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Chemistry

A. N. Murin, I. S. Kirin, V. D. Nefedov, S. A. Grachev,

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Abstract

Full Text

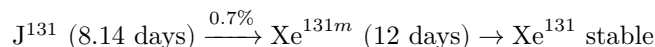
Chemistry

**A. N. Murin, I. S. Kirin, V. D. Nefedov, S. A. Grachev,
Yu. K. Gusev**

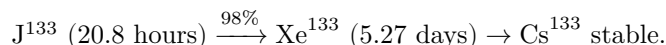
CHEMICAL CHANGES DURING THE β -DECAY OF IODINE ISOTOPES AS A METHOD FOR THE SYNTHESIS OF XENON COMPOUNDS

(Presented by Academician B. P. Konstantinov, 21 IX 1964)

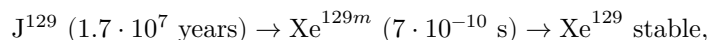
Investigations of chemical changes induced by the process of β -decay of isotopes of antimony, lead, bismuth, and other elements in various organoelement compounds have shown broad possibilities for using these processes for the synthesis and study of the properties of compounds of the daughter elements ⁽¹⁾. The synthetic methods developed as a result of these investigations, based on the processes of stabilization and decomposition of molecular ions, can be extended to other cases of successive β -transformations, for example, to the case of radioactive chains



and

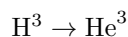


The possibilities of detecting and studying compounds of radioactive xenon isotopes formed in this way probably also extend to the case of the decay



when the chemical state of Xe^{129} can be determined from the emission Mössbauer spectrum ⁽²⁾.

Recently, analogous suggestions have been made concerning the possibility of using the β -decay process

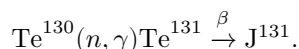


for the synthesis of helium compounds ⁽³⁾.

Fig. 1. Blowing-out of Xe^{131m} from solutions of potassium iodide and potassium periodate in 0.002 N H_2SO_4 . A –free xenon; B –after destruction of bound xenon

Figure 1: Fig. 1. Blowing-out of Xe^{131m} from solutions of potassium iodide and potassium periodate in 0.002 N H_2SO_4 . A –free xenon; B –after destruction of bound xenon

We have carried out work aimed at testing the possibility of the formation of oxygen compounds of xenon as a result of β -decay of iodine-131 incorporated in potassium iodate and periodate. The radioactive isotope iodine-131 was obtained by irradiation of a natural mixture of tellurium isotopes in a reactor by the reaction



The latter was separated from the irradiated tellurium by the method described in (4). The starting compounds KJ^{131} , $\text{KJ}^{131}\text{O}_3$, and $\text{KJ}^{131}\text{O}_4$ were synthesized by the usual methods of preparative chemistry (5). Accumulation of decay products was carried out in crystals, which were dissolved immediately before the experiment. The solutions were prepared by adding the solvent to a weighed portion of the salt in a bubbler at low temperature. After the solution had reached room temperature, a controlled stream of helium was passed through it. The gas from the bubbler passed through a tube filled with granulated caustic potash and entered the counting system.

Registration of xenon-131 was carried out on an apparatus constructed by us, based on a chamber made of a plastic scintillator placed between two photomultipliers connected in a coincidence circuit. Reduction of the background was ensured by using an anticoincidence circuit. At the outlet of the chamber, for quantitative determination of the xenon being purged and for checking its radiochemical purity, a thin-walled trap with activated charcoal, cooled with liquid nitrogen, was placed. After completion of the experiment the trap was sealed—was inserted into the well of the $\text{NaJ}(\text{Tl})$ crystal of the gamma spectrometer. The spectrum of the collected xenon was recorded on an AI-100-1 hundred-channel analyzer.

With this apparatus we were able to follow the kinetics of the blowing-out of xenon-131. It turned out that, at the helium-flow rate optimal for measuring activity (25 ml/min), more than 99.5% of xenon-131 was blown out of the potassium iodide solution in 30 min. With further passage of helium, only xenon-131 accumulating from iodine-131 during the experiment was recorded.

Fig. 1. Blowing-out of Xe^{131m} from solutions of potassium iodide and potassium periodate in 0.002 N H_2SO_4 . **A** –free xenon, **B** –after destruction of bound xenon

When xenon-131 was accumulated in potassium periodate crystals, somewhat different kinetics of blowing-out of unbound xenon were observed (Fig. 1A), which depended on the pH of the solutions prepared for the experiment.

Further experiments, confirming the possibility of formation of xenon compounds during the β -decay of iodine-131 as part of potassium iodate and periodate, were based on more or less specific reactions characteristic of oxygen compounds of xenon (6). For this purpose, iodate and periodate were dissolved in water or in 0.02 N H_2SO_4 , and xenon was blown out under these conditions for 30 min. In this way all unbound xenon was removed. Then reducing agents (potassium iodide, divalent iron, ammonia, hydrogen peroxide, mercury, hydroxylamine) were added to these solutions, and a secondary blowing-out of xenon with a helium stream was carried out for 30 min. Fig. 1B corresponds to the typical case of destruction of oxygen compounds of xenon by solutions of ammonia, divalent ferrous sulfate, and hydroxylamine. In the remaining cases, a slower release of xenon was observed. In experiments with addition of potassium iodide and hydroxylamine, a 2% starch solution was used to bind the liberated iodine; special experiments showed that its addition does not affect the process of xenon blowing-out. It is evident from Fig. 1 that, during the β -decay of iodine-131 as part of potassium periodate, when accumulation occurs in crystals, about 40% of the daughter xenon-131 is in a chemically bound form. A somewhat larger percentage of bound

xenon was observed by us for potassium iodate. Analogous experiments showed that, during the β -decay of iodine-131 in potassium iodide, no xenon compounds are formed.

According to existing ideas, the transformations of iodine-131 within iodate and periodate ions should, at the first, instantaneously occurring stage of radioactive decay, lead in most cases to the formation of neutral molecules XeO_3 and XeO_4 . Approximately half of the molecules formed will be in an excited state (¹). Removal of the excitation may be accompanied by elimination of oxygen and transition to states with lower oxidation levels, up to the formation of free xenon. It should be noted that the octavalent state of xenon is unstable in acidic solutions (6).

Thus, the preparation of xenon compounds by methods based on the use of chemical changes during β -decay processes opens up broad possibilities for research in the radiochemistry of noble-gas compounds.

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CITED LITERATURE

- ¹ V. D. Nefedov, V. M. Zaitsev, M. A. Toropova, *Usp. khim.*, **32**, No. 11, 1367 (1963).
- ² C. L. Cherick, C. E. Johnson et al., *Phys. Letters*, **5**, No. 2, 103 (1963).
- ³ G. S. Pimentel, R. D. Spratley, A. L. Miller, *Science*, **143**, No. 3607, 674 (1964).
- ⁴ An. N. Nesmeyanov, A. V. Lapitskii, N. P. Rudenko, *Production of Radioactive Isotopes*, 1954.
- ⁵ *Handbook of Preparative Inorganic Chemistry*, ed. G. Brauer, Moscow, 1956.
- ⁶ *Noble Gas Compounds*, Ed. H. H. Hyman, Chicago, 1963.

Note: Figure translations are in progress. See original paper for figures.

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