION

A NEW TRACK ETCHANT FOR PLASTIC DETECTORS

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1. INTRODUCTION

THE MOST important landmark in the history of SSNTD is the discovery of chemical etching technique of track revelation. Plastic track detectors have been extensively studied in recent years, both with regard to their practical applications and as a tool for studies of basic physical phenomena (Fleischer *et al.*, 1975).

Cellulose nitrate (CN) and polycarbonate plastic (Lexan*) are in most general use, and aqueous solutions of NaOH and KOH are commonly employed as track etchants in all the laboratories engaged in SSNTD work (Fleischer and Price, 1963: Blanford *et al.*, 1970; Khan and Durrani, 1972; Fukui *et al.*, 1975). However, some modifications have been suggested, e.g. PEW solution (15 g KOH + 40 g C_2H_5OH + 45 g H_2O) and addition of $KMnO_4$ to etching solutions of NaOH and KOH (Somogyi *et al*, 1970; Somogyi and Gulyás, 1972).

It is common experience that hydroxides of alkali metals (group I) viz. Li, Na and K, are capable of etching nuclear tracks in plastics (Hildebrand and Benton, 1980). We tried metal hydroxides of group II and obtained encouraging results using $Ba(OH)_2 \cdot 8H_2O$ for Lexan.

2. EXPERIMENTAL PROCEDURE

Experiments were performed by irradiating Lexan plastic detector sheets with a Cf-252 fission fragment source (1 μ Ci) using 2 π geometry in air. Each sample was irradiated for 2 min to record a track density of ≈ 10^5 cm^{-2}.

Metal hydroxides of Ba, Mg and Ca were dissolved in distilled water. $Mg(OH)_2$ and $Ca(OH)_2$ have poor solubility in water, but $BA(OH)_2$ gave satisfactory results on heating the solution. The solution was titrated with oxalic acid, and the maximum strength attained was found to be 0.93 N. Solutions of 0.75, 0.53 and 0.28N were prepared by dissolving $Ba(OH)_2 \cdot 8H_2O$ at different temperatures. Irradiated Lexan plastic samples, 1 cm^2 each, were etched in $Ba(OH)_2 \cdot 8H_2O$ solutions of different strengths at 70°C for different intervals of time.

Using an Olympus binocular microscope (magnification, 675 *x*), projected length, diameter and density of the tracks were recorded in Lexan, corresponding to different etching intervals and etchant concentrations. The track-diameter method (Blanford *et al.*, 1970; Enge *et al.*, 1974; Dwivedi and Mukerji, 1979) was used to measure the bulk-etch rate, V_G, which is equal to half the rate of increase of the vertically-incident fission-track diameter. The track-etch rate, V_T, was determined from the projected track lengths corresponding to different etching intervals.

In order to check the efficiency of the new etchant, V_T and V_G were measured in Lexan using NaOH and KOH solutions of the same normality as that of $Ba(OH)_2 \cdot 8H_2O$.

3. RESULTS AND DISCUSSION

Figure 1 is the plot of fission-track density recorded in Lexan versus the etching time for different concentrations of the etchant $Ba(OH)_2 \cdot 8H_2O$. Figures 2 and 3 represent the variation of projected track length and track diameter with etching time and etchant concentration for Lexan. The projected track length, track diameter and track density are found to increase with the concentration of the etchant and etching time (Figs. 1 – 3). Figures 4 and 5 show the variation of projected track length and track diameter with

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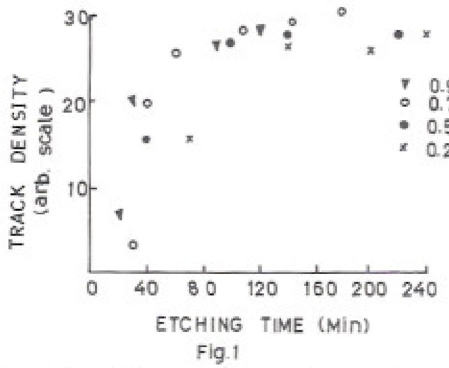

FIG. 1. Plots of fission track density *vs* etching time in Lexan at different concentrations of $Ba(OH)_2 \cdot 8H_2O$.

