Chemistry

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Fig. 1

Figure 1: Fig. 1

Abstract

Full Text

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THE USE OF CHEMICAL CHANGES IN THE PROCESSES OF BETA DECAY OF RaE FOR THE SYNTHESIS OF ORGANOELEMENT COMPOUNDS OF POLONIUM

(Presented by Academician A. N. Nesmeyanov, 10 III 1960)

The ability to form organic derivatives with definite properties is a very important characteristic of an element. The exceptional progress that has been observed in recent years in the chemistry of organoelement compounds as a whole has scarcely affected a number of elements, such as francium, astatine, and polonium. At the same time, the ability of these elements to give organoelement compounds undoubtedly follows from their position in the periodic system, as well as from the general regularity first noted by D. I. Mendeleev and formulated in its modern form by A. N. Nesmeyanov ([1,2]).

The aim of the present work was to develop new methods for the synthesis of certain previously unknown organoelement compounds of polonium. At present, only three papers devoted to the experimental study of this question have been published in the world literature ([3–6]). An effective method of synthesis may be one based on the use of chemical changes in processes of β-decay. Similar methods were used by us earlier for the synthesis of various organometallic compounds of bismuth ([7–11]).

Fig. 1

As is shown in the present work, organoelement compounds of polonium (RaF) arise during the β-decay of RaE included in certain aromatic derivatives.

The accumulation of polonium as a result of β-decay was carried out in crystals of $Bi(RaE)Rh_3$ and $Bi(RaE)Ph_3Cl_2$. To obtain these compounds of sufficiently high specific activity, chemical changes during the β-decay of RaD included in $RaDPh_4$ were used.

The task consisted in isolating and identifying the daughter compounds of polonium (RaF). As the principal method, ascending paper chromatography was

Fig. 2

Figure 2: Fig. 2

Fig. 3

Figure 3: Fig. 3

used. The role of "witnesses," making it possible to establish the position of various organoelement compounds of polonium on the chromatogram, was performed by analogous tellurium derivatives—$TePh_2$, $TePh_2Cl_2$, and $TePh_3Cl$, labeled with Te^{127} ([12–15]). The separation of organoelement compounds of Po was carried out in the presence of microgram quantities

these carriers. The chromatogram was analyzed radiometrically, using the α-activity of polonium and the β-activity of Te^{127}. The measurement results were plotted in Fig. 1, where activity was plotted on the ordinate axis, and the distance from the point at which the mixture being analyzed had been applied was plotted on the abscissa axis. The assignment of an α-active peak on the chromatogram to one or another polonium compound was established by comparing its position with the position of the peak of the analogous β-active tellurium derivative. The validity of such a method follows from the similarity of the chemical properties of polonium and tellurium. Moreover, within complex organoelement compounds the individual properties of these elements are leveled even further.

Fig. 2

Fig. 3

The solvents found to be most suitable for separating organoelement compounds of tellurium and, consequently, compounds of polonium were: ethyl acetate (with preliminary treatment of the paper with a 25% alcoholic solution of dimethylformamide), carbon tetrachloride, and petroleum ether.

In chromatography in ethyl acetate (Fig. 1), the following values of R_f were obtained for organoelement tellurium compounds: $TePh_3Cl \sim 0.1$; $TePh_2Cl_2$ 0.50—0.55; $TePh_2$ 0.70—0.75. In chromatography in carbon tetrachloride (without treatment of the paper), the following R_f values were obtained: $TePh_3Cl \sim 0$; $TePh_2Cl_2$ 0.6—0.7; $TePh_2 \sim 1$.

In petroleum ether only $TePh_2$ moves with the solvent front. The use of several solvents substantially increases the reliability of the results, which is especially important for identifying new compounds.

The distribution of α-activity among the various chemical forms of polonium during accumulation in $Bi(RaE)Ph_3$ crystals, using ethyl acetate as the chromatographic solvent, is shown in Fig. 2. The overall distribution pattern of polonium is characterized by the following data: $PoPh_2Cl_2$ $15 \pm 6\%$; $PoPh_2$

$24 \pm 6\%$, and the sum of the remaining polonium derivatives $61 \pm 6\%$. The distribution of polonium in the case of chromatography in carbon tetrachloride proved to be as follows: $PoPh_2Cl_2$ $19 \pm 6\%$, $PoPh_2$ $18 \pm 6\%$, and the sum of the remaining polonium derivatives $63 \pm 6\%$. In chromatography using petroleum ether, $19 \pm 6\%$ of the polonium was found in the form $PoPh_2$.

When polonium was accumulated in $Bi(RaE)Ph_3Cl_2$ crystals, no $PoPh_2$ was detected. Almost all the polonium ($92 \pm 3\%$) in this case was present in the form $PoPh_2Cl_2$.

The results of chromatography using ethyl acetate are presented in Fig. 3 ($R_f = 0.54$).

As can be seen from the results of the work, the chemical state of RaE has a very strong influence on the yield of the various forms of RaF. This makes it possible to use the chemical changes occurring in β-decay processes to synthesize definite organoelement compounds of polonium.

In conclusion, the authors express their gratitude to Corresponding Member of the Academy of Sciences of the USSR G. A. Razuvaev for a number of valuable suggestions and comments, and to B. K. Preobrazhenskii for numerous suggestions and assistance in questions concerning chromatographic separation methods.

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