technical note

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Thermal Stability of Fission Tracks in Sodalime Microslide Glass

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Annealing behaviour of latent damage tracks in sodalime microslide glass has been studied at different temperatures. Activation energies, corresponding to various track loss rates, are calculated. It is observed that activation energy of annealing increases with the degree of track loss.

Introduction

GLASS detectors are commonly used for neutron fluence measurement in fission-track work.[1–5] The National Bureau of Standards have prepared a wide range of standard glasses of known uranium content (0.02–500 ppm) for this purpose. The commercial microscope slides are found to have uranium as an impurity uniformly distributed throughout volume[5–7] and which can be used as a glass dosimeter.

Fission tracks in various materials begin to fade when subjected to heating.[8] Thus the study of annealing phenomena is extremely important for precision in fission-track analysis. Annealing is a diffusion process and hence temperature dependent. It is observed that an increase in temperature accelerates the annealing rate. The relation between annealing time and temperature can be expressed by the Boltzmann equation[9]

$$t = A \exp(E/KT), \quad (1)$$

where E is the activation energy, K the Boltzmann constant and A is another constant for the material. This paper summarizes the results of the annealing experiments carried out on microslide glass (Blue Star) routinely used for mounting samples for optical microscopy.

Experimental Procedure

Samples were prepared from microscope glass slides (Blue Star, PIC-2) of size 1 cm^2. Each specimen was washed with alcohol and then with distilled water. The samples were irradiated with ^{252}Cf fission fragment source (1 μCi) for 2 min each using 2π geometry in air.

Annealing of fission fragments was carried out by heating irradiated glass samples in a Muffle furnace with an accuracy of ± 5°C. Samples were annealed at 50, 100, 150 and 200°C for intervals of 10, 60, 360, 720 and 1440 min, at each temperature range successively. The latent tracks were etched with 40% HF for 30 s at 23°C after the thermal annealing. Track densities were determined using a binocular microscope (Olympus) at a total magnification of 600×. Fission-fragment tracks in glass appear in circular and elliptical shapes.

Results and Discussion

It is observed that both the track density and track size decrease with increasing annealing time and temperature. It is also evident (Fig. 1) that fission tracks begin to fade at 50°C when glass samples are heated for 2 h. Thus, sodalime

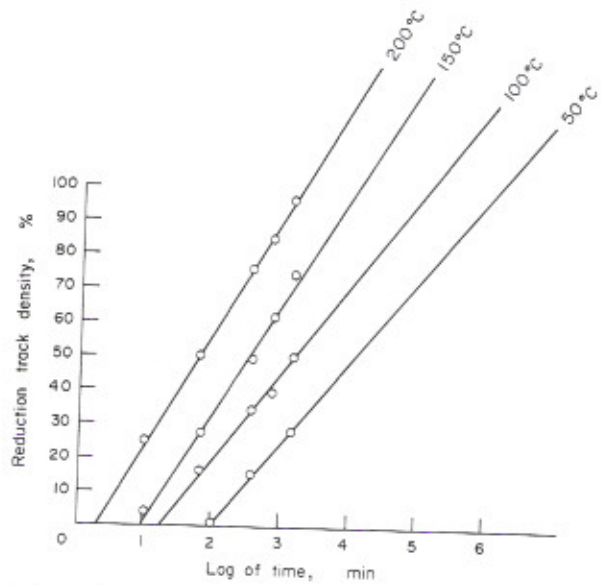

FIG. 1. Percentage reduction of track density in sodalime microslide glass with time at temperatures 50, 100, 150 and 200°C.

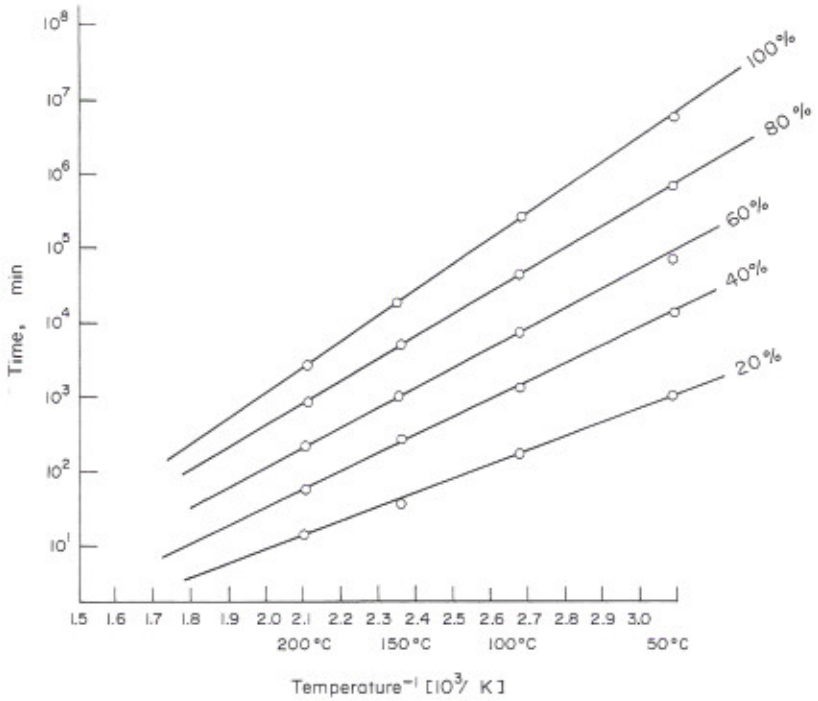

FIG. 2. Arrhenius curves (log time vs $10^3/T^\circ$ K) for percentage track loss; 20, 40, 60, 80 and 100% in sodalime microslide glass.

TABLE 1. Activation energy for sodalime microslide glass

Slide No.	Track-density reduction (%)	Activation energy (eV)
1	100	0.70
2	80	0.60
3	60	0.53
4	40	0.49
5	20	0.39

microslide glass has a relatively low thermal stability for fission tracks as compared to the SRM glass standards[4] available from the National Bureau of Standards (Washington, U.S.A.). The fading of tracks becomes more rapid as the annealing temperature is increased to 200°C. Track-density reduction vs log annealing-time plots (Fig. 1) represent a linear relation even at temperatures below 200°C and no complexity appears as reported by KUMAR *et al.*[10]

The activation energies are calculated (Table 1), corresponding to various degrees of track loss, from Arrhenius plots (Fig. 2). It is observed that the activation energy of annealing increases with the degree of track loss; a result in contradiction with that of REIMER *et al.*[11] for SRM standard glasses. For glasses, both natural and man made, activation energies between 1 and 3 eV are reported.[12,13] The low value found in the present study may be due to the high sodium and calcium contents in sodalime microslide glass.

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