# UNSTABLE HALOORGANOLITHIUM COMPOUNDS COMMUNICATION 2.\* INVESTIGATION OF THE STRUCTURE OF *o*-FLUOROPHENYLLITHIUM AND

### PHENYLLITHIUM ETHERATES†

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Earlier we showed [1, 2] that the decomposition of o-haloderivatives of phenyllithium (o-XC<sub>6</sub>H<sub>4</sub>Li), leading to dehydrobenzene, in ether medium, occurs by synchronous elimination of a LiX molecule from the etherates of these compounds, and not according to a two-step ionic mechanism with the participation of o-XC<sub>6</sub>H<sub>4</sub> [4]. For a detailed study of the mechanism of this reaction, information is necessary on the composition and structure of the initial etherates.

According to [5, 6], aliphatic organolithium compounds (OLC) in ether medium are tetraetherates of tetramers  $(RLi)_4 \cdot (R'_2O)_4$ . The information on analogous etherates of aromatic OLC is extremely contradictory [7, 8], although it is evidence of a lower degree of their association. There are not data in the literature on the structure of unstable organohalolithium compounds. To determine the composition and structure of o-halophenyllithium we conducted a detailed investigation of the systems o-fluorobromobenzene (FBB) — n-butyllithium — ether and the products of their interaction, using the method of differential thermal analysis (DTA), low-temperature cryoscopy, and PMR spectroscopy.

#### EXPERIMENTAL METHOD

All the operations with OLC were conducted in an atmosphere of dry He or Ar. n-Hexane and n-heptane, chromatographically pure substances, were produced by redistillation of the corresponding standard preparations on a column of 80-100 theoretical plates. The hydrocarbons were stored over NaH; directly before use they were refrozen under vacuum over LiAlH<sub>4</sub> in an atmosphere of dry He. Diethyl ether (DEE), tetrahydrofuran (THF), tetrahydropyran (THP), and triethylamine (TEA) were purified by repeated redistillation of commercial preparations over NaH or LiAlH<sub>4</sub> in an atmosphere of dry He or Ar. Before use these compounds were refrozen under vacuum over LiAlH<sub>4</sub>. The operations of transfer of the solvents and solutions of OLC were accomplished only between containers filled with Ar or He, with the aid of a dry medical syringe; the duration of the experiments was  $\leq 2$  h. According to the data of analysis according to Fischer, the content of water in THF and the other ethers was  $\leq 0.02$  mg/ml (~0.01%). The glass vessels, designed for work with OLC, were dried for  $\geq 1$  h at 120° and filled with inert gas. The quartz ampoules for cryoscopic investigations were dried by heating in a burner flame under vacuum.

n-Butyllithium was produced according to [9]; the analysis was conducted by double titration according to [10], using 1,2-dibromoethane (10-fold excess) and 0.1 N HCl. The solutions of butyllithium used contained, according to the data of analysis,  $\leq 10\%$  inorganic alkali; FBB was synthesized by the thermal decomposition of *o*-bromobenzenediazonium tetraborate with t. dec. 100-102°, produced from *o*-bromoaniline according to [11]; yield 74\%, bp. 157-158°,  $n_D^{20}$  1.5340, purity >99% (according to the data of gas -liquid chromatography). According to the data of gas-liquid chromatography, the purity of bromobenzene was >99%.

\*For communication 1, see [1]. †Preliminary results were cited in [2], see also [3].

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Fig. 1. Scheme of apparatus for cryoscopy and DTA: 1) working ampoule; 2) copper block; 3) comparative ampoule; 4) F-116 photoelectronic amplifier; 5, 6) KSP-4 potentiometers; 7) PP-63 potentiometer; 8) R-2 potentiometer; 9) copper block (DTA) or Dewar flask with ice (cryoscopy).

Fig. 2. Microreactor: 1) casing (teflon); 2) cover nuts; 3) tube for introduction of inert gas; 4) ampoule; 5) thermocouple; 6) capillary (glass); 7) seal (rubber).