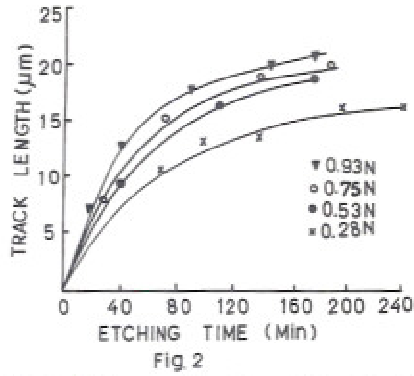

FIG. 2. Plots of fission track length *vs* etching time in Lexan at different concentrations of $Ba(OH)_2 \cdot 8H_2O$.

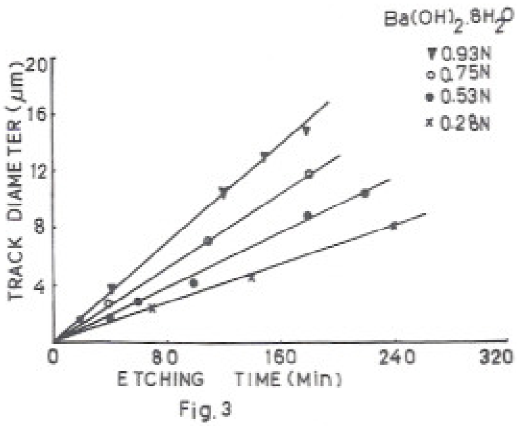

FIG. 3. Plots of fission track diameter *vs* etching time in Lexan at different concentrations of $Ba(OH)_2 \cdot 8H_2O$.

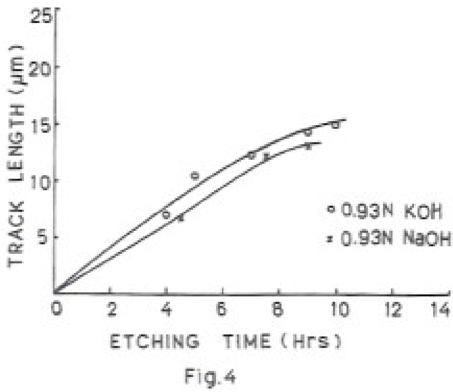

FIG. 4. Plots of fission track length *vs* etching time in Lexan at 0.93 N concentration of KOH and NaOH.

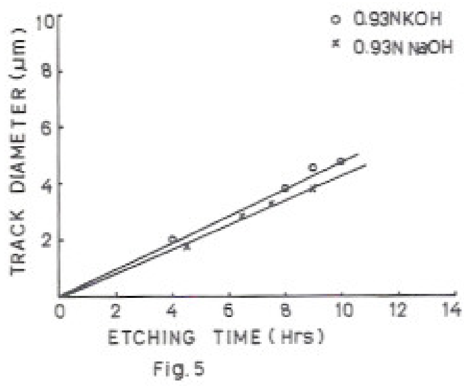

FIG. 5. Plots of fission track diameter *vs* etching time in Lexan at 0.93 N concentration of KOH and NaOH.

Table 1. Etching parameters of Lexan plastic, irradiated with fission fragments, for different etchants

Etchant	Temperature	Normality	V_T (μm/h)	V_G (μm/h)	V_T/V_G	*Efficiency* η* (%)
$Ba(OH)_2 \cdot 8H_2O$	70°C	0.93 N	35	2.6	13.5	92.6
		0.75 N	22	1.9	11.6	91.4
		0.53 N	14	1.4	10.0	90.0
		0.28 N	4.0	1.0	4.00	75.0
KOH	70°C	0.93 N	2.1	0.23	9.04	88.9
NaOH	70°C	0.93 N	1.5	0.21	6.95	85.6

*The efficiency is calculated as $\eta = 1 - V_G/V_T$ (Khan & Durrani, 1972).

etching time for Lexan using NaOH and KOH etchants of 0.93 N concentration.

Values of V_T, V_G, V_T/V_G and the efficiency η obtained for Lexan plastic, using $Ba(OH)_2 \cdot 8H_2O$, NaOH and KOH at different concentrations, are summarized in Table 1. From a comparison of the experimental data it is evident that for the same concentration of the etchant and under identical etching conditions, both the track-etch rate (V_T) and the bulk etch rate (V_G) are enhanced for $Ba(OH)_2 \cdot 8H_2O$ compared with the commonly-used etchants. This also indicates that the new etchant is more efficient compared with NaOH and KOH up to 0.93 N concentration. Studies to test its applications for various types of plastics are in progress.

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