[Contribution from the Chemical Laboratory of the University of Illinois]

STUDIES OF ORGANIC LEAD COMPOUNDS. IV. THE USE OF LITHIUM DERIVATIVES IN THE SYNTHESIS OF LEAD ARYLS. THE PREPARATION OF AMINO COMPOUNDS

By Paul R. Austin[1]

Received May 19, 1932 Published September 5, 1932

The synthesis of new types of organic lead compounds has seemed of importance due to the prevalent interest in their therapeutic value. No derivatives containing acid or basic groups have been known up to the present time and this paper describes the preparation of a series of compounds containing a tertiary amino group.

The similarity in the reactions of the Grignard reagent and lithium aryls suggested that the latter might be useful in the synthesis of other organometallic compounds, especially since lithium derivatives of unusual types may be prepared. It has been shown[2] that mercuric chloride reacts readily with benzyllithium to form dibenzylmercury and in preliminary studies it was found that di-*p*-tolylmercury and tetra-*p*-tolyltin could be easily prepared from *p*-tolyllithium and the corresponding metallic halides.

$$2RLi + HgCl_2 \longrightarrow R_2Hg + 2LiCl \qquad (I)$$
$$4RLi + SnCl_4 \longrightarrow R_4Sn + 4LiCl \qquad (II)$$

With lead chloride the lithium aryls apparently react in a manner analogous to the Grignard reagent.

$$PbCl_2 + 2RLi \longrightarrow R_2Pb + 2LiCl \qquad (III)$$
$$3R_2Pb \xrightarrow{(heat)} 2R_3Pb + Pb$$
$$4R_3Pb \xrightarrow{(heat)} 3R_4Pb + Pb$$

Lead chloride and phenyllithium gave a mixture of tetraphenyllead and triphenyllead when the reaction mixture was not heated long enough to complete the conversion of triphenyllead to the tetravalent compound.

The action of lithium aryls on organic lead salts was next investigated and under suitable conditions replacement of the halogen atom was effected.

$$R_3PbCl + R'Li \longrightarrow R_3R'Pb + LiCl \qquad (IV)$$
$$R_2PbCl_2 + 2R'Li \longrightarrow R_2PbR'_2 + 2LiCl \qquad (V)$$

It was necessary to use equimolecular proportions of the two reactants, since an excess of lithium aryl replaced the aryl groups already attached to lead. Triphenyllead chloride or diphenyllead dichloride treated with the calculated amount of *p*-tolyllithium gave triphenyl-*p*-tolyllead and diphenyldi-*p*-tolyllead. When triphenyllead chloride was heated with an excess of *p*-tolyllithium a small amount of the expected triphenyl-*p*-tolyllead was formed and, in addition, some tetra-*p*-tolyllead was isolated from

---

[1] National Research Fellow in Chemistry.

[2] Ziegler, *Ber.*, **64**, 445 (1931).

the mixture of reaction products. This must have come from the replacement of phenyl groups by tolyl. An attempt to use this reaction to prepare tetra-*p*-tolyllead from tetraethyllead and *p*-tolyllithium gave only di-*p*-tolyl; no tolyllead derivative could be isolated.

For the synthesis of the amino compounds, *p*-dimethylaminophenyllithium, $(CH_3)_2NC_6H_4Li$, was prepared from *p*-bromodimethylaniline. Unlike the Grignard reagent from this bromide,[3] the lithium derivative could be prepared easily and smoothly in good yields. This reagent readily yielded the known *p*-mercuribisdimethylaniline, $[(CH_3)_2NC_6H_4]_2Hg$, when treated with mercuric chloride. By using the required reactant, tetra-(*p*-dimethylaminophenyl)-lead, $[(CH_3)_2NC_6H_4]_4Pb$, triphenyl (*p*-dimethylaminophenyl) - lead, $(C_6H_5)_3PbC_6H_4N(CH_3)_2$, diphenyldi - (*p* - dimethylaminophenyl) - lead, $(C_6H_5)_2Pb[C_6H_4N(CH_3)_2]_2$, and tetra - (*p* - dimethylaminophenyl)-tin, $[(CH_3)_2NC_6H_4]_4Sn$, were prepared. These amino compounds were found to be well-characterized solids with definite melting points and were easily recrystallized from appropriate solvents.

The importance of the nature of the solvent used in the preparation of the amino derivatives was demonstrated when it was found that diphenyllead dichloride or triphenyllead chloride and *p*-dimethylaminophenyllithium did not give the expected products when benzene was used as a solvent, but reacted satisfactorily when a large proportion of ether was present.

