BULLETIN OF THE CHEMICAL SOCIETY OF JAPAN VOL. 43 284—285 (1970)

Recoil Reactions of Fluorine-18 in Hexa- and Pentammine Cobalt(III) Salts

Nobufusa SAITO, Fumitoshi AMBE, Shizuko AMBE and Akira SHIMAMURA

The Institute of Physical and Chemical Research, Yamato-machi, Saitama

(Received June 27, 1969)

Several investigations have been reported on the recoil reactions of chlorine,[1] and bromine[2-7] in cobalt complex salts. However, no report has been made on the recoil reactions of fluorine in similar compounds. In this note we wish to report on the chemical fate of the ^{18}F recoil atoms produced by three types of nuclear reactions in hexa- and pentamminecobalt(III) salts.

The samples were prepared by traditional methods and identified by means of absorption spectra of the aqueous solutions in visible region. Analytical results of the cobalt, nitrogen, and fluorine content were satisfactory for the present purpose.

The $^{19}F(n,2n)^{18}F$ Reaction. Recoil reactions of ^{18}F following the $^{19}F(n,2n)^{18}F$ reaction were studied in $[Co(NH_3)_6]F_3$ and $[Co(NH_3)_5F](NO_3)_2 \cdot H_2O$. The samples were irradiated with fast neutrons at an ambient temperature for 1—3 hr. The fast neutrons were obtained by bombarding a metallic lithium target with 3.5 MeV deuterons accelerated in the 66 cm cyclotron of this Institute. The neutron flux was 10^6—10^7 neutrons/cm^2·sec.

The irradiated sample was dissolved in a slightly alkaline solution containing the carriers. The solution was shaken with a 1% oxine-chloroform solution in order to eliminate 2.5 hr ^{56}Mn produced by the (n,α) reaction from ^{59}Co. The aqueous phase was washed with chloroform and passed through a column of a cation-exchange resin, Diaion SK#1 in the sodium form. The resin was then washed with a sufficient amount of water which had been made slightly alkaline with ammonia. ^{18}F atoms in the form of fluoride ions passed through the column, while those in the ligand of cobalt complex cations were adsorbed on the resin. A tracer experiment confirmed that there occurred no appreciable isotope exchange reaction of fluorine atoms between fluoride and $[Co(NH_3)_5F]^{2+}$ ions during the course of separation procedure.

The annihilation γ-rays of the positron emitted by the 111 min ^{18}F were measured by means of a single-channel γ-ray spectrometer equipped with a NaI scintillation detector.

The ligand yield (the fraction of the recoil atoms found as the ligands of the complex ions[2]) was 5.3±0.1% for $[Co(NH_3)_6]F_3$ and 17.8±0.3% for $[Co(NH_3)_5F](NO_3)_2 \cdot H_2O$.

The $^{17}O(d,n)^{18}F$ Reaction. $[Co(NH_3)_6](NO_3)_3$ and $[Co(NH_3)_5F](NO_3)_2 \cdot H_2O$ were bombarded with 3 MeV deuterons for 5 min. The beam current was 0.05—0.5 A/cm^2. Although the target assembly was cooled with water, the temperature of the samples during bombardment might have been higher than room temperature. The samples were considerably decomposed by the heat and by the radiation (about 10^9 rad) to which the samples were exposed during irradiation. The chemical distribution of the ^{18}F produced by the $^{17}O(d,n)^{18}F$ reaction was determined by a procedure similar to that employed in the case of the (n,2n) reaction. As was expected from the inconstancy of the conditions of irradiation, the reproducibility of the results was low. The ligand yield was 2—7% for $[Co(NH_3)_6](NO_3)_3$ and 5—17% for $[Co(HN_3)_5F](NO_3)_2 \cdot H_2O$.

The $^{16}O(t,n)^{18}F$ Reaction. $[Co(HN_3)_6](NO_3)_3$ or $[Co(NH_3)_5F](NO_3)_2 \cdot H_2O$ was mixed with lithium carbonate in the gram-formula weight ratio of 1 to 2. The mixture was irradiated with

1) N. Ikeda, K. Yoshihara and S. Yamagishi, This Bulletin, **34**, 140 (1961).

2) N. Saito, H. Sano and T. Tominaga, *ibid.*, **33**, 20 (1960).

3) N. Saito, T. Tominaga and H. Sano, *ibid.*, **35**, 63 (1962).

4) K. Yoshihara and G. Harbottle, *Radiochim. Acta*, **1**, 68 (1963).

5) G. B. Schmidt and W. Herr, *Z. Naturforsch.*, **18A**, 505 (1963).

6) N. Saito, S. Ito and T. Tominaga, This Bulletin, **38**, 504 (1965).

7) N. Saito, M. Takeda and T. Tominaga, *ibid.*, **40**, 690 (1967).

neutrons for 5 min at the temperature of dry ice in the rotary specimen rack of the TRIGA Mark II reactor of Rikkyo University. The neutron flux was about 5×10^{11} neutrons/cm^2·se. The ligand yields of ^{18}F produced by the ^{16}O(t,n)^{18}F reaction (which was induced by the tritons from the ^{6}Li(n,α)T reaction) were determined to be $5\pm1\%$ for $[Co(NH_3)_6](NO_3)_3$ and $4\pm1\%$ for $[Co(NH_3)_5F](NO_3)_2\cdot H_2O$.

From the observations described above, it can be concluded that some of the ^{18}F atoms, produced by the (n,2n), (d,n), and (t,n) reactions, form ^{18}F-labeled cobalt complex ions as has been reported for radioactive chlorine and bromine atoms following various nuclear reactions in similar compounds.[1-7]