Apparatus and Methods of Cryoscopic and DTA Measurements. The measurement of the freezing point of solutions of OLC was performed by a compensation method on an apparatus, the theoretical scheme of which is cited in Fig. 1. Chromel-copel thermocouples of wire 0.1 mm in diameter, a F-116/1 photoelectronic amplifier, KSP-4 automatic recording potentiometers, a PP-63 potentiometer (source of compensation voltage), and a semiautomatic R-2 potentiometer were used in the setup. Standard ampoules of an NMR spectrometer (outer diameter 5 mm) or special quartz ampoules 12 mm in diameter were used as the measuring cell of the instrument; ampoules of an NMR spectrometer were used as the reference cell. The introduction of the thermocouple into the measuring ampoule was accomplished with the aid of a special attachment (Fig. 2), also serving to introduce the sample, hermetically seal the ampoule, and maintain an inert atmosphere in it. The ampoules were placed in a massive copper block, cooled with liquid nitrogen. The determinations of the concentration of solutions of n-butyl bromide in n-hexane and n-heptane, conducted on this apparatus in the interval from 0.1 to 2.0 M, showed a maximum deviation from linearity of 3%.

Into a dry ampoule, situated in the setup for low-temperature measurements under a small excess pressure of He, we introduced 0.2-0.3 ml of a 1.0 M solution of the corresponding butyllithium etherate in n-hexane or n-heptane, cooled to  $\sim -190^{\circ}$ , added an equal amount of 1.0 M solution of FBB in the same solvent, allowed the mixture to warm up to the melting point ( $\sim -100^{\circ}$ ), mixed by agitation, and again cooled to  $\sim -190^{\circ}$ . Then the mixture was again warmed to  $\sim -75^{\circ}$  (10-15 min), exposed at this temperature for 15-20 min, after which the freezing curve of the solution was recorded with cautious cooling, taking into consideration only the data obtained in the case of supercooling of the solution of  $\leq 2^{\circ}$ . The freezing point was determined according to the position of the plateau on the curve of the dependence of the temperature of the sample on the time. After 5-6 successive determinations, the reference ampoule was transferred from a vessel with thawing ice to a copper block, which contained the measuring ampoule, the compensation voltage was turned off, and the DTA curve was recorded while heating the block with the ampoules in air (average rate ~3 deg/min). The DTA data cited in Fig. 3 were obtained by the same method, but without determination of the freezing point. On the basis of the freezing points of the investigated mixtures we determined the concentration of the dissolved substance according to a calibration curve constructed according to the data for solutions of n-butylbromide. Within the concentration range 0.1-2.0 M the graph was linear (coefficient of correlation r = 0.99). In accord with [5, 6], the degree of association of the initial n-butyllithium (0.5-1.5 M solutions in n-hexane) and its equimolar salts with THF was equal to 6 and 4  $(\pm 5\%)$ , respectively.



Fig. 3. Dependence of the temperature of the decomposition of FPL on its mole ratio to ethers in n-hexane; 1) THF; 2) THP; 3) DEE.

Method of Investigation of Reactions in an NMR Spectrometer. The investigations were conducted on a Varian DA-60-IL spectrometer (60 MHz). First the required amount of TMS was added to a thoroughly dried ampoule, then a rubber hose, connected to a chamber with He, was put over the open end of the ampoule, and 0.25-0.3 ml of a solution of the corresponding mixture of ether and butyllithium in n-heptane was introduced through the hose with a syringe. The mixture obtained was frozen on one side of the ampoule with the aid of liquid nitrogen, while the corresponding amount of a 1.0 M solution of FBB in n-hexane or n-pentane was frozen analogously onto its opposite side. The ampoule filled in this way was stored in a Dewar flask with liquid nitrogen before its introduction into the spectrometer. Then the ampoule was disconnected from the chamber, rapidly stoppered, and introduced into the pickup of the spectrometer, preliminarily cooled to  $-100^{\circ}$ . The spectra of the salts obtained were recorded while raising the temperature at 5° intervals.

