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Retention and Annealing in Solid $CsIO_3$ Activated with Fast Neutrons

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The availability of germanium gamma-detectors has rendered feasible the observation of ^{130}I in the presence of a large excess of ^{126}I. We have made use of this possibility to compare in caesium iodate the retention of ^{130}I, prepared by the $^{133}Cs(n,\alpha)$ process, with the retention of ^{128}I and ^{126}I, obtained by the nuclear reactions $^{127}I(n,\gamma)$ and $^{127}I(n,2n)$. By means of this technique we also compared the annealing of the three isotopes in the $CsIO_3$ matrix.

Our value for the retention of ^{130}I at 20 °C (cf. Table 1) is quite close to the result of an earlier determination of the retention of the same nuclide in the same matrix at room temperature by VLATKOVIĆ and KAUČIĆ (62.5 ± 2.0%) [1].

The three annealing curves are shown in Fig. 1. Those for ^{128}I and ^{126}I are quite similar, within the estimated errors the two retentions differ by a constant percentage of the total activity throughout the annealing process. (These graphs are also similar to those observed

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1. M. VLATKOVIĆ and S. KAUČIĆ, to be published in Radiochim. Acta.

for ^{128}I and ^{126}I in KIO_3 [2]). Roughly speaking the annealing curve for ^{130}I also has a similar shape and it is found to lie between the curves for the two other isotopes. However, if one studies the experimental points more carefully, it seems that at the start of the annealing the retention of ^{130}I rises more steeply than it should do if the difference in retention between this isotope and the two others would remain constant during the heat treatment.

Table 1. *Retention in solid* $CsIO_3$

Temperature of irradiation	Retention in IO_3^- in % ^{128}I	^{126}I	^{130}I
+ 20 °C	—	56.0	60.5
+ 20 °C	69.8	60.4	59.4
+ 20 °C	68.2	58.0	59.4
− 20 °C	61.6	49.5	40.3
− 20 °C	65.7	55.4	45.8

That this is actually the case is demonstrated by some irradiations which were carried out at − 20 °C instead of at + 20 °C (cf. Table 1). The difference between the retention observed in these two cases is equivalent to the annealing which takes place at 20 °C during the irradiation and the preparation for treatment. It is seen that the difference in retention between ^{128}I and ^{126}I is the same at the two irradiation temperatures.

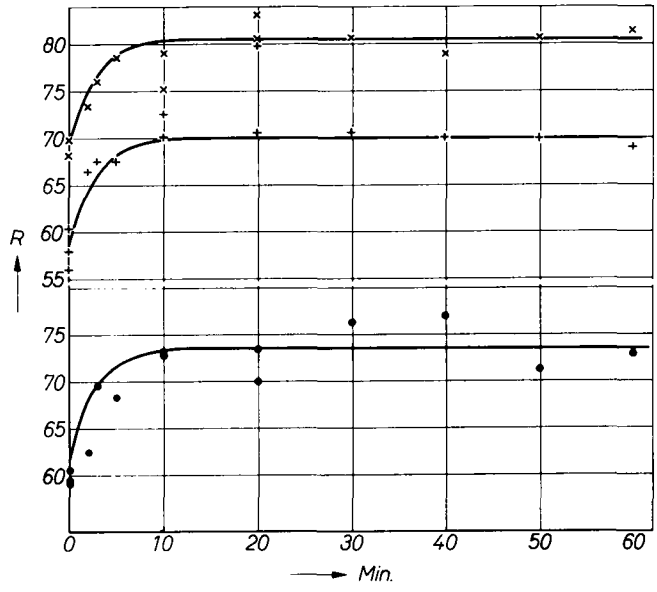

Fig. 1. Annealing curves at 100 °C in $CsIO_3$ of ^{128}I (× × × × × × ×), ^{126}I (+ + + + + + +) and ^{130}I (• • • • • • •). R = retention

For ^{130}I however, the difference in retention between the two temperatures is much larger than it is for the other two isotopes. Irradiation at + 20 °C gives a retention for ^{128}I which is 10% higher than that for ^{130}I, at − 20 °C this difference is 20%. The minor difference between the duplicates irradiated at − 20 °C is, of course, due to accidental differences in annealing during the treatment of the samples.

Our observations lead to the conclusion that if one considers $CsIO_3$ crystals with low retention and little annealing, the retention of ^{130}I rises more rapidly than that of ^{128}I and ^{126}I at the start of the annealing process, and that afterwards the three isotopes are annealed at the same rate, i. e. during the latter part of the heat treatment the retention differences, expressed in percent of the total activity, remain approximately constant.

Experimental

Caesium iodate (from British Drug Houses Ltd.) was used without pretreatment or purification in all experiments. About 300 milligrams were irradiated with fast neutrons from the (D + Be) reaction using the internal beam from the Amsterdam synchrocyclotron. The temperature during each irradiation was kept constant at ± 20 °C by means of circulating methanol from a thermostating unit. Irradiations lasted for about 3 hours. The activated solid was dissolved in 50 ml of an aqueous iodine solution. The iodine was extracted several times with carbon tetrachloride, back-extracted into a sulfite solution and precipitated with silver nitrate and nitric acid. The precipitate was collected on a small (1 cm diameter) glass filter dried, counted, and weighed.

The iodate fraction was precipitated as silver iodate for counting and weighing. The ^{128}I was counted by means of a well scintillator and multichannel analyzer, the ^{130}I and ^{126}I were measured by means of a lithium drifted germanium crystal coupled to a multichannel analyzer. We observed the 532 keV peak of ^{130}I and the 665 keV peak of ^{126}I. The same samples served for the observation of all three isotopes. Chemical yields were estimated by weighing the dried (120 °C) precipitates.

Thermal annealing of the irradiated samples was performed in a block heater at 100 °C, the samples being in contact with air during the annealing process.

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2. A. H. W. ATEN JR., M. LINDNER-GROEN and L. LINDNER, Chemical Effect of Nuclear Transformations (IAEA, Vienna 1965) Vol. II. 125.