Chemical Effects Following the Isomeric Transition of ^{80m}Br in Pentamminecobalt(III) Bromides

By Nobufusa SAITO, Shizuko ITO and Takeshi TOMINAGA

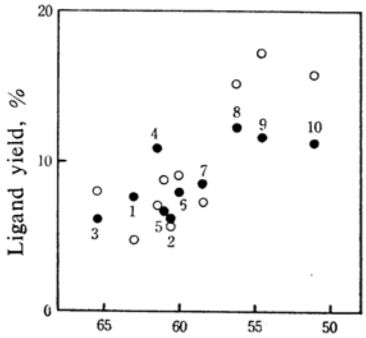
(Received December 9, 1964)

In the course of an investigation of the behavior of hot radiobromine atoms produced by (n, γ) reaction in cobaltammine bromides, two of the present authors (N. S. and T. T.) found that the percentage of such energetic radiobromine atoms finally complexed with cobalt (i. e., the ligand yield) was related to the chemical or physical properties of the ligands in the target complexes.[1] In order to clarify the mechanism of such recoil reactions, it seemed worthwhile to compare chemical effects following different nuclear reactions. Therefore, they have studied the recoil reactions following the isomeric transition of ^{80m}Br in ^{80m}Br-labeled cobaltammine bromides and have compared the results with those obtained with (n, γ) reaction.

The ten kinds of pentamminecobalt bromides listed in Tabel I have been investigated.* The ^{80m}Br-labeled bromide of each complex was precipitated from an aqueous solution by the addition of radioactive ammonium bromide irradiated in a nuclear reactor, filtered, washed

TABLE I. LIGAND YIELD OF ^{80}Br PRODUCED IN ISOMERIC TRANSITION OF ^{80m}Br

No.	^{80m}Br-labeled complex salt	Ligand yield, %	
		In dry ice-ethanol	In liquid nitrogen
1	$[Co(NH_3)_6]Br_3$	7.6±1.7	7.5±0.4
2	$[Co(NH_3)_5NCS]Br_2$	6.1±0.9	4.9±0.9
3	$[Co(NH_3)_5NO_2]Br_2$	6.1±1.3	7.8±0.3
4	$[Co(NH_3)_5OH_2]Br_3$	10.9±2.1	9.5±1.0
5	$[Co(NH_3)_5ONO]Br_2$	6.7±1.4	10.0±0.7
6	$[Co(NH_3)_5ONO_2]Br_2$	8.0±1.2	8.9±1.5
7	$[Co(NH_3)_5F]Br_2$	8.6±1.0	10.0±1.4
8	$[Co(NH_3)_5Cl]Br_2$	12.3±3.0	14.2±1.4
9	$[Co(NH_3)_5Br]Br_2$	11.7±1.4	13.8±1.3
10	$[Co(NH_3)_5I]Br_2$	11.3±1.4	13.0±0.6



Frequency of the maximum in the first absorption band, 10^{13}/sec.

Fig. 1. The relationship between the ligand yield and the frequency of the maximum in the first absorption band.
● Isomeric transition; ○ (n, γ) reaction
Numbers in Fig. 1 correspond to those in Table I.

1) N. Saito, T. Tominaga and H. Sano, This Bulletin, 35, 63 (1962).

* Bisethylenediaminecobalt bromides, $[Co(en)_2X_2]Br_{1,3}$, have also been studied, and apparent ligand yields of about 2—10%, obtained. Unlike as in pentammine-cobalt bromides, however, it appears that 2—5% of ^{80}Br is not complexed with cobalt but presumably bound in the ligand molecule (i. e., the ethylenediamine molecule).

and dried in air. After it had stood for 3 hr. in a mixture of dry ice and ethanol, or in liquid nitrogen, each salt was dissolved in water at 0°C, and cations (radiobromine complexed as ligands) and anions (bromide ions) were separated by means of ion-exchange resins. The radioactivities in both fractions were measured with a G-M counter, and the distribution of ^{80}Br was determined.

Table I shows the percentage of ^{80}Br complexed with cobalt (i. e., the ligand yield). For convenience of comparison, the ligand yields of radiobromine obtained in the (n, γ) reaction and the isomeric transition are plotted together in Fig. 1 against the frequency of the maximum in the first absorption band of the complex ion. The results may be summarized as follows:

1) Regarding the relationship between the ligand yield and the stability of the ligand, the ligand yield of ^{80}Br produced in the isomeric transition also tends to increase with the decrease in the frequency of the maximum in the first absorption band. Although this trend is very similar to that observed in the case of the (n, γ) reaction, the inclination is less pronounced for the former than for the latter.

2) Comparing ligand yields in the two reactions for the same salt, a higher ligand yield is generally obtainable in the (n, γ) reaction.

3) No remarkable difference is found between ligand yields obtained after storage in dry ice - ethanol and in liquid nitrogen.

Department of Chemistry
Faculty of Science
The University of Tokyo
Hongo, Tokyo