#### DISCUSSION OF RESULTS

As was shown by numerous measurements of the freezing point of the solutions, when the reaction  $1.0 \text{ FC}_{6}\text{H}_{4}\text{Br} + 1.0 \text{ BuLi} + 1.0 \text{ THF} \rightarrow 1.0 \text{ FC}_{6}\text{H}_{4}\text{Li} + 1.0 \text{ BuBr} + 1.0 \text{ THF}$  was conducted under conditions in which the *o*-fluorophenyllithium (FPL) formed is an entirely stable substance (-75 to -80°) (see [1]), the total amount of the reaction products is ~1.25 moles (1.23 ± 0.07 and 1.24 ± 0.05 moles for solutions in n-hexane and n-heptane, respectively). Judging by the PMR spectra, which were taken under the same conditions, the reaction goes to completion. An investigation of the freezing points and PMR spectra of hydrocarbon solutions of mixtures of butyllithium with n-butyl bromide showed that these compounds do not give mutual associates and, consequently, the n-butyl bromide formed simultaneously with FPL is a free, nonassociated compound. Thus, a mixture of one mole of FPL and one mole of THF corresponds to only 0.25 mole in the products of the reaction cited above, which is an indication of the formation of a tetramer complex with composition (*o*-FC\_6H\_4Li)\_4(THF)\_4 by these compounds.

As was shown by investigations of the dependence of the temperature of decomposition of FPL, determined according to the exothermic peak on the DTA curve, on its mole ratio with ethers (THF, THP, DEE), the stability of this compound decreases smoothly as the ether: FPL ratio decreases from 20:1 to 1:1. However, when this ratio is further decreased from 1:1 to 0.5:1, a sharp drop in the temperature at which an exothermic peak arises on the DTA curve is observed (see Fig. 3). These data not only agree with the formation of FPL etherates with a 1:1 composition, but also confirm our hypothesis [1, 2] on the mechanism of their decomposition, according to which the slow step is cleavage of the etherate bond:



When the reaction of FBB was conducted with equimolar amounts of butyllithium and THF in the pickup of an NMR spectrometer, it was found that when the sample is heated to the melting point (~-95°),  $n-C_4H_9Br$  rapidly appears in the mixture (triplet from the protons of  $\alpha$ -CH<sub>2</sub> with  $\delta$  3.20 ppm), along with an aromatic compound, the spectrum of which consists of two broadened signals at  $\delta$  6.76 (3 H) and 7.58 (1 H) ppm (Fig. 4). As it follows from a comparison of this spectrum with the spectrum of phenyllithium, produced under the same conditions by the action of butyllithium on bromo- or iodobenzene, the signals at 6.76 and 7.59 ppm should belong to the m- + p- and o-protons of FPL, respectively. In accord with the DTA data (see Fig. 3), the spectrum of FPL is maintained up to a temperature of ~-40°,\* whereupon there is a decomposition of this compound, after which the signal at 7.59 ppm rapidly disappears, while the signal at 6.76 ppm is broadened, and upon further heating is converted to the spectrum of a mixture of the final reaction products.

As can be seen from a comparison of the spectra of FPL and phenyllithium etherates (see Fig. 4), the introduction of a fluorine atom into the o-position of phenyllithium leads to a simultaneous shift of both its multiplets by ~0.25 ppm in the strong-field direction. According to [12], this is an indication of the closeness of the ionic character of the C-Li bond of the two compounds. Thus, contrary to the widespread

\*The value of the decomposition point of this compound  $(-20^\circ)$  cited in [1] pertains to a large excess of THF.





opinion [4], the C-Li bond in FPL does not experience any appreciable polarization under the influence of the neighboring fluorine atom.

As the reaction proceeds, extremely substantial changes in the position and shape of the signal of the protons of the  $\alpha$ -CH<sub>2</sub> group of THF, bonded in the complex with OLC, are also detected. Thus, at the beginning of the experiment (-95 to  $-100^{\circ}$ ), in the region of  $\delta$  3.60-3.80 ppm, only a broadened spectrum is observed, characteristic of the complex of THF with butyllithium (signal of the protons of the  $\alpha$ -CH<sub>2</sub> groups of free THF  $\sim 3.58$  ppm). However, as the reaction proceeds, resulting in the formation of FPL and nbutylbromide, the intensity of these signals decreases, and a broad signal at 2,93-3.08 ppm appears in a stronger field, the intensity of which increases synchronously with the increasing intensity of the signal of the protons of the  $\alpha$ -CH<sub>2</sub> group of n-butylbromide at 3.21 ppm. At the end of the formation of FPL, the signal of the protons of the  $\alpha$ -CH<sub>2</sub> group of THF, associated in a complex with butyllithium, disappears, while the intensity of the signal at 2.93-3.08 ppm reaches a constant value, equal to the intensity of the signal of the protons of the  $\alpha$ -CH, group in the initial complex (Fig. 5, spectra 1, 2, 3). The position of this signal and its intensity are unchanged when the temperature is raised to  $-50^\circ$ , after which as the decomposition point is approached, it begins to be slowly shifted in weak-field direction (spectra 4 and 5). The strong field shift of the protons of the  $\alpha$ -CH<sub>2</sub> group of THF is evidently associated with the transfer of this ligand from butyllithium to FPL. The simultaneous observation of two different signals of the protons of the  $\alpha$ -CH<sub>2</sub> groups of THF is evidence that the exchange process

