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C- VS. O- ALKYLATION. DIRECTIVE EFFECTS

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Recent interest[1] in the alkylation of ambident anions has led us to consider the dianion of benzophenone[2] as a model system for C- vs. O- alkylation studies. The reaction in liquid ammonia of this dianion intermediate has been studied with a wide range of electrophiles[3]. Hitherto, exclusive attack at carbon has been reported[3]. We now wish to report that alkylation of benzophenone dianion can be directed by the nature of the leaving group. Exclusively C[3]-, exclusively O- or combined C- and O-alkylation may be obtained. Furthermore, we have noticed a correlation between hardness[4] of the leaving group and the ''O : C'' alkylation ratio.

The benzophenone dianion was prepared in liquid ammonia by the addition of two equivalents of alkali metal to a solution of benzophenone[3c] in redistilled ammonia[5]. One equivalent of methylating agent in ether was then added after one hour. Normal work-up procedures were followed by v.p.c. analysis in which comparison was made with authentic samples. Diphenylmethyl carbinol[6] was prepared via the Grignard reaction; benzhydryl methyl ether by the method of Farinacci and Hammett;[7] and 1, 1-diphenylethyl methyl ether by the alkylation of the corresponding potassium alkoxide with methyl iodide in liquid ammonia. These structures were confirmed by microanalysis, i.r. spectra, and comparison of their physical properties with the literature values.

The effects of the alkali metal and the leaving group are outlined in the Table. These leaving groups were chosen since their relative order of hardness is known[8] to be $I < Br < SO_4 < OSO_2C_6H_4CH_3$ - p. The oxide site is harder than the carbanion site in the benzophenone dianion[8]. Hence it might be expected that the ''O : C'' ratio would increase in the order $I < Br < SO_4 < OSO_2C_6H_4CH_3$ -p. This expectation was borne out when the

Table

Leaving Group	Metal	% Yield of[a, b] Alkylation Product	Monoalkyl product		Dialkyl product	Ratio[e]
			% ''O''[c,d]	% ''C''	% ''OC''	''O : C''
Br	K	85	3.5	84.7	11.7	1 : 6.4
Br	Na	84	10.7	78.5	10.7	1 : 4.2
Br	Li	1	> 99	< 1	< 1	1 : 0.01
I	K	55	13.5	75.3	11.1	1 : 3.4
I	Na	74	6.7	87.8	5.4	1 : 7.7
I	Li	< 1	> 99	< 1	< 1	1 : 0.01
SO_4	K	58	8.1	60.6	31.2	1 : 2.4
SO_4	Na	73	17.8	71.2	10.9	1 : 2.7
SO_4	Li	1	> 99	< 1	< 1	1 : 0.01
$SO_3C_6H_4CH_3$-p	K	14	100	0	0	100 : 0
$SO_3C_6H_4CH_3$-p	Na	36	100	0	0	100 : 0
$SO_3C_6H_4CH_3$-p	Li	3	100	0	0	100 : 0

[a] High material balance obtained when recovered benzophenone and benzhydrol included. [b] The decreasing yield with increasing reactivity of the methyl substrate is due to the increasingly facile ammonolysis of the methylating agent[9]. [c] Relative yields, [d] v.p.c. analysis on Aerograph A350-B, linear temperature programmed at 10°/min. from 140-270°C, on a 5'x $^{1}/_{4}$'' column packed with 10% versamid 900 Chrom. W with 50ml/min. H_2 flow. [e] Inclusive of ''CO'' product.

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disodium salt of benzophenone was used. However, the order of increasing ''O : C'' ratio changed to Br < I < SO_4 < $OSO_2C_6H_4CH_3$ - p when the dipotassium intermediate was methylated. As yet this result is not clearly understood. The alkylation results of dilithio-benzophenone, included for comparison, do not give a meaningful ''O : C'' ratio. The dilithio- adduct probably undergoes a fast, virtually irreversible ammonolysis reaction[10] (I):

$(C_6H_5)_2\ CLiOLi + NH_3 \rightleftharpoons (C_6H_5)_2\ CHOLi + LiNH_2 \quad (I)$

This is indicated by (a) the results of methylation and (b) the disappearance of the characteristic blue colour of the adduct following the addition of a small quantity of methylating agent. Further, we found that lithium diphenylmethoxide formed by the interaction of lithium amide and benzhydrol in liquid ammonia, reacted with methylating agents in very low yield (1.4%). It is probable that the oxygen to lithium bond has a low dissociation constant.[11] This effect accentuated by the low temperature (-33°), would be expected to reduce the basicity of the oxygen anion site considerably[11]. Finally, exclusive O- methylation occurred when methyl tosylate was used. To our knowledge this is the first record of such a result in enolate or C-O dianion chemistry. The alkyl group effect[1c] on the ''O : C'' ratio is at present under investigation in this laboratory.

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