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TRACK RECORDING BY SENSITIZATION IN PLASTICS

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Abstract :- This work reports the visualization of fission fragment tracks from Cf^{252} source in Triafol TN and Cellit T plastics by sensitization technique. The track registration efficiency of 100% has been observed in Triafol TN and Cellit—T for swelling time of 30 minutes and 5 hrs respectively at a temperature of 20°C. Sensitization time and temperature used for the two plastics are 1 hr at 70°C and 21 hrs at 20°C (room temperature).

1. INTRODUCTION

There are various conventional etching methods viz. thermal etching, chemical etching, electro-chemical etching and solution etching for revealing the charged particle tracks in solid state nuclear track detectors (Fleischer et al., 1975). Track visualization by grafting/sensitization method has been developed by Monnin et al. (1973) and Somogyi et al. (1979). We have made use of sensitization technique in our laboratory to test the efficiency of this elegant track revelation method.

2. THEORY

When the charged particle passes through the plastic detector, its interaction with the medium creates different chemical and physical defects such as metastable chemical species, free radicals, peroxide and hydroxide groups. These active species can initiate copolymerization with unsaturated (double bond bearing) organic molecules (monomer) which diffuse through the irradiated medium. The temperature is raised to provide the necessary activation energy to trigger the chain reaction. A new polymer is formed and grafted on the polymeric detector. Since the grafted chain extends sideways from the charged particle trajectory, it ensures the enlargement of the track (Somogyi et al; 1979). Grafted copolymer sheath around the charged particle can be revealed by using a dye which is selectively absorbed by the grafted copolymer and makes the track visible.

The charged particle can also be visualized using saturated organic molecules which prevent the subsequent polymerization. Saurated organic molecules diffuse through the bulk of the material and along the track (Ferde et al; 1981) and act as a sensitizing agent. The plastic detector is soaked in the sensitizing solution that can react with a suitable dye and fix it. The dye diffuses along the track and dyes the polymer as in textile dyeing. Track revealation by use of unsaturated acid at high temperature is called grafting and that with saturated acid at a convenient temperature is termed as sensitization.

3. EXPERIMENTAL PROCEDURE

The sensitization technique involves the various steps such as irradiation, swelling, sensitization and dyeing of the detector (Fig. 1)

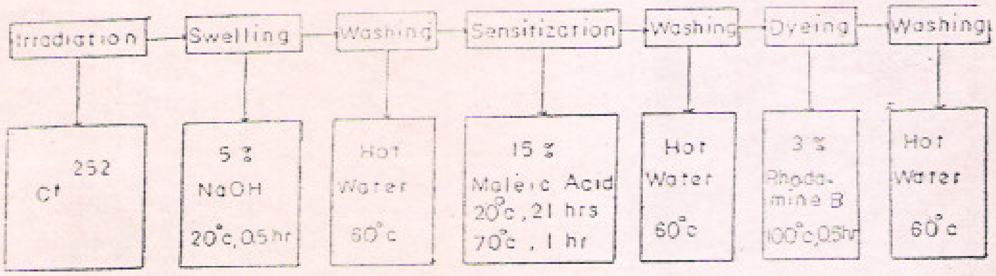

Fig. 1. Experimental parameters in sensitization technique.

3.1. Irradiation

The detector samples of Triafol TN and Cellit T each of 1 cm^2 area were irradiated with 1 μCi fission fragment source (Cf^{252}) in the 2π geometry.

3.2 Swelling

The irradiated samples were treated with 5% NaOH solution used as swelling agent at room temperature (20°C) for the period varying from 0.5 to 6 hrs. This basic solution etches out a tiny path along the track which facilitates the entry of acid and dye stuffs for sensitization and dyeing respectively (Somogyi et al., 1979). The samples were washed with running hot water.

3.3 Sensitization

After swelling, the detector samples were dipped in 15% maleic acid used as sensitizing solution at 20°C for 21 hrs. The effect of sensitizer was studied at 70°C for different intervals of time from 0.25 to 6 hrs. The samples were again washed with hot water to remove excess of acid.

3.4 Dyeing

The detector samples with sensitized tracks were dyed in a 3% Rhodamine B solution for 30 minutes at 100°C. The dyed samples were scanned after washing thoroughly under Olympus microscope at a magnification of 600× for track density measurements (Fig. 2).