$$(BuLi)_4$$
 THF<sub>4</sub> +  $(o-FC_6H_4Li)_4$  THF<sup>\*</sup>  $\Rightarrow$   $(BuLi)_4$  THF<sub>3</sub>THF<sup>\*</sup> +  $(o-FC_6H_4Li)_4$  THF<sup>\*</sup> THF etc.

proceeds slowly under these conditions (-75 to  $-80^{\circ}$ ). It is also evident that the gradual shift of this signal at relatively high temperatures (~-50°) in the strong-field direction is associated with the exchange reaction  $(o-FC_6H_4Li)_4 \cdot THF_4 + THF^* \rightleftharpoons (o-FC_6H_4Li)_4 THF_3 THF^* + THF$ , due to the appearance of free THF in the system as a result of the partial decomposition of FPL. When the temperature of exothermic decomposition of FPL is reached (~-40°, see Fig. 3), the signal of the protons of the  $\alpha$ -CH<sub>2</sub> group of THF is rapidly shifted into the position characteristic of free THF (3.57 ppm). Rapid cooling of the mixture formed to -90°, just as should have been expected, no longer changes the position of this signal.

When the reaction of equivalent amounts of butyllithium tetrahydrofuranate\* with bromo- or iodobenzene is conducted under analogous conditions (~-70°), as phenyllithium is formed, a shift of the signal of the protons of the  $\alpha$ -CH<sub>2</sub> group of THF from 3.76 to 3.00-3.07 ppm is also observed. Raising the temperature to ~20° in the case of this stable compound naturally no longer leads to any significant change in the position of the signal, and only hydrolysis of the sample again shifts the signal to 3.57 ppm. These results permit us to conclude that phenyllithium, like FPL, forms complexes of the composition (PhLi)<sub>4</sub>(R<sub>2</sub>O)<sub>4</sub> with ethers, although direct cryoscopic determinations are impossible in this case on account of the poor solubility of the phenyllithium etherates in hydrocarbons.

Shifts of this kind for the signals of the protons of the  $\alpha$ -CH<sub>2</sub> groups of the ligands are also observed when the reactions of FBB with n-butyllithium are conducted in the presence of equimolar amounts of DEE

<sup>\*</sup>As has already been noted, from the data of cryoscopic measurements in accord with [5, 6] it follows that at low temperatures an equimolar mixture of n-butyllithium and THF is the tetraetherate of the tetramer,  $(BuLi)_4 THF_4$ .



Fig. 5. Changes in the signals of the protons of the  $\alpha$ -CH<sub>2</sub> groups of THF in the formation and decomposition of FPL: 1) -90° [signal of the initial (BuLi)<sub>4</sub> THF<sub>4</sub>]; 2) -80° (appear-ance of BuBr; 3) -80° (completion of the formation of FPL); 4) -50°; 5) -45°; 6) increase in the temperature from -45 to -40°; 7) -40°.

 $(-100 \text{ to } -65^{\circ})$ , as well as in analogous reactions of bromo- or iodobenzene in the presence of DEE and TEA  $(-70 \text{ to } 20^\circ)$ ; however, the changes in the spectra observed in this case are significantly smaller. Thus, the quartet of the protons of the  $\alpha$ -CH<sub>2</sub> groups of DEE is shifted from 3.47 to 3.07-3.17 ppm during the formation of phenyllithium or FPL, while the corresponding quartet in the spectrum of TEA is shifted from 2.42 to 2.17 ppm. In this case the position of the signals of the protons of the  $\alpha$ -CH<sub>2</sub> groups of the ligands associated with phenyllithium is practically unchanged within the interval from -70 to  $20^{\circ}$ . Consequently, the changes in the chemical shift of the protons of the  $\alpha$ -CH, groups of the ligand observed during the reaction are due to the nature of the OLC bonded to them, and complex formation with aromatic OLC leads to a significant strong-field shift of the signal. Evidently the cause of this is the influence of the magnetic anisotropy of the phenyl rings, and thus, the spectra of the ligands can give information on the mutual arrangement of the phenyl groups and ligands in the complex, i.e., on the geometrical structure of the latter.

