A Novel Regiospecific Aryl Ketone Synthesis by the Reaction of Arylborate Anions with Acyl Chlorides

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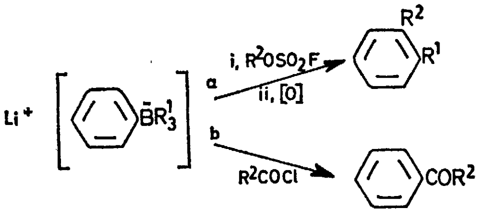
Summary The reaction of acyl halides with lithium aryltrialkylborates, readily obtainable by mixing aryllithium compounds with trialkylboranes, produces the corresponding aryl ketones in high yields.

WE have recently reported that various aryltrialkylborate complexes undergo a unique double substitution[1] as in Scheme 1 (route a). We have now found that, in marked contrast to this alkylation, aryltrialkylborate anions react with acyl halides to produce cleanly single substitution products, *i.e.*, aryl ketones (Scheme 1, b). It should be noted that alkynylborate anions[2] undergo acylation predominantly at the β- rather than the α-carbon atom.



SCHEME 1

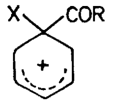
Significantly, carbinol formation has not been observed in the acylation of arylborate anions. Since the reaction of aryl-lithium compounds with acyl halides yields predominantly the corresponding carbinols, aryltrialkylborate anions themselves, rather than the dissociated aryllithium compounds, must be the reacting species. These results parallel those observed recently in the reaction of tetraalkylborate anions with acyl halides[3], suggesting that the intermediacy of a carbocation (**1**), as in the Friedel–Crafts acylation[4] ($X = H$), is not necessarily required in the reaction reported here ($X = R^1{}_3B^-$).

TABLE[a]

Expt.	R^1 in aryl bromide R^1Br	R^2 in acyl chloride, R^2COCl	Yield (%) of R^1COR_2 isolated (g.l.c.)
1	Ph	Ph	80 (85)
2	Ph	4-CNC_6H_4	70
3	Ph	Me	75
4	3-MeC_6H_4	2-MeC_6H_4	50 (65)
5	3-MeC_6H_4	4-CNC_6H_4	68[b] (78)
6	2-MeOC_6H_4	Ph	75
7	3-ClC_6H_4	3-FC_6H_4	68[c]
8	4-BrC_6H_4	Ph	54 (64)
9	$3\text{-CF}_3C_6H_4$	Me	62
10	1-Naphthyl	Ph	— (80)

[a] All products gave satisfactory spectral data and new products (expts. 5 and 7) gave satisfactory elemental analyses. [b] M.p. 123·5—124·5 °C. [c] M.p. 63·5—64 °C.

The acylation of arylborate anions has advantages over the Friedel–Crafts acylation. First, the single substitution takes place on the carbon atom bonded to the boron atom. Thus, no regiochemical ambiguity exists, and various substituents can be accommodated in predetermined positions, as in (**2**). Second, the aromatic ring may even contain deactivating groups, as in (**3**). Unlike the reaction of organolithium compounds with organic cyanides, the reaction reported here proceeds satisfactorily with acyl halides containing functional groups that are sensitive to nucleophiles, such as F and CN, as in (**2**) and (**3**).



(1)

X = H or $R^1_3B^-$

m-$\text{MeC}_6\text{H}_4\text{COC}_6\text{H}_4\text{CN}$-$p$

(2)

m-$\text{ClC}_6\text{H}_4\text{COC}_6\text{H}_4\text{F}$-$m$

(3)

We have examined the generality of the reaction for the synthesis of diaryl ketones (Table), although the reaction also takes place conveniently with aliphatic acyl halides (expts. 3 and 9). The required aryl-lithium compounds can most conveniently be obtained by halogen–methyl exchange of aryl bromides and n-butyl-lithium, $\text{Bu}^{\text{n}}\text{Br}$ by-product having no effect on the subsequent steps. The acylation generally proceeds well in benzene which is better than either hexane or tetrahydrofuran although minor amounts of these solvents can be tolerated. As the non-participating ('dummy') group on boron, secondary alkyl groups, such as cyclopentyl and norbornyl, are clearly better than primary alkyl groups, such as Bu^{n} producing cleaner products in higher yields. The procedure for the preparation of (**2**) (Scheme 2) is representative.

$$m\text{-MeC}_6\text{H}_4\text{Br} \xrightarrow[\text{ii}]{\text{i,}} m\text{-MeC}_6\text{H}_4\bar{\text{B}}(\text{Nbn})_3 \xrightarrow[\text{iv}]{\text{iii,}} (\mathbf{2})$$

Nbn = norbornyl

SCHEME 2. Reagents: i, LiBu^{n}(hexane)–Et_2O at 0—25 °C for 1—2 h; ii, B(Nbn)_3 in tetrahydrofuran at 25 °C for 1 h; iii, p-$\text{NC}\cdot\text{C}_6\text{H}_4\cdot\text{COCl}$ in C_6H_6 at 0—25 °C overnight; iv, NaOAc–H_2O_2 at 30—40 then 50 °C for 1 h.

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