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Efficiency of Radon Detector LR-115

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The efficiency of cellulose nitrate (LR-115, type II) radon detector has been measured at different angles of incidence for alpha particle detection. It is found that the detector efficiency increases with the angle of incidence. The detector is found most efficient for perpendicular incidence.

As the plastic track detector LR-115, type II is widely used for radon measurements for U/Th exploration and earthquake prediction, it is of considerable interest to measure the efficiency of the detector under different irradiation conditions. In general, the efficiency depends on the type of the detector material, the manufacturing process, the etch condition, the particle track definition and track counting method[1]. Nakahara *et al.*[2] measured the track density as a function of alpha particle energy for perpendicular incidence and Jonsson[3] studied the track density at three different alpha energies as a function of angle of incidence. In addition, some details of the handling of detector may also influence the efficiency[4]. Since the tracks on etched surface of the detector will appear only if the angle between incidence beam of alpha particles and detector surface is greater than the critical angle for track registration which is given by the relation $\theta_C = \sin^{-1} V_G/V_T$ where V_G is the bulk etch rate and V_T the track etch rate of the detector. So the efficiency of the detector depends on the angle of incidence, the aim of the present study is to estimate the recording efficiency of LR-15, type II for alpha particles at different angles of incidence so as to apply appropriate corrections in randon concentration measurement studies.

The LR-115, type II plastic track detector films were irradiated in a 5 l evacuated chamber with 1.5 μ Ci ^{241}Am α-source of beam energy between 5.3 and

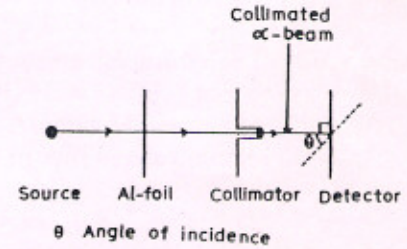

Fig. 1—Geometry of alpha beam and the detector

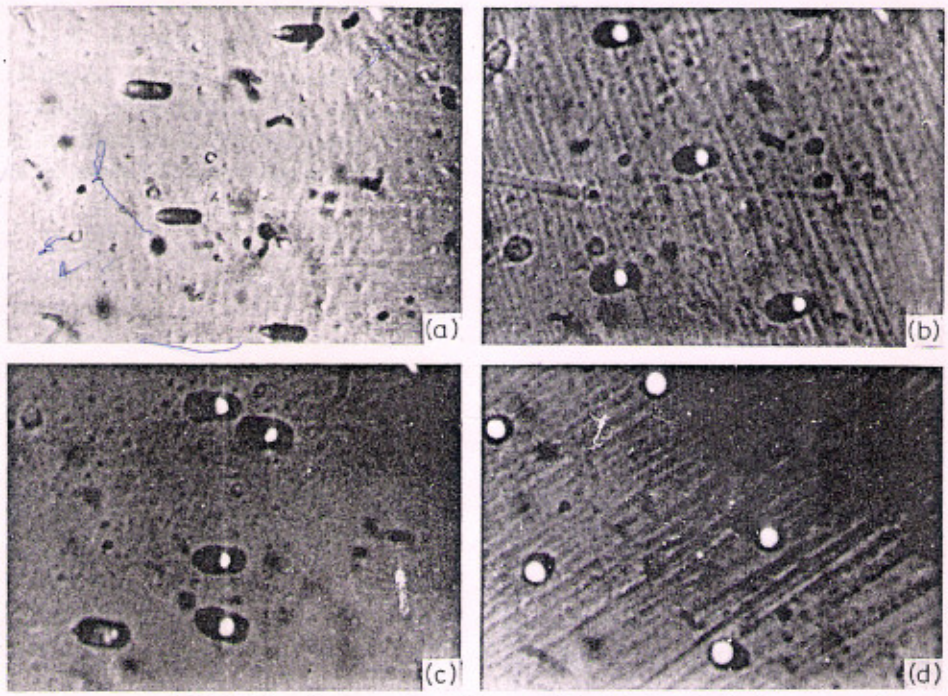

Fig. 2—Microphotographs of alpha tracks in LR-115 plastic detector exposed at (a) 30°, (b) 45°, (c) 60° and (d) 90° of incidence direction of beams

5.5 MeV. When irradiated, LR-115 produces tracks which are easily countable through the observation hole. Since the upper threshold energy for this detectgor is 4.8 MeV[5], an aluminium filter of thickness 2.7 mg/cm^2 was placed between the source and the collimater to permit only the appropriate energy levels. The angle of incidence was selected by turning the LR-115 film relative to the beam direction. The geometry of the alpha beam and detector is shown in Fig. 1. The energy of the incident beam was kept constant throughout the experiment. The irradiated films were etched in 2.5 N NaOH solution for 150 min in a constant temperature bath. The etched films were scanned under the optical microscope using a magnification of 1000 × for measurement of length and diameter of the tracks. The microphotographs of tracks at different angles are shown in Fig. 2. The detection efficiency was calculated by the relation:

$$\eta = 1 - V_G/V_T \qquad \ldots(1)$$

where V_G is the bulk etch rate, calculated by the thickness measurement method using micrometer and V_T the track etch rate given by the relation:

$$V_T = \Delta l/\Delta t \qquad \ldots(2)$$

where l is the length of track and t the etching time. In case of perpendicular exposure, it is not possible to measure the length of tracks so the relation[1]:

$$D = 2\, V_G t \{V_T - V_G)/(V_T + V_G)\}^{1/2} \qquad \ldots(3)$$

empioying diameter D is used for V_T measurement.

The values of measured efficiency for different incidence angles are given in Table 1. It is evident that the detection efficiency of LR-115 increases with increasing incidence angle. However, the maximum value of η for perpendicular incidence is 70% only. For other incidence angles, the efficiency is above 0.5, which is in fair agreement with the observations of Nakahara *et al.*[2] who found the detection efficiency to be more than 0.5 for alpha particle energies between 1.5 MeV and 4.2 MeV.

Table 1—Efficiency of CN Plastic Detector (LR-115, type II) for Different Angles of Beam Incidence

Angle of incidence (deg)	Detection efficiency (η)
30	0.57
45	0.60
60	0.64
90	0.70

It is concluded that the detection efficiency of cellulose nitrate plastic detector (LR-115, type II) is a function of the angle of incidence. The detector is found to be most effective recorder for perpendicular incidence.

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