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Chemical State of Radioiodine Formed by Fast Neutron Activation of Solid $CsIO_4$ and $CsClO_4$

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In caesiumperiodate ($CsIO_4$) the distribution of three radioactive iodine isotopes has been measured over three oxidation states; periodate, iodate and iodide + iodine. All isotopes were determined in the same sample and the following nuclear processes were used:

$$^{127}I(n, \gamma)^{128}I$$
$$^{127}I(n, 2n)^{126}I$$
$$^{133}Cs(n, \alpha)^{130}I.$$

The distribution of ^{130}I (cf. Table 1) was found to be strikingly similar to that of ^{128}I and of ^{126}I, which indicates that the type of the nuclear reaction and the value of the recoil energy play only a minor role in determining this distribution. The distribution is also quite similar to that reported for KIO_4 [1].

Table 1

Material irradiated	Temperature	Iodine isotope	Fraction of activity in $I_2 + I^-$	IO_3^-	IO_4^-
$CsIO_4$ (D)	15 °C	^{128}I	6.2±0.0	86.7±0.8	7.0±0.8
		^{126}I	4.8±0.2	89.4±0.9	5.7±1.1
		^{130}I	6.3±0.3	87.3±0.6	6.4±0.9
$CsClO_4$ (D)	10 °C	^{130}I	3.8±0.2	48.5±2.5	47.5±2.5
$CsClO_4$ (C)	10 °C	^{130}I	5.0±1.2	52.3±1.8	42.7±3.1

The samples marked (D) were prepared by the author, the sample marked (C) was a commercial product.

Analogous measurements were made for ^{130}I produced in caesium perchlorate by the $^{133}Cs(n, \alpha)^{130}I$ process. In this material almost one half of the radioactive iodine was found in the IO_4^--fraction (Table 1). This is somewhat surprising in view of the fact that by activation of periodates so little radio-iodine is produced as periodate and that by activation of perchlorates very little ^{38}Cl is produced in the perchlorate fraction [2, 3]. It demonstrates that the presence of periodate ions in the lattice is not efficient in promoting the formation of radioactive IO_4^- ions and that the individual structure of the crystal and the oxidizing action of the perchlorate lattice and its debris formed along the track of the recoil particle have a predominant influence on the fate of the radio-iodine atom formed in the crystal.

Experimental

Caesium periodate and perchlorate were synthesized by reacting Merck's caesium carbonate with periodic and perchloric acids respectively. The precipitates were washed with water until neutral reaction and dried at 120 °C. Approximately one millimole of salt was taken for each activation, using fast neutrons from the (D + Be) reaction in the internal beam of the Amsterdam synchrocyclotron. All experiments were done in duplicate. The temperature of irradiation was kept constant by means of a thermostating unit during the three hours of activation.

In the case of $CsClO_4$, the irradiated solid was dissolved in 25 ml of a solution containing iodine, caesium iodate and sodium periodate carriers. Iodine was extracted with carbon tetrachloride, back-extracted into a sulfite solution and precipitated with silver nitrate and nitric acid. Small glass filters were used to collect the precipitates for further counting and weighing. The iodate fraction was precipitated as silver iodate after the addition of excess silver nitrate and nitric acid. After a silver chloride precipitation, the periodate fraction was reduced to iodide by sodium sulfite and precipitated as silver iodide for counting and weighing.

$CsIO_4$ chemistry after irradiation was similar to that of $CsClO_4$, using $CsIO_3$ and I_2 carriers in water solution. The iodine fraction was counted and weighed as silver iodide, silver iodate precipitation accounted for the iodate fraction and the periodate was reduced as before and counted as silver iodide.

The ^{128}I activity was counted with a NaI-scintillator and a multichannel analyzer (440 keV peak) while ^{126}I and ^{130}I were measured with a lithium drifted solid state detector, also equipped with a multichannel analyzer.

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