As it follows from a consideration of volume models, in the tetramer of phenyllithium, constructed analogously to the tetramers of aliphatic OLC [6], there should be no free rotation of the phenyl groups around the axis of the tetrahedron formed by the lithium atoms (Fig. 6). An exact calculation of the chemical shift on the basis of the known data on the influence of the magnetic anisotropy of the benzene rings [13, 14] in such a complex system as the OLC etherates under consideration is extremely difficult. However, it is evident that the greatest influence of the magnetic anisotropy of the aromatic ring, manifested in the strong-field shift of the signal of the protons of the  $\alpha$ -CH<sub>2</sub> groups of the ligand, is achieved in the space enclosed between the phenyl groups in conformation A (Fig. 7).

According to the calculations (the position of the protons of the  $\alpha$ -CH<sub>2</sub> group relative to the phenyl rings was determined according to steric models of the Dreiding type), the change in the chemical shift  $(\Delta \delta)$  of the protons of phenyllithium or FPL tetrahydrofuranate due to the magnetic anisotropy of the benzene ring for conformation A at bond length Li-Li 2.56 Å, C-Li 2.31 Å [15], and Li-O 1.0, 1.5, 2.0, 2.5, or 3.0 Å, is -0.611, -0.590, -0.543, -0.412, or -0.250 ppm, respectively. The first of these values (1.0 Å), although evidently corresponding to too short an Li-O bond [16, 17], is in rather good agreement with the experimentally found difference of the values of the chemical shift of the protons of the  $\alpha$ -CH<sub>2</sub> groups of THF, contained in complexes with butyllithium and FPL ( $\Delta\delta$ -0.830 ppm). These calculated values are a maximum and pertain only to one of the possible conformations of the complex. As is shown by calculation, the rotation of one phenyl ring around the axis of the tetrahedron by 90°, i.e., transition from conformation A to conformation B (see Fig. 7), leads to a decrease in  $\Delta \delta$  at  $r_{Li-O} = 1.0$  Å from -0.611 to to -0.19 ppm. Consequently, even for distances  $r_{Li-O} = 1.0$  Å, evidently too small for a coordination bond, the structure considered cannot explain the experimental value of  $\Delta\delta$  (-0.830 ppm).

At the same time, satisfactory agreement of the calculated and experimental values of  $\Delta \delta$  is achieved for a model of the complex  $(RhLi)_4$ 

•  $(R_2O)_4$ , for which the oxygen atoms are arranged symmetrically about each of the ribs of the Li<sub>4</sub> tetrahedron, which corresponds to a three-center bond of each lithium atom with the two closest oxygen atoms (Fig. 8) and is evidently a consequence of the exchange reaction  $(RLi)_4(R_2'O)_4 \rightleftharpoons (RLi)_4(R_2'O)_3 + R_2'O$ . In the absence of free rotation of the phenyl groups and ligand molecules, the calculated values of  $\Delta\delta$  are close to the experimental values at  $r_{Li-O} = 2.1-2.2$  Å for the complex with THF and 2.4-2.5 Å for the complex with DEE, which agrees with the data on the stability of these etherates and the length of the other etherate bonds [16, 17]. It must be noted that in a tetrahedral molecule of such a complex, the Li—F distance is ~2Å, which is substant tally smaller than the monomer molecule and is practically equal to the interionic distance in the LiF crystal.Undoubtedly the closeness of these atoms is one of the causes of the lability of FPL.



Fig. 6. Structure of the complex  $(o - FC_6H_4Li \cdot THF)_4$  by analogy with the data of [6].

Fig. 7. Possible extreme conformations of the three phenyl groups of phenyllithium tetramer.



Fig. 8. Structure of tetrahydrofuranates of FPL and phenyllithium according to the data of PMR spectra (Ar  $= o-FC_6H_4$ ,  $C_6H_5$ ).

