Tetrahedron Letters No.51, pp. 6405-6408, 1966. Pergamon Press Ltd.
Printed in Great Britain.

THE ELIMINATION OF CARBON MONOXIDE FROM ACID CHLORIDES. A NEW METHOD FOR CHLOROMETHYL ETHER FORMATION.

M.H. Palmer and G.J. McVie
Department of Chemistry, University of Edinburgh

(Received 19 September 1966)

WHEN α- substituted acyl halides are subjected to Friedel - Crafts acylation conditions, the loss of carbon monoxide is frequently observed (1); thus acylation may be accompanied by or replaced by alkylation or olefin formation (2). These reactions have been rationalised in terms of unimolecular decomposition of the acylium complex to a carbonium ion complex and carbon monoxide, from which the final products are subsequently formed. The loss of carbon monoxide is probably an S_N1 type of process since the phenomenon is largely restricted to aliphatic ($R_3C\text{-}CO^+$) and aryl substituted ($Ar_2CH\text{-}CO^+$) secondary centres (3).

We now wish to report a series of decarbonylation reactions at a primary centre under Friedel - Crafts conditions, where the initial product is unable to undergo alkylation reactions or olefin formation. Phenoxyacetyl chlorides having -E-M groups in the 2- or 4- positions react with aluminium chloride in refluxing carbon disulphide with the evolution of carbon monoxide. The procedure used for the identification of the reaction products was standardised and is outlined in the following example using 5-methyl-2-nitrophenoxyacetyl chloride.

After a three hour reaction period hydrolysis of the reaction mixture with dilute hydrochloric acid, and subsequent extraction of the organic layer with aqueous sodium carbonate, yielded a neutral fraction. The infrared spectrum of this showed no carbonyl absorption, while its p.m.r. spectrum showed the presence of the 1,2,4-tri-substituted aromatic ring and a singlet (2 protons) at 4.15 τ (the aryloxyacetic acid absorbed at 5.15 τ). The product (m.pt. 59-60°) contained chlorine and vapour pressure osmometry gave a molecular weight of 195 consistent with it being 5-methyl-2-nitrophenoxymethyl chloride. The identification was completed by conversion to the ester by heating with sodium 4-nitrobenzoate (4).

All the chloromethyl ethers ($RC_6H_4OCH_2Cl$) prepared (see Table) showed a characteristic singlet at about 4 τ. The 2- and 4- nitro- compounds obtained were identical with the materials prepared by the interaction of the sodium aryloxymethanesulphonate and phosphorus pentachloride (4,5). In most cases the 4-nitrobenzoate esters were prepared (and all gave satisfactory analyses): exceptions were the 2,4-dinitro- and 4-chloro-2,6-dinitro- compounds which were unreactive to the conditions tried; these chloromethyl ethers gave satisfactory analyses.

Optimum yields of the chloromethyl ethers from the acid chlorides have not been sought, but the quantities formed after three hours at 50° in carbon disulphide are shown in the table. The yields are those calculated by qualitative p.m.r. spectroscopy using weighed amounts of

TABLE

Chloromethyl Ethers Prepared by Decarbonylation of Aryloxyacetyl Chlorides

Acid Chloride (I) R	Aryloxymethyl Chloride Yield %[a]	m.pt or b.pt.	(CH_2) τ	p-Nitrobenzoate Ester m.p.
4-NO_2	65	170-5°/15m.m.	4.00[b]	126°
2-NO_2	70	156-8°/15m.m.	4.05[b]	125°
2-NO_2,5-Me	25	59-60°	4.05[c]	117°
2-NO_2,3-Me	20	162-3°/15m.m.	4.15[b]	143°
3-NO_2	5[d]	-	4.05[c]	-
4-CN	24	164-8°/24m.m.	4.05[e]	114°
2-CN	27	150-4°/10m.m.	4.05[c]	119°
2-(p-$MeC_6H_4SO_2$)	1[d]	-	4.25[c]	-
4-(p-$MeC_6H_4SO_2$)	29	108°	4.15[c]	148°
2,4-$(NO_2)_2$	63	64°	3.95[e]	-[f]
2,6-$(NO_2)_2$,4-Cl	58	58°	4.10[c]	-[f]

a. From equimolecular quantities of acid chloride and $AlCl_3$ in CS_2 at 50° for 3 hours.

b. In CCl_4

c. In $CDCl_3$

d. No material isolated, but identified in reaction product by p.m.r. spectroscopy.

e. In $CCl_4/CDCl_3$

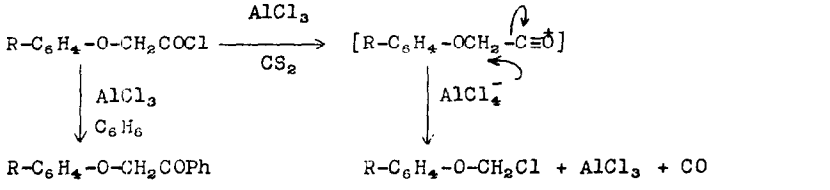
f. These compounds did not form 4-nitrobenzoate esters (see text).

dibromoethane as the calibrating compound; the amounts isolated by crystallisation were generally rather less. The best alternative solvent to CS_2, so far found, is dichloroethane (also at 50°) or nitromethane (at 20°). At higher temperatures, particularly in the more polar solvents

tars were obtained. When benzene was used as solvent in a reaction using 3-methyl-2-nitrophenoxyacetyl chloride, the product was the corresponding aryloxyacetophenone (c.f.3). Hexafluorobenzene is a satisfactory solvent for these reactions, but the (qualitative) rate is slower than in carbon disulphide.

More than one mole of aluminium chloride is disadvantageous to chloromethyl ether formation, while the reaction did not proceed in the presence of stannic chloride at 50°.

Attempts to prepare the chloromethyl ether by a similar reaction on 2,4-dinitrophenoxyisobutyroyl chloride have been unsuccessful. This is surprising in view of the many decarbonylations at a tertiary centre, and suggests that the S_N1 process does not occur in the formation of chloromethyl ethers. Nucleophilic attack by chloride or tetrachloroaluminate ions on the acylium ion, in an S_N2 process seems more reasonable.



REFERENCES

1. E. Rothstein, M.A. Saboor, J.Chem.Soc., 1943, 425

2. E. Rothstein, W.G. Schofield, J.Chem.Soc., 1965, 4566

3. M.E. Grundy, Wei-Hwa Hsü, E. Rothstein, J.Chem.Soc., 1960, 372.

4. H.J. Barber, R.F. Fuller, M.B. Green, H.T. Zwartouw, J.appl.Chem., 1953, 3, 266.

5. H.J. Barber, H.J. Cottrell, M.B. Green, J.appl.Chem., 1953, 3, 259.