LETTERS TO THE EDITORS

CHEMISTRY

Influence of Crystal Defects on the Szilard-Chalmers Process in Solids

EVEN if care is taken to ensure constant conditions of irradiation, both with respect to the dosage of fast and slow neutrons, as well as ionizing radiation and heat, and if the post-irradiation treatments are exactly the same; the reproducibility of measurements of the retention of activity in the chemical state of the target molecules, following thermal neutron capture in solids, is generally less than the measurement techniques employed would lead one to expect.

A variety of experimental evidence has now been obtained that indicates that the density, and possibly the nature, of the crystal defects in the irradiated material influence the retention, as well as the kinetic parameters of the subsequent thermal annealing of the recoil damage. The irreproducibility remarked above may well reflect these effects.

It has already been reported that the defects generated by pile neutron irradiation accelerate the post-irradiation thermal annealing of the recoil damage in potassium chromate[1] and ferrocene[2]. A brief statement of some new observations on these effects follows.

Measurements have been made on samples of single crystals and powdered potassium chromate prepared from the same batch of crystals and subjected to thermal neutron irradiation. In contrast to some earlier measurements[3], the value of this retention before any annealing, R_0, was greater for the single crystals (77·3 per cent) than for the powder (69·9 per cent), although all the conditions of irradiation were the same for the two samples. The powder, however, underwent a much more rapid thermal annealing than the single crystals. Thus, six hours heating at 212° increased the retention of the single crystals by 10·4 per cent, but the corresponding increase for the powder was 19·8 per cent. Crushing the single crystals after irradiation had a negligible effect on the retention.

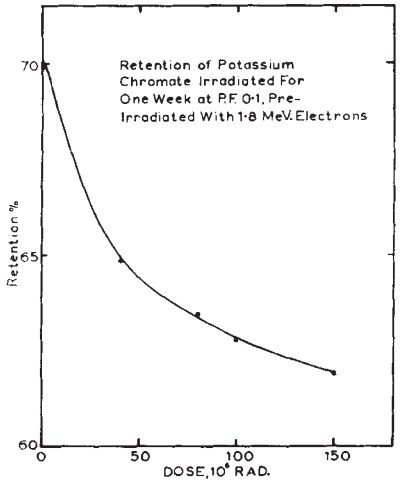

Fig. 1

Pre-irradiation of the single crystals with 1·8-MeV. electrons proved to have much the same effect as crushing the crystals. The change in R_0 with the dose of electrons during pre-irradiation, for constant conditions during and after neutron irradiation, is shown in Fig. 1.

A comparison has been made of the retention and thermal annealing of samples of normal lithium chromate with a sample containing only lithium-7. The samples were prepared and irradiated under the same conditions. They differed only in the isotopic composition of the lithium. The results are shown in Fig. 2.

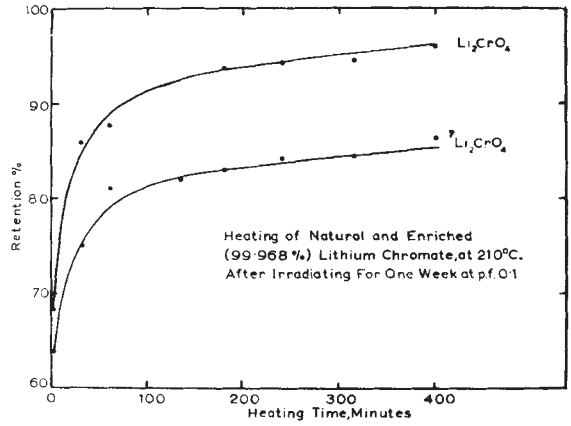

Fig. 2

In this case it appears that the difference in behaviour is to be attributed largely to the much greater radiation damage produced in the crystals containing some lithium-6 because of the fission of this nucleus by the neutrons. A simple calculation shows that the dose arising from this cause amounts to at least as much again as the effects of the fast neutron and gamma radiation.

It is believed that this evidence clearly establishes a relation between the crystal defects or inactive damage centres in the crystal and the behaviour of the recoil fragments.

One of us (J.I.V.) wishes to acknowledge leave of absence from Instituto de Pesquisas Radioativas and the Facultade de Filosofia, University of Minas Gerais, Brazil.

A. G. MADDOCK
J. I. VARGAS

University Chemical Laboratories,
Lensfield Road, Cambridge.
Oct. 10.

[1] de Maine, M. M., Ph.D. Thesis, Cambridge (1956).
[2] Sutin, N., and Dodson, R. W., *J. Inorg. Nucl. Chem.*, **6**, 91 (1958).
[3] Green, J. H., Harbottle, G., and Maddock, A. G., *Trans. Faraday Soc.*, **49**, 1413 (1953).