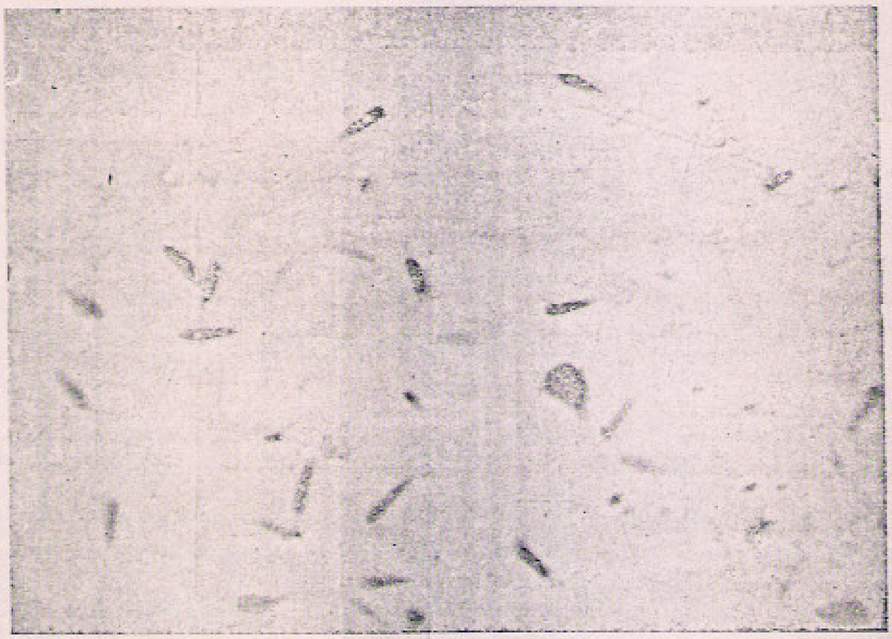

Fig. 2. Microphotograph of fission fragment dyed tracks in Triafol TN plastic detector.

4. RESULTS AND DISCUSSION

The track registration efficiency in Triafol TN and Cellit T has been found to increase with the swelling time. Triafol TN and Cellit T both are cellulose triacetate but Triafol TN gives 100% efficiency in 0.5 hrs whereas for the same efficiency in Cellit T, 5 hrs of swelling are required (Fig. 3). To record the maximum efficiency in both the detectors the sensitization time and temperature must be 1 hr at 70°C and 21 hrs at 20°C. Thus our results corroborate the findings of Somogyi et al (1979). This technique has some advantages as it gives higher track registration efficiency than chemical etching. Moreover the technique also reveals the track originating in and lying within the detector as the monomer (sensitizer) diffuses through the bulk material (Gourcy et al ; 1977).

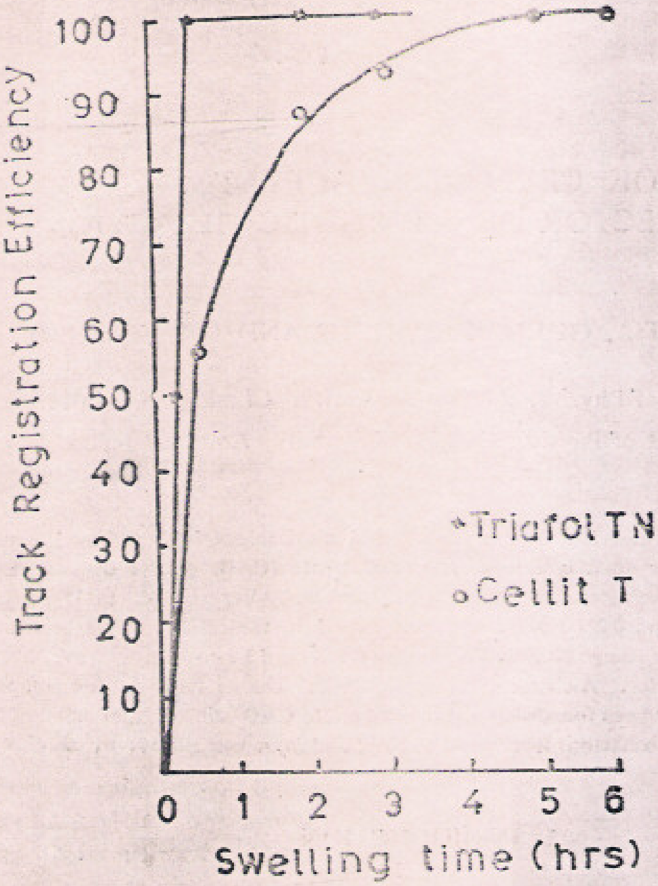

Fig. 3. Plot of track registration efficiency vs swelling time at room temperature in Triafol TN and Cellit T plastic detector.

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