The amino compounds, particularly the unsymmetrical ones, were rather sensitive to acids; one or more of the metal–carbon linkages were easily ruptured. In the case of triphenyl-(*p*-dimethylaminophenyl)-lead, acetic acid caused the severing of the dimethylaminophenyl group and the formation of triphenyllead acetate. Tetra-(*p*-dimethylaminophenyl)-tin and -lead dissolved in tenth normal nitric acid were stable for a short time, since they could be reprecipitated by alkali unchanged after about one-half hour. Longer standing in the acid solution caused the gradual decomposition of the compounds.

The lithium derivatives were all easily prepared in much the same manner as the Grignard reagent. Details of the preparation of lithium phenyl have recently been described.[4]

Experimental Part

Preparation of Lithium Aryls.—Fine shavings of lithium were placed in absolute ether and stirred vigorously during the addition of the aryl bromide in ether. To start the reaction a little of the bromide was added and the mixture was heated for a few minutes. The bromide was then added at a rate sufficient to keep the ether refluxing gently. After the addition of the bromide the mixture was refluxed for one-half hour to complete the reaction and the solution was filtered into a graduated separatory funnel. Portions of such a stock solution were then used in subsequent reactions. The solutions, which were from 0.5 to 1.0 molar, were titrated to determine the content of lithium aryl,

---

[3] Ehrlich and Sachs, *Ber.*, **36**, 4297 (1903).

[4] Gilman, Zoellner and Selby, THIS JOURNAL, **54**, 1957 (1932).

using the procedure described for the Grignard reagent.[5] Yields of about 90% were obtained. *p*-Lithiumdimethylaniline gave colored solutions which obscured the usual end-point, but by titrating directly with acid in the presence of phenolphthalein, a change from red to green could be observed quite satisfactorily. It was advantageous to carry out this titration in alcohol.

Preparation of Organo-metallic Compounds from Lithium Aryls.—For the preparation of entirely symmetrical compounds (equations I, II and III) an excess of lithium aryl was used. For the replacement of halogen in organo-metallic salts to prepare unsymmetrical compounds (equations IV and V) equimolecular quantities were used. All the reactions (except III) were practically instantaneous and were usually carried out in the cold. When the reactions were complete, the mixture was decomposed with water, the ether layer separated and evaporated and the residue purified by recrystallization from the appropriate solvent.

Table I gives a summary of the compounds prepared by this procedure. The Roman numerals correspond to the equation followed in the preparation and the reactant was the metallic or organo-metallic halide employed on which the yield was based. The yield of product given was usually once-crystallized material. The nitrogen analyses were carried out by Mr. K. W. Eder in this Laboratory using the micro-Dumas method.

TABLE I

ORGANO-METALLIC COMPOUNDS PREPARED FROM LITHIUM ARYLS AND METALLIC HALIDES

Equation	Compound	Reactant, g.	Yield g.	Yield %	M. p., °C.	Previously recorded m. p., °C.	Analyses, % Metal Calcd.	Analyses, % Metal Found	Analyses, % Nitrogen Calcd.	Analyses, % Nitrogen Found
I	$(p\text{-}CH_3C_6H_4)_2Hg$	2.7	3.4	89	237–238	238[a]				
I	$[p\text{-}(CH_3)_2NC_6H_4]_2Hg$	4.0	0.8	12	167–169	169[b]				
III	$(C_6H_5)_4Pb$	7.0	2.5	48	223–225	225[c]				
IV	$(C_6H_5)_3Pb(p\text{-}C_6H_4CH_3)$	1.3	0.6	41	124–125	125.5[d]				
V	$(C_6H_5)_2Pb[p\text{-}C_6H_4CH_3]_2$	4.3	1.9	38	121–122	[e]	38.13	38.18		
III	$[p\text{-}(CH_3)_2NC_6H_4]_4Pb$	2.8	0.6	17	197–198	[f]	30.14	29.97	8.15	8.26
IV	$(C_6H_5)_3Pb[p\text{-}C_6H_4N(CH_3)_2]$	4.7	4.3	77	124–125	[g]	37.11	37.26	2.51	2.65
V	$(C_6H_5)_2Pb[C_6H_4N(CH_3)_2]_2$	4.3	1.0	16	134–135	[h]	34.44	34.32	4.65	4.91
II	$(p\text{-}CH_3C_6H_4)_4Sn$	1.3	2.2	91	233	233.5[i]				
II	$[p\text{-}(CH_3)_2NC_6H_4]_4Sn$	2.6	2.9	58	198–199	[j]	19.82	20.17	9.35	9.24

[a] Zeiser, *Ber.*, **28**, 1670 (1895). The mercuric chloride was dissolved in 100 cc. of ether and the *p*-tolyllithium added in the cold. The product was recrystallized from benzene.

