Tetrahedron Letters No.59, pp. 5189-5191, 1969. Pergamon Press. Printed in Great Britain.

SYNTHESIS OF UNSYMMETRICAL KETONES BY THE USE OF LITHIUM ACYLTETRACARBONYLFERRATES

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(Received in Japan 31 October 1969; received in UK for publication 25 November 1969)

Aryl- and alkyllithiums react with some mononuclear metal (nickel and iron) carbonyls at low temperature to give unstable lithium acylcarbonylmetallates, which have been found to be useful for various organic syntheses because of the instability, the carbon-metal σ-bond and the nucleophilic property$^{1,2,3,4)}$.

These unstable metal complexes appear to serve as an effective reagent in the formation of a carbon-carbon bond by the nucleophilic displacement at a carbon-halogen bond in an organic halide: Lithium p-toluyltricarbonylnickelate reacts with benzyl chloride to form α-benzyl-p-toluoin, though the reaction with some other alkyl halides such as ethyl bromide and methyl chloride failed to yield detectable amounts of the products formed by the nucleophilic displacement. Acid halides also undergo the displacement at a carbon-halogen bond with acyltricarbonylnickelates to give en-diol-diesters$^{3)}$.

We now wish to report* the reaction of lithium acyltetracarbonylferrates with organic halides, which will provide a new synthetic rout to unsymmetrical ketones. The results are summarised in Table I.

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* When we were preparing this paper, Corey and Hegedus reported that lithium acyltricarbonylnickelates react with α,β-unsaturated carbonyl compounds to give 1,4-dicarbonyl derivatives in excellent yields. J. Amer. Chem. Soc., 91, 4926 (1969).

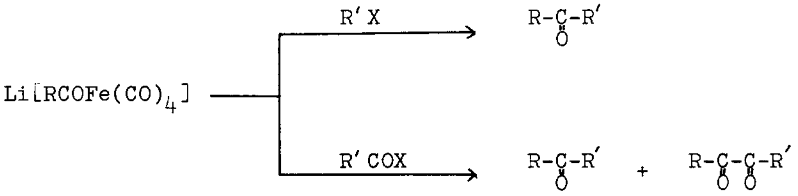

Table I

R	R'X or R'COX	Product*	%, Yield**
C_6H_5	$C_6H_5CH_2Br$	$C_6H_5COCH_2C_6H_5$	57
C_6H_5	C_6H_5COCl	$C_6H_5COC_6H_5$	22[a)]
C_6H_5	CH_3COCl	$C_6H_5COCH_3$	37[b)]
$p-CH_3C_6H_4$	$C_6H_5CH_2Br$	$p-CH_3C_6H_4COCH_2C_6H_5$	67
$p-CH_3C_6H_4$	C_6H_5COCl	$p-CH_3C_6H_4COC_6H_5$	21[c)]
$n-C_4H_9$	$C_6H_5CH_2I$	$n-C_4H_9COCH_2C_6H_5$	50[d)]
$n-C_4H_9$	C_6H_5COCl	$n-C_4H_9COC_6H_5$	36[d)]

* Products were identified by infrared spectra, elemental analyses and mixed melting point measurements.

** Yields refer to purified product, isolated by crystallization or column chromatography after distillation.

a) Benzil was given in 10% yield as a by-product.

b) Acetylbenzoyl was given in a trace amount as a by-product.

c) 4-Methylbenzil was given in 2% as a by-product.

d) The product was identified by infrared and nuclear magnetic resonance spectrum, elemental analysis, and moleclar weight measurement. The yield was determined by vapor phase chromatography.

Contrary to the behavior of nickel complexes, the acyltetracarbonylferrates give mainly unsymmetrical ketones. The tendency for the reactivity of organic halides is somewhat similar to that observed in the case of nickel complexes: Any unsymmetrical ketone could not be isolated from the reactions with ethyl bromide, bromobenzene and with 1,2-dibromoethane. When acid halides were used instead of alkyl halides, unsymmetrical ketones were formed and α-diketones as by-products. The yields are not so good at present, but we think that they will become higher if the reaction is carried out under more suitable reaction conditions.

All experiments shown in Table I were carried out under a dry argon atmosphere. The typical procedure employed is shown in the synthesis of benzyl phenyl ketone, as follows: To an ether solution of phenyllithium prepared from bromobenzene (0.05 mol, 7.9 g) and lithium (1 g), was slowly added with stirring and keeping the temperature at -40° a solution of iron pentacarbonyl (0.05 mol, 9.8 g) in 50 ml of ether. After stirring the mixture for 3 hr, benzyl bromide (0.05 mol, 8.6 g) in 30 ml of ether was added and the mixture was allowed to react at -40° for 2 hr. After 50 ml of benzene has been added, the stirred mixture was slowly warmed up to 50° and quenched by addition of 50 ml of 4-N hydrochloric acid. The organic layer separated from the resulting mixture was washed with 50 ml of saturated sodium bicarbonate solution, then with 50 ml of water saturated with sodium chloride, and dried over anhydrous magnesium sulfate. After removal of the solvent and iron pentacarbonyl, the residual oil was distilled. The fraction boiled at 145~150° (2.5 mm Hg) was recrystallized from petroleum benzine (b.p. 65~80°) to give 4.6 g (57%) of white crystals of benzyl phenyl ketone, m.p. and mixed m.p. 56~57°. This structure was further confirmed by comparison of the infrared spectrum with that of an authentic sample.

Work is continuing on the mechanistic aspect of the reaction of aroyl- or acylcarbonylmetallates (nickel and iron) and further synthetic applications of these complexes.

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