UTILIZATION OF NATURAL MICA FOR MEASURING HIGH RADIATION DOSES

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The effect of high gamma-ray and electron doses on the annealing behaviour of muscovite mica has been reported[1,2]. Muscovite mica loses its physical strength and turns silvery white when heated at a temperature of 715°C for 1 hr, whereas that exposed to gamma doses above 9 x 10^3 MRad shows the same behaviour at about 825°C.

Fig. 1 shows the thermal decomposition of muscovite mica exposed to various gamma-ray doses when heated for 1 hr at 750°C.

Fig. 2 shows the resistance to thermal decomposition of muscovite mica as a function of absorbed gamma-ray dose. The ordinate is the temperature at which muscovite mica loses its physical strength and turns silvery white when heated for one hour. The abscissa denotes absorbed gamma-ray dose. The resistance increases markedly in the dose range from 5 x 10^3 to 8 x 10^3 MRad.

The dependence of the resistance on thermal decomposition of muscovite mica for a given amount of energy absorbed suggests the use of mica for the assessment of high gamma-ray, electron and other ionizing radiation doses[3,4,5].

The aim of the present report is to demonstrate the potential of "mica dosimeters" for the measurement of high gamma-ray and electron doses from various irradiation facilities and sources up to several thousand megarads.

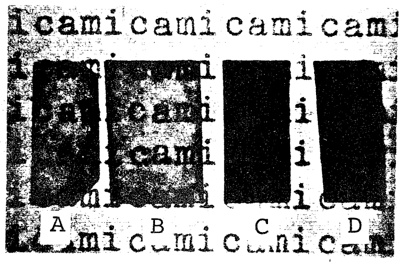

Fig. 1. Thermal decomposition of muscovite mica. The specimens were annealed for one hour at 750°C after exposed to various gamma-ray doses.
A: 1.5 x 10^4 MRad, B: 9.2 x 10^3 Mrad, C: 4.3 x 10^3 MRad, D: unexposed.

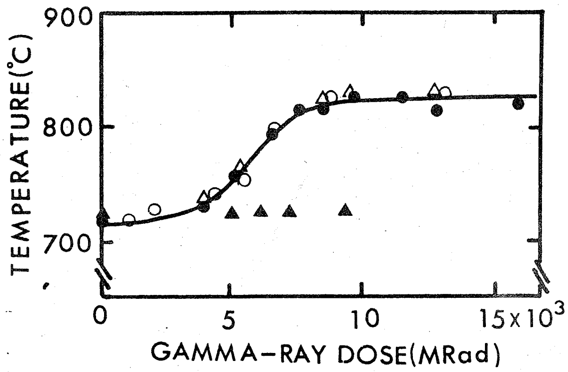

Fig. 2. Resistance to thermal decomposition of muscovite mica as a function of absorbed gamma-ray dose. ● gamma-ray irradiation, ○ electron irradiation, ▲ gamma-ray irradiation(160°C-170°C), △ annealed after one year of storage from the end of the gamma-ray irradiation.

Experimental isodose and depth-dose curves were obtained for 15-MeV electrons incident on an aluminium cylinder using mica sheets. Fig. 3 shows an isodose curve of 5.1 x 10^3 MRad in aluminium due to penetration of a well collimated 15-MeV electron beam. The beam current and irradiation time were 15 μA and 100 min, respectively.

In Fig. 4 a similar method was used to obtain beam profiles for 400-keV electrons after passing through a beam scanner.

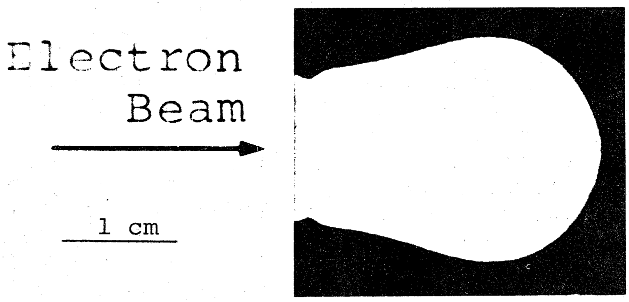

Fig. 3. An experimental isodose curve in an aluniminum cylinder for a collimated 15-MeV electron beam. The isodose curve is recorded in a mica sheet(right).

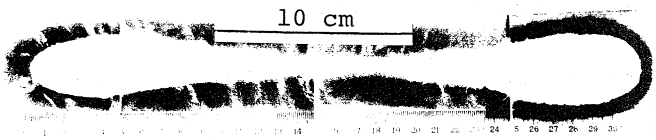

Fig. 4. An experimental beam profile for 400-keV electrons from a scanning electron beam system. The beam current and irradiation time were 400 μA and 60 min, respectively.

The mechanisms that cause aforementioned effect of high gamma-ray and electron doses on the annealing behaviour of muscovite mica are not presently clear. However, this experiment shows that muscovite mica can be used in manufacture of dosimeters for measuring and recording radiation fields with high spatial resolution.

References

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