[b] Schenk and Michaelis, *ibid.*, **21**, 1501 (1888). In this preparation the mercuric chloride in ether was added to the lithium derivative and the mixture refluxed for one hour. For purification the product was recrystallized repeatedly from benzene. The yield was based on pure product.

[c] Gilman and Robinson, THIS JOURNAL, **49**, 2317 (1927). The lithium phenyl and lead chloride in 100 cc. of ether and 150 cc. of benzene were refluxed for four hours. Besides the tetraphenyllead there was obtained 1.8 g. of a mixture of triphenyllead and tetraphenyllead. It blackened at about 150° and melted at 216–220°. Triphenyllead decomposes at 155° with the deposition of lead [Krause and Reissaus, *Ber.*, **55B**, 888 (1922)].

[d] Krause and Schmitz, *ibid.*, **52**, 2153 (1919). The triphenyllead chloride in 50 cc. of benzene was treated in the cold with *p*-tolyllithium. The product was recrystallized from alcohol. In another experiment 5.6 g. of triphenyllead chloride was added to a large excess of *p*-tolyllithium and refluxed for two hours. The product was fractionated

---

[5] Gilman, Wilkinson, Fishel and Meyers, THIS JOURNAL, **45**, 150 (1923).

from benzene–alcohol mixture and the most soluble fraction (0.4 g.) was recrystallized from alcohol; it melted at 124–126° and was therefore triphenyl-*p*-tolyllead. The least soluble fraction (1.3 g.) was recrystallized repeatedly from alcohol–benzene or acetone–benzene mixture and melted at 236–237°. A mixed melting point with an authentic specimen of tetra-*p*-tolyllead showed no depression.

[e] The diphenyllead dichloride was suspended in 50 cc. of benzene and 50 cc. of ether and stirred vigorously during the slow addition of the *p*-tolyllithium. The product was recrystallized from alcohol.

[f] The lead chloride was added to an excess of the lithium derivative in 100 cc. of ether and 150 cc. of benzene and then refluxed for eight hours. The product was recrystallized from a ligroin–benzene or alcohol–benzene mixture which gave cream-colored needles.

[g] The triphenyllead chloride in 100 cc. of benzene and 50 cc. of ether was heated to boiling and then treated with the lithium derivative. The product was recrystallized from alcohol–benzene mixture or from ligroin, which gave a white crystalline powder. When the triphenyllead chloride was dissolved in benzene alone the expected product was not obtained.

[h] The diphenyllead dichloride was suspended in 150 cc. of ether and stirred vigorously and the lithium derivative added dropwise. The product was recrystallized from alcohol–benzene mixture and gave a white crystalline powder. When benzene was used as the solvent the only product was a tarry material.

[i] Krause and Becker, *Ber.*, **53**, 178 (1920). The stannic chloride in 25 cc. of benzene was added to the vigorously stirred solution of *p*-tolyllithium. The tetra-*p*-tolyltin was recrystallized from benzene.

[j] This compound was prepared as described for tetra-*p*-tolyltin and was recrystallized from an alcohol–benzene mixture which gave light brown needles.

Triphenyl-(*p*-dimethylaminophenyl)-lead and Acetic Acid.—Five-tenths of a gram of the lead compound in absolute alcohol was treated with the calculated amount of acetic acid in petroleum ether to form the salt. However, there was isolated only 0.1 g. of original material and 0.1 g. of triphenyllead acetate, m. p. 206–207°. A mixed melting point with an authentic specimen of triphenyllead acetate[6] showed the two substances to be identical.

Tetraethyllead and *p*-Tolyllithium.—An excess of *p*-tolyllithium and 3.2 g. of tetraethyllead in 70 cc. of benzene and 50 cc. of ether were refluxed for eight hours. The product on standing gave a crystalline material in oil. This was filtered and gave 0.2 g. of what was shown to be di-*p*-tolyl. After recrystallization from alcohol it melted at 118–119° and a mixed melting point with an authentic specimen showed no depression. The oily product was not investigated.

The author wishes to express his appreciation to Professor C. S. Marvel for many helpful suggestions.

Summary

Lithium derivatives have been shown to be generally applicable to the preparation of organic compounds of mercury, tin and lead.

p-Bromodimethylaniline readily yields a lithium derivative which has been used in the synthesis of a series of compounds containing the dimethylaminophenyl group.

URBANA, ILLINOIS

---

[6] Austin, THIS JOURNAL, **53**, 3517 (1931).