According to the data of DTA (see Fig. 3), the stability of FPL drops sharply when its mole ratio with  $R_2O$  is varied from 1:1 to 1:0.5. To determine the causes of this destabilization we studied the PMR spectra of mixtures of FBB with incomplete butyllithium etherates, containing <1 mole of  $R_2O$  per mole of BuLi (-100 to -50°). For comparison we also studied the spectra of the analogous stable systems PhBr + BuLi +  $nR_2O$  (n < 1, 20°). The latter, as was found, do not manifest any significant differences in the PMR spectra from the corresponding 1:1 complexes, and a decrease in the amount of ether leads only to an appreciable slowdown of the reaction of phenyllithium formation. On the contrary, in the spectra of a mixture of  $o-FC_6H_4Br + BuLi + 0.5$  THF, substantial differences from the analogous mixture at n = 1 were observed; at the temperature preceding the exothermic state (-100 to -70°), negligible amounts of FPL were registered in the aromatic portion of the spectrum, while when the temperature was increased to -55°, most of the FBB was converted directly to

stable reaction products. An analogous picture was also observed when the interaction of FBB was conducted with butyllithium in the presence of 0.25 equivalent of THF; however, in this case within the interval from -100 to  $-65^{\circ}$ , no formation of FPL was recorded at all, while at  $> -65^{\circ}$  the signal of the initial compound smoothly turned into the spectrum of a mixture of the final stable products. The same results were given by an investigation of this reaction in the presence of insufficient DEE (n = 0.5 and 0.25). Thus, incomplete etherates of FPL are not detected by the method of PMR spectroscopy in view of their instability, which is evidently associated with the coordination unsaturation of the lithium atoms and their closeness to the fluorine atoms in the tetrahedral complex.

The data obtained in this work permit us to assert that o-haloderivatives of phenyllithium, like other lithium aryls, are tetraetherates of tetramers  $(ArLi)_4(R_2O)_4$ , which are entirely coordination-saturated compounds, in ether media. This explains their relative thermal stability and permits us to assume that the decomposition of these compounds is due to thermal dissociation of the O-Li etherate bond.

$$4 \circ -FC_{6}H_{4}Br + (BuLi)_{4} (R_{2}O)_{4} \xrightarrow{} (\circ -FC_{6}H_{4}Li)_{4} (R_{2}O)_{4} \rightarrow$$

$$\rightarrow \left[ (\circ -FC_{6}H_{4}Li)_{3} (R_{2}O)_{3} \left( \circ -C_{6}H_{4} \xrightarrow{F} \bigcup_{Li \leftarrow \cdots \rightarrow O} R_{2} \right) \right] \rightarrow [C_{6}H_{4}] + [(\circ -FC_{6}H_{4}Li)_{3} (R_{2}O)_{3}] + LiF + R_{2}O$$

In the presence of a smaller amount of ether, insufficient for the formation of the tetraetherate, FPL is unstable and the reaction can proceed according to the scheme

$$o\text{-FC}_{6}\text{H}_{4}\text{Br} + (\text{BuLi})_{4}(\text{R}_{2}\text{O})_{2} \rightarrow (o\text{-FC}_{6}\text{H}_{4}\text{Li})(\text{BuLi})_{3}(\text{R}_{2}\text{O})_{2} \xrightarrow[\text{rapid}]{} [\text{C}_{6}\text{H}_{4}] + [(\text{BuLi})_{3}(\text{R}_{2}\text{O})_{2}] \xrightarrow[\text{rapid}]{} [\text{rapid}]{} [\text{C}_{6}\text{H}_{4}] + [(\text{BuLi})_{3}(\text{R}_{2}\text{O})_{2}] \xrightarrow[\text{rapid}]{} [\text{rapid}]{} [\text{rapid}]{$$

#### CONCLUSIONS

1. According to the data of the PMR spectra, low-temperature cryoscopy, and differential thermal analysis, o-fluorophenyllithium in the presence of no less than equivalent amounts of an ether in hydro-carbon solutions at temperatures from -100 to  $-40^{\circ}$  exists in the form of a tetrasolvated tetramer  $(o-FC_{6}H_{4}Li)_{4}(R_{2}O)_{4}$ .

2. The similarity of the PMR spectra of etherates of o-fluorophenyllithium and phenyllithium indicates that phenyllithium and probably other ArLi as well also form tetramer complexes of the  $(ArLi)_4L_4$ type in the presence of ethers or trialkylamines.

3. The steric structures of etherates of aromatic lithium compounds and the mechanism of the decomposition of o-fluorophenyllithium with the formation of dehydrobenzene were discussed.

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